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The impact of smoking on finger dexterity and dual-task activities in elderly adults: a cross-sectional study

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Abstract

Introduction. Extensive research has focused on the cardiovascular, pulmonary, and cancer-related health consequences of smoking. However, there is a lack of specific investigations into the consequences of prolonged smoking on human neurocognition and neurobiology, particularly related to finger dexterity and dual-tasking abilities in elderly individuals. Understanding the impact of smoking on dual-tasking conditions and finger dexterity can provide valuable insights into potential cognitive decline and impairment in daily activities among elderly smokers.

Methods. This study recruited 40 subjects based on inclusion and exclusion criteria by convenience sampling of an old age home in Delhi. Participants were divided into elderly smokers (group 1) and non-smokers (group 2) by self-reported smoking status and the results of a Fagerstrom Test for Nicotine Dependence (FTND) questionnaire. Both groups performed dual-task finger dexterity using the nine-hole peg board (9HPT) and were assessed for task speed and activities of daily living (ADL). ADL was assessed using the Katz Index of Independence in ADL (KATZ). Data were analysed to detect differences between the groups.

Results. The study findings indicated a statistically significant difference between group 1 and group 2 in the 9HPT ($p < 0.05$). There were statistically significant differences between group 1 and group 2 in dual-task cognitive 9HPT (C9HPT) and motor 9HPT (M9HPT) tests ($p < 0.05$). However, analysis using the KATZ found between-group differences.

Conclusions. Smoking had a negative impact on dual-task finger dexterity, potentially due to its effects on neurocognition and neurobiology.

Key words: elderly, activities of daily living, cognition, rehabilitation, sedentary lifestyle

Introduction

The elderly stage of life represents the final period in the cycle of human existence. As people grow older, their physiological functions decrease due to the deteriorative processes of ageing [1]. The progression of ageing increases the vulnerability of elderly individuals to various health risks [2], with diminishing tissue capacity resulting in setbacks in bodily functions, including decreased memory, cognitive health decline, and reduced physiological capacity [3–5]. Lifestyle factors, including smoking, insufficient physical activity, and the intake of unhealthy foods, play a substantial role in the development of numerous diseases. Significantly, engaging in smoking is a behaviour that significantly affects health [6].

India, with approximately 120 million smokers, is home to 12 % of the world's smoking population, according to the World Health Organization (WHO). According to the WHO Report on the Global Tobacco Epidemic, the prevalence of cigarette smoking among elderly adults (aged 65 years and older) was 9.7% in India in 2023. Alarmingly, more than one million people in India succumb to tobacco-related illnesses each year [7]. As a result, cigarette smoking is recognised as the primary preventable cause of mortality in contemporary society, representing the most critical public health concern of our era [8]. Cigarette smoke contains over 7,000 chemicals, exposing smokers to a toxic mixture that can damage nearly every organ in the body [9, 10]. Persistent smoking during middle and late adulthood has been connected to the early onset and swift advancement of chronic diseases [11–13], diminishing the ability to perform daily activities and compromising postural stability in older adults [14, 15].

Recent research suggests that persistent cigarette smoking is correlated with impairments in auditory-verbal learning, memory, general intellectual capacity, processing speed, cognitive flexibility, executive functions, and overall cognitive performance. Additionally, smoking might elevate the likelihood of developing vascular dementia and Alzheimer's disease [16–21].

Cigarette combustion generates highly reactive oxygen species, which have the potential to induce oxidative stress, initiate a robust inflammatory response, and contribute to the initiation or advancement of diverse central nervous system disorders [22–28]. The decline in hand-muscle function in the elderly population includes diminished muscle mass, strength, coordination, finger dexterity, and hand sensation, along with central nervous system degeneration. These factors impede hand manipulation abilities and diminish the overall quality and independence of life among the elderly [29]. Indeed, finger dexterity plays a crucial role in activities of daily living (ADL) and self-care.

According to past research, smoking negatively impacts cognitive functions, including attention, working memory, and executive function, that are essential for doing dual-task activities. Therefore, assessing impairment in finger dexterity is essential for providing rehabilitative care to the elderly [29].

