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Influence of occlusal characteristics, food intake and oral hygiene habits on dental caries in adolescents: a cross-sectional study

ABSTRACT

Aim *Dental caries is one of the most common oral diseases affecting children. The complex multifactorial aetiology of caries involves host (saliva composition and tooth enamel characteristics), oral microflora and substrate (oral hygiene quality and dietary habits composition). Occlusal characteristics may be also a factor in dental caries development. The aim of this aepidemiologic study was to verify the association between DMFT (Decayed, Missed, Filled Teeth) index and occlusal characteristics, dietary habits, oral hygiene habits and parents' education level in a sample of 12-year-old schoolchildren from Southern Italy.*

Materials and Methods *A sample of 536 children was examined to detect dental caries status and several occlusal variables (i.e. molar relationship, overjet and overbite, presence of crossbite, scissor bite, crowding, diastemas and/or midline deviation). A questionnaire to retrieve parents' educational level, patient's dietary and oral hygiene habits was administered. The associations among these variables were assessed statistically through the* χ^2 *test.*

Results *A positive association was found between caries, parents' social status and some occlusal disorders. va specificato, l'abstract non può essere una caccia al tesoro. In relation to occlusal variables, crossbite* (χ^2*=3.96, P=0.04) was significantly associated to caries. A significant association was also found between the education level of mothers* (χ^2*=7.74, P<0.01) and fathers* (χ^2*=6.35, P=0.01) and the presence of caries. Dietary habits, oral hygiene and remaining occlusal characteristics were not associated with caries presence (all P>0.05).*

Conclusions *Of the evaluated occlusal characteristics only posterior crossbite was associated with caries prevalence. Education level of the parents was the other factor significantly associated with caries. Dietary habits, oral hygiene frequency and the remaining occlusal characteristics were not associated with dental caries.*

Keywords *Dental caries; Malocclusions; Diet; Oral health; Social class.*

Introduction

Dental caries is one of the most common oral diseases affecting children and adolescents throughout the world. Recent data from developed countries suggest a decline of dental caries over the last 30 years [Auad et al., 2009; Campus et al., 2008; Llena et al., 2015] (Table 1). The complex multifactorial aetiology of caries involves host (saliva composition and tooth enamel characteristics), oral microflora and substrate (oral hygiene quality and dietary habits) [Campus et al., 2007; Matarese et al., 2013].

Occlusal characteristics, like dental crowding, may be a risk factor for the occurrence of dental caries [Perillo et al., 2011]. Crowding affects normal interproximal tooth contacts with improper embrasures leading to increase food accumulation and plaque retention [Hafez et al., 2012; Feldens et al., 2015; Iancu Potrubacz et al., 2016]. Previous studies reported a positive correlation between

Author	Year of publication	Geographic Area	Sample	Age	DMFT	Prevalence
Angelillo et al.	1998	Catanzaro, Italy	385	12	-	88.1%
Szoke et al.	2000	Hungary	900	12	-	84.5%
Nieto et al.	2001	Spain	347	7-12-14	3.91	-
Auad et al.	2009	Brasil	458	13-14	3.95	78%
Mtaya et al.	2009	Tanzania	369	12	-	22%
Migale et al.	2010	Cutro	103	11	2.60	-
Mazza et al.	2010	Burkina Faso	354	12	-	22.9%

TABLE 1 Prevalence of dental caries and DMFT in 12-year-old children.

malocclusions and caries in different populations [Gábris et al., 2006; Singh et al., 2011], whereas others reported no or a negative correlation between crowding and dental caries [Staufer and Landmesser, 2004]. A systematic review showed a lack of studies with adequate methodological quality to clearly support or not this association [Hafez et al., 2012]. This may be related to the different definitions used for malocclusion factors and how their specific components were measured.

In the aetiology of dental caries, dietary habits play a significant role in dental erosion [Llena et al., 2015]. Nutrition and dietary components may contribute to the development of enamel defects (e.g., enamel hypoplasia, fluorosis). Evidence of an association between consumption of sugar-rich foods and caries has been portrayed. Conversely, consumption of other kinds of food, like cheese, avoids the pH reduction associated with sugar consumption. In addition, the presence of calcium in dairy food stimulates salivary secretion. This influences the balance between enamel de- and re-mineralisation with an effective increase of calcium concentration in dental plaque, thus representing a protective factor for dental caries [Moynihan and Petersen, 2004].

