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Dental caries and childhood obesity: analysis of food intakes, lifestyle

ABSTRACT

Aim *The aims of this cross-sectional statistical study were to evaluate the association between obesity and dental caries and to assess the impact of food intake, oral hygiene and lifestyle on the incidence of dental caries in obese paediatric patients, analysed by Dual X-ray Absorptiometry (DXA).*
Materials and methods *A sample of 96 healthy patients, aged between 6 and 11 years (mean age 8.58±1.43) was classified in relation to body composition assessment and McCarthy growth charts and cut-offs. Body composition analysis, to obtain body fat mass (FM) and body fat free mass (FFM) measurements, was determined by means of a DXA fan beam scanner. The subjects underwent dental examination to assess the dmft/DMFT, and completed a questionnaire on food intake, oral hygiene habits and lifestyle. The sample was subsequently subdivided into four groups: Group A (normal weight – caries-free), Group B (normal weight with caries), Group C (pre-obese/obese – caries-free), Group D (pre-obese/obese with caries). Statistics: The statistical analysis was performed using SPSS software (version 16; SPSS Inc., Chicago IL, USA). Spearman's correlation was performed to evaluate the correlation between dmft/DMFT and FM%. The chi-square test was performed to assess the categorical variables, while the non-parametric Kruskal Wallis test and the Mann Whitney test were employed for the quantitive variables. Statististical significance was set at a P-value of 0.05.*
Results *The preobese-obese children had higher indexes of dental caries than normal weight subjects, both for deciduous teeth (dmft 2.5±0.54 vs 1.4±0.38; p=0.030) and permanent teeth (DMFT 2.8±0.24 vs 1.93±1.79; p=0.039). The correlations between dmft/DMFT indexes and body composition parameters were analysed and a significant correlation between dmft/DMFT indexes and FM% was observed (p=0.031 for dmft, p=0.022 for DMFT). According to the data recorded, there was no statistically significant difference between Groups A, B, C and D in terms of food intake between meals (p=0.436), frequency of starch intake limited to the main meals (p=0.867), home oral hygiene (p=0.905), dental hygiene performed at school (p=0.389), habit of eating after brushing teeth (p=0.196), participation in extracurricular sport activities (p=0.442) and educational level of parents: father (p=0.454), mother (p=0.978). In contrast, there was a statistically significant difference between Groups A, B, C and D in terms of intake of sugar-sweetened drinks (p=0.005), frequency of sugar intake limited to the main meals (p<0.001), frequency of food intake between meals (p=0.038) and sedentary lifestyle (p=0.012). Successive analysis revealed a statistically significant difference between Group A and D in terms of intake of sugar-sweetened drinks (p=0.001), frequency of sugar intake limited to the main meals (p=0.008), and frequency of food intake between meals (p=0.018), and between Group C and D in terms of frequency of sugar intake limited to the main meals (p<0.001), and frequency of food intake between meals (p=0.040).*
Conclusion *This study shows a direct association between dental caries and obesity evident from a correlation between prevalence of dental caries and FM%. The analysis of food intake, dmft/DMFT, FM%, measured by DXA, demonstrates that specific dietary habits (intake of sugar-sweetened drinks, frequency of sugar intake limited to main meals, frequency of food intake between meals) may be considered risk factors that are common to both dental caries and childhood obesity.*

Keywords *Childhood obesity; Dental caries; Food intake.*

Introduction

Many studies available in the literature have evaluated the association between obesity and the prevalence of dental caries, but the results obtained are often discordant.

Some authors have reported no association between dental caries and childhood obesity [Hong et al., 2008;

Kopycka-Kedzierawski et al., 2008; D'Mello et al., 2011; Yen and Hu, 2013], while others have shown a weak association [Gerdin et al., 2008]. On the other hand, several studies have found positive association between these two childhood conditions [Hilgers et al., 2006; Pinto et al., 2007; Willerhausen et al., 2007; Willershausen et al., 2007; Alm et al., 2008], and have suggested that obese children are at increased risk of dental caries. In contrast, Macek and Mitola [2006] reported that the 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 that only three studies had a sufficient level of contributory evidence, of which only one demonstrated the relationship between obesity and dental caries [Kantovitz et al., 2006]. A recent cross-sectional study [Costacurta et al., 2011] has highlighted for the first time the relationship between the prevalence of dental caries and body fat mass percentage (FM%) measured by Dual X-ray Absorptiometry (DXA), which provides a more specific assessment of body composition and is a reliable screening tool for obesity, when compared to Body Mass Index (BMI). Certainly, the evaluation of the association between obesity and dental caries is complicated, because each has multiple etiopathogenetic factors (including biological, genetic, socioeconomic, cultural, environmental and lifestyles variables), but it is possible that they also share common risk factors [Hong et al., 2008].