Dual-tasking, or the performance of two tasks simultaneously, is a common demand in daily activities. However, exceeding attention capacity during dual-tasking can lead indi-

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viduals to pay less attention to each task [30]. Studying the influence of age-related changes on the stability of apparently simple motor tasks and the performance of secondary cognitive tasks sheds light on motor stability and cognitive performance during dual-tasking [31]. Dual tasks place demands on attentional resources and serve as indicators of cognitive decline in older adults and those with cognitive impairment [32].

The objective of this study was to explore the influence of smoking on finger dexterity under dual-tasking and single-tasking conditions, as well as the effect on ADL in elderly smokers and non-smokers.

Understanding the impact of smoking on finger dexterity during dual-tasking conditions will contribute to our knowledge of the effects of smoking on elderly individuals and provide insights into potential cognitive declines. This study holds significance in revealing the potential impairment in finger dexterity during dual-tasking in elderly smokers compared to elderly non-smokers, providing an understanding of the effects of smoking on the everyday activities and cognitive function of older adults.

Subjects and methods

Subject selection

This comparative study encompassed a cohort of 40 male participants aged between 65 and 75 years, who were categorised into group 1 (n = 20 smokers) and group 2 (n = 20 non-smokers) based on inclusion and exclusion criteria by convenience sampling. Subjects were selected from Sandhya Old Age Home, Block-G, Netaji Nagar, New Delhi-110023. Community-dwelling males of 65-75 years who reported continuous smoking for at least five years, scored one or more on the Fagerstrom Test for Nicotine Dependence (FTND), and were undiagnosed with smoking-induced respiratory or cardiac diseases were chosen to participate in the study. The FTND serves as a widely used tool for evaluating the level of physical dependence on nicotine and was created to provide a ranking-based assessment of nicotine dependence associated with cigarette smoking [33]. The subjects were excluded if the individual was not currently smoking cigarettes but had a history of cigarette use, previous drug or alcohol dependence, communication difficulties, any neurological condition such as stroke, Parkinson's disease, Alzheimer's disease, or dementia, or any fine motor skill disorder, any musculoskeletal disorder related to upper limb, or any psychiatric condition. The subjects were requested to sign a consent form prior to the study. The Jamia Hamdard Institutional Ethical Committee (JHIEC), Jamia Hamdard, New Delhi, India, approved the research methodology, protocol and sample collection on 27th January 2020.

Assessment

Both groups performed the nine-hole peg test (9HPT) under dual-task conditions. The 9HPT measures finger dexterity and demonstrates outstanding consistency in test-retest reliability (intraclass correlation [ICC] = 0.95 for the right hand and ICC = 0.92 for the left hand) [34]. Meanwhile, the Katz Index of Independence in ADL (KATZ) assessed task speed and ADL [35].

Nine-hole peg board

Both the primary and non-primary hands underwent two rounds of testing. Participants sat in front of a table with the wooden pegboard placed on the side corresponding to the hand being assessed, with chair height adjusted according to participant height to fix the table position at mid-chest level. The free hand was used to stabilise by holding the edge of the board. Following a starting cue, the stopwatch was initiated, and the participants sequentially inserted nine pegs into nine holes as fast as possible. Once the pegs were placed, they promptly removed them one at a time. The scores were determined by the duration taken to finish the test task, measured in seconds. The stopwatch commenced when the participant touched the first peg and concluded when the last peg contacted the container.

Dual-task pairings

Subjects underwent evaluation for 3 days, with the 9HPT performed on the first day and the 9HPT with a cognitive task (C9HPT) on the second.

In C9HPT, subjects engaged in a word recall during the administration of the 9HPT, wherein they were instructed to repeat a specific set of three words provided to them at the commencement of the test.

On day three, subjects were asked to perform the 9HPT with a motor task (M9HPT), during which they executed the 9HPT while concurrently engaging in therapist-instructed forced foot tapping. The foot tapping involved using the right foot when performing the test with the right hand and the left foot when performing the test with the left hand.

