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Association of Cigarette Smoking and Serum Concentrations of Vitamins A and E in Men: A Case-Control Study

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A B S T R A C T

Background: Cigarette smoking is associated with changes in blood concentrations of some antioxidant vitamins. This study aimed to determine the association of cigarette smoking with serum concentrations of vitamins A and E in men.

Methods: This was a case-control study, in which the participants were 80 male smokers and 84 male nonsmokers (age range: 20-60 years). Data on dietary intake, health status, smoking habits, anthropometric characteristics, and vitamin levels were compared between cases and controls.

Results: Smokers had significantly lower concentrations of serum vitamin E ($p = 0.001$) and vitamin A ($p = 0.013$) compared with nonsmokers. However, serum vitamin E to cholesterol ratio was not significantly different between smokers and nonsmokers. Moreover, the highest circulating concentrations of vitamin E was observed in smokers who smoked ≤9 cigarettes per day ($p < 0.03$), while and the lowest vitamin E was seen in men smoking ≥20 cigarettes per day.

Conclusion: The results of this study identified that cigarette smoking is associated with lower levels of serum vitamin E and vitamin A, although it was not associated with vitamin E to cholesterol ratio.

Introduction

The tobacco epidemic is one of the biggest health problems in the world. According to the World Health Organization (WHO), near 6 million people die from cigarette smoking each year. More than 5 million of those deaths are the result of direct tobacco smoking, while more than 600000 deaths are the result of second-hand smoke [1]. Smoking is a preventable risk factor for numerous illnesses, including cardiovascular disease, cancer, and chronic obstructive pulmonary disease [2].

The underlying biochemical mechanisms for many pathological conditions associated with smoking are not fully understood. One of the underlying factors that may contribute to the detrimental health effects of cigarette smoking is oxidative stress [3]. Cigarette smoke contains numerous species of free radicals and oxidants, including nitric oxide radicals, singlet oxygen, and hydrogen peroxide, which induce oxidative stress [4-5].

The antioxidant system plays a major role in defense against oxidative stress in the human body. The antioxidant defense system comprises elements that either are micronutrients (e.g., vitamins C and E) or rely upon dietary micronutrients (e.g., CuZn and Mn superoxide dismutases) [6]. Antioxidants like vitamin E can protect the body from oxidant factors [7]. Evidence about the association of serum vitamin E level and tobacco smoking is controversial. Some studies showed significantly lower serum levels of vitamin E for smokers [8-9], whereas others found no difference in serum levels of this nutrient between smokers and nonsmokers [10-11]. In animal models, vitamin A depletion occurred by the administration of benzo(a)pyrene, a cigarette smoke constituent

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[12]. A study found that smokers with cardiovascular disease had lower retinol, vitamin E, and some trace elements such as iron and zinc compared with nonsmokers [13]. Given the inconsistency of the available data on the effect of smoking on the levels of vitamins A and E, the current study aimed to assess the association of cigarette smoking on serum concentrations of vitamins A and E in men.

Materials and Methods

Subjects

This case-control study consisted of 80 male smokers and 84 male nonsmokers who volunteered for the study. The exclusion criteria were having diverticulosis, ileum or stomach surgery, inflammatory bowel disease, intestinal absorptive disorders, diabetes, or cardiovascular diseases; using antacids, metformin, aminosalicylic acid, colchicine, neomycin, or alcohol; or being on a vegetarian diet. Subjects who had been smoking more than 5 cigarettes per day for the last six consecutive months were categorized as smokers. Current smokers were asked about the amount and duration of smoking.

All the participants were informed about the project objectives and procedures and signed an informed consent form. The protocol was approved by the local ethics committee of Tehran University of Medical Sciences.

Anthropometric assessment

Subjects were weighed without shoes and in light clothing using a Clara 803 portable digital scale (Seca Corporation, Hamburg, Germany) with an accuracy of 100 g. Height was measured without shoes to the nearest 0.1 cm using a Seca 206 measuring tape (Seca Corporation, Hamburg, Germany). Body mass index (BMI) was calculated as body weight in kilograms (kg) divided by the square of the body height in meters (m^2).

