G. Vallogini*, V. Nobili**, R. Rongo***,
S. De Rosa*, F. Magliarditi*, V. D'Antò***,
A. Galeotti*

*Bambino Gesù Children's Hospital, Department of Paediatric Dentistry, Rome, Italy
**Bambino Gesù Children's Hospital, Hepato-Metabolic Disease Unit, Rome, Italy
***University of Naples "Federico II", Department of Neurosciences, Reproductive Sciences and Oral Sciences, Naples, Italy

email: giulia.vallogini@gmail.com

DOI: 10.23804/ejpd.2017.18.04.02

Evaluation of the relationship between obesity, dental caries and periodontal disease in adolescents

ABSTRACT

Aim *To assess the prevalence of caries, oral hygiene quality and periodontal disease in a cohort of obese adolescents compared to a control group.*

Methods *Study Design: cross-sectional study conducted on 204 subjects (age range 10-16 years).*
Ninety obese subjects (BMI >90°) and 114 normal-weight subjects (BMI <75°) were visited at the Bambino Gesù Children's Hospital and in a junior high school in Rome, respectively. An ad hoc questionnaire (investigating demographic and oral health behaviour data) was filled in by patients and their caregivers. Accurate oral examinations were conducted. The Decayed-Missing-Filled Teeth/Surfaces Index in both permanent (DMFT/DMFS) and primary dentition (dmft/dmfs), Gingival Bleeding Index (GBI), Visible Plaque Index (VPI), and Probing Depth (PD) were recorded. Statistics: data analysis was carried out using the Statistical Package for the Social Sciences (SPSS 21.0; SPSS IBM, New York, NY). The data of the two groups were compared by means of Student's t Test or the Mann-Whitney test for numerical data and the Chi-square test for categorical data.
Results: Patients affected by obesity, compared with controls, presented less compromised teeth in the primary dentition (dmft obese: 0.30 ± 1.12; normal-weight: 1.00 ± 1.90; P<0.001) and less compromised dental surfaces (dmfs obese: 0.51 ± 2.14; normal-weight: 1.61 ± 3.10; P<0.001). Furthermore obese patients showed minor gingival inflammation with less bleeding on probing (GBI) (obese: 23.95 ± 21.43; normal-weight: 38.17 ± 24.37; P<0.001), and less probing depth in a greater number of sites (PPD ≤ 3) (obese: 101.92 ± 9.27; normal-weight: 97.28 ± 12.13; P<0.001). Moreover, the obese group showed a better oral hygiene (VPI) (obese: 25.69 ±25.83; normal-weight: 37.72 ±24.34; P<0.001).
Conclusion *In our study, obese adolescents showed a better oral hygiene, fewer compromised teeth and better periodontal health when compared with normal-weight patients.*

Keywords *Adolescents; Dental caries; Obesity; Periodontal disease.*

Introduction

Excessive weight is a considerable public health problem. The number of affected children is increasing and not all the health consequences of paediatric obesity are well perceived [Baker et al., 2007].

The condition is the result of a composite interaction of cultural, environmental, socioeconomic, behavioural, genetic, and metabolic factors. Overweight children have an increased chance of becoming overweight or obese adults and developing hypertension, type II diabetes, cardiovascular disease, orthopaedic problems, sleep apnoea, and asthma which greatly affect their quality of life [Mazzone et al., 2013].

Socioeconomic factors play a crucial role. In fact, the increased consumption of fatty foods and sodas, less exercise combined with technology-driven playtime can lead to overweight [Mathus-Vliegen et al., 2007].

BMI percentile is commonly used in children as an age- and sex-specific classification that accounts for changes in body composition during growth [BMI Growth Charts, 2000].

The literature presents a multitude of articles on the correlation between obesity and oral health issues [Kantovitz et al., 2006; Marshall et al., 2007]. Most of the studies focus on the relationship between obesity and caries. Nevertheless, the data regarding this association are controversial. A systematic review reported that only one in seven cross-sectional studies with paediatric patients showed an interaction between obesity and dental caries [Marshall et al., 2007].

It has been suggested by Marshall [2007] that neither "obesity increases the risk of caries" nor "caries increases the risk of obesity" but he speculated the presence of

risk factors for both diseases, i.e. dietary factors and socioeconomic status. In fact, a dietary habit which is responsible for obesity could also increase caries risk [Costacurta et al., 2014].

