The relationship between overweight/obesity and oral health in children

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Research

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Abstract

Aim

The purpose of this study was to evaluate the effects of obesity and overweight on oral/dental health and blood biochemistry parameters in children. Eighty-seven children (29 boys and 58 girls) aged 1-18 presenting to in our pediatric clinic were included in the study.

Methods

The patient group consisted of overweight or obese children, and the control group of normal weight individuals. Pediatric patients were examined simultaneously by a pediatrician and a pediatric dentist. Oral/dental health examinations were performed by a pediatric dentist, and DMFT/dmft index, CPITN index and dental plaque calculations were made. In addition, daily tooth brushing habits were evaluated by questioning the time of the last dental examination. Oral and dental health examination findings and blood biochemistry parameters were compared between the two groups.

Results

Obesity/overweight was found to be associated with, the dental plaque index, DMFT/dmft index, and elevation in the blood biochemistry parameters CRP and PTH among the children in this study.

Conclusion

The observation of significant elevation in DMFT and dental plaque indices, and numbers of filled deciduous teeth showed that oral/dental health problems and dental decay may emerge more frequently in obesity/overweight children.

Introduction

Obesity is a chronic disease recognized as a global epidemic by the World Health Organization. Obesity and overweight remain a growing problem across the world, one that leads to potentially life-threatening systemic problems. In addition to genetic factors, the prevalence of the condition has increased because of a sedentary lifestyle, increased consumption of processed foods, changes in eating habits, and imbalance between energy intake and expenditure \(^1\). The body mass index (BMI) is a simple and reliable method and the preferred means of diagnosing obesity in children \(^2\). The obesity classification based on BMI is given in Table 1 \(^3\). Based on Percentile values for body mass index in Turkish children (kg/m2), a child between the 85th and 95th percentiles for sex and age is defined as overweight, and a child over the 95th percentile as obese \(^4\). Obesity causes various diseases such as high blood pressure, type II Diabetes Mellitus, hyperlipidemia, polycystic ovary syndrome, obstructive sleep apnea, osteoarthritis, depression and breast cancer\(^5,6\). In addition to endocrinological, cardiovascular, gastrointestinal, metabolic, and neurological disorders, oral health problems such as erosion of the enamel surface, halitosis, bruxism,
periodontal disease, and dental caries may also be seen in obese individuals. Existing epidemiological studies show an inverse correlation between increasing BMI and current number of teeth\(^7\). Tooth decay is associated with bad dietary habits, while bad dietary habits are associated with obesity. Therefore, it is understood that there is a correlation between tooth decay and obesity\(^8\). While carbohydrate-rich dietary habits are the main reason for the development of obesity and tooth decay, lack of oral hygiene, changing saliva values, genetic, socio-economic and environmental factors are common etiological factors for both diseases\(^9\). Periodontal disease is a chronic inflammatory, multifactorial disease of the tissues supporting the teeth, in which microbial dental plaque is the primary etiological factor, and can be modified by systemic, genetic and environmental factors\(^10\). Dental plaque formation for reasons such as a lack of attention to oral hygiene and inadequate brushing is an important factor in the development of intraoral periodontal disease and dental caries. The micro-organisms deriving from dental plaque can cause periodontal disease. If left untreated, inflammation developing in supporting bone and connective tissue causes breakdown in periodontal tissues, and the disease becomes chronic\(^5\). A significant association has been determined between obesity in children and adolescents and periodontal disease, in which cytokines and hormones originating from adipose tissues are thought to be involved. Obesity is a hyper-inflammatory state that stimulates the production of acute phase reactants such as C-reactive protein (CRP), leading to immune system response changes and heightened susceptibility to bacterial infection. CRP concentrations can rise due to both obesity and periodontal disease\(^6\). Low serum vitamin D (25-OH D) is thought to be one potential cause of overweight. Vitamin D is an important determinant of serum PTH levels. Increased PTH increases the flow of calcium to adipocytes and raises lipogenesis in intracellular calcium. PTH elevation can thus encourage weight gain. Although there have been few studies on this subject, obesity has been associate with low serum vitamin D (25-OH D) concentrations and increased serum PTH levels\(^11\). Chronic diseases and oral-dental diseases can be prevented by means of measures adopted during childhood to combat overweight and obesity that can give rise to such conditions. The purpose of this study was to examine the effects of obesity on oral/dental health, periodontal disease, and blood parameters in obese and overweight pediatric patients.