Dietary assessment

Dietary intake data were obtained using a quantitative food frequency questionnaire (FFQ) consisting of a list of food items and their serving sizes in household measure. All participants were asked for the amount and frequency of consuming each food item during the past year on a daily (e.g., bread), weekly (e.g., rice, meat), or monthly (e.g., fish) basis. The total amounts of foods in household measures were then converted to grams [14]. The validity and reliability of the FFQ have been evaluated previously [15]. Energy intakes of below 3350 kJ/d (800 kcal/d) or above 17570 kJ/d (4200 kcal/d) denoted misreporting and were excluded from analyses [16].

Laboratory measurements

Venous blood samples were taken from all participants by trained staff for biological screening tests between 7:00 and 9:00 a.m., following an overnight fast. Serum samples were separated and stored at -70°C. Biosafety principles were observed for this collection. Serum cholesterol was measured using commercial kits (Pars Azmun Co., Karaj, Iran). Serum vitamin A and vitamin E concentrations were determined using high-performance liquid chromatography (HPLC) [17].

Assessment of other variables

Data on demographic characteristics, including education, occupation, current diet, and medication and supplement use were collected via interviewer-administered questionnaires.

Statistical analysis

All statistical tests were performed by using IBM SPSS, version 22, with the statistical significance level set at $\alpha = .05$. The normality of data distribution for variables was examined by the Kolmogorov-Simonov test. All data are reported as mean ± standard deviation (SD). Independent-samples t tests were used to compare quantitative variables between cases and controls, and ANOVA models were used to examine the effects of smoking intensity (cigarettes per day) and duration on serum levels of vitamin A and E.

Results

The mean ± SD age for the smokers was 36.90 ± 0.93 years compared with 38.86 ± 1.09 years for the nonsmokers. Dietary intake and anthropometric characteristics of smokers and nonsmokers are shown in (Table 1). They did not differ significantly in terms of dietary intake or anthropometric characteristics ($p > 0.05$). However, energy intake and vitamin E intake were higher in the smoker group than in nonsmokers, while nonsmokers had a significantly higher vitamin A intake.

Our results revealed that the difference between smokers and nonsmokers in the serum levels of vitamins E and A was related to cigarette smoking. Nonsmokers had significantly higher serum levels of vitamins A and E than

smokers did ($p = 0.013$ and $p = 0.001$, respectively), but there was no significant difference in vitamin E to cholesterol ratio between the groups ($p = 0.24$) (Table 2).

We found a significant relationship between serum vitamin E level and smoking intensity. Serum vitamin E was higher in men smoking ≤9 cigarettes per day ($p < 0.03$), while the lowest level of vitamin E was seen in men who smoked≥ 20 cigarettes per day (Table 3).

Table 1. Dietary intake and anthropometric characteristics of cases and controls

Variables	Smokers (n = 80) mean ± SD	Nonsmokers (n = 84) mean ± SD	P value†
Age (years)	36.90 ± 0.93	38.86 ± 1.09	0.17
Height (cm)	175.51 ± 0.69	175.17 ± 1.36	0.82
Body weight (kg)	81.20 ± 1.33	82.54 ± 1.73	0.54
BMI (kg/m^2)	26.32 ± 0.40	26.35 ± 0.59	0.96
Total energy (kcal/d)	2316.66 ± 59.11	2234.22 ± 54.39	0.30
Vitamin A (RE/d)	1064.11 ± 56.80	1072.19 ± 60.38	0.92
Vitamin E (mg/d)	3.92 ± 0.14	3.69 ± 0.13	0.23

† P values from the *t* test
BMI: Body mass index

Table 2. Association of smoking with serum concentrations of vitamin E, vitamin A, cholesterol, and vitamin E to cholesterol ratio