Marshall et al. [2007a] suggested that neither "obesity increases the risk of caries" nor "caries increases the risk of obesity", but rather a common risk factor increases the likelihood of both diseases, which are then observed in association. Food choices, lifestyle factors (such as dietary habits) and socioeconomic status (i.e. parental education levels and family income) were hypothesised to be common risk factors that potentially link obesity and dental caries [Kantovitz et al., 2006; Marshall et al., 2007a].

The aim of this cross-sectional statistical study was to evaluate the association between obesity and dental caries and to assess the impact of food intake, oral hygiene and lifestyle on the incidence of dental caries in obese paediatric patients, analysed by DXA.

Materials and methods

The enrolment of 96 healthy patients, aged between 6 and 11 years (mean age 8.58±1.43), was carried out at the Paediatric Dentistry Unit of PTV Hospital, University of Rome Tor Vergata.

Each patient underwent anthropometric measurements, calculation of BMI, DXA exam and dental check-up, after a signed informed consent from the parents or guardian. Moreover a questionnaire on food intake, oral hygiene habits and lifestyle was administered.

Anthropometric measurements, DXA exam

The anthropometric measurements, BMI calculation and DXA exam were performed at the Human Nutrition Unit, University of Rome Tor Vergata.

Body weight (kg) was measured to the nearest 0.1 kg, using a balance scale (Invernizzi, Rome, Italy), height (cm) was measured using 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.

BMI was calculated using the standard formula: BMI = body weight (kg)/height (m^2).

Body composition analysis, to obtain body fat mass (FM) and body fat free mass (FFM) measurements, 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 for 24 h prior administration of the test. They had to wear a standard cotton t-shirt, shorts and socks. They had to lay supine on the DXA machine, without moving for 20 min while the DXA scan recorded their results. The intra- and inter-subjects coefficient of variation (CV%=100x SD/mean) ranged from 1% to 5%. The coefficient of variation for bone measurements was less than 1%; CVs on this instrument for five subjects scanned six times over a nine month period were 2.2% for fat mass and 1.1% for lean body mass. The effective radiation dose from this procedure is about 0.01 mSv.

Dental examination

The dental examination was performed by a trained dentist from the Paediatric Dentistry Unit of PTV Hospital, University of Rome Tor Vergata.

Medical history was obtained during the visit, including information on asthma, allergies, diabetes, coeliac disease, body growth delay, gastrointestinal diseases; these conditions were considered as exclusion criteria for enrolment.

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

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

Questionnaire

The patients and their parents completed a specific questionnaire, designed to evaluate:

- eating habits: intake of food between meals, intake of sugar-sweetened drinks, frequency of sugar

intake limited to the main meals, frequency of starch intake limited to the main meals, frequency of food intake between meals;
- oral hygiene habits: home oral hygiene, dental hygiene performed at school, habit of eating after brushing teeth;
- lifestyle: extracurricular physical activity, sedentary lifestyle (watching tv, computer, reading, studying), educational level of parents.

Subject classification

The subjects were classified as pre-obese/obese according to Mc Carthy's age-sex specific centile curves [McCarthy et al., 2006].

According to the FM% McCarthy classification the subjects were classified into underweight (FM%<2ndcentile), normal weight (2ndcentile<FM%<85thcentile), pre-obese (85thcentile<FM%<95thcentile), obese (FM%>95thcentile) groups.

The sample was subsequently subdivided into four groups:
- Group A: normal weight caries-free.
- Group B: normal weight with caries.
- Group C: pre-obese/obese caries-free.
- Group D: pre-obese/obese with caries.

