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Original Article

Obesity and Salivary Parameters (Flow Rate, Buffer Capacity, and Salivary pH) in Children of Moradabad, India

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Abstract

Introduction: According to the World Health Organization, by 2015 approximately 2.3 billion adults worldwide will be overweight and more than 700 million obese.

Aim: To evaluate the relationship between obesity and salivary parameters (salivary flow rate, buffer capacity, and pH) among 14 and 15-year-old school children of Moradabad, India.

Materials and Methods: A study was conducted among 25 obese and 25 normal weight children. Anthropometric measurements were performed to obtain body mass index (BMI). Those children whose BMI >30 kg/m^2 were considered as obese and those with BMI in between 18 and 25 kg/m^2, as non-obese. Those students who gave the consent in participation fulfilled the eligibility criteria were included in the study. The subjects' salivary parameters were estimated using GC Saliva-Check Kit. All the participants were examined for the plaque and bleeding on probing and dental caries experience.

Results: The mean BMI of obese and non-obese subjects was found to be 30.98 kg/m^2 and 21.91 kg/m^2, respectively, and the difference was found to be statistically significant. On comparing the salivary flow rate, salivary pH, and salivary buffer capacity between obese and non-obese children, the difference was found to be statistically significant (P = 0.00).

Conclusion: It was concluded that obesity is be one of risk factors responsible for deranged salivary parameters that in turn has an adverse effect on oral health.

Key words: Obesity, Children, Saliva

INTRODUCTION

Obesity and overweight are defined as being an excess of body fat related to lean mass, with multifactor conditions, involving psychological, biochemical, metabolic, anatomic, and social alterations.[1] Spending too much time watching television or playing electronic games together with substituting industrialized food (rich in carbohydrates/fats and poor in fiber) for processed foodstuffs are the main causes of obesity and overweight.[2] The prevalence of child obesity is increasing rapidly worldwide. Childhood obesity presents both immediate and long-term health risks. It is associated with several risk factors for later heart disease and other chronic diseases including hyperlipidemia, hyperinsulinemia, hypertension, and early atherosclerosis.[3] These risk factors may operate through the association between child and adult obesity, but they may also act independently.[4]

While obesity has been proved to be a risk factor for the general health of an individual, its adverse effect on oral health cannot be ignored. Several cross-sectional studies have demonstrated that obesity is associated with chronic

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periodontitis in adults.[5] Moreover, a link between obesity and dental caries has also been explored. Most of the studies regarding the association between obesity and dental caries are based on clinical data expressing caries experience reflecting not only the actual caries situation but also previous accumulation of caries and filled surfaces. Although there are clinical studies demonstrating a relationship between obesity and dental caries,[6] contradictory results are also present.[7] The association between dental caries and obesity is complicated because both are complex conditions with multiple contributing factors including biological, genetic, socioeconomic, cultural, dietary, environmental, and lifestyles issues.

Together with other risk indicators to decay, the salivary flow, pH, and buffer capacity become useful to diagnose the potential cariogenic activity and to predict the risk to caries for an individual.[8]

Obesity is linked to chronic inflammation and a number of adipose-related pro-inflammatory cytokines, so-called adipokines, are enhanced in plasma from obese subjects contributing to enhanced inflammatory response in many body organs.[9] The immune system modulates central nervous system function particularly by cytokines, and the hypothalamic-pituitary-adrenal axis is reported to be dysregulated in subjects with abdominal obesity. Altered function of the hypothalamic-pituitary-adrenal axis may affect the neuroendocrine regulation of salivary glands characterized by diminished salivary gland secretion.[10] Decreased Salivary flow rate, in turn, reduces its buffer capacity and hence shifts the oral environment to acidic pH. As very few reports are present in the literature regarding the association of obesity and salivary parameters among adolescents; hence, a study was conducted to find out if there exists any relation between obesity and salivary parameters among 14 and 15-years-old school children in Moradabad, India.

MATERIALS AND METHODS

A study was conducted among 25 obese and 25 normal weight children of age group 14 and 15 years old. Before conduct of the study, the ethical clearance was taken from the Institutional Ethics Review Board, Kothiwal Dental College and Research Centre, Moradabad. A convenient sample was selected from few private schools in Moradabad, Uttar Pradesh, India, upholding the same socioeconomic status. Anthropometric measures were performed to obtain body mass index (BMI). Those children whose BMI >30 kg/m^2 were considered as obese (cases) and those with BMI in between 18 and 25 kg/m^2, as non-obese (controls); and their consent of participation in the study was taken. The cases and controls were matched with respect to age and gender. The study participants who were on medications or suffering from systemic diseases such as diabetes or undergoing any orthodontic/periodontal treatment were excluded from the study. In addition to the demographic data, the subjects were asked about their parents' educational qualification, the frequency of tooth brushing, dental visits, and food intake. The subjects' salivary parameters, i.e., their salivary flow rate, buffer capacity, and its pH were estimated using GC Saliva-Check Kit (GC Asia Dental Pvt. Ltd-India; Lot: 1205111). All subjects' salivary parameters were estimated between 10 and 11 am, and they were instructed not to eat/drink anything and to refrain from brushing their teeth, 1 h before the conduct of the study. All the participants were examined for the plaque (O' Leary Plaque Index, 1967) and bleeding on probing (BOP) (Ainamo and Bay, 1975), and dental caries experience (using decayed-missing-filled teeth [DMFT] index).