Another risk factor for caries development in children is the parents' educational level [Mtaya et al., 2009]. Home enviroment can also influence oral hygiene habits [Cvikl et al., 2014; Di Domenico et al., 2012].

Over the years, several aepidemiological studies assessed the association between dental caries and some of these variables in specific countries or geographic areas during different dentition stages [Cvikl et al., 2014; Gábris et al., 2006; Mtaya et al., 2009; Singh et al., 2011].

Relatively few researches have been performed on caries prevalence to date, some focusing on geographic areas [Angelillo et al., 1998; Mazza et al., 2010; Perinetti et al., 2006; Szöke and Petersen, 2000]. For example, in Italy, Campus et al. [2007] evaluated the relationship between caries prevalence, toothbrushing and dietary habits in a 13 to 18-year-old sample from Milan, whereas no studies on the other associations with dental caries were performed in Southern Italy.

No study has considered so far the simultaneous analysis of occlusal characteristics, dietary and oral hygiene habits, and parents' education level. Therefore, the aim of the present aepidemiological study was to verify the correlation between the DMFT (Decayed, Missed, Filled Teeth) index and several occlusal characteristics (molar relationship, overjet and overbite, presence of crossbite, scissor bite, crowding, diastemas and/or midline deviation), dietary habits, oral hygiene habits and parents' education level in a sample of 12-year-old schoolchildren from Southern Italy.

Materials and methods

Approval for this study was obtained from the Institutional Review Board of the University of Campania "Luigi Vanvitelli" (N° Prot.1023).

The study sample involved schoolchildren attending the 2nd year of secondary school (corresponding to the eighth grade) in the 10th district in Naples to avoid bias ensuing from social heterogeneity. The schools were randomly sampled, and 48 schools were randomly selected from an initial pool of 79 schools, according to a cluster sample design previously identified by the school district. Classes within each school were sampled systematically. All students recruited in the sampled classes were examined, both to improve study feasibility and also to avoid any discriminations among pupils in the same school class. A total of 987 students were randomly selected, and a written consent to perform the examination was obtained from the childrens' parents or guardians.

The sample size was calculated assuming a precision of the estimate of ± 3 with a 95% confidence interval (sampling from finite population, nQuery Advisor, v. 4.0, Statistical Solution Ltd, Cork, Ireland).

All the selected children were recruited among those attending the schools on the examination day, thus 867 subjects partecipated in the study. Students with a history of orthodontic treatment and those who were undergoing an active treatment at the time of the study were excluded. Therefore, the final sample was comprised of 536 orthodontically untreated subjects.

The students were examined for 15 minutes in a quiet classroom of their school without external interference, under natural or artificial illumination. The dental occlusion

Districts	Total n (%)	DMFT=0 n (%)	DMFT=0 n (%)	χ^2 for trend P
40	85 (15.86)	37 (13.03)	48 (19.05)	
41	21 (3.92)	7 (2.45)	14 (5.55)	
42	83 (15.48)	47 (16.55)	36 (14.28)	
43	61 (11.37)	32 (11.28)	29 (11.51)	
44	69 (12.86)	42 (14.79)	27 (10.70)	χ^2 =5.52
45	-	-	-	P =0.70
46	67 (12.50)	36 (12.68)	31 (12.30)	
47	38 (7.09)	25 (8.80)	13 (5.16)	
48	57 (10.62)	30 (10.55)	27 (10.70)	
49	55 (10.25)	28 (9.86)	27 (10.70)	

TABLE 2 Prevalence of caries in relation to districts.

assessment was carried out using latex gloves, sterile dental mouth mirrors and millimeter rulers. Personal data were obtained directly from each student. No radiographs, study casts, or previous written records were used. The two examiners (LP and DG) had previously undergone calibration to standardise their procedures before the clinical examination phase. The examination was focused on oral hygiene, occlusal variables and the evaluation of decayed (D), missing (M) and filled (F) teeth (T), or DMFT index [Campus et al., 2006; Perillo et al., 2010]. Missing teeth were considered only if missing for caries [Hobdell et al., 2003; Guido et al., 2011].