**Methods**

Eighty-seven patients (29 boys, 58 girls) aged 1-18 years presenting to our pediatric clinic between 15 December, 2021, and 15 March, 2022, were included in the study. This prospective study was performed after University Hospital ethics committee approval (project no. 2021/301) and in accordance with the Declaration of Helsinki. Pediatric patients were examined simultaneously by a pediatrician and a pediatric dentist. The patients were divided into two groups, an overweight/obese patient group (n: 47) and a normal weight control group (n: 40). Patients’ BMI values were calculated as weight in kilograms divided by height in meters squared. Percentile values (kg/m\(^2\)) were used for body mass index in Turkish children. Children with BMI between the 5th and 85th percentile for sex and age were regarded as normal weight, those with BMI values between the 85th and 95th percentiles as overweight, and those with values at the 95th percentile or higher were considered obese. Underweight children less than the 15th percentile were excluded from the study. In addition, patients with fever, any infection, malignancy or
neuromotor developmental delay were excluded from the study. Demographic data such as the patient's age, sex, blood parameters, and BMI were recorded from the hospital records. Blood biochemistry parameters, serum vitamin D (25-OH D) and parathyroid hormone (PTH) were investigated in all cases. Oral/dental health examinations were performed by a specialist pediatric dentist with the receipt of informed consent. Daily brushing habits of the patients were questioned. Daily brushing habits of the patients were questioned and scored (0: rarely, 1: once a day, 2: twice a day, 3: more than twice a day). In addition, the last dental examination time was questioned and scored (1: more than 2 years, 2: 1 to 2 years, 3: 6-12 months, 4: 0-6 months). Daily brushing habits and last dental examination times were compared between the groups. To determine the severity of dental caries DMFT/dmft index is used. (d= decayed deciduous teeth, D= decayed permanent teeth, m= missing deciduous teeth, M= missing permanent teeth, f= filled deciduous teeth, and F= filled permanent teeth) [12]. The Community Periodontal Index of Treatment Needs (CPITN) 23 index, the dental plaque index 35 were evaluated at oral/dental health examinations.

**Statistical Analyses**

Data analyses were performed on SPSS for Windows version 22.0 (SPSS Inc., Chicago, IL, USA). Normality of distribution of continuous variables was determined using the Kolmogorov Smirnov test. Levene's test was used for the evaluation of homogeneity of variances. Unless specified otherwise, continuous data were described as mean ± SD for normal distributions, and as mean ± SD and median (min-max) for skewed distributions. Categorical data were described as number of cases (%). Statistical analysis differences in normally distributed variables between two independent groups were compared using Student's t-test, while Mann Whitney U test was applied to compare non-normally distributed data. Categorical variables were compared using Pearson's chi-square test or Fisher's exact test. p values <0.05 were regarded as significant for all statistical analyses.

**Results**

Eighty-seven patients (29 boys, 58 girls) were included in the study. Mean ages were 11.74±3.61 years among the overweight/obese patients and 10.42±3.90 among the controls, and there was no significant difference between the groups in terms of age or gender. However, BMI values were significantly higher in the patient group than in the control group (p = 0.001) (Table 2). There was no significant difference between the groups in terms of daily brushing habits and last dental examination times.

Dental plaque index values were also significantly higher in the patient group (p=0.012). While mean DMFT index values were significantly higher in the patient group (p=0.014), dmft was significantly lower (p=0.032). However, among the dmft indices, numbers of filled deciduous teeth (f) was significantly higher compared to the control group (p=0.007), while numbers of decayed deciduous teeth (d) were significantly lower than in the control group (p=0.001) (Table 3). When the DMFT score and dental plaque index were compared between the groups, it was observed that they were significantly higher in the overweight/obesity group(Figure 1).
Patient group CRP and PTH values were significantly higher than those in the control group (p= 0.036 and p=0.005, respectively). No significant differences were observed between the groups in terms of other parameters (Table 4).