Obesity is considered a presumed risk factor for periodontal disease, as demonstrated by several systematic reviews [Suvan et al., 2011; Katz and Bimstein, 2011] ,and an increased prevalence of periodontitis has been shown in young obese adults [Al-Zahrani et al., 2003]. Furthermore, in 2011 Salekzamani proved a positive association between measures of body composition and the severity of periodontal disease [Salekzamani et al., 2011]. A possible mechanism could be the overexpression of systemic markers of inflammation that has been demonstrated in obese subjects, leading to a hyperinflammation status, which may influence the severity of periodontal disease [Fadel et al., 2014].

Habits, such as oral hygiene practices, can be negatively influenced by the psychosocial status of obese individuals and indirectly affect periodontal health [Dumitrescu and Kawamura, 2010].

The aim of this study was to analyse the relationship between obesity and oral health in adolescents, assessing the prevalence of caries, the periodontal health and the hygiene levels.

Material and methods

A cross-sectional study was conducted on 90 obese subjects (42 females and 48 males, mean age 11.66 ± 2.23, mean BMI 31.07 ± 5.71) and 114 normal-weight subjects (58 females and 56 males, mean age 10.51 ± 1.52, mean BMI 17.01 ± 1.71). The obese subjects were enrolled at the Department of Liver-Metabolic Diseases of the Bambino Gesù Children's Hospital, Rome (Italy), according to the following inclusion criteria: age between 10 and 16 years old and BMI >90°.

The control group was recruited from the students of a junior high school in Rome, according to the following inclusion criteria: age between 10 and 16 years old and BMI <75°.

The following exclusion criteria were used for both groups (Fig. 1):

1. any antibiotic treatment or periodontal treatment in the last 3 months;
2. ongoing orthodontic treatment;
3. any congenital defects;
4. any systemic disease which could modify the normal growth pattern;
5. daily smoking habit.

All the data were collected between February 2014 and October 2015.

The Ethics Committee of the Bambino Gesù Children's Hospital (protocol number 723_OPBG_2013) approved the study, which was performed according to the Helsinki Declaration. All parents and children signed a consent form before being enrolled in the study.

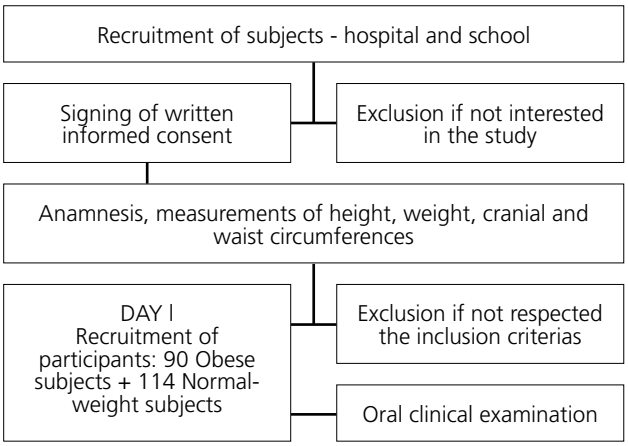

FIG. 1 Flow chart illustrating the study design

Clinical examination

Obese and normal-weight patients were referred to the Unit of Stomatology for evaluation of the oral health status. Clinical examinations were conducted using a plane buccal mirror, a dental probe and a periodontal probe (UNC 15).

The VPI index was used to record the presence of dental plaque on tooth surfaces [Ainamo and Bay, 1975].

Gingival inflammation was defined using the GBI according to Ainamo and Bay [1975].

The PPD was recorded at four sites of each tooth using a periodontal probe (UNC 15). Values of 4 mm were considered pathological and were recorded for each subject [Savage et al., 2009].

The presence of decayed, missing, filled teeth were recorded using the DMFT, dmft, DMFS and dmfs indices [Becker et al., 2007].

All subjects answered a questionnaire which covered topics related to their medical condition, meal frequency, oral hygiene habits, smoking habits as well as their parents' education and country of birth. All participants also answered the Oral Behaviour Checklist (OBC) questionnaire and their parents filled out the OSA Quality of Life questionnaire.

