SALIVARY CHARACTERISTICS AMONG 12-YEAR-OLD CHILDREN WITH SIGNIFICANT CARIES INDEX FROM URBAN AND SUBURBAN SCHOOLS IN CAN THO CITY

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ABSTRACT

Background: *Dental caries is the most prevalent chronic childhood disease with numerous predisposing factors. Salivary properties have been linked to progressive dental caries in previous studies. However, the role of these contributing factors in the management of dental caries in children remains insufficient. Thus, the investigation of salivary characteristics from different types of communities within a specific pediatric population is an obvious demand.* ***Objectives:*** *To assess the salivary characteristics among school-going children aged 12 years from two urban and suburban schools in Can Tho city.* ***Materials and methods:*** *A cross-sectional descriptive study was conducted on 62 twelve-year-old students with significant caries index in two locations with different socioeconomic status in Can Tho city. Those participants underwent saliva testing by using a saliva testing kit (Saiva-Check BUFFER) to evaluate stimulated and unstimulated saliva parameters including consistency, flow rate, pH and buffering capacity.* ***Results:*** *Out of the total population, males and females made up 40.3% and 59.7%, respectively. Both boys and girls had similarities in all salivary parameters ($p > 0.05$). Nearly half of suburban students (48.4%) had resting frothy bubbly saliva while more than half of urban students (58.1%) had watery clear saliva at rest. All students had moderate and normal acidic saliva before and after stimulation regardless of living areas. The discrepancy in resting salivary viscosity, resting salivary pH was statistically significant based on region ($p < 0.05$). 64.5% of the students in both suburban and urban enclaves had a normal stimulated saliva flow rate. In contrast, a normal or high buffering capacity of stimulated saliva was only seen in a few students. Regarding the flow rate, pH, and buffering capacity of stimulated saliva, there were no differences between urban and suburban areas ($p > 0.05$).* ***Conclusions:*** *The findings of this study provide additional proof of the significance of salivary properties in assessing dental caries, especially in socioeconomic deprivation areas. Furthermore, it also implies that salivary parameters should be taken into account as a potential indicator for managing high caries-risk children.*

Keywords: *caries, children, saliva, suburban, urban*

I. INTRODUCTION

Saliva plays an essential role in oral protection. The typical daily salivation volume ranges from 0.5 to 2 liters in a healthy person. The great deal of secreted saliva is related to multiple factors, including time duration, medication usage, the neurological system and hydration status [1]. Salivary pH is another characteristic frequently mentioned, ranging from 6 to 7 under normal conditions [2]. Acidity in the saliva rises at night and falls in the morning. The salivary pH parameter can also be affected by other variables, such as dietary nutrition or systemic illness. Prior to stimulation, saliva flow is measured to be between 0.33 and 0.55 mL per minute and can alter in response to various stimuli [1]. Saliva consistency is primarily

determined by protein composition. Additionally, the buffering mechanisms help to maintain a high level of pH and prevent the production of microbial acids. The key elements of buffering activity in saliva are hydrogen carbonates, phosphates and proteins [2].

Dental caries is the most common noncommunicable disease in human beings and is also ranked one of the major oral diseases, along with periodontal disease, edentulism and oral cancer. It is the foremost widespread chronic disorder during childhood with an estimated 514 children worldwide suffering from dental caries without receiving any treatment [3]. Among several predisposing factors of dental caries, salivary characteristics take a crucial responsibility for sustaining the dynamic processes of demineralization and remineralization [1]. In a variety of studies, salivary flow rate, pH and buffering capacity were reported to be associated with dental caries experience in the population of school-aged children [4], [5]. However, it was a scarcity of studies on the true role of these contributory factors that forced this study to be conducted. In addition, the geographical and sex differences in saliva parameters among children with high caries-risk have not been adequately comprehended yet. Thus, this study was carried out to fill the gap with the purpose of assessing salivary characteristics among school-going children aged 12 years from two urban and suburban schools in Can Tho city.

