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BRIEF COMMUNICATION

Cigarette smoking might impair memory and sleep quality

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Although nicotine can enhance some cognitive functions, cigarette smoking may impair memory and sleep quality. Our aim was to investigate the impact of cigarette smoking on memory and sleep quality in healthy smokers. Sixty-eight healthy participants (34 smokers and 34 controls) completed the Wechsler Memory Scale-Revised and a Chinese version of the Pittsburgh Sleep Quality Index. The Wilcoxon signed ranks test was performed, and Hochberg's Sharpened Bonferroni correction was applied for multiple comparisons. The results show that current smokers had a worse visual memory compared to nonsmokers. There was no significant correlation between the index of Wechsler Memory Scale-Revised and Fagerström test for nicotine dependence. Moreover, smokers had poorer sleep quality. Cigarette smoking might impair memory and adversely influence sleep quality.

Introduction

While cigarette smoking is a serious health hazard to the brain,[1] data showed that nicotine enhances some cognitive functions, such as finger tapping, focused and sustained attention, recognition memory, and reasoning in nonsmokers and non-deprived smokers.[2,3] However, cigarette smoke contains more substances aside from nicotine; considering

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its complex constituents, we question the influence of long-term smoking on cognitive functions. Studies have assumed that cigarette smoking is adversely associated with cognitive functioning, fine motor speed, flexibility, memory, and sleep quality.[4–7] The possible mechanism may be due to the toxic effects of cigarette smoke components, including oxidative stress, inflammation, and atherosclerosis, to the human brain and cardiovascular system. However, few studies have explored the impact of long-term cigarette smoking regarding memory and sleep in Asian population. The aim of this study was to investigate the influence of cigarette smoking on memory and sleep quality in healthy Taiwanese smokers.

Methods

Participants

A total of 68 healthy participants (34 smokers and 34 controls) were recruited in various community studies through research advertisements. A smoker was defined as a person who smoked at least 1 cigarette per day for successive 12 months. The healthy controls and smokers were matched for age, gender, and educational level. Informed consent was obtained from all study participants. The study protocols were approved by the Ethical Committee for Human Research in the National Cheng Kung University Hospital. The smokers were allowed to smoke whenever they had the urge during the assessments. At the beginning of each session, the level of carbon monoxide (CO) that smokers exhaled was measured which is significantly correlated with the plasma nicotine level.[8] They also completed the Fagerström test for nicotine dependence (FTND) and a smoking history questionnaire. The results of nicotine-related assessments were used as demographics for describing our sample of smokers.

The exclusion criteria for smokers were as follows: (1) taking any medication within the past 3 months; and (2) presence of any physical and/or mental illnesses, including alcohol or illegal substances abuse/dependence. Aside from a physical examination, all participants were interviewed by a senior psychiatrist using the Chinese version of the Mini International Neuropsychiatry Interview.[9] All participants had normal brain MRI results, and they also underwent a comprehensive physical examination.

Assessments

Wechsler Memory Scale-Revised

The Wechsler Memory Scale-Revised (WMS-R)[10] was administered by a trained psychologist (who had a master's degree) to measure the visual memory index, verbal memory index, general memory index, delayed-recall memory index, and attention/concentration index. The mean score and standard deviation (SD) for the WMS-R in the general population are 100 and 15, respectively, and cross-validation of this test has been confirmed in previous research.[11]

Chinese version of the Pittsburgh Sleep Quality Index

The Pittsburgh Sleep Quality Index (PSQI) is a self-administered questionnaire to evaluate subjective sleep quality during the previous month.[12] It contains 19 self-rated questions, yielding a total score and seven subscore components: subjective sleep quality, sleep latency, sleep duration, sleep efficiency, sleep disturbance, use of sleep medication, and daytime dysfunction. Each subscore component is scored from 0 to 3, yielding a total PSQI score between 0 and 21, with higher scores indicating a poorer quality of sleep. A PSQI total score greater than 5 indicates "poor sleep" with a sensitivity of 89.6—98.7% and a specificity of 84.4—86.5%.[12,13] The cut-off score of the Chinese version of PSQI is 5, which has a sensitivity of 98% and a specificity of 55%.[14] It is a reliable and valid tool for the assessment of sleep quality.[12,14]

Statistical analysis

Since the scores of some WMS-R indexes and PSQI were not normally distributed, Wilcoxon signed ranks test and Spearman's rho correlation were performed. Hochberg's sharpened Bonferroni correction was used for multiple comparisons. The threshold for statistical significance was set at $p < 0.05$. SPSS version17 (SPSS Inc., Chicago, IL, USA) was used for all analyses.

