Obesity and dental caries in paediatric patients. A cross-sectional study

**Aim** The aim of the present cross-sectional study was to evaluate the relationship between childhood obesity and dental caries, in paediatric subjects, through the use of two methods of diagnosis of overweight-obesity: Body Mass Index (BMI), and Dual energy X-ray Absorptiometry (DXA).

**Methods** A total of 107 healthy patients, aged between 6 and 12 years (53.3% females, 46.7% males) were included in the study. Each patient underwent a nutritional examination and dental check-up. The nutritional examination was performed at the Department of Neuroscience, Human Nutrition Unit, University of Rome "Tor Vergata" and consisted of anthropometric measurements, BMI calculation, DXA exam, body fat mass (FM) assessment. Dental examinations were performed by a trained dentist of the Paediatric Dentistry Unit of PTV Hospital, University of Rome "Tor Vergata". Dental caries was assessed using visual-tactile method and X-rays (bite-wing and panoramic radiography); the dmft/DMFT index was calculated. The subjects were classified as underweight, normal weight, pre-obese, obese, according to different criteria: a) age- and sex-specific BMI according to the Cacciari growth charts and cut-offs, b) body fat mass percentage (FM %) according to the WHO cut-offs, c) body fat mass percentage (FM %) according to the M. Carthy growth charts and cut-offs. Statistics: The statistical analysis was performed with the SPSS software (version 11.01; SPSS Inc., Chicago, IL, USA). The dmft/DMFT index was checked for normality using the Kolmogorov-Smirnov test. Independence of the dmft/DMFT distribution from sex and age was checked by using the Mann Whitney and Kruskal Wallis tests. Differences in the dmft/DMFT values between groups, according to BMI and FM % classifications, were tested using the Mann Whitney test. The minimal level of significance of the differences was fixed at p-values ≤0.05 for all procedures.

**Results** The comparison between BMI and DXA data shows statistically significant differences between BMI-%FM (WHO cut-offs) classifications (p≤0.001) and BMI-%FM (MCarthy cut-offs) classifications (p≤0.001). According to the BMI classification, there was no significant association between increase of dmft-DMFT and pre-obesity/obesity, but according to the FM % (WHO cut-offs) classification, the pre-obese/obese children had higher caries indexes than normal weight subjects, both in deciduous teeth (p=0.003) and permanent teeth (p=0.000). Furthermore, according to the FM % (MCarthy cut-offs) classification, obese children had higher caries indexes than normal weight and pre-obese subjects, both in deciduous teeth (p=0.030, p=0.02) and permanent teeth (p=0.019, p=0.011), respectively, but they had a dmft-DMFT value comparable with underweight children.

**Conclusion** The BMI misclassified adiposity status of the paediatric population compared to DXA, which provides a reliable screening and a more specific assessment of body composition. The misclassification of childhood obesity, determined by the BMI, could be used to explain the conflicting data in the literature on the association between obesity and dental caries. Our results highlighted for the first time the relationship between dental caries prevalence and body fat percentage measured by DXA.

**Keywords:** Body Mass Index (BMI); Dental caries; Dual energy X-ray Absorptiometry; Obesity.

**Introduction**

The prevalence of overweight and obesity in children is steadily increasing in recent years worldwide, including Europe [Lobstein and Frelut, 2003]. In Italy, the obesity levels of children aged 8-9 years, according to the IOTF (International Obesity Task Force) cut-offs, ranged from 7.5% in the North to 16.6% in the South [Binkin et al., 2009], while in France, the prevalence of overweight 7-9-year-old children was 15.8%, including 2.8% of obese subjects [Salanave et al., 2009]. The World Health Organization [2003] has compared this marked change in body weight to a "global epidemic disease".

Obesity is a condition in which energy intakes exceed the energy requirements resulting in the deposition of body fat; it is defined as an excess of body fat and has both genetic and environmental origins [Marshall et al., 2007]. Childhood obesity status carries both immediate and long-term health risks: type II diabetes, metabolic syndrome, hypertension, hypercholesterolemia, hyperadrogenism, orthopaedic complications, sleep apnoea, cardiovascular disease and behavioural problems [Wyatt et al., 2006]. Moreover, obese adolescents are more likely to become obese adults, and obese adults have an increased risk of morbidity and mortality in adulthood [Kantovitz et al., 2006].

