ORIGINAL ARTICLE

EVALUATION OF UNSTIMULATED SALIVARY FLOW RATE VARIATIONS AND ITS RELATIONSHIP WITH DENTITION AND DEMOGRAPHIC FACTORS AMONG HEALTHY CHILDREN AND ADOLESCENT

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Background: Saliva, the composite bio fluid serves as the primary defence mechanism in safeguarding oral health. Scientific evidence exists regarding the variations in the flow rate of children and young adults is scarce. Thus, this research aims to assess the salivary flow during early mixed, late mixed, and permanent dentition in children and adolescent to find its association with age, gender, & socioeconomic status during different dental transitional stages. **Methods:** This cross-sectional study comprised of 384 volunteers, randomly selected from private and public schools across Karachi. The 6–16 years old participants were included in the study and stratified after oral examination into early mixed, late mixed, and permanent dentition groups. Passive Drool Method was used for saliva collection. The amount of saliva collected was divided by the time interval for sample collection to measure the saliva flow rate. Salivary flow rate was presented as mean and standard deviations; chi-square test was used to find the association among three dental transitional periods and salivary flow rate. **Results:** The mean unstimulated salivary flow rate (US-SFR) was observed to be 0.37±0.07 ml/min. Permanent dentition period has the highest mean salivary flow. Age and Socioeconomic Class (SEC) show significantly increased flow rate (i.e., $p<0.05$) among three dental transitional stages while gender has no statistically significant effect. **Conclusions:** The mean US-SFR values vary greatly in different dental transitions having positive association with age among different SEC strata. While boys and girls show much variability between the groups but have no statistically significant difference.

Keywords: Age, Dentition; Gender; Socioeconomic status; Unstimulated salivary flow rate

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INTRODUCTION

Saliva functions as the primary defence mechanism in the oral cavity. The composition and functions of saliva has been studied comprehensively in previous time.[1] It is composed of water, organic and inorganic constituents that are performing specific biologically essential tasks for homeostasis of the oral cavity, by aiding in digestion, protecting against microbial infections, and preventing dental caries.[1,2] The secretion of saliva is controlled by autonomic nervous system and the variation in salivary volume is due to type and intensity of stimulation[3]. The natural circadian rhythm of body is also observed for salivary secretion as the maximum amount of saliva is produced around mealtimes (i.e., before, during, after) and lowest amount of saliva is observed while sleeping.[4,5] It is evident that adequate flow/volume and composition of saliva has a significant protective role of lubrication of oral mucosa.[6] Protection of soft tissues of oral cavity is necessary to counter dehydration, infiltration, ulceration, and potential carcinogens.[6] Mechanical cleansing and enamel remineralization are vital functions of saliva essential to maintain the integrity of the tooth.[7] Impaired saliva synthesis and/or secretion can lead to difficulty in mastication, tasting and swallowing of food.[8] Moreover, salivary flow has a substantial role in oro-dental health as impaired salivary flow rate leads to various oral cavity ailments.[9] Hyposalivation has been associated with insufficient intake of food and thereby insufficient nutrition to the salivary glands, for example in children with malnutrition, or individuals with eating disorders. There are various causes of

hyposalivation in adults such as dehydration, depression and certain medication like antihypertensive, anti-depressants and some muscles relaxants.

Various researchers worked in the past to find the mean secretion rate of saliva in different populations.[10–13] The salivary flow rate depends on multiple factors even in normal healthy subjects[14]. Understanding the influence of these salivary flow parameters and determining the salivary protective role may be significant in maintaining oral health. The evaluation of unstimulated salivary flow rate (US-SFR) variations and their relationship with dentition and demographic factors among healthy children and adolescent is crucial for understanding oral health dynamics. The data currently available is largely acquired from adults, little is known about the differences in children and adolescent.[15] Also, the existing literature lack the knowledge of unstimulated salivary flow rate values during the transitional stages of dentition and other demographics from Pakistani population. Hence, assessing US-SFR provides insights into normal physiological variations influenced by factors such as age, gender, and dentition stages (primary, mixed, or permanent), which are critical during childhood and adolescence. Variations in salivary flow rates can serve as early indicators of systemic or oral health issues, potentially informing preventive and therapeutic strategies specific to paediatric populations. Furthermore, this research contributes to baseline data essential for comparing pathological conditions, aimed at improving oral health outcomes in children and adolescent groups. Thus, this research aims to evaluate the US-SFR during early mixed, late mixed, and permanent dentition in children and to find out the association of salivary flow with age, gender, & socioeconomic status during early mixed, late mixed, and permanent dentition of the sample from Pakistani population.