Results

The mean age was 31.9 years (SD = 8.4) for smokers and 32.0 years (SD = 8.4) for nonsmokers, and the mean duration of cigarette smoking was 10.6 years (SD = 6.9). No significant difference in terms of years of education was found between smokers and nonsmokers (Wilcoxon signed ranks test = −0.11, $p = 0.92$). The demographic data of the groups are shown in Table 1. Compared to controls, smokers had significantly poorer visual memory (Wilcoxon signed ranks test = −2.21, $p = 0.03$) and sleep (Wilcoxon signed ranks test = −2.04, $p = 0.04$). There was no correlation between the results of WMS-R and FTND ($p > 0.28$).

Discussion

In this study, we found that long-term cigarette smoking might impair the visual memory. It is known that nicotine can activate the release of dopamine, which improves the cognitive performance. In addition, nicotine also increases the strength of synaptic connections in the hippocampus which supports the enhancement of short-term memory. Nicotine can dose-dependently improve recognition memory, as well as decrease response time and increase the number of fast reaction times in cognitive tasks among nonsmokers.[15] It can also enhance cognitive functions such as finger tapping and focused and sustained attention in both nonsmokers and non-deprived smokers.[2,16]

However, cigarette smoke also contains other components besides nicotine, and at least 4700 other constituents of cigarette smoke have been identified. Many components of cigarette smoke have been confirmed to be toxic to the human brain and cardiovascular system. Such compounds include vinyl chloride, hydrogen cyanide, arsenic, lead, and carbon monoxide. Cigarette smoking can damage the endothelium and thereby cause atherosclerosis[17] and

Table 1 Demographic data and comparison of the results of smokers and controls.

	Group mean and SD				Statistical test		
	Smokers ($n = 34$)		Controls ($n = 34$)		Wilcoxon signed ranks test	p	p_c
	Mean	SD	Mean	SD			
Age	31.9	8.4	32.0	8.4	−0.69	0.49	0.05
Gender (male/female)	33/1		33/1		—	—	—
Education years	14.3	2.2	14.3	2.4	−0.11	0.92	0.05
FTND	3.10	2.32	—	—	—	—	—
Smoking year	10.6	6.9	—	—	—	—	—
CO level (ppm)	10.21	5.47	—	—	—	—	—
WMS-R							
Verbal memory index	94.19	16.47	97.62	12.97	−0.84	0.40	0.010
Visual memory index	107.54	15.01	116.81	13.14	−2.21	0.03*	0.050
General memory index	97.85	16.60	103.42	13.00	−1.23	0.22	0.017
Attention/concentration	113.04	13.54	118.46	8.37	−1.72	0.09	0.025
Delayed-recall memory index	104.42	17.08	108.96	13.99	−1.18	0.24	0.013
PSQI	5.77	2.45	4.74	1.75	−2.04	0.04*	0.05

*Significance at the study-wise type I error rate of 0.05 (two-tailed) after adjustment (when $p < p_c$).
CO = carbon monoxide; p_c = significance level with Hochberg's sharpened Bonferroni correction; PSQI = Pittsberg Sleep Quality Inventory; WMS-R = Wechsler Memory Scale-revised version.

induce inflammations, which can result in cognitive impairment by damaging neurons. Moreover, based on the study of Chen et al,[18] dopamine activity is correlated with memory functions, particularly in the verbal memory index but not in the visual memory index. This might explain why cigarette smokers performed worse in visual memory tasks—but not in verbal memory tasks—compared to nonsmokers in our study.

Ernst et al[3] reported that smoking history may be negatively related to working memory performance. Similarly, Richards et al[6] indicated that smoking is associated with faster declines in verbal memory. However, these studies did not control for any confounding factor(s), such as years of education. (It is known that years of education can influence cognitive performance.[19]) However, even after controlling for years of education, our results still showed another kind of memory impairment linked with smoking.

Our previous work has shown that smokers have less striatal dopamine transporter availability,[20] and dopamine transporter availability is correlated with cognitive function[21] and sleep quality in healthy individuals.[22] In this study, smokers were noted to have poorer sleep quality, which is consistent with the results of aforementioned studies and supports the findings of the polysomnography study performed by Zhang et al.[7] Our results may need to be interpreted with caution for several reasons: (1) the small sample size with male dominant participants; (2) lack of FTND and exhaled CO level data of the controls, although the exhaled CO level data from our smokers was consistent with results of previous studies, a reading of more than 6 ppm indicates smoking[23]; (3) the possibility of reverse causation that those who did not perform well cognitively tended to use nicotine by cigarette smoking to enhance their ability; and (4) cigarette smoking behavior and poor sleep quality might share a common biological or psychological ground.

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