The Katz Index of Independence in Activities of Daily Living

The KATZ evaluates an individual's capacity to carry out daily living activities autonomously. The index assesses the adequacy of performance in six functions, including bathing, dressing, toileting, transferring, continence, and feeding. Participants received yes/no scores based on their independence in each of these functions. A score of six signifies complete functional ability, four indicates moderate impairment, and two or less indicates severe functional impairment [35].

Data analysis

Data analysis was employed Statistical Product and Service Solution (SPSS, V.21) (IBM Corporation, NY, USA) for Windows, and a Microsoft Excel master sheet containing subject data was imported. Descriptive statistics, including mean and standard deviation, as well as percentiles and frequencies of subjects, were used to analyse characteristics such as age, height, weight, and body mass index (BMI). Between-group analysis used an independent two-tailed t-test for the variables HPT, C9HPT, M9HPT and KATZ. The level of statistical significance was set at $p < 0.05$.

Results

The study encompassed a cohort of 40 male participants aged between 65 and 75 years categorised into group 1 (n = 20 smokers) and group 2 (n = 20 non-smokers). There were no significant differences between the groups when comparing anthropometric data (Table 1). The mean values for 9HPT were significant between in group 1 and group 2 (28.07 ± 2.03 vs 26.33 ± 2.47, t = 2.30, df = 34, $p < 0.05$), as were the values for C9HPT (30.19 ± 2.26 vs 28.00 ± 2.80, t = 2.57, df = 34, $p < 0.05$) and M9HPT (30.16 ± 2.07 vs 28.18 ± 3.04, t = 2.28, df = 34, $p < 0.05$) (Table 2). However, KATZ scores were the same for both groups (6.00 ± 0.00) (Table 2).

Table 1. Descriptive subject characteristics of group 1 and group 2

Variables	Group 1 (n = 20) mean ± *SD*	Group 2 (n = 20) mean ± *SD*	*t*-value	*p*-value
Age (years)	69.50 ± 2.97	69.28 ± 2.78	–0.23	0.86
Height (cm)	173.72 ± 5.08	175.72 ± 3.92	1.321	0.07
Weight (kg)	74.56 ± 8.33	73.72 ± 7.94	–0.30	0.54
BMI	24.67 ± 3.07	23.90 ± 2.70	–0.80	0.93

BMI – body mass index

Table 2. Between-group analysis for 9HPT, C9HPT, M9HPT, and KATZ

Variables	Group 1 (n = 20) mean ± *SD*	Group 2 (n = 20) mean ± *SD*	*t*-value	*p*-value
9HPT	28.07 ± 2.03	26.33 ± 2.47	2.30	0.02
C9HPT	30.19 ± 2.26	28.00 ± 2.80	2.57	0.01
M9HPT	30.16 ± 2.07	28.18 ± 3.04	2.28	0.02
KATZ	6.00 ± 0.00	6.00 ± 0.00	–	–

9HPT – Nine-hole peg board, C9HPT – cognitive 9-hole peg board, KATZ – Katz Index of Independence in Activities of Daily Living, M9HPT – motor nine-hole peg board

Discussion

The study investigated the effects of smoking on ADL and finger dexterity under dual-task conditions in participants aged 65–75 using smokers and non-smokers.

Studies have shown that tobacco smoke contains substances that can directly cause neurotoxicity. Additionally, smoking increases carbon monoxide concentrations in the cerebral circulation, leading to an alteration in the oxygen balance. These effects of smoking on neurobiology may contribute to an increased risk of depression and cognitive impairment in smokers [36].

The results align with the findings of previous research that cigarette smoking is associated with impairments in attention, semantic fluency, visual learning, and global cognition [37]. Indeed, a study by Suzumura et al. [38] found that decreased finger dexterity was linked to a decline in cognitive function, which suggests that finger dexterity can act as an indicator of cognitive function.

