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ORIGINAL ARTICLE

Interrelation between obesity, oral health and life-style factors among Turkish school children

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Abstract Obesity, dental caries and periodontal diseases are among major public health concerns which may affect children's growth and development. This study seeks any clustering between obesity, oral health and life-style factors among school children in Istanbul, Turkey. A cross-sectional study of children, 10- to 12-year-olds, from a public and a private school was undertaken with questionnaires for children and their mothers and child oral health data, in Istanbul (n=611). DMFS (number of decayed, missing and filled surfaces of permanent teeth), CPI (Community Periodontal Index), body mass index (BMI) and life-style factors (tooth-brushing frequency, milk consumption at breakfast and bedtimes on school nights) of children were examined. Data analysis included factor analysis, Student's t test and Chi-square tests by cross-tabulation. Public school children were more dentally diseased but less obese than were those in private school (P<0.001). They more frequently had calculus (62%) and reported non-recommended tooth-brushing (68%) than did those in private school (37%, 56%; P<0.05). Principal component analysis revealed that DMFS, CPI and BMI shared the same cluster among all children. A need exists for addressing obesity, oral health and nutrition jointly in health promotion strategies to improve children's well-being and empower good life-style factors.

Keywords Oral health · Obesity · Life-style factors · School children · Socio-economic status

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Introduction

The World Health Organization (WHO) underlines the need to adopt an integrated approach to the promotion of general and oral health [1], as both share common risk factors [2]. The common risk factor approach [2] has been suggested as more cost-effective, affordable and sustainable than are traditional single-level strategies [1].

Obesity in childhood is among the major public health concerns, one described as a pandemic because of its global distribution and severe consequences [3]. Dental caries and periodontal diseases have historically been considered one of the most important global health burdens [1] affecting the growth and development of children [4, 5].

The school-age period from childhood to adolescence is a critical life stage when health- and oral health behaviours develop [1, 4]. WHO proposes the need for integration of oral health promotion among school-aged children with efforts addressing other health issues such as healthy nutrition and obesity, plus strengthening learning experiences [4]. Research into the interrelation between dental health, periodontal diseases and obesity as well as the common life-style factors among children has, however, been scarce.

The aim of the present study was to assess clustering between obesity, oral health and life-style factors among Turkish school children.

Materials and methods

Study design and subjects

In spring 2004, a cross-sectional study of 611 Turkish school children from the fourth, fifth and sixth grades, 10- to 12-year-olds, was undertaken with questionnaires for children and their mothers as well as child oral health data, in Kadiköy (a managerial district of Istanbul). Two schools were selected by cluster sampling from high- and low-socio-economic-level suburbs to represent the general profile of the Kadikoy district. In Turkey, children's education depends on individual fees ranging from low in public to high in private schools, representing families' low or high socio-economic profile [6].

Self-administered health behaviour questionnaires meant for these children and their mothers were revised after testing them in a pilot study in 2003 on a sample of 63 fourth-grade elementary school children in Istanbul [6].

Response rates were 95% for the clinical examinations (332 in public- and 220 in private school children), 97% for the health behaviour questionnaires for the children (in 345 public- and 246 in private schools), and 87% for the mothers (from 334 in public- and 199 in private schools). Boys comprised 51% of the population.

Ethical approval and written permission were granted to conduct the study, and written informed consent was provided by all the participating mothers and children [6]. Two native speakers translated the questionnaires from English into Turkish to ensure accuracy comparable to that of the original forms in English. The child health behaviour questionnaires were completed in classes, whereas those for mothers were taken home and returned by the children during the following 2 weeks.

Clinical examinations

Clinical examinations measured children's dental health (DMFS; number of decayed, missing and filled surfaces of permanent teeth) and periodontal status (CPI; Community Periodontal Index), based on WHO criteria [7]. Examinations were performed in classes of each school using a lightweight portable examination light (in the blue–white spectrum), as suggested by WHO [7]. They were carried out in the classrooms 2 weeks before the survey by two calibrated paediatric dentists (ABC and SC) who worked professionally in dental university clinics.

The dental examinations were performed under field conditions. The child was seated in a chair with a high backrest; the examiner stood in front of the chair and used plane mouth mirrors and blunt dental probes. Following WHO recommendations, the examiners first recorded caries scores on dental charts, in terms of DMFS. Lesions were recorded as present when a carious cavity was detected on manual inspection. DMFS of both groups were dichotomized into healthy (DMFS=0) and diseased (DMFS>0) subgroups for further analysis.