Statistics

Data analysis was carried out using the Statistical Package for the Social Sciences (SPSS 21.0; SPSS IBM, New York, NY).

Numerical variables were expressed as means ± standard deviations while nominal variables were expressed as percentages. In order to compare the information on dental and periodontal health between the two groups, data were analysed by Student's t-test if the data had a normal distribution (or log-normal), or the Mann-Whitney U test if the data did not follow a normal distribution (or log-normal). All the numerical variables were analysed by means of the Shapiro-Wilk test to evaluate the data distribution. The Chi-square test was used to compare

Variable	Normal-weight group (mean ± SD)	Min.	Max.	Obesity group (mean ± SD)	Min.	Max.	P value
Age (y + m)	10.51 ± 1.52	9	15	11.66 ± 2.23	9	17	P < 0.001
Weight	34.15 ± 9.15	20	65	74.65 ±23.28	39	156	P < 0.001
Height	140.15 ± 14.17	130	171	153.58 ± 14.10	125	186	P < 0.001
Cranial circumference	53.59 ± 2.06	48	60	55.62 ± 5.48	36	91	P < 0.001
Waist circumference	62.19 ± 7.86	40	95	89.43 ± 18.47	54.5	129	P < 0.001
BMI	17.01 ± 1.71	13.40	21.90	31.07 ± 5.71	23.10	45.18	P < 0.001
VPI (%)	37.72 ± 24.34	0	100	25.69 ±25.83	0	100	P < 0.001
GBI (%)	38.17 ± 24.37	0	87	23.95 ± 21.43	0	83.3	P < 0.001
Number of sites PPD ≤ 3 mm	97.28 ± 12.13	0	112	101.92 ± 9.27	76	112	P < 0.001
Number of sites PPD > 3 mm	1.47 ± 2.21	0	10	0.67 ±2.17	0	15	P < 0.001
DMFT	0.81 ± 1.34	0	4	1.19 ± 1.74	0	7	P = 0.112
dmft	1.00 ± 1.90	0	8	0.30 ± 1.12	0	7	P < 0.001
DMFS	1.14 ± 198	0	8	1.38 ± 2.01	0	9	P = 0.191
dmfs	1.61 ±3.10	0	12	0.51 ± 2.14	0	14	P < 0.001

BMI: Body Mass Index, VPI: Visible Plaque Index, GBI: Gingival Bleeding Index, PPD: Pocket Probing Depth, DMFT: Decayed Missing Filling Teeth (permanent dentition), dmft: Decayed Missing Filling Teeth (primary dentition), DMFS: Decayed Missing Filling Surfaces (permanent dentition), dmfs: Decayed Missing Filling Surfaces (primary dentition), P values of the Student's t-test or Mann-Whitney U test

TABLE 1
Clinical parameters in both obesity and normal-weight groups.

categorical data. The level of significance was set at P<0.05.

Results

The obese group showed higher values of height (153.58 cm ± 14.10), cranial circumference (mean 55.62 cm ± 5.48) and waist circumference (89.43 cm ± 18.47) than the normal-weight group (height 136.05 cm ± 17.48, cranial circumference 53.59 cm ± 2.06, waist circumference 62.19 cm ± 7.86). All these values showed a statistical significant difference (P < 0.001).

We found significant differences between the two groups regarding oral hygiene, periodontal status, and dental caries (Table 1).

The obesity group had lower VPI score (25.69% ± 25.83) compared to the same index in the control group (37.72% ± 24.34; P < 0.001).

The control group also had a greater GBI score (23.95% ± 21.43) compared to the same index in the study group (38.17 % ± 24.37; P < 0.001).

Also, the PPD showed a statistically significant difference (P < 0.001) in the normal and pathological values (respectively ≤ 3mm and > 3mm) between the two groups: the obese patients had fewer sites with pathological probing (0.67 ±2.17) compared to controls (1.47 ± 2.21) who, on the contrary, had lower values of physiological probing (97.28 ± 12.13) compared to the obese group (101.92 ± 9.27).