Anthropometry is one of the most basic tools for assessing nutritional status, whether overnutrition or undernutrition; the anthropometric-based measurements are skinfold-thickness or circumference measurements or various height- and weight-based indexes such as weight-for-height, body mass index (BMI) and Rohrer index (RI).
methods of diagnosis of overweight-obesity: Body Mass Index (BMI) and Dual energy X-ray Absorptiometry (DXA).) [Mei et al., 2002]. Furthermore, there are several methods for assessing body composition, body fat mass (FM) and body fat free mass (FFM). Commonly used techniques for the accurate estimation of body fatness include underwater weighing, Dual energy X-ray Absorptiometry (DXA), total body water, total body electrical conductivity, total body potassium, and computed tomography [Mei et al., 2002]. However, the use of most of these methods is limited to research settings because of their complexity and cost [Mei et al., 2002].

The aim of the present study was to evaluate the relationship between childhood obesity and dental caries, in Italian paediatric population, through the use of two methods of diagnosis of overweight-obesity: Body Mass Index (BMI) and Dual energy X-ray Absorptiometry (DXA).

Materials and methods

The enrolment of 107 healthy patients, aged between 6 and 12 years (mean age 8.77±1.79), was carried out at the Paediatric Dentistry Unit of PTV Hospital, University of Rome “Tor Vergata”. Each patient underwent a nutritional examination and dental check-up, after having obtained a signed informed consent of the parents or guardians.

Nutritional examination

The nutritional examination was performed at the Department of Neuroscience, Human Nutrition Unit, University of Rome Tor Vergata and consisted of anthropometric measurements, BMI calculation, DXA exam, and FM % assessment.

Anthropometric measurements

Body weight (kg) was measured to the nearest 0.1 kg, using a scale (Invernizzi, Rome, Italy), height (cm) was measured using a stadiometry to the nearest 0.1 cm (Invernizzi, Rome, Italy) and waist (W) and hip (H) circumferences were measured with a flexible steel metric tape to the nearest 0.5 cm. The BMI was calculated using the standard formula: BMI = body weight (kg)/height (m²).

Dual X-ray Absorptiometry (DXA)

The body composition analysis was determined by means of a DXA (Lunar model DPX-IQ Lunar Corp., Madison, WI) fan beam scanner. The subjects were instructed not to exercise within 24 h from the test. They wore a standard cotton t-shirt, shorts and socks. They laid supine on the DXA, without moving for 20 min while the DXA scan recorded their data. The coefficient of variation (CV% =100x SD/mean) intra- and inter-subjects ranged from 1% to 5%. The coefficient of variation for bone measurements was less than 1%. The effective radiation dose from this procedure is about 0.01 mSv.

Dental examination

Dental examinations were performed by a trained dentist of the Paediatric Dentistry Unit of PT Hospital, University of Rome “Tor Vergata”.

Medical history was obtained in the interview, including information on asthma, allergies, diabetes, celiac disease, body growth delay, gastrointestinal diseases; these conditions were exclusion criteria for group enrolment.

The dentition assessment included teeth count (deciduous and permanent teeth), teeth extracted for caries and other reasons, caries, dental sealants, dental trauma, permanent or temporary restoration.

Dental caries was assessed using visual-tactile method and X-rays (bite-wing and panoramic radiography); the dmft/DMFT index was calculated.

Subjects classification

Subjects were classified according to different criteria.

• The subjects were considered as pre-obese/obese according to the age and sex specific BMI (BMI classification), by using Italian population specific growth charts [Cacciari et al., 2006]. The 3rd, the 75th, and the 95th centiles were considered the cut-off points to evaluate underweight, overweight and obese subjects. According to the BMI classification the subjects were subdivided into two groups.

Group 1: underweight, normal weight (BMI<75th centile).

Group 2: pre-obese/obese (BMI>75th centile).

According to BM classification the subjects were further subdivided in four groups.

Group A: underweight (BMI<3rd centile).

Group B: normal weight (3rd centile<BMI<75th centile).

Group C: pre-obese (75th centile<BM<95th centile).

Group D: obese (BMI>95th centile).

• The subjects were classified as pre-obese/obese according to a World Health Organization [WHO, 2003] Technical Report. The 25% and the 30% of FM were considered the cut-offs to evaluate pre-obese/obese subjects, between males and females, respectively (FM % WHO classification) [De Lorenzo et al., 2007]. According to the FM % WHO classification the subjects were subdivided into two groups.

Group 3: underweight, normal weight (FM <25% for males and FM<30% for females).

Group 4: pre-obese/obese (FM % >25% for males and FM >30% for females).

