

# **Obesity and Dental Caries – A Systematic Review**

Kamila Rosamilia Kantovitz<sup>a</sup>/Fernanda Miori Pascon<sup>a</sup>/ Regina Maria Puppin Rontani<sup>a</sup>/Maria Beatriz Duarte Gavião<sup>a</sup>

**Purpose:** The purpose of this paper was to undertake a systematic review about the relationship between obesity in childhood, adolescence and/or adulthood and the prevalence of dental caries.

**Methods:** The authors searched Bireme, Medline, ISI, Cochrane Library and the internet for papers from 1984-2004. The main search terms were 'obesity' and 'dental caries'. The inclusion criteria were studies that defined obesity (body mass index) and dental caries (total number of decayed, and filled teeth – DFT/DFS/dft/dfs) in their subjects. The following were excluded from this paper: articles on reviews, dietary guidelines, policy statements, papers related to oral health and nutrition deficiency – underweight, and with no relation between obesity and dental caries prevalence or dental health problems.

Results: No systematic review has focused on correlating obesity and caries and only three studies had high levels of evidence.

**Conclusion:** Only one study with high level of evidence showed direct association between obesity and dental caries. In view of the findings, further well-designed randomised studies are needed to demonstrate the relationship between dental caries and obesity.

Key words: review literature, dental caries, obesity, body mass index, DMF index

Oral Health Prev Dent 2006; 4: 137-144.

Submitted for publication: 30.08.05; accepted for publication: 07.12.05.

utrition is vital to human development and maintaining health. Today, more than ever before, people are concerned with optimising their health by acquiring nutritional information and applying it to their daily lives, because obesity and other nutritionally related chronic disorders are on the rise (Romito, 2003). Obesity has become a global health problem existing throughout post-industrial and developing regions. The prevalence of overweight status is higher than 30% in Latin America (Gahagan, 2004). Global changes over the past decade have led to serious dietary changes in populations, like the trend towards consuming soft drinks and fast foods, which together with other life styles changes have contributed to the ever-increasing number of overweight people worldwide (Romito, 2003).

According to the American Academy of Pediatrics, Committee on Nutrition (2003), being overweight is now the most common medical condition of childhood, with the prevalence having doubled over the past 20 years. About one in three children is at risk of being overweight, and one out of every six is overweight. In Brazil, overweight and obesity are also considered to be a public health problem. The prevalence of overweight and obesity are, respectively, 15.74% and 17.97% for children (7-10 years old); 22.1% overweight for teenagers (11-16 years old); and 21% and 40% for adults (Data from Brazil Government, Health Division, 2004). Overweight and obesity are multifactorial conditions involving physiological, biochemical, metabolic, anatomic, psychological, and social alterations (Taubes, 1998). Contrary to popular belief, medical causes (endocrine and genetic disturbances) of childhood obesity are relatively rare, comprising 1-4% of all childhood obesity cases (Karp, 1998). Complications of the obesity epidemic include high cholesterol, high blood pressure, type II diabetes mellitus, coronary plaque formation, and serious psychosocial implications (AAP, 2004). The overweight condition in childhood and adoles-

<sup>&</sup>lt;sup>a</sup> Department of Paediatric Dentistry, University of Campinas, Brazil.

**Reprint requests:** Prof M. B. Gaviao, Paediatric Dentistry, University of Campinas, Barao Geraldo, Campinas, São Paulo, Brazil. E-mail: mbgaviao@fop.unicamp.br

cence increases the risk for adult obesity and its consequent health risks during adulthood.

Health care professionals frequently neglect to inquire about patients' nutrition status and offer little guidance in this area. Dentists must be aware of how nutrition impacts on general and oral health and how dental treatment can impact on the patient's nutritional status (Romito, 2003). Oral health is strongly influenced by the daily intake of food; on the other hand, oral health can also play a significant role in nutritional intake and general health status (Willershausen et al, 2004).