MATERIAL AND METHODS

The samples for this cross-sectional study were collected from randomly selected private and public schools based on socioeconomic class (SEC) from across Karachi city. The 384 (both girls and boys) participants were recruited in the study using stratified random sampling method, where sample was divided into three strata's according to socioeconomic classes. The schools were selected by random number generation via excel program from the list of schools in the chosen towns of Karachi city, one private and one public school was selected from each town. Healthy participants of both gender between the age of 6–16 years were included in the study. The participants with the history of any medication, radiation exposure, developmental anomaly, any systemic disease or with signs of oral dryness (like dry lips, halitosis, burning or soreness of mouth, altered taste sensation, difficulty in speaking or swallowing) were excluded.

The sample size was calculated using Open epi calculator for proportion. The confidence interval was taken as 95% and the anticipated frequency to be as 50%. The total sample size was estimated to be N=384.

This study was conducted in accordance with the Declaration of Helsinki. This analytical cross-sectional research was approved by the Research and Ethics Committee of Hamdard University Dental Hospital, Hamdard University Ref. No. HCM&D/HUDH/1102-10-21. Further, approval for subjects and sample collection was taken from the principals of selected schools and written informed consent/assent were taken from participants and parents (for participants under 16 years).

A total of 500 consent forms were distributed a week before the sample collection. Only 438 participants returned it with the permission to collect saliva. Total n=54 participants were excluded as they did not fulfil the inclusion criteria. The oral examination was carried out in artificial light using mirror and disposable tongue depressor while children sat comfortably on the chair. The children were grouped into early mixed (6–8 years), late mixed (9–12 years), and permanent dentition (13–16 year) based on the number of teeth present in the oral cavity in three transitional stages.

All the data collected was recorded in a self-designed proforma with three sections, in section- I the demographic details with the questions related to socioeconomic status. In section-II the observations from the oral examination were noted for the number of teeth present and signs of oral dryness along with the past medical and drug history and in section-III the salivary flow rate was recorded and calculated. All samples were collected by the principal investigator who was calibrated for both oral examination and saliva sample collection. All samples were collected between 9 and 11 am, this was to minimize the circadian rhythm effect on saliva flow. Participants were advised to refrain from consuming any food or beverage one hour prior to sample collection. The collection of resting whole saliva sample was performed by Passive Drool Method[11]. Participants were instructed to sit relaxed on a chair with their head bowed and placed the graduated saliva collection tube in close contact to lower lip and let the saliva dribble into the tubes. Time was noted at the start of sample collection. Each saliva sample was collected for 3 minutes. The amount of saliva collected was divided by the time interval for sample collection to measure

the saliva flow rate. The flow rate was recorded in ml/min. The measurement of whole unstimulated salivary flow was scored as: low (<0.25 ml/min), normal (0.25–0.37 ml/min) and high (> 0.37 ml/min) within the normal physiological range.[12]

Gender, socioeconomic class and the three dental transitions, i.e., early mixed, late mixed and permanent dentition were the independent qualitative variables whereas age is the quantitative independent variable. Salivary flow rate was the dependent quantitative variable.

IBM Statistical Package for Social Sciences (SPSS) Version 26 software was used for data management and analysis. The quantitative variable that is; age and salivary flow rate was presented in form of mean and standard deviations, and all qualitative variables (Dentition, Gender, Socioeconomic status) were presented as frequencies and percentages. To analyze the relation of salivary flow rate with dentition, age, gender, and socioeconomic status the chi- square test was applied. *p*-Value <0.05 was considered statistically significant.

RESULTS

Of the 384 participants in the present study, the selected girls (187) and boys (197) were examined with the mean age of 11.29 (±03.13) years. The saliva samples were collected, and the mean unstimulated salivary flow rate was found to be 0.37ml/min (±0.07) in the overall study sample.

Table-1 shows the distribution of low, normal, and high resting salivary rate values within the normal physiological range among the three dentition periods. In early mixed and late mixed dentition >50% of the participant have normal range of US-SFR while in permanent dentition most participant, i.e., 54%. have the highest values of the normal range.