Statistical analysis

The statistical analysis was performed using SPSS software (version 16; SPSS Inc., Chicago IL, USA). Spearman's correlation was performed to evaluate the correlation between dmft/DMFT and FM%.

Inferential statistical tests were applied to Groups A, B, C, and D in order to compare the groups in terms of the relevant variables. The initial analysis was performed on all the groups together, then it was narrowed to compare two groups at a time. The chi-square test was performed to assess the categorical variables, while for the quantitative variables, the non-parametric Kruskal-Wallis test was employed when the four groups were analysed together and the Mann-Whitney test when a comparison between two groups was made. The level of significance was set at a P-value of 0.05.

Results

Ninety-six patients, aged between 6 and 11 years, with a mean age of 8.58±1.43, were analysed; 52 were female (54.2%) and 44 were male (45.8%).

The anthropometric, body composition characteristics and dmft/DMFT index of the study population are listed in Table 1.

According to the analysis of FM% (McCarthy cut-offs) classification, 25 subjects (26.1%) were normal weight, 22 subjects (22.9%) were pre-obese and 49 subjects (51.0%) were obese. No underweight subjects were identified in this sample.

The preobese-obese children had higher indexes of dental caries than normal weight subjects, both for deciduous teeth (dmft 2.5±0.54 vs 1.4±0.38; p=0.030) and permanent teeth (DMFT 2.8±0.24 vs 1.93±1.79; p=0.039), which remained significant when assessed in different categories stratified by age and sex.

The correlations between dmft/DMFT indexes and body composition parameters were analysed and a significant correlation between dmft/DMFT indexes and FM% was observed (p=0.031 for dmft, p=0.022 for DMFT).

According to the data recorded, there was no statistically significant difference between Groups A, B, C and D in terms of food intake between meals

	Mean	Std. Deviation	Min	Max
Age	8.58	1.43	6.00	11.00
Height (m)	1.35	0.10	1.15	1.61
Weight (Kg)	34.01	11.52	19.00	69.60
BMI (Kg/m2)	18.37	4.17	11.86	30.12
Waist (cm)	62.02	9.99	46.00	87.00
Hip(cm)	72.60	10.84	56.50	103.00
Waist/Hip ratio	0.85	0.05	0.74	0.98
Fat Mass (Kg)	10.87	6.76	1.56	35.04
Fat Mass %	30.56	9.49	6.90	52.00
Lean Mass (Kg)	21.59	5.05	12.00	36.77
Bone Mineral Content (g)	1182.22	421.99	626.40	4200.00
Bone Mineral Density (g/cm2)	0.79	0.10	0.60	1.08
dmft	2.04	1.02	0	4.00
DMFT	2.53	1.99	0	8.00

TABLE 1 The anthropometric, body composition characteristics and dmft/DMFT index of the study population.

		Group A	Group B	Group C	Group D	P value
		normal weight caries free	normal weight with caries	pre-obese/obese caries free	pre-obese/obese with caries	
Food intake between meals (%)	yes	66.7	90.0	72.7	84.7	0.436 a
	no	33.3	10.0	27.3	15.3	
Sugar intake-sweetened drinks (%)	yes	33.3	35.0	54.5	78.0	0.005 a
	no	66.7	65.0	45.5	22.0	
Sugar intake limited to main meals (mean)		1.6	1.7	0.7	2.5	<0.001 b
Starch intake limited to main meals (mean)		3.7	3.3	3.5	3.6	0.867 b
Food intake between meals (mean)		1.9	2	1.9	2.5	0.038 b
(a) Chi-Square Test (b) Kruskal-Wallis Test						

TABLE 2 Differences between Groups A, B, C and D in terms of food intakes.

(p=0.436) and frequency of starch intake limited to the main meals (p=0.867) (Table 2).

Among the examined children, 78.5% reported the habit of eating food between meals; 65.0% preferred foods containing refined sugar outside of mealtimes, while drinks ranged from soft drinks (52.9%), juice (18.9%), milk (17.1%), and tea (11.4%).

In contrast, there was a statistically significant difference between Groups A, B, C and D in terms of intake of sugar-sweetened drinks (p=0.005), frequency of sugar intake limited to the main meals (p<0.001), and frequency of food intake between meals (p=0.038) (Table 2).