Diets high in sugar (for example, added sugar) have been associated with various health problems, such as dental caries, dyislipedemias, obesity, bone loss and fractures and poor diet quality. Added sugar is defined as sugar that is eaten separately at the table or used as an ingredient in processed or prepared foods, such as cakes and cookies, soft drinks and ice cream. This term helps consumers to identify food and beverages that mostly provide energy but are poor sources of micronutrients (Johnson and Frary, 2000). In addition, sweetened drinks (fruitades, fruit drinks, soft drinks, etc) constitute the primary source of added sugar on children's daily diet (Guthrie, 2000). Furthermore, soft drinks pose a risk of dental caries because of their high sugar content and enamel erosion due to their acidity (Heller et al, 2001). When sugar intake exceeds 15 to 20 kilograms per person per year, such intake is directly associated with increasing caries prevalence (Sheiham et al, 2002). In addition, people with early tooth loss clearly showed a deviation from preferred foods, as well as a deficiency of certain vitamins and microelements. This may be because people who cannot chew or bite comfortably are less likely to consume high-fibre foods such as bread, fruit and vegetables, thereby risking reducing their intake of essential nutrients (Brodeur et al, 1993).

The purpose of this article was to undertake a systematic review of the relationship between obesity in childhood, adolescence and/or adulthood and the prevalence of caries, based on nutritional concepts as they apply to overall health and specifically to oral health situations.

## **METHODS**

## **Question Addressed by this Review**

What is the relationship between obesity in childhood, adolescence and/or adulthood and caries prevalence?

## **Literature Searching**

The authors searched Bireme, Medline, ISI, Cochrane Library and the internet for papers from January 1984 to the end of December 2004. The search was supplemented by manual searching of reference lists from each relevant paper identified.

The main search terms were 'obesity' and 'dental caries'. A total of 69 records were originally identified. Filters were then used to allow only subject papers to be connected, which resulted in 33 articles. These were printed as abstracts, or full-text articles, if the abstract was missing. In a second step, two examiners selected relevant records independently, and the papers that were considered of interest for the project were ordered in full-text versions. The search was limited to randomised, cross-sectional (CS) and retrospective studies (RS), which were considered relevant records. Only original papers were considered. Interim reports, abstracts, letters, short communications, and chapters in textbooks were discarded. Articles in Swedish, Danish, Norwegian, English, German, French, Portuguese and Spanish were accepted. During the evaluation process, reference lists were searched by hand. Further details of the search strategies used are available from the corresponding author.

## Inclusion and Exclusion Criteria

After appraisal, studies were included only if they defined obesity and dental caries, as well as the respective interrelations, in their subjects. The best available obesity definitions are based on body mass index (BMI). BMI is defined as weight in kilograms divided by height in meters squared (Kg/m<sup>2</sup>). The World Health Organization defines overweight as a BMI of 25 or greater and obesity as a BMI of 30 or greater for adults (WHO, 1998). The standards work well for adults, but do not apply to children because normal BMI changes throughout childhood. Instead, the Centers for Disease Control and prevention classify children whose BMI is between the 85th percentile and 95th percentile for age and gender as 'at risk' for overweight and children whose BMI exceeds the 95th percentile as overweight (CDC, 2000). The present evidence appraisal is based largely on studies in which obesity was defined in this way. The dental caries is also a chronic disease and may be depend on oral hygiene, high intake of sugar added to food, lifestyle factor, and host factors (salivary flow, buffer capacity and buccal microflora). The bestpresented simple caries definitions are the total num-