The DMFT index and the DMFS index did not show any significant differences between the two groups (P = 0.112 and P=0.191 respectively). Regarding the DMFT index, the obese subjects had a mean value of 1.19 ± 1.74 and the control group subjects had a mean value of 0.81 ± 1.34; concerning the DMFS index, the mean value was 1.38 ± 2.01 and 1.14 ± 1.98 for the two groups respectively.

There was a significant difference between the groups with respect to the dmft index and the dmfs index. The obese group had lower dmft index score (mean value 0.30 ± 1.12) compared to the normal-weight group (mean value 1.00 ± 1.90; P < 0.001). Also for the dmfs Index, the obese group showed lower values (mean value 0.51 ± 2.14) compared to the normal-weight group (mean value 1.61 ± 3.10; P < 0.001).

The questionnaire results are reported in Table 2. Considering the education levels of the parents, the difference was significant (P < 0.001): the obese group showed a decreasing percentage starting from a junior high school degree to a post-graduate degree (42.70% junior high school degree, 41.57% high school degree, 11.24% graduate degree, 4.49% post-graduate degree), while the normal-weight group showed the opposite trend, except for the post-graduate degree (10.43% junior high school degree, 37.39% high school degree, 33.91% graduate degree, 18.26% post-graduate degree).

The results pointed out significant differences between obese and normal-weight subjects concerning the percentage of tooth brushing in the morning and in the evening (P = 0.01 and P < 0.001 respectively). The obese group showed a lower toothbrushing frequence (60.67% in the morning and 50.56% after dinner) compared to the normal weight (80% in the morning, and 77.39% after dinner).

Discussion

The reports on connection between obesity and dental caries shows controversial results. A systematic review of 2012 reports that there is still disagreement regarding the connection between BMI and dental caries [Hooley et al., 2012]. In this review, 48% of the primary studies demonstrated the lack of this association; on the contrary, 35% of studies showed a positive association. Both cariogenic and obesogenic factors, such as high sugar consumption, overweight parents, low household

education and low socioeconomic status have been claimed as risk factors for dental caries in overweight children.

The outcomes of our study indicate that obesity is not related with dental caries or the presence of compromised teeth. As for the permanent dentition, both DMFT and the DMFS indexes showed no significant difference when comparing obese group scores with the control group scores.

As for the deciduous dentition, both the dmft and the dmfs indexes showed a significant difference when comparing obese group scores with control group scores. The amount of decayed, missing, filled deciduous teeth and surfaces was considerably higher in the normal-weight group.

The lack of a significant association between BMI and dental caries in the deciduous dentition, found in our study, agrees with several other studies [De Jong Lenters et al., 2015; D'Mello et al., 2011; Macek and Mitola, 2006; Yen and Hu, 2013; González Muñoz et al., 2013]. A recent review [Hayden et al., 2013], which investigated and quantified the correlation between obesity and dental caries in children, found a comprehensive connection between obesity and the level of caries in the permanent dentition. Caries were more prevalent in obese children than in normal-weight children. The same study did not find any correlation between obesity and caries in the deciduous dentition. Unexpectedly, we found not only a lack of association but a reverse correlation between dental caries and body weight for the deciduous dentition; confirming the results of previous studies [Macek and Mitola, 2006; Pinto et al., 2007; Goodson et al., 2013]. In 2006, Macek and Mitola did not report any association between overweight and increased prevalence of dental caries in primary or permanent dentition and found that obese children had a significantly lower dental caries severity than normal-weight children [Macek and Mitola, 2006]. Perhaps these findings and the results of our study illustrate that the correlation between obesity and dental caries in children is more complex and a simple explanation based on carbohydrate consumption is insufficient.

Our findings that obesity is not linked to dental caries is in contrast with many clinical studies. The fact that normal-weight children have significantly less caries in their primary and permanent teeth than the overweight children was demonstrated by Willershausen in 2004 [2004]. In his study, 36% of the normal-weight childrenwere caroesfree, while only 28% of the overweight and 30% of the obese children had healthy teeth. Recently, the same group [Willerhausen et al., 2007] examined 1290 children to analyse the connection between dental caries and overweight: healthy dentition was evident in 44.7% of underweight children and 40.7% of normal-weight children, although only 31% of overweight children and 31.7% of obese children presented healthy teeth. In their study, overweight was considered responsible for an increased number of caries but they stated that overweight is not the only aetiological factor for the caries process.