One examiner (ABC) recorded the corresponding CPI index following the dental examinations on the same school day, based on WHO recommendations. The child lay on two school chairs with her or his head resting on a cushion in the examiner's lap. The WHO probe suggested for this examination [7] was gently introduced into the sulcus at three different sites (mesial, central and distal) on both buccal and lingual aspects of each of six index teeth (16, 11, 26, 36, 31, 46) [7] to determine periodontal status. The highest value for the code: 0 (healthy), 1 (bleeding), 2 (calculus) in each sextant was registered as the value for that sextant [7]. If fewer than two permanent teeth were present, the sextant was recorded with a cross (x). The highest score among the six index teeth was coded as maximum CPI for each child for further analysis. Those children with CPI=0 (0.7%, n=4) were excluded from the data analysis.

Of the study group, 10% were re-examined for inter-examiner (0.81) and intra-examiner reliability (0.92 and 0.94) of DMFS (P<0.05).The intra-examiner reliability of CPI was 0.87 (P<0.05).

Life-style factors and BMI measures

For final analysis, these variables were extracted from the following sources:

Child health behaviour questionnaire [6]

- Tooth-brushing frequency (ranging on a six-point Likert scale as never, less than once a week, once a week, more than once a week, once daily, twice daily or more) was dichotomized as twice daily or more (recommended=0) and less than twice daily (non-recommended=1) [8, 9].
- Daily consumption of milk at breakfast and bedtimes on school nights: yes (favourable=0), no (unfavourable=1).

Children were asked to answer the question 'When do you go to bed on school nights?" by selecting one of these choices; 'I usually go to bed regularly on school-days, at _____o'clock' or 'I usually go to bed irregularly on school nights'. The mean of self-reported regular bedtimes was 21.52±0.83, ranging between 19.00 and 24.00.

Maternal health behaviour questionnaire [6]

- Children's Body Mass Index (BMI)

Mothers were asked to measure weight to the nearest 0.1 kg, and height to the nearest 0.1 cm with children wearing only their underwear, barefoot, standing erect

against a wall-mounted measuring tape. Parents were asked not to include any earlier measurements available, but to take new measurements after the arrival of the questionnaires at home. Of the study group, 10% of mothers were asked to complete again the maternal health behaviour questionnaires 2 weeks after cessation of the survey for the measurement of intra-examiner reliability; this was 0.78 for height, and 0.74 for weight ($P<0.05$).

Body mass index (BMI)-for-age [(weight in kilogrammes)/(height in metres)^2] percentiles, developed and used as a growth and nutrition reference by WHO, are dependent on gender- and age-specific weight-for-height charts for those aged 5 to 19 years [10]. According to these charts, 'non-obese', 'at risk for overweight' and 'overweight' were defined, respectively, as fifth percentile< BMI-for-age<85th percentile, 85th percentile≤BMI-for-age<95th percentile, and BMI-for-age≥95th percentile [11]. Public- and private school children with underweight/undernutrition-BMI-for-age ≤5th percentile [12] (8% vs. 3%, $n=26$, $n=7$, $P<0.05$) were excluded from further data analysis in order to compare the non-obese and the obese. The children at risk for overweight and overweight were assigned to the obese group [13]. Assignment of public- and private school children to non-obese and obese groups was based on quite recently developed WHO international growth charts [10] for standardisation.

Further statistical analysis was performed according to the question with the lowest response rate–body weight and height measures (279 public- and 172 private school; Fig. 1).