The increasing trend of salivary flow rate can be observed from early mixed (6–8 years), dentition to late mixed (9–12 years), and permanent dentition (13–16 years) in the table-2 and this difference was statistically significant. The table-3 shows that there was no statistically significant difference found in the mean values of boys and girls where girls showed a higher flow rate than boys; however, the variability of the means can be observed within the groups.

The table-4 the present means US-SFR in the three socioeconomic classes. Statistically significant difference in the mean values of US-SFR can be seen among the three groups, with highest variability can be observed in the lower socioeconomic class.

Figure-1 presented the line chart for the differences in the mean values of US-SFR among the three dental transitions i.e., early mixed (6–8 years), late mixed (9–12 years), and permanent dentition (13–16 years) to observe its association with sex and SEC.

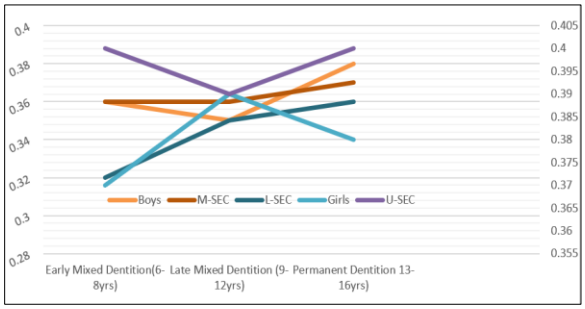

Figure-1: Shows the unstimulated salivary flow rate variations among Early mixed, late mixed and Permanent dentition children, and its association with the gender and the three Socioeconomic classes

Table-1: Descriptive distribution of demographic factor in relation to low, normal, and high values of US-salivary flow rate

Categories		US-SFR[a] within normal physiological range			Total (N)
		Low US-SFR n (%)	Normal US-SFR n (%)	High US-SFR n (%)	
Dentition	Early mixed[b]	2(2.08)	52(54.16)	42(43.75)	384
	Late mixed[c]	5(3.81)	62(52.98)	64(47.32)	
	Permanent[d]	13(8.28)	60(38.21)	84(53.50)	

a: US- SFR: Unstimulated salivary flow rate. b: (6-8yrs) c: (9–12 years) d: (13–16 years)

Table-2: Mean value of unstimulated salivary flow rate in relation to dentition and age

Demographic Factors	Dental Transition	Mean US-SFR (ml/min) Mean (SD [a])	*p*-value [b]
Dentition/Age	Early Mixed Dentition (6–8 years)	0.33±0.07	0.04
	Late Mixed Dentition (9–12 years)	0.35±0.07	
	Permanent Dentition (13–16 years)	0.36±0.09	

a:SD Standard deviation. b: chi-square test: *p*-Value <0.05 was considered statistically significant.

Table-3: Mean value of unstimulated salivary flow rate in relation to dentition and sex

Demographic Factors Gender	US-SFR (ml/min) Mean (SD [a])			Mean US-SFR (ml/min) Mean (SD [a])	*p*-value [b]
	Early Mixed Dentition	Late Mixed Dentition	Permanent Dentition		
Boys	0.36(0.55)	0.35(0.05)	0.38(0.07)	0.36±0.09	0.10
Girls	0.37(0.65)	0.39(0.08)	0.38(0.09)	0.38±0.08	

a:SD Standard deviation. b: chi-square test: *p*-Value <0.05 was considered statistically significant.

Table-4: Mean value of unstimulated salivary flow rate in relation to dentition and SEC

Demographic Factors SEC	US-SFR (ml/min) Mean (SD [a])			Mean US-SFR (ml/min) Mean (SD [a])	*p*-value [b]
	Early Mixed Dentition	Late Mixed Dentition	Permanent Dentition		
Upper SEC	0.40(0.05)	0.39(0.08)	0.40(0.08)	0.40(0.07)	0.01
Middle SEC	0.36(0.05)	0.36(0.05)	0.37(0.07)	0.37(0.06)	
Lower SEC	0.32(0.04)	0.35(0.05)	0.36(0.07)	0.34(0.06)	

a:SD Standard deviation. b: chi-square test: *p*-value <0.05 was considered statistically significant.