Werner [2012] retrospectively evaluated a cohort of patients aged 6 to 9 years old, seen for the first examination with, at least, one follow-up exam, finding a possible connection between obesity and dental caries in the deciduous dentition. In fact, a smaller percentage of obese and overweight children presented with primary tooth caries than underweight and normal-weight children; the limit of their study lies in its retrospective nature and in the fact that the dental examinations were performed by different operators.

Variable	Normal weight group (%)	Obesity group (%)	P value
Mother's country of birth			
Abroad	14.22	5.39	P=0.02
Italy	42.16	38.24	
Father's country of birth			
Abroad	9.80	3.92	P=0.08
Italy	46.57	39.71	
Educational level of the parents			
Junior High School Degree	5.8	18.63	P<0.001
High School Degree	21.08	18.14	
Graduation Degree	19.12	4.90	
Postgraduation Degree	10.29	1.96	
Teeth brushing in the morning			
Yes	45.10	26.47	P=0.002
No	11.27	17.16	
Teeth brushing after lunch			
Yes	6.37	7.35	P=0.25
No	50.00	36.27	
Teeth brushing in the evening			
Yes	43.63	22.06	P<0.001
No	12.75	21.57	
Use of electric toothbrush			
Yes	10.29	7.35	P=0.79
No	46.98	36.27	
Use of dental floss			
Yes	8.82	2.94	P=0.05
No	47.55	40.69	
P value of the Chi-square test			

TABLE 2 Sociodemographic variables and daily habits in both the obesity and normal-weight groups.

In 2010, Modéer et al. [2010]. claimed that obesity in children is associated with a reduced flow rate of stimulated saliva and development of dental caries, strengthening the negative effect of obesity on children's oral health. The control group of this study consisted of individuals receiving their regular dental treatments at the Department of Paediatric Dentistry, so this could have affected the results because they were children already in need of dental care or were receiving regular follow-up. In our study, the socioeconomic status of both groups did not affect the results because our sample included people from different regions of Italy with different levels of socioeconomic status and, consequently, distinct levels of education on dental care. Moreover the obese patients were at their first visit so they hadn't received yet any oral hygiene instruction about the correct toothbrush technique or dietary advice.

After analysing the parameters concerning periodontal

health, which were GBI and PPD, our results revealed that obese subjects present a better periodontal condition.

As for GBI, we found a significant difference when comparing obese group scores with normal-weight group scores, meaning that subjects affected by obesity showed minor gingival inflammation with less bleeding on probing. As for the PPD, the results showed a significant difference when comparing obese group scores with normal-weight group scores, indicating less probing depth in a greater number of sites (PPD<3) in the obese subjects. This result indicates a healthier periodontal condition in the obese patients.

Our results are in contrast with a recent study, which investigated the possible correlation between obesity and periodontal disorders in children [Scorzetti et al., 2013]; their outcomes indicate a connection between obesity and periodontal risk markers (plaque index, gingival inflammation, bleeding on probing and probing depth) even if their sample was limited to only 44 subjects for the study group and 59 subjects for the control group.

In relation to the level of oral hygiene, the results of our study showed that obese subjects had a higher level of hygiene: the VPI showed a significant difference (P<0.001) when comparing obese group scores with normal-weight group scores. The amount of plaque recorded on the teeth surfaces of the obese subjects was significantly less than in the control group. These results concerning periodontal health and oral hygiene may be clarified considering that obese subjects and their families are aware of the seriousness of this pathology. This could lead to a strict follow-up of obese children and the result could be better oral healthcare. It means that, independent from the socio-economic status, families know that oral hygiene is important and they pay serious attention to this aspect.

Conclusion

Less caries in the primary dentition, less gingival inflammation and bleeding and less probing depth in a greater number of sites were observed in obese adolescents. No differences between the groups were observed with regard to decayed teeth in the permanent dentition. Adolescents with obesity present a higher quality of oral hygiene, less compromised teeth and a better periodontal status compared with control group patients.

Conflicts of Interest Statement

Conflict of interest are none.