#### Table 1 Criteria for grading of assessed papers

<b>Grade A</b> All criteria stated below should be met	Study group representative, inclusion criteria described Stratified by age, sex, social group and caries indexes Defined methods for caries diagnosis Bias or confounders taken in account Randomisation by children, adolescents and/or adults A representative sample of the population under study; results can be generalized Diagnostic reliability test described Baseline DFT/DFS (dft/dfs) values described Independent outcome assessment Statistical analysis Body mass index was considered
	Randomised by class/school and described
	The population under study defined; results cannot be generalised
	Methods for clinical caries diagnosis not completely described or validated
Grade B	Diagnostic reliability test described
All criteria stated below	Bias or confounders taken into account
should be met	Baseline DFT/DFS (dft/dfs) values described
	Independent outcome assessment
	Relative risk reduction or relative disk described
	Body mass index was considered
	Several non-calibrated examiners
	No or unclear randomisation
Grade C	The population under study not defined
One or more of the	Methods for clinical caries diagnosis not completely described
conditions stated below	Diagnostic reliability test not described
	Bias or confounders not reported or valued
	Baseline DFT/DFS (dft/dfs) values not described
	No independent outcome assessment
	Relative risk reduction or relative disk not described and cannot be calculated
	from the results
	Potentially significant bias/confounders that could distort the results not considered

ber of manifestly decayed and filled surfaces (DFT/dft). This was relatively common in the literature searched for this project. Case studies and reviews of case studies were excluded. Evidence from studies of subjects aged two to 65 years was considered.

# **Evaluation of Scientific Papers and Levels of Evidence**

The papers that met the inclusion criteria were subjected to critical appraisal, carried out independently by at least two members of the project group. Data were extracted using a pilot-tested form and each paper was assessed with a score from A to C, according to predetermined criteria for methodology and performance, as defined in Table 1. In the case of disagreement between the examiners, the paper was re-evaluated and discussed by the entire group until consensus was reached. If, for some reason, a selected paper was found to be irrelevant for the research question, the article was excluded. A total of seven papers were selected. Based on the evaluated literature, the final level of evidence was judged according to the protocol of the Swedish Council on Technology Assessment in Health Care (Britton, 2000), as described in Table 2.



Table 2 Definitions of e	evidence level*	
1. Strong evidence	At least two studies with high level of evidence (grade A) or a good systematic review	
2. Moderate evidence	One study with high level of evidence (grade A) and at least two studies with a moderate level of evidence (grade B)	
3. Limited evidence	At least two studies with a moderate level of evidence (grade B)	
4. Inconclusive evidence	Fewer than two studies with a moderate level of evidence (grade B)	
*Modified from Britton (2000)		

# RESULTS

Out of the 33 papers that were critically assessed, seven studies identified during the search were included in the project critical appraisal, on the grounds that they did define obesity and dental caries in their subjects, or did relate them (Table 3). Papers classified as grade A (Tuomi et al, 1989; Chen et al, 1998; Willershausen et al, 2004) describe the relationship between dental caries and obesity in children from three to 13 years, thus caries in primary and permanent teeth were considered. In grade B (Dye et al, 2004; Larsson et al, 1995) the papers verified the relationship between dental caries in primary teeth and healthful eating habits in children aged two to 15 years. Furthermore, they considered the relationship between dental caries and overweight or obese people, but such considerations were not the primary aim. The articles by Johansson et al (1994) and Sheiham et al (2002) were included in grade C, since they did not take into account the frequency of caries, but they considered tooth loss as an oral condition caused by dental caries as a factor with influence on general health. These two studies were carried out with middle-aged and older people, respectively. Johansson et al (1994) correlated dental status, diet and cardiovascular risk factors, and Sheiham et al (2002) verified the relationship between oral health status and BMI.

The main reasons for excluding 26 of the articles were: they were reviews (Palumbo, 1985; Karp, 1998; Ruxton et al, 1999; Marcenes et al, 2003; Romito, 2003; Shenkin et al, 2003; Steyn et al, 2003; Gahagan, 2004), dietary guidelines (Johnson & Frary, 2001; Steyn et al, 2003; Eissa and Gunner, 2004), policy statement (AAP, 2004), no relationship between obesity and prevalence of dental caries or dental health problems (Nuttall

and Gannon, 1981; Eronat and Eden, 1992; Gortmaker et al, 1996; Del Val et al, 1997; Larsson et al, 1997; Wilson et al, 1999; Martin-Iverson et al, 2000; Rodrigues and Sheiham, 2000; Söderling, 2001; Forlund et al, 2002; Grant et al, 2004; Sanders, 2004; Soringuer, 2004), article- related oral health and nutritional deficiency – underweight (Mojon et al, 1999).

