Body adiposity status in teenagers and snacking habits in early childhood in relation to approximal caries at 15 years of age

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Background. The prevalence of overweight and obesity in children is steadily increasing in many countries. Dental caries and obesity are both multifactorial diseases and are associated with dietary habits.

Objective. The purpose of this study was to investigate the relationship between body weight status in adolescents and snacking habits in early childhood to approximal caries prevalence at 15 years of age. **Methods.** This study is part of a series of surveys of oral health in children followed from the ages of 1 year to 15 years. Body adiposity status was estimated at 13.5–16.4 years using the International Obesity Task Force cut-off values [age-specific body mass index (isoBMI)]. Information about snacking habits in early childhood was collected from

Introduction

The prevalence of overweight [age-specific body mass index (isoBMI) 25–29.9] and obesity (isoBMI \ge 30) in children is rapidly increasing in many countries around the word, including those in Europe^{1.2}. The World Health Organization has compared this marked change in body weight to a 'global epidemic disease'. According to the American Academy of Pediatrics, Committee on Nutrition³, overweight and obesity are now the most common medical conditions of childhood. The potential health problems of overweight/obesity in children are numerous; they include insulin resistance,

interviews conducted at 1 year and 3 years. Approximal caries information was obtained from bitewing radiographs at 15 years. Data related to isoBMI and approximal caries were available in 402 teenagers. **Result.** Adolescents with isoBMI ≥ 25 (n = 64) had an approximal caries prevalence that was a mean of 1.6 times higher than those with isoBMI < 25(n = 338) (4.64 vs. 2.94; P = 0.014). Furthermore, children's snacking habits at an early age were associated with approximal caries at 15 years. Conclusion. Overweight and obese adolescents had more approximal caries than normal-weight individuals. Moreover, the frequent consumption of snacking products during early childhood appears to be a risk indicator for caries at 15 years. Future preventive programmes should therefore include, on a multidisciplinary level, strategies to prevent and reduce both obesity and dental caries at an early age.

hypertension, orthopaedic complications, increased risk of osteoporosis, adult obesity, and effects on quality of life¹. A recent study of 10-yearolds conducted in the western part of Sweden revealed that 18% were overweight and 3% were obese. This corresponds to a twofold increase in overweight and a fourfold increase in obesity from 1984 to 2000⁴. Global changes over the past decade have led to serious behavioural changes in populations, such as the increased consumption of soft drinks and fast food, which, together with more sedentary lifestyles⁵, have contributed to the increasing number of overweight people worldwide⁶.

Dental caries and obesity are both associated with dietary habits. A recent prospective Finnish study examined children from infancy to the age of 10 years⁷. It was concluded that a persistently high sucrose intake increases the risk of dental caries in children. A sugar-rich

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diet, including beverages, is also associated with various health problems such as obesity, increased risk of osteoporosis, and poor diet quality^{8,9}.

Relatively few studies on the relationship between obesity and dental caries have been published, and a systematic review revealed contradictory results⁹. Recently published studies also found conflicting results. Hilgers et al.¹⁰ and Willerhausen et al.¹¹ reported an association between high weight and high caries frequency in children aged 6–11, whereas Macek and Mitola¹² found no significant association between weight and caries among US children aged 2-17 years. The aims of this study were to investigate the relationship between isoBMI and approximal caries prevalence in teenagers, and to relate snacking habits in early childhood to caries prevalence at 15 years of age in an unselected population.

Population and methods

This investigation, which was partly designed as a cross-sectional study, is part of longitudinal surveys of oral health in children followed from the ages of 1-15 years. All 671 children who were 1 year of age in 1988 and living within the districts of four of the 13 child welfare centres in the municipality of Jönköping were invited to participate. These four districts included the town, suburbs, and rural areas, and were chosen to reflect the socioeconomic levels of the population living in this part of Sweden^{13–17}. During this long period, the children in this study received dental care free of charge (at public dental service clinics), as well as regular check-ups of weight and growth as part of school health care. Data related to approximal caries and adiposity status at 15 years of age were available in 402 teenagers. The Ethics Committee at the University of Linköping, Sweden approved the study.

Dental examinations

The examinations at 1 year, 3 years, 6 years, and 15 years have been described in detail elsewhere^{13–17}. Information on approximal caries at 15 years of age was obtained from bitewing radiographs at 15 years of age.

Body adiposity status

Data concerning the weight and height of the 402 adolescents were obtained from school health care records when the teenagers were 13.5-16.4 years of age. In this study, 24 teenagers did not want to check their weight and were analysed separately in relation to approximal caries. Body adiposity status was determined by calculating body mass index (BMI) (kg/m²) using the international classification system for childhood obesity (isoBMI) recommended by the International Obesity Task Force cut-off values¹⁸. The teenagers were divided into three groups according to this classification system: (i) low normal weight (isoBMI < 25); (ii) overweight (isoBMI 25-29.9); and (iii) obesity (isoBMI \geq 30). In some of the analyses, groups 2 and 3 were combined, here called overweight/obesity (isoBMI ≥ 25).