• The subjects were classified as pre-obese/obese according to McCathy's age-sex specific centile curves. The 2nd centile was selected to define the upper limit of underweight, 85th and 95th centiles to define the lower limits of pre-obese and obese [McCathy et al., 2006]. According to the FM % McCathy classification the subjects were subdivided into four groups.

Group E: underweight (FM %<2nd centile).

Group F: normal weight (2nd centile<FM %<85th centile).

Group G: pre-obese (85th centile<FM %<95th centile).

Group H: obese (FM %>95th centile).

Statistical analysis

The statistical analysis was performed with the SPSS software (version 11.01; SPSS Inc., Chicago, IL, USA). The dmft/DMFT was checked for normality using the Kolmogorov-Smirnov test. The homogeneity of variances in dmft/DMFT values between groups was also tested through the Levene test. Independence of the dmft/DMFT distribution from sex and age was checked by using the
Mann Whitney and Kruskal Wallis tests. Differences in the dmft/DMFT values between groups, according to the BMI and FM% classifications, were tested using the Mann Whitney test. Spearman’s correlation test was performed to evaluate the relationships among variables. The McNemar test was used to test the difference between paired proportions, according to the BMI and FM% classifications. The minimal level of significance of the differences was fixed at p-values ≤0.05 for all the procedures.

Results

A total of 107 patients, aged between 6 and 12 years, mean age 8.77±1.79, were analysed; 57 were females (53.3%) and 50 were males (46.7%).

The prevalence of the dental caries, the anthropometric and body composition characteristics of the study population are listed in Table 1 and 2.

Figure 1 shows the comparison of the physical status assessed by BMI and FM% (WHO cut-offs) evaluation. According to the analysis of the BMI classification, 39 of all paediatric patients (36.4%) were pre-obese/obese, 68 subjects (63.6%) were under/normal weight; whereas according to the analysis of FM% (WHO cut-offs) classification, 49 subjects (45.8%) were under/normal weight, and 58 (54.2%) were pre-obese/obese. The difference between the two methods of diagnosis of pre-obesity/obesity in paediatric patients (BMI, FM%-DXA according to WHO cut-offs) was statistically significant (p≤0.001) according to the McNemar test.

Figure 2 shows the comparison of physical status assessed by BMI and FM% (McCarthy cut-offs) evaluation. According to the analysis of the BMI classification, 12 subjects (11.2%) were underweight, 56 subjects (52.3%) were normal weight, 25 (23.4%) were pre-obese, 14 (13.1%) were obese; whereas, according to the analysis of the FM% (McCarthy cut-offs) classification, 5 subjects (4.7%) were underweight, 24 (22.4%) were normal weight, 23 (21.5%) were pre-obese and 55 (51.4%) were obese. The difference between the two methods of diagnosis of pre-obesity/obesity in paediatric patients (BMI, FM%-DXA according to McCarthy cut-offs) was statistically significant (p≤0.001) according to the McNemar test.

Table 3 highlights the caries experience in different groups according to the BMI and FM% (WHO cut-offs) classifications.

Groups 1-2 were homogeneous, equally distributed by age (p=0.243) and sex (p=0.194), similarly to Groups 3-4 for age (p=0.190) and sex (p=0.463).

There was no statistically significant difference between Group 1 and Group 2 in relation to the dmft (1.78±1.03 vs. 2.23±1.35; p=0.201) and DMFT (2.31±1.89 vs. 2.97±2.18; p=0.173), also assessed in the different categories stratified by age and sex.

Regarding Groups 3 and 4, the pre-obese/obese children had higher caries indices than normal weight subjects, both in deciduous teeth (dmft 1.50±0.68 vs 2.60±1.02; p=0.003) and permanent teeth (DMFT 1.80±1.65 vs 3.19±2.09; p=0.000), also assessed in the different categories stratified by age and sex.
Several studies have reported no association between dental caries and childhood obesity [Hong et al., 2008; Kopycka-Kedzierawski et al., 2008]. Moreover, Macek and Mitola [2006] reported that overweight status may be associated with a somewhat decreased risk for caries among US children aged 2-17 years.

A systematic review of the substantial literature on the impact of obesity on dental health, limited to randomised, cross-sectional and retrospective studies conducted from 1984 to 2004, showed only three studies with a sufficient level of evidence, of which only one demonstrated the relationship between obesity and dental caries [Kantovitz et al., 2006]. Furthermore, all studies in the literature have evaluated the association between obesity and dental caries using the BMI index [Hilgers et al., 2006; Kantovitz et al., 2006; Willerhausen et al., 2007; Alm et al., 2008; Hong et al., 2008], but none of them explored the issue making a more specific assessment of body composition.