References

- Ainamo J, Bay I. Problems and proposals for recording gingivitis and plaque. Int Dent J 1975;25: 229–235.
- Al-Zahrani MS et al. Obesity and periodontal disease in young, middle-aged, and older adults. J Periodontol 2003;74:610–615
- Baker JL et al. Childhood body-mass index and the risk of coronary heart disease in adulthood. N Engl J Med 2007;357:2329–2337.
- Becker T et al. How much does the DMFT index underestimate the need for restorative care? J Dent Educ 2007;71:677-681.
- BMI Growth Charts. National Center for Health Statistics in collaboration with the national center for Chronic Disease Prevention and Health promotion (2000).
- Costacurta M, Di Renzo L, Sicuro L, Gratteri S, De Lorenzo A, Docimo R. Dental caries and childhood obesity: analysis of food intake, lifestyle. Eur J Paediatric Dent 2014; 15(4):343-8.
- De Jong Lenters M et al. Body mass index and dental caries in children aged 5 to 8 years attending a dental paediatric referral practice in the Netherlands. BMC Research Notes 2015;8:738.
- D'Mello G et al. Childhood obesity and dental caries among paediatric dental clinic attenders. Int J Paediatr Dent 2011;21:217-222.
- Dumitrescu AL, Kawamura M. Involvement of psychosocial factors in the association of obesity with periodontitis. J Oral Sci 2010;52:115–124.
- Fadel HT et al. Clinical and biological indicators of dental caries and periodontal disease in adolescents with or without obesity. Clin Oral Investig 2014;18:359-368.
- González Muñoz M et al. Systematic review about dental caries in children and adolescents with obesity and/or overweight. Nutr Hosp 2013;28:1372-1383.
- Goodson JM et al. Obesity and dental decay: inference on the role of dietary sugar. PLoS One 2013;8:e74461.
- Hayden C et al. Obesity and dental caries in children: a systematic review and meta-analysis. Community Dent Oral Epidemiol 2013;41:289-308.
- Yen CE, Hu SW. Association between dental caries and obesity in preschool children. Eur J Paediatr Dent 2013 Sep; 14(3): 185-9.
- Hooley M et al. Body mass index and dental caries in children and adolescents: a systematic review of literature published 2004 to 2011. Syst Rev 2012;1:57.
- Kantovitz KR et al. Obesity and Denal Caries: A Systematic Review. Oral Health Prev Dent 2006;4:137-144.
- Katz J, Bimstein E. Pediatric obesity and periodontal disease: a systematic review of the literature. Quintessence Int 2011;42:595–599.
- Macek MD, Mitola DJ. Exploring the association between overweight and dental caries among US children. Pediatr Dent 2006;28:375-380.
- Marshall TA et al. Dental caries and childhood obesity: roles of diet and socioeconomic status. Commun Dent Oral Epidemiol 2007;35: 449–458.
- Mathus-Vliegen EM et al. Oral aspects of obesity. Int Dent J 2007;57:249-256.
- Mazzone L et al. Paediatric non-alcoholic Fatty liver disease: impact on patients and mothers'quality of life. Hepat Mon 2013;13:e7871.
- Modéer T et al. Association between obesity, flow rate of whole saliva, and dental caries in adolescents. Obesity 2010;18:2367–2373.
- Pinto A et al. Is there an association between weight and dental caries among pediatric patients in an urban dental school? A correlation study. J Dent Educ 2007;71:1435-1440.
- Salekzamani Y et al. Association between human body composition and periodontal disease. ISRN Dent 2011;2011:863847.
- Savage A et al. A systematic review of definitions of periodontitis and methods that have been used to identify this disease. J Clin Periodontol 2009; 36: 458–467.
- Scorzetti L et al. Association between obesity and periodontal disease in children. Eur J Paediatr Dent 2013;14:181-184.
- Suvan J et al. Association between overweight/obesity and periodontitis in adults. A systematic review. Obes Rev 2011;12:e381–e404
- Werner SL et al. Association between childhood obesity and dental caries. Pediatr Dent 2012; 34:23-7.
- Willershausen B et al. Relationship between high weight and caries frequency in German elementary school children. Eur J Med Res 2004;9:400-404.
- Willerhausen B et al. Association between body mass index and dental health in 1,290 children o elementary schools in a German city. Clin Oral Invest 2007;11: 195-200.