Variables	Smokers (n=80) mean ± SD	Nonsmokers (n=84) mean ± SD	P value†
Serum vitamin E (µg/ml)	6.97 ± 0.43	8.27 ± 0.32	0.001
Serum vitamin A (µg/ml)	0.39 ± 0.01	0.49 ± 0.03	0.013
Serum cholesterol (mg/dl)	162.82 ± 4.68	175.33 ± 4.79	0.06
Vitamin E to cholesterol ratio	0.04 ± 0.003	0.05 ± 0.002	0.24

† P values from the *t* test

Table 3. Association of number of cigarettes with smoking duration on vitamin E, vitamin A, and vitamin E to cholesterol ratio

Variables	Cigarettes per day mean ± SD				Smoking duration (year) mean ± SD			
	≤9 (n = 26)	10-19 (n = 32)	≥20 (n = 22)	P value†	≤10 (n = 33)	11-19 (n = 27)	≥20 (n = 24)	P value†
Vitamin A (µg/ml)	0.42 ± 0.03	0.45 ± 0.02	0.41 ± 0.03	0.74	0.43 ± 0.03	0.43 ± 0.02	0.41 ± 0.04	0.89
Vitamin E (µg/ml)	0.86 ± 0.03	0.80 ± 0.03	0.72 ± 0.03	0.03‡	0.81 ± 0.03	0.82 ± 0.03	0.73 ± 0.03	0.23
Vitamin E to cholesterol ratio	0.05 ± 0.006	0.04 ± 0.004	0.03 ± 0.004	0.07	0.04 ± 0.005	0.04 ± 0.004	0.03 ± 0.003	0.11

† P values from ANOVA
‡ Statistically significant

Discussion

In the present study, there was no significant difference in dietary intake and anthropometric indices between healthy adult male smokers and nonsmokers. Therefore, smoking appears an important determinant of significant differences in serum vitamin E and A between the study groups.

Findings on the association of smoking with serum vitamin E and vitamin A concentrations are controversial. The results of the present study support the findings of a study by Bashar and Mitra [13], who showed that smokers with cardiovascular disease had significantly lower serum concentrations of retinol and alpha-tocopherol. Also, these observations agree with the findings of previous studies showing that smoking can decrease serum vitamin E concentrations [8-9], although other studies reported no difference between smokers and non-smokers' serum levels of vitamin E (α-tocopherol) [10-11] or vitamin A (retinol) [18]. Galan et al. [19] found no significant difference in serum vitamin E concentration between current male smokers and male nonsmokers, although male smokers tended to have lower serum vitamin E. Another study, which was done on people aged 65 years and older, established that cigarette smoking had no effect

on serum vitamin E status after adjustment for age, sex, and place of living [20]. These conflicting findings may relate to differences in study population, study design, and also dietary intake of participants, which were not assessed in some studies. Moreover, some characteristics of participants such as sex, age, BMI, and disease history could have contributed to obtaining different results.

There was no difference between smokers and nonsmokers in the ratio of vitamin E to cholesterol in this study. The results of the present study also showed a negative relationship between smoking intensity (cigarettes per day) and serum concentrations of Vitamin E. Evidence on the association between smoking intensity and vitamin E status is controversial [13, 20]. Smoking intensity is usually classified based on the number of cigarettes smoked per day (0, <10, 10-20, or >20 cigarettes per day) [21] or based on the serum cotinine level (<14, 14-100, 100-200, or >200 ng/mL) [22]. The use of various definitions might, to some extent, account for this discrepancy.

Some limitations must be considered in the interpretation of our findings. Smoking status in this study was assessed by the questionnaire only; and biochemical markers, such as serum cotinine, were not available to determine the accuracy of the reported levels of cigarette smoking [23]. Since there were no female cigarette smokers in this study, the results only could be applied to males [24].

Conclusion

Cigarette smoking decreases serum levels of vitamin A and E in men, with higher smoking intensity having a greater negative effect on serum concentrations of vitamin A and E. As a result, it is important to plan some practical health programs, including more advertisements about adverse effects of the tobacco and cigarettes consumption to avoid smoking-related abnormalities like oxidative stress in the human body.

Conflict of interest

None of authors have conflict of interests.

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