

Effect of cigarette smoking on salivary electrolyte composition in a sub-urban Nigerian population

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Abstract

Background: Cigarette smoking is a factor that affects the health of humans. It has been shown to be an important risk factor for a variety of disorders such as disease of the lungs, brain damage and has also been linked to the development of periodontal disease. There are, however, few and conflicting studies on its effect on salivary electrolyte composition.

Aim: The aim of this study is to evaluate the effect of chronic cigarette smoking on electrolyte concentration of saliva and to determine its effect on normal oral homeostasis.

Methods: A total of 40 male subjects of between 25–40 years were divided into two groups, A and B. Group A comprised of 20 smokers and Group B, 20 non-smokers. Saliva from each subject was collected into a plain sample bottles and immediately analysed.

Results: Results showed a significantly lower concentration of Na⁺ and Cl⁻ and a significantly higher HCO₃⁻ and K⁺ in smokers than non-smokers.

Conclusion: This shows that the concentration of electrolytes in the saliva may be affected by the chronic use of tobacco which could have adverse consequences on the normal homeostasis of the oral environment especially with regard to increased salivary alkalinity as a result of increased salivary bicarbonate.

Keywords: Bicarbonate, chloride, cigarette smoking, potassium, salivary electrolytes, sodium

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INTRODUCTION

Cigarette smoking is a lifestyle that affects the health of humans. It has been shown to be a risk factor in a lot of disorders such as disease of the lungs, brain damage, cardiovascular diseases and many cancers.¹⁻³ Salivary fluid is an exocrine secretion consisting of approximately 99% water, containing a variety of electrolytes (sodium, potassium, calcium, chloride, magnesium, bicarbonate and phosphate) and proteins, represented by enzymes,

immunoglobulin and other antimicrobial factors, mucosal glycoproteins and traces of albumin.⁴ Whole saliva refers to the complex mixture of fluids from the salivary glands, the gingival fold, oral mucosa transudate, in addition to mucous of the nasal cavity and pharynx, non-adherent oral bacterial, food remainders, desquamated epithelial and blood cells as well as traces of medications or chemical products.⁵ Many researchers have made use of sialometry and sialochemistry to diagnose systemic illnesses, monitoring general health and as an indicator

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of risk for diseases creating a close relationship between oral and systemic health.⁶⁻⁹ However, since several factors can influence salivary secretion and composition a strictly standardized collection must be made.

Smoking has great effects on salivary flow (SF) and its electrolyte composition; it varies with body posture and lighting conditions. Patients kept standing up or lying down present higher and lower SF, respectively, than the seated patients.^{10,11} The irritating effect of tobacco increases glandular excretion and nicotine causes severe morphologic and functional alterations in the salivary glands.¹²

Several researchers have reported conflicting results of salivary composition in smokers.¹³⁻¹⁶ A non-significant difference for salivary potassium, sodium and calcium electrolyte compositions in smokers and non-smokers was reported by some researchers^{14,15} while Avşar *et al.*¹⁶ reported a significant increase in serum levels of sodium and potassium in smokers.¹³ Men that smoke present significantly higher stimulated SF than non-smoking men.¹⁷ The irritating effect of tobacco increases glandular excretion and nicotine causes severe morphologic and functional alterations in the salivary glands.¹²

This study is, therefore, aimed at evaluating the effect of cigarette smoking on electrolyte concentration of saliva in a suburban community in Nigeria.

METHODS

Subjects

The study was a cross-sectional comparative study done among 40 apparently healthy subjects of whom 20 were smokers and 20 non-smokers. All the 40 subjects used were male with age range of 20–45 years residing in Ekosodin, Benin City, Nigeria. The duration of tobacco use was 5–7 years. Subjects with seldom use of tobacco were excluded from the study. Other exclusion criteria were present use of medication and systemic illness. The details about the smoking habits, dental and dietary habits and other Information was assessed through questionnaires before collecting saliva for the estimation of salivary electrolytes (sodium, potassium, chloride and bicarbonates) by routine methods in smoking and non-smoking male subjects. The questionnaire also helped in ruling out any medical conditions such as hypertension, ischemic heart disease, stroke, diabetes or any other disorders. Informed consent for each subject's participation was obtained before sample collection.

Sampling

The selection of the non-smokers was based on the method of simple random sampling which was unbiased. The

smokers were selected based on a convenience sampling technique.

Collection of saliva samples

Before sample collection, each subject was briefed about the procedure and instructed to wash his mouth by gargling with plain water twice. The saliva of each subject was collected under resting conditions 1 h after breakfast. A volume of 2.5 ml of saliva was collected (for 10 min) into plain sample bottles from each subject for laboratory analysis. Other baseline variables such as body mass index (BMI), blood pressure and pulse rate were also measured.

Statistical analysis

The data were analysed statistically using Graph pad prism 5.0 version. Concentration difference between smoking and non-smoking groups was accessed using the two-sample Student *t*-test. The level of statistical significance was set at $P < 0.05$.