The occlusal characteristics considered were molar relationship, overjet and overbite, presence of crossbite, scissor bite, crowding, diastemas and/or midline deviation. In more detail, the molar relationship was determined as the relationship between the upper and lower first permanent molars according to Angle's classification; patients with subdivision malocclusions were included in the Class II or Class III groups on the basis of the predominant occlusal characteristic or of the relationship between the canines. In cases where molar relationship was different to the canine one, only the molar class was considered. Overjet and overbite with values between 0 and 4 mm were considered normal. A crossbite, unilateral (right or left) or bilateral was diagnosed when a crossover of at least one tooth was detected in the anterior and posterior segments of the dental arches. A scissor bite was considered when the palatal cusps of the upper molars were positioned buccally in relation to the buccal cusps of the lower molars. Crowding and spacing were recorded for the anterior or the posterior segments. A midline diastema was considered to be present when there was a space of at least 2 mm between the maxillary central incisors.

Questionnaire

The data were obtained from the parents or guardians with a list-type questionnaire that was sent together with the written consent by the School Dean. Information about oral hygiene and dietary habits was obtained with questions on daily oral hygiene practices, intake and frequency of different types of foods (i.e., carbohydrates, dairy products, sweets). The frequency of any dental check-up was also investigated. Regarding parents' scholarly level, a distinction was made between low educational level (no education or compulsory schooling), and medium or high educational level (apprenticeship training, vocational school, high school or higher education).

	DMFT Mean ± SE	DT Mean ± SE	MT Mean ± SE	FT Mean ± SE
Total	1.88 ± 0.09	1.52 ± 0.08	0.07 ± 0.02	0.28 ± 0.04
Boys	1.71 ± 012	1.36 ± 0.11	0.07 ± 0.03	0.28 ± 0.05
Girls	2.02 ± 0.13	1.65 ± 0.12	0.07 ± 0.02	0.29 ± 0.05
	P =0.09	P =0.07	P =0.97	P =0.80

TABLE 3 Caries index and subcomponents by total population and gender.

Statistical analysis

DMFT values for each subject were used. The association between occlusion variables, oral health, dietary habits, and caries was assessed with, the χ^2 tests for evaluating the statistical significance. The significance level was set at 0.05.

Results

The final study sample was composed of 536 12-year-old students (283 females, 253 males). Dental caries was recorded in 321 students (59.8%). No difference was observed in the prevalence of caries according to gender (2.02 ± 0.13 in girls and 1.71 ± 012 in boys), or school district location (χ^2=5.52, P =0.70) (Table 2 and 3). Decay (D) component was more common in the posterior areas (1.45 ± 1.80). The first permanent maxillary molar was the tooth most affected by caries (46.83%) and the least prevalence was for lateral incisors (0.34%) (Table 4).

Table 5 shows the distribution of the sample according to the occlusal variables. Class I was the most represented occlusion (59.41%), followed by Class II (35.66%) and Class III (4.94%). Overjet and overbite were normal in most students. A midline deviation was detected in the 32.09% of the sample, while the presence of anterior and/or posterior crossbite was recorded in the 11.75% of the sample. The statistics showed a significant correlation between dental caries and Class I, Class II division 1 and Class III (Table 6). Crossbite was significantly associated to caries (χ^2=3.96, P =0.04) (Table 7), whereas crowding was increased, but not statistically significant in subjects with

caries (χ^2=1.95, P =0.09) (Table 8).

No statistically significant relation between caries and dietary habits was found. In particular, there was neither correlation between carbohydrates consumption and caries (χ^2=1.89, P =0.1) (Table 9) nor between daily diary consumption and caries prevention (χ^2=2.1, P =0.08) (Table 10).

Positive association was found between the education level of mothers (χ^2= 7.74, P <0.01) and fathers (χ^2= 6.35, P =0.01) and the presence of caries (Table 11).

No association was found in the adolescents brushing their teeth more than once a day compared to those who did not brush them at least after eating (χ^2=5.15; P =0.27) (Table 12).