Successive analysis revealed a statistically significant difference between Group A and D in terms of intake of sugar-sweetened drinks (p=0.001), frequency of sugar intake limited to the main meals (p=0.008), and frequency of food intake between meals (p=0.018), and between Group C and D in terms of frequency of sugar intake limited to the main meals (p<0.001), and frequency of food intake between meals (p=0.040).

There were no statistically significant differences between Groups A, B, C and D as concerns home oral hygiene (p=0.905), dental hygiene performed at school (p=0.389), and the habit of eating after brushing teeth (p=0.196).

According to the data recorded, subjects reported a mean tooth-brushing frequency of 2 times/day. Only 16.0% brushed their teeth at school, while 34.0% of the sample habitually ate after having brushed their teeth; this appeared to particularly occur at night in front of the television before going to bed.

No statistically significant differences were found between Groups A, B, C and D with regards to participation in extracurricular sport activities (p=0.442) and educational level of parents: father (p=0.454), mother (p=0.978).

However, a statistically significant difference was found in terms of time spent watching television, using the computer or studying/reading; that is to say, obese subjects had a more sedentary lifestyle compared to normal-weight subjects (p=0.012).

Discussion

Although dental caries and obesity are both associated with dietary habits, several studies in the literature have often reported conflicting results. In fact, some studies have shown a direct association between dental caries and obesity [Hilgers et al., 2006; Pinto et al., 2007; Willerhausen et al., 2007; Willershausen et al., 2007; Alm et al., 2008], while others have not [Macek and Mitola, 2006; Hong et al., 2008; Kopycka-Kedzierawski et al., 2008; D'Mello et al., 2011; Yen and Hu, 2013]. However, the results of this study indicate a positive association between obesity and dental caries and confirm the relationship between the prevalence of dental caries and FM% measured by DXA, highlighted in a recent study [Costacurta et al., 2011]. Consequently we hypothesised potential common risk factors that may link obesity to frequency of dental caries, as has been confirmed by other authors [Kantovitz et al., 2006; Marshall et al., 2007a], and these risk factors were sought by analysing food intake and lifestyle in preobese-obese subjects. Other studies have carried out this type of analysis, however the paediatric population was classified according to BMI [Alm et al., 2008; Gerdin et al., 2008; Marshall et al., 2007a]. The present study addressed the issue, making use of a more specific assessment of body composition by DXA scanning, and a more reliable clinical diagnosis of obesity.

The relationships between obesity and dental caries, with potential mediation by dietary factors and socioeconomic status, have not been thoroughly investigated. Knowledge of these relationships could lead to preventive health measures designed to decrease the prevalence/incidence of both obesity and dental caries [Marshall et al.,2007a].

It is well established that obesity and dental caries have multiple etiopathogenetic factors, including biological, genetic, socioeconomic, cultural, environmental and lifestyles variables [Marshall et al.,2007a; Hong et al., 2008], and distinguishing between the contributions of each in an observational study is difficult.

Dietary habits and energy-dense, highly refined foods not only contribute to the obesity epidemic but also increase the likelihood of dental caries [WHO, 2003; Alm et al., 2008].

From the results obtained we can see that the differentiating factor between normal-weight subjects without dental caries (Group A) and pre-obese/obese with dental caries (Group D) is the intake of sugar-sweetened drinks (p=0.001), frequency of sugar intake limited to main meals (p=0.008) and frequency of food intake between meals (p=0.018), while pre-obese/obese without caries (Group C) and obese with caries (Group D) differed in terms of frequency of sugar intake limited to the main meals (p<0.001), and frequency of food intake between meals (p=0.040). Therefore, an unbalanced diet with an intake of sugar-rich foods and high frequency and duration of sugar-eating events may be related to increased prevalence of dental caries [WHO, 2003; Marshall et al., 2007b] and to increased prevalence of obesity [Ludwig et al., 2001; Nicklas et al., 2001].