All articles included for evaluating evidence were used as a basis for conclusions.

# DISCUSSION

The present review was the first to systematically search and critically appraise the substantial literature on the impact of obesity on dental health. Systematic reviews are an important tool for studying the relationship of general health and dental caries. They can also provide information on costs and benefits, and sometimes on the process of delivery. It is important as well that this review will contribute towards the development of new methodologies needed to conduct reviews in the area of public health, such as the relationship between obesity and oral health.

The outcomes of the studies included in the grade A led to contradictory conclusions. Willershausen et al (2004) showed that the children whose weight was normal had significantly less caries in their deciduous and permanent teeth than the overweight children. They found that 12.9% of all children were overweight, and 13.2% were classified as obese in this sample, reflecting the current trend of the rise in the entire population. By taking into account the BMI value, 36% of the normal weight children had healthy teeth, whereas only 28% of the overweight and 30% of the obese children showed healthy dentition. However, Chen et al (1998)

Table 3 Res	sults of re	ferences app	raised								
First author	Year	Reference	Study design	Subjects	Age year	BMI	Oral Conditions	Material and	Association BMI x Methods	Evidence level oral health	
Tuomi	1989	39	CS/RS	516	5-13	> 97.5%*	dmft	Files	Obesity do not predict caries	А	
Johansson	1994	17	S	2202	25-64	> 30**	Loss of teeth	Questionnaire	>BMI <number of teeth</number 	U	
Larsson	1995	20	CS	181	15 K	> 90th bercentile	DFS dft	Oral examination Bitewing RX	Positive correlation BMI x DFS	۵	
Chen	1998	Q	CS	5133	ε	>95th bercentile	m non considered N. of teeth	Oral examination Oral examination	No association BMI x dtf	۲	
Sheiham	2002	32	CS	629	≥ 65	≥ 30	N. of posterio occluding pairs	r Health interview	< Number of teeth > BMI	U	
Dye	2004	Ø	S	4236	2 - 5 F	>95th bercentile	dfs DFT/dft	Oral examination	No association BMI x dfs	۵	
Willershausen	2004	40	S	842	6 - 11	≥ 30**	M and m non considered	Oral examination	Association BMI x DFT/dft	۲	
* According to CD(	C (2000); **	According to WH	10 (1998); CS - Cross-S	Sectional; RS - Re	etrospectiv	e Study; N.	- Number				

Vol 4, No 2, 2006

copyrig

Kantovitz et al

L.I.hressenz

#### Kantovitz et al

did not find association between dental caries in deciduous teeth and BMI in three-year-old children. The mean and standard deviation of dft score in children with dental caries was 4.2±3.1. According to the criteria used, 6.5% of the children were classified as obese. Among groups with different BMI (obese and normal children), the proportion of children with one or more decayed or filled teeth and the dft score of children with dental caries did not differ significantly. Furthermore, the BMI values between children with or without caries did not differ significantly. The correlation coefficient between BMI and dft score was 0.001, which indicates no relationship. Tuomi (1989) has searched for the possibility of predicting future decay, using obesity and earlier caries experience as predicting variables in five to 13-year-old children. Obesity alone was not a good predictor of dental caries; incorrect diet predicts both obesity and caries, but obesity develops more rapidly than caries.

In order to interpret these conflicting results, some details of the methodologies must be considered as possibly being influencing factors, such as data collection, for example. In the Willershausen et al (2004) study, with an age range of six to 11 years, the pupils were asked to clean their teeth well before the oral examination. In addition, the examiners used cotton rolls, thus the examination was carried out in a clean and dry field. These steps were not mentioned in the Chen et al (1998) study, which involved a greater number of three-year-old children. Tuomi (1989) obtained his data from the local center health files and considered that the caries prevalence may not be representative of the whole of the country, because the criteria used to register dental caries may differ systematically among different areas. Furthermore, the children involved were treated by the same dentist and preventive program had been implemented, probably affecting the occurrence of dental caries during the period studied. Due the exploratory nature of the study, the significance of the fact that some children appear in more than one group has not been separately analysed; it is possible that children who were obese both before and during the caries registration increased the predictive values of obesity, as it was considered that obesity developed more rapidly than caries. Thus, the length of the overweight period should be taken into account.

