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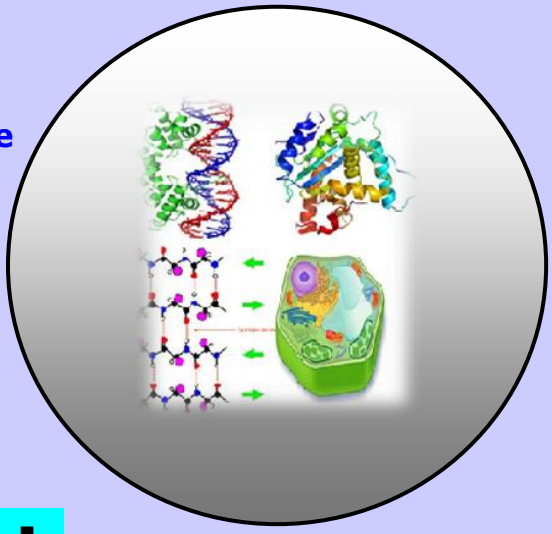

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RESEARCH PAPER

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The Effect of Smoking on Plasma Concentrations of Sodium and Potassium

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ABSTRACT

The effect of smoking on plasma concentrations of sodium and potassium were studied in a group of students in the Faculty of Medicine and Health Sciences, Shendi University. Forty students were selected for this study, their ages ranged from 20-30 years; and Mean body mass index 21. The sample included 10 students who are non- smokers as a control group; 15 moderate smokers (less than 7 cigarettes /day) and 15 heavy smokers (more than 15 cigarettes / day) for acute experiment study. The study carried out by Quasi pre - post - interventional study. At base line; all groups emptied their bladder and drank 500ml of water. Blood and urine were then collected after one hour. In the second step the smokers repeated the water load of 500ml; then smoked two cigarettes separated by 30 min; blood and urine were collected at the end of one hour. Blood samples were used for measurement of sodium and potassium. While urine samples were used for measurement of urine sodium and potassium. Baseline results showed that the plasma sodium & potassium of smokers changed slightly but were found to be insignificant compared to non-smokers. After smoking a cigarette, plasma sodium and potassium were increased significantly in both groups of smokers with a P-value of < 0.001. The concentrations of urine sodium and potassium decreased in both groups of smokers after smoking; the decrease in sodium was found to be significant in both moderate and heavy smokers with a P-value of <0.001 and <0.05 respectively. Urine potassium was significantly decreased in moderate smokers and heavy smokers with a P-value of <0.01 and <0.05 respectively.

According to the above results the effects of smoking were more clearly demonstrated in moderate smokers than heavy smokers, propably due to adaptation that occurs in heavy smokers. The explanation and form of adaptation or decreased of sensitivity to nicotine remains to be explained.
Key words: Cigarette Smoking, Sodium, Potassium and Plasma Concentrations.

INTRODUCTION

Smoking is a major public health problem worldwide and a barrier to development in many developing countries **(**WHO, 1994**)**. While Smoking decreased in most industrialized countries, in developing countries cigarette smoking is increasing by 3% per year **(**Bartecchi et al., 1995**)**. It is estimated that the total number of deaths attributable to smoking worldwide has increased from 2.5 million in 1995 to 12 million by the year 2050 **(**Peto R et al, 1994**)**. Most of these deaths have occurred in developing countries. During the past two decades, cigarette consumption in high-income countries has declined by 0.5%, while in low-income countries it has increased by 2.5% **(**WHO, 1997**)**.

The effects of these changes in consumption are already becoming apparent in terms of tobacco-related deaths. In the year 2000 there were at least a million deaths attributable to tobacco worldwide, with the increase being most marked in low-income countries **(**WHO 2002**)**.

Nicotine is a highly toxic alkaloid that affects the autonomic nervous system and can act as both a ganglionic stimulant and depressant, and many of its complex effects, which are mediated by catecholamines, have been found to produce the following: -

- Tachycardia **(D**HHS, 1994**)**.
- Increased blood pressure **(**Rose, et al, 2001**)**.
- Constriction of blood vessels under the skin **(**Barua, et al, 2002**)**.
- Increased aldosterons, cortisol, vasopressin and β-endorphin levels **(**Hoff Brand et al., 2001**)**.

Although the cardiovascular and possible renal effects have been studied, little is known about the effects of smoking on plasma electrolytes. The purpose of this study is to provide more information about the effects of smoking on sodium and potassium concentrations in plasma and urine. This information is relevant in the climatic condition prevalent in Sudan and in patients who are susceptible to electrolytes disturbances e.g. hypertension & heart disease. Na^+ & K^+ levels should be maintained within the normal range in such patients. Pressure and pulse rate) were also monitored.

MATERIAL AND METHODS

The groups consisted of 15 moderate smokers for the acute experiments, 15 heavy smokers and 10 non- smokers were studied for baseline data.

Selection criteria

Inclusion criteria

- Age 20-30 years old
- Medical and Health Sciences students, Shendi University.
- Hemoglobin (Hb) (13.5-17.5g\L)
- Blood pressure (Bp) (120/80mmHg)

Exclusion criteria

History of renal diseases, cardiovascular diseases, and liver diseases.

Samples were collected from an antecubital vein by plastic disposable syringes; 2.5 ml of blood was collected into containers with lithium heparin and was separated by centrifugation. The plasma was removed by Pasteur pipettes and placed into glass tubes to be analyzed.