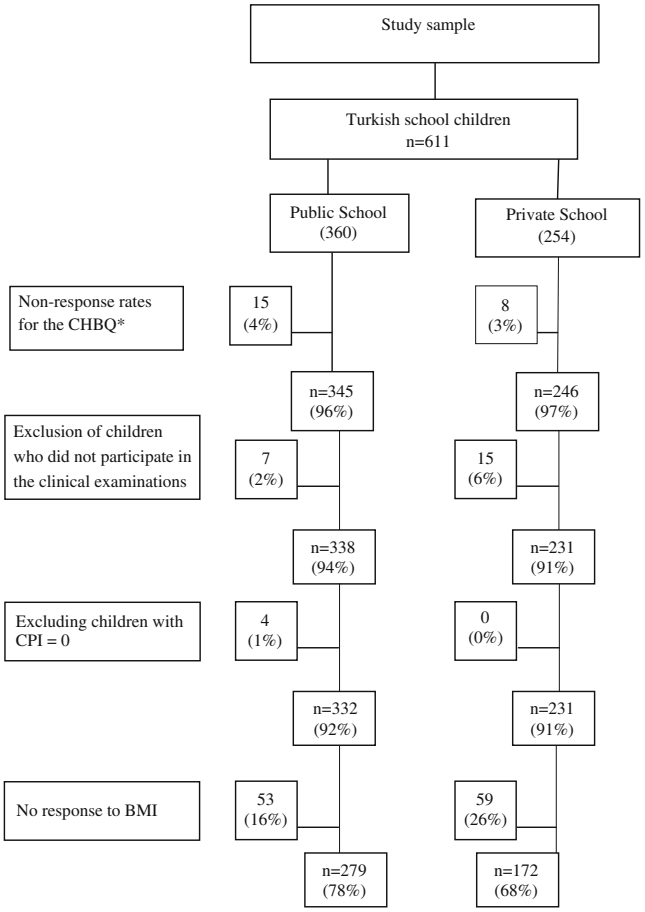

Fig. 1 Distribution of Turkish children by school type

Statistical methods

Factor analysis was used to uncover the latent dimensions of a set of variables. It reduces a larger number of variables to a small number of factors, and it does not assume that a dependent variable is specified [14]. Factor analysis was applied to the variables in the present study by principal component analysis and Varimax rotation to analyse not the associations but the interrelationships, and common underlying dimensions among dental health, periodontal status, obesity and life-style factors, by classifying these variables into discriminative clusters based on their factorial loadings, ranging from the highest to lowest values. Factors were extracted based on meeting the Kaiser criterion of eigenvalue greater than 1.

Descriptive statistics, frequency distributions and the contingency coefficient for determining associations between variables, Student's t test and logistic regression were applied. In addition, Chi-square tests by cross-tabulation were applied to compare frequencies, and the corresponding odds ratios were calculated. Statistical significance was set at $P<0.05$.

Results

Dental health, periodontal needs and BMI measures

Public school children had poorer dental health than did those in private school ($P<0.001$; Table 1). They also had lower mean BMI (18.32±2.85) than did their counterparts in private school (19.17±2.79; $P<0.001$).

Table 1 Components of DMFS among Turkish school children by school type

	Turkish school children mean (SD)	
	Public school ($n=279$)	Private school ($n=172$)
DS	3.80 (2.5)	2.14 (2.3)
FS	0.19 (1.3)	0.44 (1.4)
MS	0.46 (1.9)	0.03 (0.4)
DMFS	4.44 (3.4)	2.64 (2.6)

Student's t test. All P values 0.001

Table 2 Oral health and BMI measures of Turkish school children by school type

	Turkish school children %	
	Public school (n=279)	Private school (n=172)
DMFS		
Healthy	9	30
Diseased	91	70
Maximum CPI		
Gingival bleeding	38	63
Calculus	62	37
BMI		
Non-obese	75	60
Obese	25	40

Chi-square test. All P values 0.001

The public school children were more likely to have calculus (62% having CPI=2) but to be less obese (25%, BMI-for-age≥85th percentile) than were those in private school (37% CPI=2, 40% BMI-for-age≥85th percentile; P<0.001; Table 2). No association appeared between dental health, periodontal status and obesity among both public- and private school children (logistic regression; unadjusted P>0.05, adjusted for life-style factors P>0.05).

Life-style factors

Public school children were less likely to practise recommended tooth-brushing (32%) (OR=0.81: CI95% 0.68–0.95) than were their private school counterparts (44%), (P=0.008). This was, however, not the case for respective daily milk consumption at breakfast (40% vs. 49%) and for regular bedtimes on school nights (82% vs. 79%), (P>0.05). Public school children reporting irregular bedtimes on school nights were more likely not to consume milk at breakfast daily (78%; OR =2.77: CI95% 1.35–5.72) than were those sleeping regularly (56%; P<0.05).