Larsson et al (1995) study, included in grade B, checked whether the high caries scores during adolescence indicate a more unfavorable traditional risk factor profile for cardiovascular diseases (CVD), obesity being one of known risk factors. The methodology described in the Dye et al (2004) study, also



In the Larsson et al (1995) study the dental caries recordings were done by three calibrated dentists, and the methodology differs from the other studies consulted for evidence, since they diagnosed proximal caries through two Bitewings radiographs, if the lesion reached into the dentin. A significant positive correlation was found for the whole group between DFS-score and BMI in an unvaried correlation test, as well as multiple linear regressions. The proportion of adolescents with BMI > 26 increased along with increasing caries scores. Adolescents with DFS > 9 had significantly higher BMI than the caries free group.

Considering the studies include in grade C, in both the number of natural teeth in the mouth was considered in the oral health status. Furthermore, Sheiham et al (2002) considered the number of posterior occluding pairs in the evaluation of oral health. Johansson et al (1994) demonstrated that edentulous men and women were more obese than that ones with natural teeth. The presence of two or more CVD incidents was more common in edentulous middleaged individuals, thus they have a more unfavorable risk factor profile for CVD. The association between CVD and dental status is not fully understood and this study design does not allow any conclusion on causality, but merely on co-variations between these variables. Counseling on balanced dietary habits and on other risk factors, like smoking, given by dental



personnel to orally diseased patients – recommendations given to improve resistance to dental caries or periodontitis – might therefore improve general health and possibly also lessen risk factors for CVD.

Sheiham et al (2002) showed that having functioning natural dentition, defined as having more than 20 teeth, increased the likelihood of having a 'normal' BMI. Dentate people with fewer than 20 natural teeth were on average three times more likely to be obese than those with 20-32 teeth. Amongst adults over 65 years of age, having natural teeth or none at all was associated with a greater risk both of being underweight and being obese. It is clear that people with early tooth loss showed a deviation from preferred foods, as well as a deficiency of certain vitamins and microelements (Brodeur et al, 1993). The association of poor oral health with obesity is likely to be associated with the quality of the diet. The findings of this study provide further scientific evidence that 20 or more natural teeth are a reasonable threshold for acceptable oral health and functional dentition into old age.

Over the last few decades large increases in the number of overweight and obese children, adolescents and adults have been noticed. Variations in lifestyle, low socioeconomic status, low income, and CVD may increase obesity risk factors and caries development. Both dental caries and obesity are multifactorial diseases impacted by dietary habit. The triangular relationship of sugar, dental caries and obesity needs to be further explored.

One of the main concerns of obesity in childhood is that it will probably continue into adulthood. Obesity can cause health problems irrespective of the person's age (hypertension, CVD, dyslipidemia, type II diabetes, insulin resistance). Tooth loss may be another factor related to increased obesity. Thus, the nature of the relationship between BMI and oral health is clearly complex and not linear. The association of poor oral health with obesity is likely to be associated with the quality of the diet (Willershausen et al, 2004).

Future preventive measures must include strategies to prevent and reduce obesity and dental caries in the population. The main effort is to change dietary habits (restricting soft drinks, carbohydrates and sucrose). In addition, specific preventive measures such as physical activities, dental hygiene, general advice (stop smoking) are also relevant. The significant success in the reduction of caries prevalence with preventive programs in schools could represent an exemplary concept for corresponding health efforts in the area of nutritional guidance (Willershausen et al, 2004). Nevertheless, since obesity and dental caries are, in principle, caused by the poor dietary habits, further studies should evaluate the relationship between these two most prevalent health oral problems in children, adolescents, and adults.