A high intake of sugar-sweetened drinks in obese children emerges from our results, evident in both the group without dental caries (Group C) and those with caries (Group D). This fact may confirm the relationship between consumption of sugar–sweetened drinks and childhood obesity [Ludwig et al., 2001] and highlights that the associations between different types of sugared beverages and dental caries are non-linear, which could be attributable to the different sugar compositions of the beverages or different roles in the diet [Marshall et al., 2003]. For example Marshall [2003] maintains that the regular consumption of soft drinks, regular powdered beverages, and, to a lesser extent, 100% juice were associated with increased risk of caries, while milk had a neutral association. Furthermore, in our study pre-obese/obese subjects tended to have a more sedentary lifestyle compared to normal-weight subjects (p=0.012); this could have an influence on eating habits. For example, according to Giammattei et al. [2003] the habit of spending long periods watching television was positively correlated with both the increased consumption of soft drinks and obesity.

Multiple studies have reported that the consumption of snacks during childhood appeared to be associated with more caries [Alm et al., 2008; Johansson et al., 2010] and obesity [Nicklas TA et al., 2001]. Instead in this study, no significant differences between groups A, B, C, and D in terms of food intake between meals was evident from the data analysis of this study (p=0.436), however the frequency of food intake was higher in Group D compared to Groups A and C (p=0.018, p=0.040 respectively). In fact, in the National Italian Guidelines for dental caries prevention in 0 to 12 year-old children, a strong correlation between dental caries and fermentable carbohydrate intake, frequency of food intake and sugar consumption outside of mealtimes was evident [Campus et al.,2007].

The frequency of sugary foods consumption should usually be considered of greater aetiological importance than the total amount of sugars [Lingström et al., 2000; Chankanka et al., 2011]. Cariogenicity is more likely a function of the food and/or beverage vehicle delivering the sugar and the nature of exposure, that is, frequency and duration of eating events, than the category of sugar [Marshall et al., 2007b].

If on the one hand pro-cariogenic and cariostatic foods have been appropriately identified, the significance of the glycemic index (GI), important in the provision of more effective dental caries prevention, has not been adequately emphasised. In fact, the bioavailability of carbohydrates, in terms of bacterial metabolism, is linked not only to the molecule type, but more importantly to the individual characteristics of the food in which the carbohydrates are contained, and the combination of different foods present in the meal [Lingström et al., 2000]), which can influence the glycemic index [D'Alessandro et al., 2009]. A diet rich in sugars does not only provide cariogenic bacteria with the necessary substrates, but reduces the formation of dentin during dentinogenesis, independent of insulin [Pekkala et al., 2002]. Moreover, if obesity is associated with accelerated skeletal-dental maturation [Costacurta et al., 2012], the early eruption of permanent teeth, when the children might not be able to carry out a proper oral hygiene, could result in an increased incidence of dental caries.

It is important to note that there were no statistically significant differences between Groups A, B, C and D when oral hygiene habits were analysed. The subjects reported a mean tooth-brushing frequency of 2 times/day, as evidenced also by Cerulli Mariani et al. [2006]. But a positive association between periodontal disease and obesity in paediatric patients was suggested by several authors [Scorzetti et al, 2013].

The limitations of this study include sample size for the complexity and cost of assessing body composition using DXA scanning in paediatric population, and data lacking on socioeconomic status.

Low socioeconomic status may be responsible for the coexistence of obesity and dental caries in childhood [Marshall et al., 2007a]. However Bailleul-Forestier et al.

[2007] reported a statistical increase in caries in obese adolescents even in an intermediate socio-economic environment. Individuals with lower socioeconomic backgrounds are more likely to eat low-cost foods containing more sugar and fat, which increase the risk of obesity and dental caries [Drewnowski and Specter, 2004].

Conclusion

This study shows a direct association between dental caries and obesity evident from a correlation between prevalence of dental caries and FM%. The analysis of food intake, dmft/DMFT, FM%, measured by DXA, demonstrates that specific dietary habits (intake of sugar-sweetened drinks, frequency of sugar intake limited to main meals, frequency of food intake between meals) may be considered risk factors that are common to both dental caries and childhood obesity.

Acknowledgements

The authors would like to thank Dr. E. Tyndall for revising and proofreading the article, and Dr C. Gavrila and F. Sarlo for their support with the research.

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