II. MATERIALS AND METHODS

2.1. Study subjects

The sample size for this study was determined using following statistical formula:

$$n = Z^2_{1-\frac{\alpha}{2}} \times \frac{\sigma^2}{E^2} = 1.96^2 \times \frac{1.90^2}{0.475^2} \approx 62$$

In which:

n: sample size

E: margin of error ($E = 0.475$)

Z: confidence level with $\alpha = 0.05$ ($Z_{0.975} = 1.96$)

σ: standard deviation of the population mean ($\sigma = 1.90$)

The estimated standard deviation of significant caries index for permanent dentition in 12-year-old students was based on previous research by Andegiorgish A.K. *et al.* (2017) [6].

Twelve-year-old students of either gender who voluntarily participated under the permission of their parents or guardians were included in the study. The exclusion criteria were students who were systemically or locally diseased, medically and physically compromised, on medication, and absent at either of two sampling stages.

2.2. Study methods

A cross-sectional descriptive study was carried out at two lower secondary schools in Can Tho city, Vietnam. Two schools were randomly chosen, one from 11 urban schools in Ninh Kieu district and the other from 6 suburban schools in Phong Dien district. The data was collected from March 2023 to May 2023. A multistage cluster random sampling method was performed, thereby selecting a total of 62 students joining in this study.

The oral examination was conducted by four trained examiners with the overall Kappa's score of 0.87 interpreting almost perfect agreement. Dental caries status was recorded with the Decayed, Missing, and Filled Teeth Index (DMFT) according to the World Health Organization (WHO). The plane mouth mirrors and dental probes were used for caries detection, and a saliva testing kit (Saiva-Check BUFFER, Nimi Chemical

Industrial Co., LTD., Gunma, Japan) was used to measure saliva characteristics including consistency, flow rate, pH, and buffering capacity.

The process of collecting saliva was based on the manufacturer's instructions. At least an hour prior to saliva collection, students were not allowed to rinse their mouths, brush their teeth, or consume foods or beverages. At first, the consistency of saliva at rest was determined by observing saliva in their mouths with a plane mouth mirror. The strip for pH testing was determined after being dipped into saliva for 10 seconds. Then, the students were asked to chew a piece of wax gum and spit saliva into the plastic cup with markings every 30 seconds for 5 minutes. The stimulated saliva was used for assessment of flow rate, pH and buffering capacity. Buffering capacity was assessed by dropping the plastic pipette over three test pads of the buffer test strip, and recording after 2 minutes. The categorical variables used in this study are summerized in Table 1.

Table 1. The salivary parameters were used in this study

Type	Characteristics	Categories	Value
Resting	Consistency	Sticky frothy	
		Frothy bubbly	
		Water clear	
	pH	Highly acidic	From 5.0 to 5.8
		Moderately acidic	From 6.0 to 6.6
		Normal acidic or healthy	From 6.8 to 7.8
Stimulated	Quantity	Very low	Less than 3.5 mL
		Low	Between 3.5 mL and 5.0 mL
		Normal	More than 5.0 mL
	pH	Highly acidic	From 5.0 to 5.8
		Moderately acidic	From 6.0 to 6.6
		Normal acidic or healthy	From 6.8 to 7.8
	Buffering capacity	Very low	A score range of 0–5
		Low	A score range of 6–9
		Normal or high	A score range of 10–12

2.3. Statistical analysis

Data were analyzed using SPSS 22.0 software for Windows (IBM Corp., New York, NY, USA). All categorical variables including saliva consistency, pH, flow rate and buffering capacity were exhibited in frequencies and proportions. The Chi-square test (χ^2), Fisher's Exact Test (F) and Fisher-Freeman-Halton Exact Test (FFH) were applied for analysis of the relationship among salivary characteristics' groups. The significance was set at a *p-value* ≤ 0.05.

2.4. Ethical approval

The Declaration of Helsinki was adequately addressed, and ethical clearance for the research was obtained from the Ethics Committee of Can Tho University of Medicine and Pharmacy (decision no. 22.161.SV/PCT-HĐĐĐ). Before data collection, written informed consent was acquired from the parents or guardians of the participants with a thorough explanation of the research including purposes, procedures, risks and benefits. The enrollment of the participants was entirely voluntary and the right to withdraw from participation was acceptable at any time without penalty.