RESULTS

Table 1 showing significant differences ($P < 0.05$) in the BMI, systolic blood pressures and pulse rates in the two groups studied; however, there was no significant difference ($P > 0.05$) in their ages.

Figure 1 showing the Salivary Sodium ion concentration in smokers and non-smokers. $n = 40$; means \pm standard error of mean (SEM). Statistical comparison showed a clear significant decrease in sodium levels in smoking subjects $P < 0.05$.

Figure 2 showing the salivary potassium ion concentration in smokers and non-smokers. $n = 40$; means \pm SEM. Statistical comparisons showed significantly higher potassium levels in smoking subjects $P < 0.05$.

Figure 3 showing the salivary bicarbonate ion concentration in smokers and non-smokers. $n = 40$; means \pm SEM. Statistical comparisons showed significantly higher bicarbonate levels in smoking subjects $P < 0.05$.

Figure 4 showing the salivary chloride ion concentration in smokers and non-smokers. $n = 40$; means \pm SEM. Statistical

Table 1: Anthropometric and other baseline data

Data parameters	Smokers (Group A)	Non-smokers (Group B)	<i>P</i>
Age	30.95 \pm 0.95	29.45 \pm 0.92	0.67
BMI	19.29 \pm 0.39	21.78 \pm 0.36	0.0002
Systolic blood pressure	118.7 \pm 0.74	115.2 \pm 0.80	0.0005
Pulse rate	73.20 \pm 0.43	71.05 \pm 0.4197	0.0235

Mean difference statistically significant at $P < 0.05$; SEM. SEM: Standard error of mean, BMI: Body mass index