## CONCLUSION

In this systematic review, only three studies on children were found to provide high level of evidence (evidence level A) on the study topic and there were conflicting findings. Thus, no clear conclusion can be drawn at this stage. In view of the findings, further well-designed randomised studies are needed to demonstrate the relationship between dental caries and obesity.

## ACKNOWLEDGEMENTS

We thank Kathleen Gaboardi Neiva for her efforts in literaturesearching.

## REFERENCES

- 1. American Academy of Pediatrics, Committee on Nutrition. Prevention of pediatric overweight and obesity. Pediatrics 2003;112:424-430.
- 2. American Academy of Pediatrics, Committee on School Health. Soft drinks in schools. Pediatrics 2004;113:152-154.
- Britton M. Sa graderas en studies vetenskapliga bevisvärde och slutsatsernas styrka. Läkartidningen 2000;97:4414-4415. (In Swedish)
- Brodeur JM, Laurin D, Vallee R, Lachapelle D. Nutrient intake and gastrointestinal disorders related to masticatory performance in the edentulous elderly. J Prosthet Dent 1993; 70:468-473.
- Centers for Disease Control and Prevention, National Center for Health Statistics: 2000 CDC growth charts: United States. Available at: http://www.cdc.gov/growth charts/.
- Chen W, Chen P, Chen SC, Shih WT, Hu HC. Lack of association between obesity and dental caries in three-year-old children. Acta Paed Sin 1998;39:109-111.
- Del Val TL, Estivariz CF, Icaya PM, Jaunsolo MA, Del Olmo D, Martinez CV. Consumo de alimentos del grupo "dulces y golosinas" en la población infantil escolarizada de la Comunidad Autónoma de Madrid. Med Clin 1997;109:16-19.
- Dye BA, Shenkin JD, Ogden CL, Marshall TA, Levy SM, Kanellis MJ. The relationship between healthful eating practices and dental caries in children aged 2-5 years in the United States, 1988-1994. JADA 2004;135:55-66.
- Eissa MAH, Gunner KB. Evaluation and management of obesity in children and adolescents. J Pediatr Health Care 2004;18:35-38.
- Eronat N, Eden E. A comparative study of some influencing factors of rampant or nursing caries in preschool children. J Clin Pediatr Dent 1992;16:275-279.

#### Kantovitz et al

- Forlund HB, Lindroos AK, Blomkvist K, Hakeberg M, Berggren U, Jontell M, Torgerson JS. Number of teeth, body mass index, and dental anxiety in middle-aged Swedish women. Acta Odontol Scand 2002,60:346-352.
- 12 Gahagan S. Child and adolescent obesity. Curr Probl Pediatr Adolesc Health Care 2004;34:6-43.
- 13 Gortmaker SL, Must A, Sobol AM, Peterson KRD, Colditz GA, Dietz W. Television viewing as a cause of increasing obesity among children the United States, 1986-1990. Arch Pediatr Adolesc Med 1996;150:356-362.
- Grant AM, Ferguson EL, Toafa V, Henry TE, Guthrie BE. Dietary factors are not associated with high levels of obesity in New Zealand pacific preschool children. J Nutr 2004;134:2561-2565.
- 15. Guthrie JF, Morton JF. Food sources of added sweeteners in the diets of Americans. J Am Diet Assoc. 2000;100:43-51.
- Heller K, Burt BA, Eklund SA. Sugared soda consumption and dental caries in the United States. J Dent Res. 2001;80:1949-1953.
- Johansson I, Tidehag P, Lundberg V, Hallmans G. Dental status, diet and cardiovascular risk factors in middle-aged people in northern Sweden. Community Dent Oral Epidemiol 1994;22:431-436.
- Johnson RK, Frary C. Choose beverages and foods to moderate your intake of sugars: the 2000 dietary guidelines for Americans--what's all the fuss about? J Nutr. 2001 Oct;131:2766S-2771S.
- Karp WB. Childhood and adolescent obesity: a national epidemic. CDA Journal 1998;26:771-773.
- Larsson B, Johansson I, Hallmans G, Ericson T. Relationship between dental caries and risk factors for atherosclerosis in Swedish adolescents? Community Dent Oral Epidemiol 1995;23:205-210.
- Larsson B, Johansson I, Weinehall L, Hallmans G, Ericson T. Cardiovascular disease risk factors and dental caries in adolescents: effect of a preventive program in Northern Sweden (the Norsjö project). Acta Paediatr 1997;86:63-71.
- 22. Marcenes W, Steele JG, Sheiham A, Walls AWG. The relationship between dental status, food selection, nutrient intake, nutritional status, and body mass index in older people. Cad Saúde Pública 2003;19:809-816.
- Martin-Iverson N, Pacza T, Phatouros A, Tennant M. Indigenous Australian dental health: a brief review of caries experience. Aust Dent J 2000;45:17-20.
- 24. Data from Brazil Government, Health Division. XIII CONBRAN The prevention of overweight and obesity using health nutrition. Avaliable at URL: http://portalweb01.saude.gov.br/alimentacao/documentos/CONBRAN\_2004curso.pdf [2004]. (In Portuguese)