Interviews at 1 year and 3 years of age

Data relating to dietary habits in early childhood were selected from interviews conducted with the parents at the dental examinations when the children were 1 year and 3 years of age¹⁹. Using a semistructured form, the accompanying parent was asked questions about the children's dietary habits at 1 year and 3 years of age. Questions regarding 'consumption of caries risk products', such as soft drinks, fruit soup, sweets (candy, confectionery), ice cream, or biscuits, were stratified into two groups: (i) three times a day or less; and (ii) more than three times a day. The variable 'consumption of sweets' was stratified into two groups: (i) sweets once a week or less; and (ii) sweets more than once a week. The cut-off point of once a week or less was chosen, as this is the most common recommendation to parents of preschool children in Sweden. More details on project population and drop-outs have been given previously^{16,17}.

Radiographic analysis at 15 years of age

The radiographic procedures have been described in detail elsewhere¹⁶. The approximal surfaces from the distal surface of the first premolar to the mesial surface of the second molar (a total

		Caries prevalence at 15 years					
		D _{i+1}	_m Fa	D _m Fa			
Group	Number of children	Mean	SD	Mean	SD		
All	402	3.21	3.95 _	0.42	1.13		
isoBMI < 25	338	2.94	3.62	0.35	0.89		
isoBMI ≥ 25	64	4.64	5.15 +	0.83	1.93		
isoBMI 25–29.9	50	4.18	5.14	0.84	2.02		
isoBMI ≥ 30	14	6.29	5.04	0.79	1.63		

Table 1. Mean number of carious (D) and filled (F) approximal tooth surfaces in all children and in different age-specific body mass index (isoBMI) groups (i = initial; m = manifest).

P values obtained using unpaired two-sample t-test.

SD, standard deviation.

**P* < 0.05.

of 24 surfaces) were evaluated. Caries was registered as initial or manifest caries as follows. Initial caries $(D_i a)$ was defined as 'a caries lesion in the enamel that has not reached the dentino-enamel junction or a lesion that reaches or penetrates the dentino-enamel junction, but does not appear to extend into the dentine'. Manifest caries $(D_m a)$ was defined as 'a caries lesion that clearly extends into the dentine'. The total approximal caries prevalence and fillings $(D_i a + D_m a + Fa)$ were used in the analysis and will subsequently be called $D_{i+m}Fa$. According to the caries prevalence at 15 years of age, the children were stratified into the following three groups: (i) $D_{i+m}Fa = 0$; (ii) $D_{i+m}Fa$ \geq 4; and (iii) $D_{i+m}Fa \geq$ 8. Please observe that all the individuals in the $D_{i+m}Fa \ge 8$ group are also included in the $D_{i+m}Fa \ge 4$ group. More details about these three groups have been given previously¹⁷.

Statistical analysis

The data were processed using the Statistical Package for the Social Sciences (SPSS, version 12.0 for Windows). The differences between the proportions of children in different groups according to isoBMI and the three groups of caries prevalence were tested using an approximate normal distribution with continuity correction. When two groups were compared, an unpaired two-sample *t*-test was used. *P* values below 0.05 were considered statistically significant.

Results

Body adiposity status and drop-outs

Of the 402 adolescents (206 boys and 196 girls) included in the analyses of isoBMI in relation to approximal caries prevalence, 338 (84%) had low normal weight, 50 (12%) were overweight, and 14 (4%) were obese. Of the 64 adolescents with overweight/obesity, 34 were boys and 30 were girls. There were no significant differences in caries prevalence between boys and girls in the different isoBMI groups.

At 15 years of age, the 402 examined children had a mean of 3.21 (± 3.95) $D_{i+m}Fa$ and 0.42 (± 1.13) D_mFa (Table 1). The teenagers who did not want to check their weight (n = 24) were analysed separately; they had a mean of 3.67 (± 4.39) $D_{i+m}Fa$, and 0.75 (± 1.70) D_mFa . These differences were compared with the study group and were found not to be statistically significant.

Caries prevalence at 15 years of age in relation to isoBMI

Table 1 and Fig. 1 show the mean numbers of initial and manifest caries lesions and fillings at 15 years of age distributed according to isoBMI. Adolescents with overweight/obesity (isoBMI \ge 25; *n* = 64) had a significantly higher approximal caries prevalence than low-normal-weight individuals (isoBMI < 25; *n* = 338)



Fig. 1. Distribution of mean numbers of approximal (a), initial (i), and manifest (m) caries lesions and fillings ($D_{i+m}Fa$ and D_mFa) at 15 years of age distributed according to age-specific body mass index (isoBMI).

(P < 0.05). Individuals with obesity (isoBMI ≥ 30 ; n = 14) had more than twice as many approximal caries lesions and fillings compared with low-normal-weight individuals (isoBMI < 25) (P < 0.05). Initial caries was more commonly diagnosed than manifest caries in all BMI groups (Fig. 1).

isoBMI according to different caries prevalence groups

In Table 2, the distribution and percentage of individuals in the three isoBMI groups are related to the three caries prevalence groups. Differences between obese (isoBMI \ge 30) and

low-normal-weight (isoBMI < 25) groups were statistically significant in terms of caries prevalence $D_{i+m}Fa \ge 4$ and $D_{i+m}Fa \ge 8$ (P < 0.01 for both). In the 'high caries prevalence group' ($D_{i+m}Fa \ge 8$), 30% of the adolescents were overweight/obese (isoBMI ≥ 25) and 11% were obese (isoBMI ≥ 30) compared with 15% and 2% in the caries-free group ($D_{i+m}Fa = 0$), respectively (P < 0.05 for both comparisons).