III. RESULTS

Among 62 participants enrolled in the study, 25 of the subjects were boys and 37 of the subjects were girls, which were accounted for 40.3% and 59.7%, respectively. The boy-to-girl ratio was 2:3.

3.1. Resting salivary characteristics

Table 2. Resting saliva consistency based on school area and gender

Categorical variable		Resting saliva consistency (n, %)			χ^2	*p**
		Sticky frothy	Frothy bubbly	Watery clear		
School	Suburban	9 (29.0)	15 (48.4)	7 (22.6)	8.113	0.017
	Urban	5 (16.1)	8 (25.8)	18 (58.1)		
Gender	Boy	5 (20.0)	10 (40.0)	10 (40.0)	0.220	0.896
	Girl	9 (24.3)	13 (35.1)	15 (40.5)		
* Pearson Chi-Square Test						

Table 2 shows that the percentage of the suburban students who had resting frothy bubbly saliva was 48.4%, while 58.1% of the students living in urban regions had watery clear saliva at rest. Only a small number of boys and girls had sticky frothy resting saliva. The difference was statistically significant by area, but not by gender.

Table 3. pH of resting saliva based on school area and gender

Categorical variable		pH of resting saliva (n, %)			χ^2	*p**
		Highly acidic	Moderately acidic	Normal acidic		
School	Suburban	0 (0)	24 (77.4)	7 (22.6)	5.599	0.018
	Urban	0 (0)	15 (48.4)	16 (51.6)		
Gender	Boy	0 (0)	16 (64.0)	9 (36.0)	0.022	0.883
	Girl	0 (0)	23 (62.2)	14 (37.8)		
* Pearson Chi-Square Test						

In Table 3, most children had moderately acidic saliva at rest. In urban areas, the number of children with normal acidic unstimulated saliva (51.6%) was higher than that with moderately acidic unstimulated saliva (48.4%). In contrast to gender, the level of resting saliva pH was significantly different based on enclave.

3.2. Stimulated salivary characteristics

Table 4. pH of stimulated saliva based on school area and gender

Categorical variable		pH of stimulated saliva (n, %)			F	*p***
		Highly acidic	Moderately acidic	Normal acidic		
School	Suburban	0 (0)	5 (16.1)	26 (83.9)	-	0.053
	Urban	0 (0)	0 (0)	31 (100)		
Gender	Boy	0 (0)	1 (4.0)	24 (96.0)	-	0.640
	Girl	0 (0)	4 (10.8)	33 (89.2)		
** Fisher's Exact Test						

The majority of the subjects had normal acidic stimulated saliva. There was not a statistically significant difference depending on region and gender. These are demonstrated in Table 4.

Table 5. Stimulated saliva flow rate based on school area and gender

Categorical variable		Stimulated saliva flow (n, %)			FFH	*p****
		Very low	Low	Normal		
School	Suburban	3 (9.7)	8 (25.8)	20 (64.5)	1.178	0.656
	Urban	1 (3.2)	10 (32.3)	20 (64.5)		
Gender	Boy	2 (8.0)	6 (24.0)	17 (68.0)	0.739	0.696
	Girl	2 (5.4)	12 (32.4)	23 (62.2)		
*** Fisher-Freeman-Halton Exact Test						

Table 5 displays that a normal stimulated saliva flow rate was seen in a large number of students and the disparity was not remarkably significant between different locations or genders.

Table 6. Buffering capacity of stimulated saliva based on school area and gender

Categorical variable		Buffering capacity of stimulated saliva (n, %)			χ^2	*p**
		Very low	Low	Normal/High		
School	Suburban	10 (32.3)	12 (38.7)	9 (29.0)	3.253	0.197
	Urban	7 (22.6)	19 (61.3)	5 (16.1)		
Gender	Boy	5 (20.0)	13 (52.0)	7 (28.0)	1.419	0.492
	Girl	12 (32.4)	18 (48.6)	7 (18.9)		
* Pearson Chi-Square Test						

Low buffering capacity of stimulated saliva had the largest proportion and neither school areas nor genders showed any statistically significant differences, which are presented in Table 6.