- Mojon P, Jorgensen EB, Rapin CH. Relationship between oral health and nutrition in very old people. Age and Ageing 1999;28:463-468.
- Nuttall FQ, Gannon M. Sucrose and disease. Diabetes Care 1981;4:305-310.
- Palumbo FM, Dietz WH. Children's television: its effect on nutrition and cognitive development. Pediatric Annals 1985; 14:793-801.
- Rodrigues CS, Sheiham A. The relationship between dietary guidelines, sugar intake and caries in primary teeth in low income Brazilian three-year-olds: a longitudinal study. Int J Paediatr Dent 2000;10:47-55.
- 29. Romito LM. Nutrition and oral health. Dent Clin North Am 2003;47:187-430.
- Ruxton CHS, Garceau FJS, Cottrell RC. Guidelines for sugar consumption in Europe: is a quantitative approach justified? European Journal of Clinical Nutrition 1999;53:503-513.
- Sanders TAB. Diet and general health: dietary counseling. Caries Res 2004;38 (suppl 1):3-8.
- 32. Sheiham A, Steele JG, Marcenes W, Finch S, Walls AWG. The relationship between oral health status and body mass index among older people: a national survey of older people in Great Britain. Br Dent J 2002;192:703-706.
- Shenkin JD, Heller KE, Warren JJ, Marshall TA. Soft drink consumption and caries risk in children and adolescents. Gen Dent 2003;51:30-36.
- 34. Söderling E. Nutrition, diet and oral health in the 21st century. Int Dent J 2001;51:389-391.
- 35. Soringuer F, Rojo-Martinez G, Esteva de Antonio I, Ruiz de Adana MS, Catalã M, Merelo MJ, Beltran M, Tinahones FJ. Prevalence of obesity in south-east Spain and its relation with social and health factors. Eur J Epidemiol 2004;19:33-40.
- 36. Soxman JA. Considerations for treating adolescent patients. Gen Dent 2003;51:24-26.
- Steyn NP, Myburgh NG, Nel JH. Evidence to support a foodbased dietary guideline on sugar consumption in South Africa. Bull World Health Organ. 2003;81:599-608.
- 38. Taubes G. As obesity rates rise, experts struggle to explain why. Science 1998;29:1367-1368.
- 39. Tuomi T. Pilot study on obesity in caries prediction. Community Dent Oral Epidemiol 1989;17:289-291.
- 40. Willershausen B, Haas G, Krummenauer F, Hohenfellner K. Relationship between high weight and caries frequency in German elementary school children. Eur J Med Res 2004;9:400-404.
- Wilson N, Quigley R, Mansoor O. Food ads on TV: a health hazard for children? Aust N Z J Public Health 1999;23:647-650.
- World Health Organization. Obesity: Preventing and Managing the Global Epidemic. Report of a WHO Consultation on Obesity 1997; 3-5. Geneva: World Health Organization, 1998.