Clustering between DMFS, CPI and BMI

Principal component analysis revealed that DMFS, CPI and BMI shared the "health" cluster among Turkish public- and private school children (Table 3).

Discussion

The interrelation between obesity, poor dental health and periodontal status has been a neglected research issue. In the present study, the clustering of obesity with high levels of DMFS among private school children may be explained by their poor-quality diet, in terms of overnutrition. Overnutrition is a type of malnutrition, and defined as 'a chronic condition where intake of food is in excess of dietary energy requirements by over-consumption of energy-dense, nutrient-poor foods and leisure-time activities' [15]. Consumption of healthy food is reduced by the higher intake of unhealthy food in such a diet [16], a diet which may contribute to high levels of caries [17]. Studies

Table 3 Factor analysis for assessing behavioural clusters of DMFS (dentally healthy vs. diseased), maximum CPI (gingival bleeding vs. calculus) and BMI (non-obese vs. obese) among Turkish school children by Varimax rotated solution

	Private school children Component		Private school children Component	
	Health	Life-style factors	Health	Life-style factors
DMFS	0.431	–[a]	0.455	–[a]
BMI	−0.680	–[a]	0.625	0.461
Maximum CPI	0.570	–[a]	−0.719	–[a]
Tooth-brushing frequency	0.415	0.475	–[a]	0.528
Regular bedtime on school nights	–[a]	0.670		0.653
Daily consumption of milk at breakfast	–[a]	0.709	–[a]	0.629

The clusters in two study groups, in total, accounted for 40.9% and 41.3% of the total variance. All life-style variables (daily consumption of milk at breakfast, regular bedtime on school nights, and recommended tooth-brushing) classified as favourable (0) and unfavourable (1) along with health measures (dentally healthy =0, gingival bleeding =0, non-obese =0)

[a] Loadings below 0.40 extracted for ease of communication

have shown that high level of caries is positively interrelated with obesity among children [18, 19] and that the poor dental health of children from families of higher socio-economic status is interrelated with obesity and poor dietary habits [20]. Among Turkish children, obesity due to overnutrition has been found to be directly correlated with high socio-economic profile [21]; however, the interrelation between obesity and DMFS and nutrition has not been reported. The present study seems to support the notion of the role of poor dietary habits intermediating between obesity and dental caries.

The public school children with dental calculus were more likely to be non-obese but dentally diseased; this may indicate undernutrition, another type of malnutrition, defined by WHO as 'food intake that is continuously insufficient to meet dietary requirements' [15]. Poor diet quality is associated with high levels of calculus among adults [22]. Among children, deficiencies in protein, energy foods or both, relative to the body's needs may lead to protein-energy malnutrition [23] directly associated with a decreased salivary flow rate [24, 25]. This situation may lead to calculus formation [26], high levels of caries [25, 27], and delayed growth [25]. The interrelation between caries and obesity may be multidimensional; caries and its consequences may restrict the quantity and variety of food eaten [28], leading to inadequate food intake following undernutrition and to decreased BMI-for-age among children and adolescents [29]. A high level of caries is positively interrelated with low BMI-for-age among young children [30, 31] and older children from low socio-economic-level families [20], which is a contributing factor for undernutrition [32]. In line with all these studies, poor dental health among these Turkish public school children may indicate undernutrition leading to lower BMI and to higher levels of calculus. Poor oral health among public school children may also reflect their poor oral health habits such as irregular dental visits or tooth-brushing habits as found earlier [33] that are mostly seen in families of poor socio-economic status [34], thus providing further support for need to assess the interrelation between lifestyles and oral health.

The relation between dental caries and undernutrition demands further attention because international agencies, particularly the United Nations, state that undernutrition among poor children should be tackled together with obesity [32]. This is essentially critical in developing countries which undergo rapid nutrition transition because under- and overnutrition coexist in these countries, figuring out the double burden of malnutrition [32, 35]. Turkey, as one of these countries [35], still has public health problem of undernutrition that has been mostly observed in families of low socio-economic status [36, 37]. Turkish public school children with high levels of caries may be at increased risk for experiencing double burden of malnutrition; undernutrition at present and as well becoming obese in future if their dental health improves since young children with high levels of untreated caries who are lower in BMI-for-age, have been shown to catch up to their ideal BMI-for-age after dental treatment [30].