Tooth	Maxillary		Mandibular	
	Right %	Left %	Right %	Left %
Permanent central incisor	1.06	-	-	-
Permanent lateral incisor	-	0.34	0.34	-
Deciduous canine	-	-	-	-
Permanent canine	-	-	0.70	-
First deciduous molar	0.34	-	-	-
Second deciduous molar	2.82	1.75	2.11	2.82
First permanent premolar	2.45	2.11	0.70	1.06
Second permanent premolar	1.06	1.06	1.41	0.70
First permanent molar	46.83	36.27	40.84	25.00
Second permanent molar	9.86	7.38	10.55	11.62

TABLE 4 Caries prevalence.

Occlusal variables	Number of subjects (%)
Molar Class I	307 (57.37)
Canine Class II	11 (2.04)
Canine Class III	0
Molar Class II	184 (34.33)
Class II, division 2	7 (1.33)
Molar Class III	26 (4.94)
Overjet >4 mm	3 (0.56)
Overjet 0-4 mm	446 (83.21)
Overjet <0 mm	87 (16.22)
Overbite > 4 mm	3 (0.56)
Overbite 0-4 mm	427 (79.65)
Overbite <0 mm	106 (19.76)
Median line	172 (32.09)
Crossbite	63 (11.75)
Monolateral crossbite	51 (9.51)
Bilateral crossbite	12 (2.24)
Crowding	253 (47.20)
Diastema	123 (22.95)

TABLE 5 Frequency of occlusal variables in the sample.

Discussion

This study was designed and carried out in the schools of Naples, one of the most populous cities in Italy and one with the highest birth rates. For this city the OMS goal for the year 2000, i.e. a DMFT value ≤ 3, was reached as reported in several studies [da Silveira Moreira, 2012; Majorana et al., 2014].

The D value in the DMFT score was always the highest and the variations observed among the different districts

	DMFT>0 n (%)	DMFT=0 n (%)	OR (95%CI)
Class I	176 (54.83)	131 (60.92)	1.34 (1.07 / 1.68)
Class I with >OVJ	7 (2.18)	4 (1.86)	1.75 (0.51 / 5.98)
Class II, division I	113 (35)	71 (33)	1.6 (1.04 / 1.91)
Class II, division II	4 (1.25)	3 (1.40)	1.33 (0.30 / 5.96)
Class III	14 (4.36)	3 (1.40)	4.67 (1.34 / 16.24)
Class III, subdivision	7 (2.18)	3 (1.40)	2.33 (0.60 / 9.02)
χ^2 for trend = 3.55; P =0.04.			

TABLE 6 Caries prevalence (DMFT>0) across malocclusions.

	DMFT=0 n (%)	DMFT>0 n (%)	χ^2 for trend P
Crossbite	39 (61.90)	24 (38.09)	χ^2 =3.96
			P =0.04*
χ^2 for trend = 3.96; P =0.04			

TABLE 7 Caries prevalence (DMFT>0) and posterior crossbite.

	DMFT=0 n (%)	DMFT>0 n (%)	χ^2 for trend P
Dental crowding	130 (51.37)	123 (48.62)	χ^2=1.95
			P =0.09
χ^2 for trend = 1.95; P =0.09			

TABLE 8 Caries prevalence (DMFT>0) and crowding.

for mean values of DMFT may be due to socio-economic and/or cultural differences [Källestål and Wall, 2002; Uceda et al., 2013]. In fact, a positive correlation was found in our sample between educational level of parents and presence of caries.

Higher values of DMFT were found in students who had no intake of milk or dairy products. This finding may be in line with earlier studies [da Silveira Moreira, 2012; Källestål and Wall, 2002; Uceda et al., 2013] showing that milk and dairy products consumption was associated with reduced frequency of caries.

In the last few years, a distinct association between oral hygiene and prevention of dental caries has been demonstrated. Some studies [Maltz et al., 2010; Migale et al., 2009; Nieto Garcìa et al., 2001; Perillo et al., 2011; Giugliano et al., 2015] found out that the prevalence of caries was not related to adequate oral hygiene practices, as also reported in other surveys, strengthening the hypothesis of a multifactorial origin of caries. The dietary habits and oral hygiene frequency were not associated with dental caries in the present study, maybe because of the increased use of fluoridated water and fluoride dentifrices for dental caries prevention.