Experimental protocol to test acute effect of smoking in moderate and heavy smokers

Time	Intervention / Samples
0.0 min	• Emptying bladder • Water load of 500ml
60.00 min	Blood &urine samples
60.01 min	Water load of 500 ml
60.05 min	Smoke one cigarette
90.00 min	Smoke one cigarette
120.00 min	Blood &Urine samples (serum & urine Na+& K+).

RESULTS AND DISCUSSION

The concentration of serum sodium was found to be significantly increased in both groups of smokes after smoking with a P-value of <0.001. While the concentration of urine sodium was significantly decreased in both moderate and heavy smokers with a P-value of<0.001 and <0.05 respectively after smoking. Table (1 and 2).

Table 1. Basal level parameters in non smokers and smokers.

Parameters	Non smokers Mean ±SD ±SEM	Moderate Mean ±SD ±SEM	Heavy Mean ±SD ±SEM
Na^+ (mmol/l)	139.80 ± 4.42 ± 1.4	138.53 ±4.26 ±1.10	144 ± 10.10 ± 2061
K^+ (mmol/l)	3.84 ± 0.331 ± 0.105	3.980 ±033.1 ±0.105	4.07 ±0.539 ±0.139
Systolic blood pressure (mm/Hg)	118 ±10.328 ±3.266	118 ±14.74 ±3.80	109.67 ±8.76 ±2.26
Diastolic blood pressure (mm/Hg)	72.50 ±8.12 ±2.10	75.33 ±8.12 ±2.10	74.33 ±7.29 ±1.88
Pulse rate	74.40 ±5.40 ±1.70	80.13 ±6.78 ±1.75	84.8 ±8.31 ±2.15

Table 2. Effect of smoking on serum and urine sodium.

Smokers	Serum Na^+ before smoking Mean ±SD ±SEM	Serum Na^+ after smoking Mean ±SD ±SEM	Urine Na^+ before smoking Mean ±SD ±SEM	Urine Na^+ after smoking Mean ±SD ±SEM
Moderate	138.47 ± 4.14 ± 1.07	145.73 ±4.26 ±1.10	108.87 ± 10.10 ± 2061	94.6 ±42.85 ±11.06
Heavy	144 ± 10.10 ± 2.61	152. 87 ±2.63 ±0.93	106.20 ±36.87 ±9.52	93.20 ±35.53 ±9.17

The concentration of serum potassium was found to be increased significantly after smoking in both smoker groups with a P-value of <0.001. While urine potassium decreased significantly in both moderate and heavy smokers with a P-value of<0.01and <0.05 respectively after smoking Table (3).

Table 3. Effect of smoking on serum and urine potassium.

Smokers	Serum K^+ before smoking Mean ±SD ±SEM	Serum K^+ after smoking Mean ±SD ±SEM	Urine K^+ before smoking Mean ±SD ±SEM	Urine K^+ after smoking Mean ±SD ±SEM
Moderate	3.98 ± 0.332 ± 8.575	4.247 ±0.323 ±8.33	11.38 ± 5.494 ± 1.419	9.63 ±3.62 ±1.192
Heavy	4.07 ± 0.539 ± 0. 139	4.7 ±0.703 ±0.182	11.907 ±8.234 ±2.126	8. 073 ±5.140 ±1.327

Plasma and Urine Sodium

Sodium was measured in the plasma and urine; at baseline there was a slight difference between smokers and non-smokers.

After smoking the plasma sodium was found to be increased significantly with a P-value of < 0.001, this agrees with results obtained by Eliasson M., et al who investigated electrolytes level in three groups of healthy young adults **(**Eliasson, et al 1993**)** also similar study was carried out by Emad Aldien I. Osman et al who investigated electrolytes level in thirty smokers before and after smoking and the result obtained a significant increase in sodium level immediately after smoking among smokers ($p < 0.05$) and no significant change in potassium level. No change was found in plasma sodium level between smokers (before smoking) and non-smokers. In addition, there is a decrease in plasma potassium level among smokers (before smoking) **(**Emad-Aldin I. Osman et al 2011**)**.

The increased level in plasma sodium may be explained by increased levels of aldosterone and cortisol during smoking (WHO, 2002). Aldosterone release is potentiated by hyperkalemia, induced by smoking. Another explanation is reduction in GFR leading to increased sodium reabsorption **(**Brenner, et al 1968**)**. However, the exact mechanisms involved in the electrolyte concentration changes in the serum after smoking is not yet fully understood. In the urine, sodium was decreased significantly; which is consistent with release of the aldosterone leading to increased sodium reabsorption in the renal tubules **(**Wallach, 2000). Benowitz et al found that smokeless tobacco increased sodium excretion in the urine of humans, whereas potassium excretion did not increase significantly **(**Benowitz, et al, 1984**)**.

Plasma and Urine potassium

Potassium was measured in the plasma and urine, at baseline the difference between smokers and non – smokers was found to be insignificant. After smoking potassium was increased significantly with a P-value < 0.001, this also agree with that obtained by Eliasson M. et al, and by Goya W., et al who found a raised level in serum potassium related to smoking (Eliasson M et al 1993 and Goya, w., et al. 1997). Despite the fact that smoking increases the level of aldosterone, which should lower the serum potassium, still serum potassium is increased. This may be explained by the toxic effects of smoking on tubular cells, but the base-line results do not support this assumption **(**Mann, Sj. et al, 1991**)**. However it is more likely that K+ and aldosterone are both the result of the decreased GFR. Another cause may be due to the small size of the sample in this study. Further studies are needed to ascertain this fact taking into consideration the timing of samples to find which the cause is and which is the effect.

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