The outcomes revealed a noteworthy disparity in dual-task finger dexterity between the two groups, as smokers took significantly longer to complete the dual-task finger dexterity tests compared to non-smokers. Dual-task dexterity activities (C9HPT and M9HPT) cause divided attention, and this function was affected among smokers when compared to non-smokers. The disparity could be due to reduced cognitive reserve, recall performance, and executive functioning among smokers [39].

According to a study by Mazzone et al. [40], exposure to reactive oxygen species produced during cigarette combustion can result in oxidative damage and initiate inflammatory processes, which can play a role in the initiation and advancement of central nervous system disorders. However, no significant difference was found in ADL between the smoker and non-smoker groups. This suggests that, while smokers may experience impaired finger dexterity, they are still able to maintain a similar level of independence in performing daily activities compared to non-smokers. Other compensatory mechanisms or adaptations in motor skills may help smokers overcome specific deficits in finger dexterity. While analysing issues concerning the ageing process, it is important to consider bodily changes occurring in the elderly [41].

Based on our findings, physiotherapy management can be planned to enhance dual-tasking capacity, cognitive ability, physical functioning, and ADL and to prevent complications related to cognitive ability and conditions such as Alzheimer's disease and mild cognitive disorders. Improvements in hand dexterity during dual-tasking situations may promote better ADL function. In addition, providing feedback to participants during the tasks, such as information on correct performance, may facilitate their dual-task performance.

The findings revealed a substantial difference in dual-task finger dexterity between the two groups, indicating that smoking may have an adverse effect on cognitive resources and performance during dual-tasking. However, it is crucial to consider the limitations of this study when interpreting the results. Firstly, the study had a relatively small sample size; a larger sample size would have enhanced statistical power and increased the generalisability of the findings. Furthermore, the study focused on a specific age group (65–75 years), which also limits the generalisability of the results. Additionally, the study did not consider important factors such as the duration and intensity of smoking, comorbidities, and socioeconomic status, which could potentially confound the relationship between smoking and finger dexterity. The study design poses limitations in establishing causal relationships. Longitudinal studies with follow-up assessments would provide more robust evidence regarding the long-term effects of smoking on dual-task finger dexterity. Moreover, the lack of control for potential confounding variables, such as physical activity level, cognitive abilities, and medication use, introduces the possibility of bias and limits the interpretation of the study findings. Generalisability is also a concern as the study was carried out within a specific geographic area and community, and the results may not accurately reflect other populations or cultural settings. Hence, prudence is advised when extrapolating these findings to diverse environments.

The measurement limitations of the study should also be considered. While the C9HPT and M9HPT are commonly used to assess finger dexterity under dual-task conditions, they may not fully capture the complexity of real-life finger dexterity. Also, the grip was not taken into consideration while performing the tasks. Incorporating additional measures or task combinations could provide a more comprehensive assessment of dual-task finger dexterity. Lastly, results could be interpreted based on a dominant or non-dominant side.

Despite these limitations, the current study adds to our comprehension of how smoking affects finger dexterity during dual-tasking in the elderly. Future research with larger sample sizes, longitudinal designs, control for confounding variables, diverse populations, and incorporation of neurobiological measures would further enhance our knowledge in this area. The findings of this study have potential implications for physiotherapy interventions aimed at improving dual-task capacity, cognitive abilities, physical functioning, and ADL performance in elderly individuals, particularly smokers.

Conclusions

This study provides insights into the effect of smoking on finger dexterity under dual-task conditions in elderly individuals. The findings suggest that smoking has a negative impact on dual-task finger dexterity, potentially due to its effects on

neurocognition and neurobiology. These results emphasise the importance of smoking cessation and interventions to improve cognitive and motor abilities in older smokers.

Ethical approval

The research related to human use has complied with all the relevant national regulations and institutional policies, has followed the tenets of the Declaration of Helsinki, and has been approved by the Jamia Hamdard Institutional Ethics Committee on 21st Jan, 2020.

Informed consent

Informed consent has been obtained from all individuals included in this study.

Disclosure statement

No author has any financial interest or received any financial benefit from this research.

Conflict of interest

The authors state no conflict of interest.

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