DISCUSSION

It is well established that good oral health is the essential component of good general health. Though enjoying good oral health includes more than just having healthy teeth, many children and young adults have inadequate oral and general health because of active and uncontrolled dental caries. Saliva plays a major role in maintaining oral health via its salivary clearance mechanism. Both stimulated and unstimulated salivary flow rates in adults have been shown to decrease with advancing age; a finding that remained unclear[13, 14]. There are few studies on these salivary parameters in children and young adults[15]. In children and adolescents, the salivary flow increases with increasing age until 15years when the salivary glands are fully developed, and this trend continues till 30–35 years of age.[16] Hence, to understand these changes' comparison with the group of older population had to be made. This study included subjects of 6-16years of age. The recruited children were divided into three age groups: early mixed dentition (6–8 years), late mixed dentition (9–12 years), and permanent dentition (13–16 years). The unstimulated salivary flow rate shows much variability among three dental transitional stages Unstimulated salivary flow rates in the children of early mixed dentition (6–8 years) were slightly lower than in late mixed dentition (9–12 years), and permanent dentition (13–16 years). Many of the children in permanent dentition (13–16 years) in this study have their salivary flow value was on higher side within the normal range. Previous reports showed a similar change in children and adolescent population.[17-19] There are multiple factors that could affect the dental health as well as on salivary secretion.[20] In the present study, it was not possible to determine such a correlation. While as far as age is concerned, the lowest mean flow rate was found in children, indicating that older age had a positive influence on salivary flow because of the developmental process[21] and this difference was statistically significant. Therefore, our finding that unstimulated salivary flow rate increases significantly with increasing age in healthy children is generally in agreement with previous reports.[22–24] In fact, age-related gradual loss of secretory tissue and increased number of apoptotic salivary epithelial cells may contribute to the observed functional deterioration, but these changes can only be observed late in life.[25]

Gender is another demographic factor that may influence salivary clearance. The effect of gender on resting salivary flow is not clear; data of no effect[18, 25] and positive effect[26, 27] have been reported. Previous studies had shown that males have higher saliva output than females[28, 29] even in children[24]. These results were contrary to this study, which showed that girls have higher salivary output when compared to boys in three dentitions though this difference was not statistically significant. However, the US-SFR showed much variability among the three dental transition with highest flow rate 0.39 (0.08) ml/min was observed in late mixed dentition in girls whereas in boys highest mean 0.38 (0.08) is observed in permanent dentition.

The mean salivary flow rate showed statistically significant difference between the three dental transitions. Participants from the lower SEC have lowest mean US-SFR, i.e., 0.32(0.06) ml/min in early mixed dentition period whereas in the upper SEC strata early mixed and permanent dentition showed 0.40(0.06) ml/min. Associations between socioeconomic levels and oral health behaviours have been shown in various research, suggesting that a high socioeconomic level could improve the conditions against dental caries by utilizing better oral hygiene habits, diet, and access to dental care.[30] In this study there was a significant difference in unstimulated salivary flow among children from different towns stratified on the bases of socioeconomic classes. The scope of this study couldn't explain this fact. However, it could be hypothesized based on

previously available literature and from the results of this study that malnourishment could be the cause of decreased resting salivary flow.

It can be deducted from the study beside other factors[10,31]; developing dentition could greatly alter salivary functions and if it combines with the demographic factors like gender and low socioeconomic class where primary oral hygiene measures can be overlooked along with the malnutrition that correlates with decreased salivary flow into the adolescent years[32,33] could lead to compromised oral health and so the general health. However, further studies are needed to find the cause of these effect

CONCLUSION

Within the limitations of this cross-sectional study design, it has been recognized that the mean unstimulated salivary flow rate values vary greatly in different groups of healthy children in relation to dentition, age, sex, and different socioeconomic strata. The US-SFR increased significantly among three groups of dentitions (early mixed. late mixed and permanent). US-SFR also significantly increased with age and SEC where low and middle SEC have no difference in mean US-SFR value, but upper SEC US-SFR was significantly increased. Gender showed no significant difference in salivary flow rate while girls have higher mean values than boys among early mixed late mixed and permanent dentitions. The data from this study provide the base line values of unstimulated salivary flow rate of healthy children from the age of 6 to 16 years in the sample from Pakistani population for comparison to the children with systemic diseases affecting salivary parameters, in particular the salivary flow rate.

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Competing interests

Thera have no competing interests (financial and non-financial) related to the article.

AUTHORS' CONTRIBUTION

ASA was the principal investigator and has contributed to concept, design, data acquisition, result interpretation, and drafted the manuscript. IA has contributed to the conception, design, and interpretation of results MAQ has contributed to the conception and design and drafting the manuscript. ZM has contributed to managing the data, statistical analysis, and results compilation. AR contributed to data collection and critically revised the manuscript. All authors read and approved the final manuscript.

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