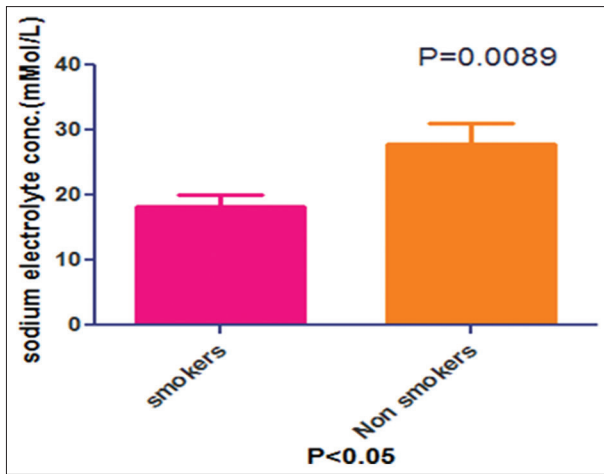


Figure 1: Sodium electrolyte concentration in smokers and non-smokers

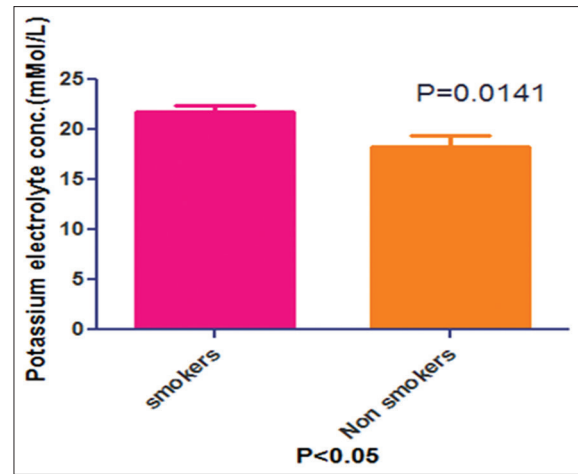


Figure 2: Potassium electrolyte concentration in smokers and non-smokers

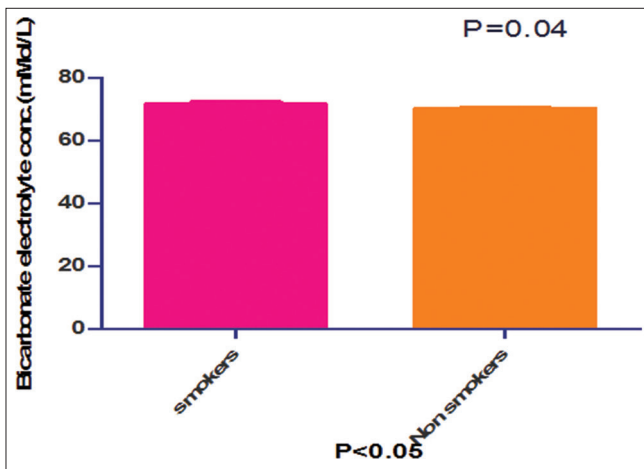


Figure 3: Bicarbonate electrolyte concentration in smokers and non-smokers

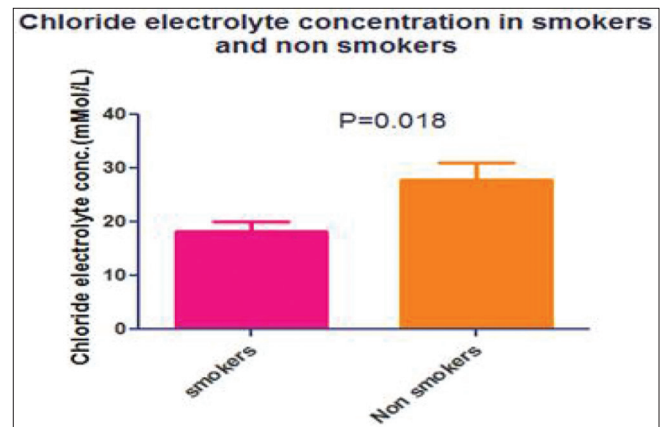


Figure 4: Chloride electrolyte concentration in smokers and non-smokers

comparisons showed significantly lower potassium levels in smoking subjects $P < 0.05$.

DISCUSSION

Tobacco smoking has been implicated as a cause of over 3 million deaths yearly.³ Chronic smokers are at increased risk of gastrointestinal, cardiovascular, respiratory diseases and many cancers^{1,2,18} Some researchers have been able to relate chronic smoking to alterations in serum electrolytes which could lead to life-threatening metabolic imbalances.¹¹ Many oral and systemic conditions manifest themselves as changes in the flow and composition of saliva.¹⁹ Saliva is secreted in two stages. It is first secreted into the acinus of salivary glands and this fluid (primary secretion) is not much different from extracellular fluid.

The tobacco smoke has been found to alter normal homeostasis of the oral cavity including the antioxidant and

other protective systems of saliva¹¹ The mucosal changes in smokers may also arise from the drying effects of the mucosa, intraoral pH changes high intraoral temperatures, altered resistance to bacteria, fungal and viral infections, local alteration of membrane barriers and immune responses.¹¹ Smoking-related cell damage may leave molecular footprints in the saliva, offering the potential for non-invasive early diagnosis of tobacco-related oral diseases.²⁰

When the primary secretion flows through the acinar ducts, some ions are actively reabsorbed from and some are actively secreted into the acinar duct lumen. During maximal salivation, there is not much time for this process to occur and the levels of these ions are reversed. Smoking causes a temporary increase in unstimulated salivary flow (SF).^{5,18} Men that smoke present significantly higher stimulated SF than non-smoking men. The irritating effect of tobacco increases glandular excretion and nicotine causes severe morphologic and functional alterations in the

salivary glands.¹⁰ As the SF increases, the concentrations of total protein, sodium, calcium, chloride and bicarbonate as well as the pH increases to various levels, whereas the concentrations of inorganic phosphate and magnesium diminish.^{5,21}

In this study, we found significantly higher levels of potassium and bicarbonate in the saliva of tobacco users as compared to non-users. This could be possibly as a result of increased flow that has been reported in smokers. Laine *et al.*¹⁴ reported that smoking was associated with higher concentration of salivary potassium, sodium and total protein. However, this finding is entirely opposite to that of Khan *et al.*,²² who reported that potassium decreases with increase in the SF rate of chronic tobacco users. The carbonic acid/bicarbonate buffer is the major buffer in stimulated saliva with bicarbonate acting mainly to neutralize acids produced by bacteria when they digest sugars in the mouth or acids from the stomach. The concentration of the bicarbonate ion depends largely on the SF rate.²³ It has been reported that increased alkalinity (pH) of the oral environment is needed for the growth of dental plaque which is the primary etiologic factor in periodontal disease.²⁴ The significant increase in bicarbonate concentration in smokers observed in this study can be a possible factor in the high prevalence of periodontal diseases observed in chronic smokers.²⁵

It was also observed in this study that the sodium and chloride concentration was significantly lower in smokers. This contradicts the work of Erdemir and Erdemir¹⁵ which showed non-significant difference for salivary sodium, potassium, bicarbonate and chloride. This difference in results could be as a result of the selection of smokers used for the research. This work was done on chronic smokers while theirs was not specified.

Some other researchers reported that chronic use of tobacco decreased the sensitivity of taste receptors which in turn leads to depressed salivary reflex.^{18,22} This possibly leads to altered taste receptor response and hence to changes in SF rates. Some even reported a reduction in the SF which could also lead to a reduction in the electrolyte composition of saliva. Khan *et al.*²² in their study, on the other hand, reported that long-term smoking does not adversely affect the taste receptor response and hence SF rate.

Limitation of the study

Participants of this study were selected from only one suburban region in Edo State, Nigeria. To enable better generalizability of the study findings, replication of this study in different regions of Nigeria is recommended.

CONCLUSION

This research shows that chronic smoking caused considerably significant effects on the stability and normal secretion of salivary electrolytes with significantly higher salivary concentrations of potassium and bicarbonate ions and lower concentrations of sodium and chloride ions observed in chronic smokers. This could have adverse consequences on the normal homeostasis of the oral environment especially with regard to increased salivary alkalinity as a result of increased salivary bicarbonate which is an established predisposing factor to periodontal diseases. However, further studies with larger samples size are recommended.

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Conflicts of interest

There are no conflicts of interest.

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