The present study found low milk consumption among both Turkish public- and private school children. Such a diet may lead to obesity [38, 39], which also triggers the immune system by generating a state of chronic systemic inflammation [40, 41]. Periodontal blood vessels and tissues may be affected either by these negative alterations in the immune system [41], or be affected directly by a poor-quality diet such as low consumption of dairy products [42], leading to periodontal diseases [41, 42]. All these potential mechanisms may explain the positive interrelation between obesity and the gingival bleeding among all these Turkish children, as already found among young adults [43–45]. Gingival bleeding is a sign of pathology, an indicator of periodontal diseases especially among children [46]. This may indicate that these obese Turkish children may be at increased risk for chronic systemic inflammation.

The separate clustering of life-style factors in the present study, regardless of the type of school attended, may stem from the characteristics of these behaviours in this cluster, either health-enhancing [47] or health-promoting [48]. Tooth-brushing frequency is positively associated, among adolescents, with regular breakfast [48], bedtime and time of arising [49, 50]. Obesity is positively related to infrequent intake of breakfast at home, and low daily consumption of milk and dairy products [51, 52] and short night-time sleep duration among school children [53]. The finding that non-obesity is also a factor in the favourable life-style cluster among private school children seems to agree with these earlier findings.

Among public school children, recommended tooth-brushing was also a factor in the favourable health cluster that may be attributed to its primary role in maintenance of good oral hygiene and therefore of better oral health [54] which contributes to the undernutrition and to the growth of children [32, 43, 44]. Considering the clustering of BMI and tooth-brushing in both health and life-style clusters among these children, it may be proposed that oral- and general health are embedded in a broader social environment and are not independent of contextual influences. Integration of oral health and behaviour into the health care and health promotion of children is therefore necessary [3, 55].

Parental self-reported body measurements is important in monitoring overweight and obesity [56], however, there is a need to recognise that these reports may under- or overstate the problem because of possible variations in the scales

used by the parents or rounding the measurements. Thus, measurement of BMI by self-report in the present study may be biassed, however, parent-reported body measurements for adolescents have been shown to be reliable and valid [56]; the intra-examiner reliability in the present study was found at least moderate. It has been found earlier in Turkey [57–59] that higher economic status is directly related with obesity among children. Bearing this and the skewed distribution of missing BMI data in mind, the results should be interpreted rather as underestimation or overestimation of the real situation and the associations found. Validation of parental self-report measures on a subset of children would be complementary; thus, lack of such a measurement should be seen as another limitation of the study.

Dental health and periodontal status data were collected by use of WHO-standardised recording criteria [7]. These criteria have proved to be a valuable epidemiological tool, since the criteria for assessment of dental health status are practical and reliable under field conditions [7]. Self-reported tooth-brushing data are susceptible to bias toward socially desirable behaviour. However, the self-reported tooth-brushing frequency in the present study was of the magnitude of earlier figures from the WHO international health behaviour survey on school-aged children (HBSC) [60], and a nationwide survey [61] among Turkish school children, thus speaking for the reliability of the corresponding finding.

The limitation of this study is that the children's pubertal stages were not assessed. New evidence shows that childhood obesity induces early puberty [62], and furthermore, puberty can result in an increased probability of higher BMI [63] and DMFT [60], due to physiological changes during this stage. In puberty, the gingivitis levels increase [64], which may be attributed to the plaque accumulation and inflammatory changes associated with tooth eruption and exfoliation and to the influence of hormonal factors, as well as to poor hygiene habits [65]. In the present study, the clustering between obesity and poor oral health thus may also underlie the fact that children with obesity and oral diseases experience early puberty or puberty as a common risk factor. Health promotion activities should take puberty into account because these years (age 10–12) are critical; poor oral and general health, particularly obesity [66–68] as well as the related life-style [69] tracks into adulthood.

Implications

High levels of dental disease—especially in developing nations with a range of socio-economic profiles—should be studied based on stratification by these profiles, because the negative consequences of higher caries rates among children of low socio-economic status may lead to undernutrition and predict an increased risk for obesity. DMFS may be interpreted as a proxy indicator for both types of malnutrition and periodontal health for growth, particularly BMI. Therefore, oral health, obesity and nutrition should be addressed as joint objectives of health-promoting strategies to improve children's well-being, along with empowerment for good life-style factors.

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Conflict of interest The authors declare that they have no conflict of interest.

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