Salivary Analysis

Estimation of stimulated salivary flow rate

The participants were asked to chew the paraffin wax, and after 30 s, they were asked to expectorate into the spittoon and continued chewing for 5 min. Then, saliva was collected into the graduated collection cup for 5 min at regular intervals. Then, the flow rate was obtained by dividing the quantity of saliva collected, by 5 to get the flow rate in ml/min.

Estimation of pH and buffer capacity

The pH strips, in GC Saliva-Check Kit, were used to evaluate the salivary pH by dipping the strip into the sample for 10 s and then comparing the color change using the standard color chart, provided in the saliva GC kit. The buffer capacity was calculated by dispensing the saliva drops onto the three test pads on each buffer strip and then the color change was observed after 2 min to record the buffer capacity by adding the points according to the final color of each test pad.

Then, the data collected was statistically analyzed using Chi-square test, *t*-test, and Mann–Whitney U-test.

RESULTS

The mean BMI of obese and non-obese subjects was found to be 30.98 kg/m^2 and 21.91 kg/m^2, respectively, and the difference was found to be statistically significant. On comparing the salivary flow rate, salivary pH, and salivary buffer capacity between cases and controls, the difference was found to be statistically significant ($P = 0.00$). The mean DMFT among obese and non-obese subjects was 3.76 and 3.80, respectively, and the difference between the two was

not found to be statistically significant ($P = 0.75$) (Table 1). The scores for plaque and BOP were dichotomized as present or absent for easy analysis.

A negative correlation was found between BMI and salivary flow rate, buffer capacity, and salivary pH; which was found to be statistically significant (Table 2).

DISCUSSION

According to the World Health Organization, by 2015 approximately 2.3 billion adults worldwide will be overweight and more than 700 million obese.[11] Burden of the associated cardiometabolic risk components, such as Type 2 diabetes mellitus, dyslipidemia, and cardiovascular disease, is also growing rapidly. Excessive body fat and its metabolic consequences are worldwide epidemics.[12] Obesity has also been associated with an increased risk for periodontal disease[13] as well as dental caries.[7] The adverse effect of obesity on the periodontium may be mediated through pro-inflammatory cytokines such as interleukins (IL-1, IL-6, and tumor necrosis factor-α), adipokines (leptin, adiponectin, resistin, and plasminogen activator inhibitors-1), and several other bioactive substances such as reactive oxygen species, which may affect the periodontal tissues directly.[14]

Table 1: Comparison of frequency of variables among obese and non-obese subjects

Variable	Mean (SD)		*P*-value
	Obese	Controls	
BMI	30.98±0.6	21.91±1.4	0.00*
Salivary flow rate	0.50±0.1	0.74±0.1	0.00*
Salivary buffer capacity	6.8±1.8	9.6±1.7	0.00*
Salivary pH	6.45±0.3	6.8±0.2	0.00*
DMFT	3.7±1.2	3.8±1.0	0.75 (NS)
Plaque			
Present (%)	18/25 (72)	14/25 (56)	0.18
Absent (%)	7/25 (28)	11/25 (44)	
BOP			
Present (%)	10/25 (40)	8/25 (32)	0.38
Absent (%)	15/25 (60)	17/25 (68)	

*P<0.05, Statistical significance at P<0.05. DMFT: Decayed-missing-filled teeth, BMI: Body mass index, BOP: Bleeding on probing, SD: Standard deviation

Table 2: Linear correlation of BMI and DMFT with salivary parameters (salivary flow rate, buffer capacity, and pH)

Parameters	Spearman's rho	Salivary flow	Salivary buffer	Salivary pH
BMI	Correlation coefficient	−0.709**	−0.651**	−0.697**
	Significant (two-tailed)	0.000	0.000	0.000
DMFT	Correlation coefficient	−0.047	−0.114	−0.123
	Significant (2-tailed)	0.747	0.432	0.396

**Correlation is significant at the 0.01 level (two-tailed).
DMFT: Decayed-missing-filled teeth, BMI: Body mass index

It is possible that being overweight is also a determinant of hyposalivation and thus increases the risk of caries.[15] Saliva composition, together with its flow, seems to be a relevant factor in the etiopathology and progression of the decay.[16] The more saliva is produced, the more protection against dental caries.[17,18] It contains innate or acquired defense factors, able to inhibit bacterial growth and its metabolism through different mechanisms.[17] Saliva is able to modify the pH of the oral cavity, from acidic to neutral. Hence, its normal flow rate is essential for maintaining good oral health.