Discussion

Obesity and overweight have become a particularly important problem of our age, and can lay the foundations for chronic disease and impaired quality of life by compromising general health\(^13\). In our study, we found that overweight/obesity in children affected DMFT and dental plaque indices and significantly increased serum CRP and PTH values. In the present study, there was no significant difference between the groups in terms of tooth brushing frequencies or the last dental examinations. High CRP and PTH values determined in obese/overweight children showed that excess weight causes an inflammatory process in the body. At the same time, the high significant DMFT scores and dental plaque index we found in children with overweight/obesity may be evidence that overweight plays an effective role in dental caries in children. A carbohydrate-based diet, which is mostly seen in obese children, is thought to cause high cariogenic activity in the mouth, dental caries, and many other oral-dental health problems. Studies have shown a link between obesity and dental caries in children and adolescents\(^14,15\). While some studies examining the association between obesity and the DMFT indices used to assess the severity of dental caries in the study have reported that caries increases in line with BMI\(^16\). A cohort study involving 671 children found that the relationship between obesity and dental caries increased with age\(^17\). Others have reported no correlation\(^18\). Some studies have even observed a decrease in dental caries as BMI rises\(^19,20\). Gerdin et al. evaluated 2303 children over 10 years and detected positive correlation between dental caries and obesity. However, inverse correlation was observed between obesity and deciduous tooth caries\(^21\). The significantly high DMFT index we found in children with overweight/obese in our study showed that obesity plays an important role in dental caries developing in the permanent dentition period. The situation in deciduous teeth was the exact opposite, with mean dmft index and numbers of decayed primary teeth (d) being significantly lower, and numbers of filled milk teeth (f) being higher. The findings of this study suggested that overweight may increase the probability of dental caries among children in line with age. In addition, the significant increase in the number of filled deciduous teeth in children with overweight or obesity in the present study also showed that oral-dental health problems may occur more frequently in these patients. It is known that dental plaques have an important role in oral and dental health. Indeed, Chandki R et al. showed that dental plaque is effective in the development of periodontal disease and dental caries\(^22\). Moreover animal studies have shown more severe periodontal inflammation and tissue destruction in the face of dental plaque deposition in obese than in non-obese animals\(^23\). In the study of Saito T et al., the fact that every 5% increase in body weight increases the risk of periodontal disease by 30%, suggesting that excess weight may be a risk factor for periodontal disease\(^24\). However, the relationship between obesity and periodontitis is thought to be a two-way one, and the presence of inflammation in periodontal tissues has been suggested as a predisposing factor for obesity\(^25\). In order to examine periodontal health status,
periodontal treatment needs can be evaluated using the community periodontal index of treatment needs (CPITN) index, first looking considering periodontal pockets, dental calculus, and gingival bleeding\textsuperscript{26}. Some studies evaluating periodontal disease status and treatment requirements using the CPITN have shown a positive relationship between increased BMI and the progression of periodontal disease\textsuperscript{27}. In our study, while there was no significant difference between the groups in terms of CPITN index scores in overweight/obese children, we found that dental plaque indices were significantly higher (p=0.012). The high dental plaque index we found in our study results suggested that overweight and obesity may have an important role in the development of dental caries in children.

In addition, studies are known in which the systemic effects of obesity and overweight are evaluated and its relationship with high inflammation markers is investigated. In the study conducted by Singer K et al., in which 6950 children were examined, CRP levels were found to be higher in children with a higher body fat percentage\textsuperscript{28}. Similar studies have shown a positive correlation between increased BMI levels and increased CRP levels in obese or overweight individuals\textsuperscript{29,30}. In our study, CRP levels were found to be significantly higher in children with overweight/obesity in line with the literature. In studies to understand the systemic effects of obesity, the relationship between obesity and PTH, a calcium regulating hormone, has been examined. Studies have shown that serum PTH values are positively correlated with BMI, and that serum PTH value may constitute an independent marker of obesity. A 1 pmol/l increase in serum PTH has been found to cause a 0.17 kg/m\textsuperscript{2} increase in BMI in men and a 0.26 kg/m\textsuperscript{2} increase in women\textsuperscript{11,31}. In another study, low vitamin D levels and high serum PTH levels were shown in children with severe dental caries in early childhood\textsuperscript{32}. Studies have reported lower vitamin D levels in obese compared to non-obese individuals, and that these are negatively correlated with BMI\textsuperscript{33,34}. PTH values in the present study were significantly higher in the patient group with significantly greater BMI compared to the control group. Serum PTH levels were positively correlated with BMI. In terms of vitamin D (25-OH D), although there was no significant difference between the two groups, the mean values in both were beneath normal thresholds. Insufficient exposure to sunlight and insufficient nutrition were considered as likely causes of the vitamin D deficiency in children in our study. The limitations of this study are that the children's nutritional habits, activity levels, and socioeconomic status are not known and the low number of patients. The high CRP and DMFT scores detected in overweight/obesity children in this study suggest that obesity causes inflammatory changes in body tissues, negatively affecting oral and dental health, and plays a role in the development of dental caries.

**Conclusion**

The results of this study show that obesity or overweight in children increased the dental plaque index, DMFT index, and levels of the blood biochemistry parameters CRP and PTH. The elevation in the DMFT and dental plaque indices, and numbers of filled deciduous teeth suggested that oral-dental health, dental decay problems may emerge more frequently in overweight or obese children. We have shown that obesity/overweight negatively affects both systemic health and oral and dental health in children. We also think that it may play an active role in the development of dental caries. A multidisciplinary approach
in the early period is important in combating the effects of obesity on both systemic and oral health in children.

Declarations

Acknowledgements None

Ethics declaration

The authors declare that they have no conflicts of interest. The present study was approved by the Bolu Abant İzzet Baysal University, Turkey (approval number: 2021/301). All participants’ parents/caregivers provided informed consent at registration.

Author Contributions

Meyri Arzu Yoldaş had the original idea, contributed for the writing and editing of the manuscript.