In fact, the role of body composition assessment in dental caries-obesity association has not been thoroughly investigated.

The BMI index is the one most commonly used for classifying overweight-obesity [Mei et al., 2002]; it is used mainly in epidemiological studies for the simplicity of data collection, low cost and ease of comparing data. Although several studies have reported no association between dental caries and childhood obesity [Hong et al., 2008; Kopycka-Kedzierawski et al., 2008]. Moreover, Macek and Mitola [2006] reported that overweight status may be associated with a somewhat decreased risk for caries among US children aged 2-17 years.

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Table 4 highlights the caries experience in different groups according to BMI and FM% (McCarthy cut-offs) classifications.

Groups A, B, C, D were equally distributed by age (p=0.191) and sex (p=0.195), similarly in Groups E, F, G, H, for age (p=0.277) and sex (p=0.428).

There was no statistically significant difference between the Groups A, B, C, D in relation to the dmft and DMFT, also assessed in the different categories stratified by age and sex.

Regarding Group H and F, the obese children had higher caries indices than normal weight subjects, both in deciduous teeth (dmft 2.40±0.52 vs. 1.95±0.25; p=0.02) and permanent teeth (DMFT 3.10±2.11 vs. 1.74±1.68; p=0.011), also assessed in the different categories stratified by age and sex.

Analyzing Groups H and Group E, the underweight children had comparable caries indices than obese subjects, both in deciduous teeth (dmft 2.40±0.52 vs. 2.00±0.61; p=0.530) and permanent teeth (DMFT 3.10±2.11 vs. 3.60±2.70; p=0.697).

The correlations between dmft/DMFT indexes and body composition parameters were analyzed; a significant correlation between dmft/DMFT indexes and FM% was observed (r =0.221 for dmft, p=0.026; r =0.237 for DMFT, p=0.014).

Discussion and conclusion

All the studies available in the literature evaluated the association between obesity and dental caries using the BMI index, but the results obtained are often contrasting. Infact, many studies showed a weak [Gerdin et al., 2008] or positive association between these two conditions in childhood [Hilgers et al., 2006; Pinto et al., 2007; Willerhausen et al., 2007; Alm et al., 2008]. Otherwise
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the BMI is correlated with adiposity in children, it may not be suitable in some subgroups of the paediatric population, because of its inherent status as a weight-based index [Sardinha et al., 1999; Taylor et al., 2002]. Its limit is linked to the fact that it is not able to distinguish between fat free mass and fat mass [Nooynes et al., 2007], and then there is the impossibility of assessing body composition necessary to determine a correct clinical diagnosis of obesity.

For the first time, in the present cross-sectional study, it was considered appropriate to classify the Italian paediatric population according to both methods (BMI, DXA). Thus it was possible to compare the data on the pre-obese/obese subjects, provided by BMI, with the data obtained by DXA as the gold standard. The comparison between BMI and DXA data shows statistically significant differences between the BMI-L%FM (WHO cut-offs) classifications (p=0.001) and the BMI-L%FM (McCarthy cut-offs) classifications (p=0.001) (Fig. 1, 2). Thus, analyzing our results, the BMI misclassified adiposity status of the paediatric population compared to the DXA, which provides a reliable screening. This consideration is essential to conduct an assessment of the association between dental caries and obesity. The misclassification of the childhood obesity, determined by BMI, could be used to explain the conflicting data in the literature concerning the association between obesity and dental caries.

Our results highlighted for the first time the relationship between dental caries prevalence and body fat percentage measured by DXA. In fact, according to the BMI classification, there was no significant association between increase of the dmft-DMFT value and pre-obesity/obesity, but according to the FM % (McCarthy cut-offs) classification, the pre-obese/obese children had higher dental caries than normal weight subjects, both in deciduous teeth (p=0.003) and permanent teeth (p=0.000). Furthermore, according to the FM % (McCarthy cut-offs) classification, the obese children had higher dental caries indexes than normal weight and pre-obese subjects, both in deciduous teeth (p=0.030, p=0.02) and permanent teeth (p=0.019, p=0.011), respectively, but they had a comparable dmft-DMFT value with underweight children. Despite that, the comparison between Group E and Group F was not statistically significant (p=0.162) for the limited number of subjects in Group E.

In conclusion, the multidisciplinary diagnostic approach (nutritionists and paediatric dentists), adopted in this study, should also be applied to identify, with specific longitudinal studies, the common multiple factors (dietary habits, SES) that affect simultaneously dental caries and childhood obesity.

References