In the present study, we tried to analyze if any association of salivary parameters with obesity exists or not. The cutoff value of stimulated salivary flow rate of 0.5 ml/min was considered to be an indication of hyposalivation.[19] It was found that the mean stimulated salivary flow rate was 0.50 ml/min in obese children, and it was 0.74 ml/min in normal weight children, and the difference between the two was found to be statistically significant. This finding is similar to previous studies, wherein it is stated that hyposalivation is linked to obesity; as obesity causes chronic inflammation and a number of pro-inflammatory cytokines which increases the inflammatory response in many body organs, thus altering the function of hypothalamic-pituitary-adrenal axis that affects the neuroendocrine regulation of salivary glands and hence results in diminished salivation.[10]

In the present study, it was found that salivary pH had a negative correlation with BMI. The reason might be due to the decrease of salivary flow rate, with increase in BMI, the pH also decreases. This observation corroborates with the previous studies which emphasize the fact that the salivary function depends on its flow rate and composition. The saliva flow rate is also a modulator of salivary pH. At low flow rates, less bicarbonate is released, hence decreasing the pH.[20]

Yang *et al.* (2001) in their study reported that plasma adiponectin, adipocyte-derived protein, concentration, however, unlike other adipocytokines, is decreased in adiposity and increases after weight reduction.[21] Moreover, the change in pH in obese individuals is also due to alterations of adiponectin concentration. Normally, it is produced by salivary gland epithelial cells where it might be implicated in regulation of local immune response and hence preserves a good salivary function and maintains the salivary pH.[22]

Wikner and Soder[23] found poor salivary flow rates may predict poor buffering capacity. Moritsuka *et al.*[24] reported that patients with a good buffering capacity had associated high salivary flow rates while another study found that there was an increase in buffering capacity as the salivary

flow rate increased. Similarly, in the present study, it was found that the buffer capacity of saliva decreased with the increase in BMI, which might be due to decrease salivary flow rate among obese subjects.

In the present study, it was found that there was no statistically significant difference in DMFT between obese and non-obese subjects. There are contradictory results shown by previous researchers where some of the studies[7] have demonstrated a positive association of obesity and dental caries while as many other studies showed no significant relation of obesity with dental caries.[25]

These data contribute toward the multifactor aspect of both diseases (dental caries and obesity). The concept of dental caries, which was initially based on a model proposed, in 1962 (host, diet, and microorganisms), is inadequate in the present scenario where lifestyle has changed altogether. The modern concept of dental caries includes social and behavioral factors regarding a particular individual. In turn, obesity has been associated with diet, genetic, behavioral, and psychological factors. Hence, all these factors need to be taken into considerations while evaluating the relation between obesity and dental caries.

In the present study, 40% of obese individuals were found to have BOP, whereas 32% of non-obese children had BOP, but the difference between the two was not statistically significant ($P = 0.38$). This finding does not corroborate with previous studies. A cohort study demonstrated that overweight and obesity are associated with gingival inflammation and dental calculus in young adults, showing the evolution of periodontal conditions over the years.[26] According to Susin *et al.*, 2011,[27] the presence of dental calculus and gingival bleeding in adolescents is considered risk factors for the development of chronic and aggressive periodontitis, reinforcing the importance of controlling these factors in early life.

Moreover, in the present study, dental plaque was present in 72% of the obese subjects, whereas it was present in 56% of non-obese subjects, and the difference was not found to be significant ($P = 0.18$). These findings are not in agreement to the results of earlier studies, which might be due to the difference in sampling, study design, and diagnostic criteria. In previous studies, it has been observed that the relationship between poor periodontal condition and high plaque scores was highly significant;[28] hence, the establishment of healthy habits like proper oral hygiene maintenance in childhood could be an important factor for disease prevention in adult life. It has been observed that tooth brushing enhances the salivary flow rate. Hence, in addition to the measures taken for preventing obesity, the personal behavioral changes, such as proper oral hygiene maintenance, are of utmost importance to compensate for the adverse systemic effects of obesity on salivary parameters and oral health as a whole.

The limitations of the present study were that the dietary patterns could not be controlled which might have an effect on obesity, dental caries, and salivary parameters. Furthermore, the onset of obesity could not be taken into consideration. So, within the limitations of the study, it was concluded that obesity is one of the factors responsible for deranged salivary parameters, i.e., diminished stimulated salivary flow rate, buffer capacity, and salivary pH which in turn has an adverse effect on oral health.

A multidisciplinary action for controlling obesity will be beneficial not only for maintaining general health but also the oral health by both medical and dental health care professionals. It is recommended that a common risk approach should be adopted instead of focusing on a specific disease which is quite essential for promoting health in an economical way.

- As there has been found the association between obesity and oral health, so it calls for the collaborative measures between pediatric dentists and medical physicians in preventing the development of obesity and its associated health problems.
- As there has been a noticeable increase in the number of obese children visiting the pediatric dentists for their treatment, so it becomes the moral obligation of the dentists to educate both the patients as well as their parents for the control of obesity.
- Preventive and interventional efforts by experts in obesity in collaboration with pediatric dentists and dental educators can prove beneficial to the community.

CONCLUSION

It was concluded that obesity is be one of risk factors responsible for deranged salivary parameters that in turn has an adverse effect on oral health.

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