The hypothesis that some occlusal characteristics may increase the risk of caries was also tested. Based on the current findings the need for any orthodontic treatment should not be linked to a suggestion of decreased risk of caries. In this study a higher prevalence of caries was only

	DMFT=0 n (%)	DMFT>0 n (%)	χ^2 for trend P
Sweets*			
None	24 (8.45)	26 (10.31)	
Low	114 (40.14)	97 (38.49)	
Normal	70 (24.64)	73 (28.96)	
High	76 (26.76)	56 (22.22)	
			χ^2 =1.89
			P =0.1
Cake**			
None	24 (8.4)	22 (8.73)	
Low	104 (36.61)	101 (40.07)	
Normal	87 (29.57)	74 (29.36)	
High	69 (24.29)	55 (21.82)	
Sweet Snacks	122 (42.95)	108 (42.85)	
χ^2 for trend = 1.95; P =0.09			
*Sweets: None (no sweets), low (seldom), normal (1-2 times per day), high (>twice a day)			
**Cake: None (no cake), low (seldom), normal (once a day), high (> once a day)			

TABLE 9 Association between prevalence of caries and carbohydrate consumption.

	DMFT=0 n (%)	DMFT>0 n (%)	χ^2 for trend P
Dairy*			
None	37 (58.72)	26 (41.27)	χ^2=2.1
Low	57 (54.81)	47 (45.18)	P =0.08
Normal	150 (50.00)	150 (50.00)	
High	40 (57.96)	29 (42.03)	
*None (no dairy), low (< 2 twice a week), normal (2-4 times per week), high (> 4 times per week)			
χ^2 for trend = 1.95; P =0.09			

TABLE 10 Association between prevalence of caries and dairy consumption.

	DMFT>0 n (%)	DMFT=0 n (%)	OR (95%CI)	χ^2 for trend P
Mother				
Low	72 (27.91)	38 (21.60)	1.90 (1.28 / 2.80)	χ^2=7.74 P <0.01*
Medium	80 (31.00)	45 (25.57)	1.78 (1.23 / 2.56)	
College	79 (30.62)	58 (32.95)	1.36 (0.97 / 1.91)	
Degree	27 (10.47)	35 (19.88)	0.77 (0.47 / 1.27)	
Father				
Low	51 (20.00)	22 (12.72)	2.31 (1.40/14.86)	χ^2=6.35 P =0.01*
Medium	88 (34.51)	56 (32.37)	1.57 (1.12 / 2.20)	
College	76 (29.80)	55 (31.79)	1.38 (0.98 / 1.95)	
Degree	40 (15.69)	40 (23.12)	1.00 (0.64 / 1.55)	
χ^2 for trend (Mother) =7.74; P =0.01 χ^2 for trend (Father) =6.35; P =0.01				

TABLE 11 Caries prevalence (DMFT>0) across parents' education level.

associated to crossbite, maybe related to crowding [Perillo et al., 2012; Fleming, 2015].

The main future perspective will be to assess 12-year-old school children in Southern Italy to monitor the achievement of a DMFT goal <1.5 for the year 2020. The objectives of the WHO Global Oral Health Programme are crucial to integrate oral health promotion and care, to reduce disparities in oral health between different socio-economic groups within a country and across countries, and finally to increase the number of health care providers who are trained in accurate aepidemiological surveillance of oral diseases and disorders.

	DMFT=0 n (%)	DMFT>0 n (%)	χ^2 for trend P
Brushing tooth			
Never	11 (7.74)	7 (2.77)	
1 time/day	24 (8.45)	21 (30.55)	
2 times/day	99 (34.85)	77 (30.55)	χ^2=5.15
3 times/day	107 (37.67)	117 (46.43)	P =0.27
4 times/day	42 (14.78)	30 (11.90)	
χ^2 for trend = 5.15 P =0.01			

TABLE 12 Prevalence of caries and toothbrushing frequency.

Conclusions

In the 12-year-old school children sample from Southern Italy a positive correlation was found between dental caries and parents' educational status. Only crossbite was an occlusal characteristic associated with caries prevalence. Dietary habits, oral hygiene frequency and the other occlusal characteristics considered were not associated with dental caries.

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