IV. DISCUSSION

Saliva characteristics including saliva consistency, flow rate, pH, and buffering capacity were evaluated based on gender and locality. The lack of statistically significant sex differences in the whole set of salivary indicators was described in this study. A study of González-Aragón Pineda A.E. *et al.* previously recruited 421 Mexican aldolescents from 12 to 14 years of age reported that resting and stimulated pH, flow rate and buffer capacity were found to be associated with gender [5]. These distinct findings might be a result of the two studies' different subject populations.

Considering the elasticity of non-stimulated saliva, the gap between urban and periurban locations was seen in this study. It is known that salivary consistency depends on saliva composition, mainly its protein concentration, so the protein composition of saliva may differ in suburban and urban subjects of this study [1]. Similarly, a prior investigation by Mazengo M.C. *et al.*, conducted on 330 subjects in Tanzania, concluded the difference in protein composition in saliva between urban and rural enclaves [4].

In addition, the resting salivary pH in suburban students was significantly lower than that in urban students, so the resting pH of saliva was found to be associated with students' living areas. This was similar to the result of Kedjarune U. *et al.* on 105 students from an urban center of Bangkok and 138 students from a rural area of Khon Kaen in Thailand reported that the mean of salivary pH was higher in the urban region as compared to the rural region [7]. Furthermore, a study of Duong Hoai Giao Ha investigated the salivary characteristics related to dental caries among urban children in Can Tho, announcing that most urban students had moderate and normal acidity in resting salivary pH [8]. Unlike the salivary pH at rest, the stimulated salivary pH was found to not differ significantly between the suburb and the urban center.

In their study, García-Godoy F. and Hicks M.J. assumed that once the salivary pH level was low, the caries-risk was high due to the change in remineralization [9]. The past study of Zhen Hu *et al.*, which was enrolled 88,972 Chinese students aged 12 years, claimed that the observation of urban-rural differences in 12-year-old caries children was reached [10]. Additionally, even though it is acknowledged that saliva pH was under the impact of multiple factors comprised of daily cycles, diet, and systemic diseases, the study's method ensured the same procedure and the same conditions of the subjects [1]. Hence, the salivary pH value may predict the susceptibility to dental caries at the research site.

As regards stimulated salivary flow rate, this study revealed no difference between two geographical enclaves, which was in line with the result of Mazengo M.C. *et al.* undertaken in 46 subjects from rural areas and 37 subjects from urban areas among 83 students aged 12 years [4]. Nevertheless, the research by Gaur A. *et al.* among 80 schoolchildren aged 12-15 years in Jaipur city of India reported that there was a disparity in stimulated salivary quantity among students from urban and rural regions in summer season, while this difference was not observed in winter season [11]. Besides that, salivary buffering capacity did not remarkably vary among two enclaves. Similarly, a study of Gaur A. *et al.* exhibited that there was not significantly different between two areas in both summer and winter seasons [11]. Conversely, Mazengo M.C. *et al.* reported that 12-year-old children from rural areas had higher buffering capacity than those from urban areas due to dietary fiber foods, whereas Kedjarune U. *et al.* detected that buffering capacity was lower in rural children than in urban children [4], [7].

Buffer capacity, a significant property of saliva, aids in neutralizing the microbial acids primarily through the concentration of hydrogen carbonate ions. At the same time, the salivary flow rate is also directly proportional to the concentration of hydrogen carbonate ions [1], [2]. The outcomes of the study in contrast to the aforementioned studies could be attributed to the sample of subjects and the use of different metrics for salivary parameters' assessment.

It is recognized that studies focusing on those with significant caries index from two types of communities are relatively scarce. This research highlighted salivary characteristics in the high-caries child population from urban and periurban areas and provided valuable insight into the point-of-care saliva testing for dental caries, especially in disadvantaged places. Nonetheless, further investigations should be taken in geographical enclaves with marked socioeconomic differences or performed in several cities across the country.

V. CONCLUSIONS

In spite of no significant changes in the patterns of flow rate, pH and buffering capacity in saliva after stimulation, the consistency and pH of resting saliva considerably vary according to region. The findings of this study contribute evidence for the value of salivary characteristics for dental caries evaluation in urban and suburban environments. It could be proposed as a prospective tool for management of a child population at high caries risk.

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