Simge Vural developed the research work. Semih Bolu and Ayşegül Danış collated and formatted manuscripts and data.

References


**Tables**

**Table 1.** Classification of obesity

<table>
<thead>
<tr>
<th>Classification</th>
<th>BMI (kg/m²)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Underweight</td>
<td>&lt;18.5</td>
</tr>
<tr>
<td>Normal</td>
<td>18.5-24.9</td>
</tr>
<tr>
<td>Overweight</td>
<td>25-29.9</td>
</tr>
<tr>
<td>Obese Clas 1</td>
<td>30-34.9</td>
</tr>
<tr>
<td>Obese Clas 2</td>
<td>35-39.9</td>
</tr>
<tr>
<td>Obese Clas 3</td>
<td>&gt;40</td>
</tr>
</tbody>
</table>

**Table 2.** Demographic and anthropometric characteristics of the groups

<table>
<thead>
<tr>
<th></th>
<th>Patient Group (n:47)</th>
<th>Control Group (n:40)</th>
<th>p</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gender, n (%)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>boy</td>
<td>15 (31.9%)</td>
<td>14 (35%)</td>
<td>0.761</td>
</tr>
<tr>
<td>girl</td>
<td>32 (68.1%)</td>
<td>26 (65%)</td>
<td></td>
</tr>
<tr>
<td>Age (year)</td>
<td>11.74±3.61</td>
<td>11 (1-17)</td>
<td>0.084</td>
</tr>
<tr>
<td>Body mass index (kg/m²)</td>
<td>24.33±5.88</td>
<td>21.9 (17.2-41.4)</td>
<td>&lt;0.001</td>
</tr>
</tbody>
</table>

**Table 3.** Comparison of dmft/DMFT indexes of caries, missing and filled teeth in primary and permanent teeth
<table>
<thead>
<tr>
<th>Biochemical parameters</th>
<th>Patient Group</th>
<th>Control Group</th>
<th>P</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>n 47 ( min-max)</td>
<td>n 40(min-max)</td>
<td></td>
</tr>
<tr>
<td>Glucose(mg/dl)*</td>
<td>92,00(70-181)</td>
<td>86,00(66-116)</td>
<td>0,057</td>
</tr>
<tr>
<td>Ferritin/ng/l)*</td>
<td>26,50(5,30-214)</td>
<td>23,48(5,40-118,9)</td>
<td>0,707</td>
</tr>
<tr>
<td>CRP(mg/dl)*</td>
<td>0,60(0,04-95,40)</td>
<td>0,10(0,10-37,90)</td>
<td>0,036</td>
</tr>
<tr>
<td>LDH(U/L)</td>
<td>253,92±86,12</td>
<td>281,23±131,89</td>
<td>0,538</td>
</tr>
<tr>
<td>Phosphorus(mg/dl)</td>
<td>4,24±0,73</td>
<td>4,50±0,60</td>
<td>0,091</td>
</tr>
<tr>
<td>Ca(mg/dl)*</td>
<td>10(0,30-11,20)</td>
<td>10,15(8,80-11,20)</td>
<td>0,355</td>
</tr>
<tr>
<td>Albumin (g/dl)</td>
<td>47,40±4,32</td>
<td>49,33±4,56</td>
<td>0,221</td>
</tr>
<tr>
<td>PTH (pg/ml)</td>
<td>77,46±34,12</td>
<td>57,31±21,78</td>
<td>0,005</td>
</tr>
<tr>
<td>T4 (ng/dl)</td>
<td>0,99±0,10</td>
<td>1,02±0,12</td>
<td>0,243</td>
</tr>
<tr>
<td>TSH (mIU/l)</td>
<td>2,11±0,86</td>
<td>2,54±1,61</td>
<td>0,156</td>
</tr>
<tr>
<td>HbA1c(%)</td>
<td>5,75±1,65</td>
<td>6,10±1,15</td>
<td>0,472</td>
</tr>
<tr>
<td>Vitamin D (µg/L)</td>
<td>15,07±9,52</td>
<td>17,82±8,62</td>
<td>0,065</td>
</tr>
<tr>
<td>Folic_Acid(µg/L)</td>
<td>17,16±57,68</td>
<td>8,73±2,12</td>
<td>0,088</td>
</tr>
</tbody>
</table>
LDH, lactate dehydrogenase; CRP, C-reactive protein; Ca, calcium; PTH, parathyroid hormone. Data compatible with normal distribution. Student's T test was applied as the statistical technique, the results being expressed as mean (±standard deviation)*. Data incompatible with normal distribution. Wilcoxon rank sum test was applied as the statistical technique, the results being expressed as median (IQR).

**Figures**

![Bar chart comparison of DMFT score and dental plaque index between groups](image)

**Figure 1**

Comparison of DMFT score and dental plaque index between groups