Caries prevalence at 15 years of age in relation to snacking habits at 1 year and 3 years of age

Table 3 shows the mean numbers of approximal initial and manifest caries lesions and fillings at 15 years of age, distributed according to consumption of caries risk products at 1 year and 3 years of age. There was a difference in caries prevalence at 15 years of age between children who consumed caries risk products more than three times a day and children who consumed caries risk products three times a day or less at both 1 year and 3 years of age $(P < 0.05 \text{ for } D_{i+m}Fa \text{ at } 1 \text{ year and for } D_mFa \text{ at}$ 3 years). Children who consumed sweets more than once a week at 3 years of age had a higher caries prevalence at 15 years of age compared with children who ate sweets once a week or less (P < 0.05 for $D_{i+m}Fa$).

Discussion

The main finding in this study was that overweight and obese adolescents had more approximal caries than normal-weight adolescents. Another interesting observation was that the consumption of snacking products and soft

Table 2. Distribution of individuals in different age-specific body mass index (isoBMI) groups according to three caries prevalence groups.

Group	Caries prevalence at 15 years						
	$D_{i+m}Fa = 0$		$D_{i+m}Fa \ge 4$		<i>D</i> _{i+m} <i>Fa</i> ≥ 8		
	%	n	%	n	%	n	
isoBMI < 25	33	110/338	30	101/338]	12	40/338]	
isoBMI 25–29.9	32	16/50	38	19/50 🐇	22	11/50 🐇	
isoBMI ≥ 30	21	3/14	71	10/14	43	6/14	

P values obtained using an approximate normal distribution with continuity correction, testing differences between proportions. **P < 0.01.

	Caries prevalence at 15 years				
	D _{i+r}	"Fa	D _m Fa		
Snacking habit	Mean	SD	Mean	SD	
At 1 year of age					
Consumption of caries-risk products	2.98	3.70]	0.37	1.00	
≤ 3 times a day (<i>n</i> = 367)		*			
Consumption of caries-risk products	5.35	5.35	0.84	1.75	
> 3 times a day (<i>n</i> = 31)					
Sweets \leq once a week ($n = 367$)	3.10	3.94	0.38	1.06	
Sweets > once a week $(n = 30)$	3.93	3.38	0.67	1.35	
At 3 years of age					
Consumption of caries-risk products	2.77	3.53	0.25	0.597	
\leq 3 times a day (<i>n</i> = 204)				*	
Consumption of caries-risk products	3.36	4.12	0.48	1.27	
> 3 times a day (<i>n</i> = 162)		7			
Sweets \leq once a week ($n = 225$)	2.64	3.34	0.32	0.95	
Sweets > once a week $(n = 141)$	3.66	4.37 <u>Ĵ</u>	0.48	0.97	

Table 3. Cons	umption of cari	ies risk products a	at 1 year an	d 3 years of	f age in relat	ion to mea	n number of	carious (D) ar	۱d
filled (F) appr	oximal tooth su	urfaces at 15 year	s of age (i =	initial; m =	manifest).				

P values obtained by unpaired two-sample t-test.

SD, standard deviation.

*P < 0.05.

drinks at an early age appears to be associated with caries at 15 years of age.

In the last few decades, Swedish studies have revealed an increasing prevalence of overweight and obesity among children and adolescents. Data collected from 2000 to 2002 on 15-year-old adolescents report that 15% of the girls and 18% of the boys were overweight, and a total of 3% of the girls and 4% of the boys were obese²⁰. This study revealed a somewhat lower prevalence of overweight adolescents. One explanation could be a difference in demographic factors in the two studies, and another could be that the 24 teenagers in this study who did not want to check their weight presumably had a higher isoBMI.

Several characteristics of today's society are contributing to the widespread childhood obesity problem. Children today have a more sedentary lifestyle. On average, children in the United States watch more than 4 h of television a day⁵, which is positively correlated with both the increased consumption of soda and obesity²¹. In addition, Guthrie and Morton²² showed that sweetened drinks constitute the primary source of added sugar in children's daily diet. Marshall *et al.*²³ have suggested that contemporary changes in beverage intake, particularly the increase in soda pop consumption, have the potential to increase dental caries rates in children.

The result of this investigation is in accordance with a recent study by Willerhausen *et al.*¹¹, who studied German elementary schoolchildren (6-11 years of age). They reported an association between high body weight and caries frequency in the primary and permanent dentition. Hilgers et al.¹⁰ found an association between BMI and an increased incidence of permanent molar interproximal caries among US schoolchildren aged 8-11 years. Additionally, Larsson et al.²⁴ evaluated the relationship between dental caries and risk factors for atherosclerosis in Swedish adolescents. They compared the decayed and filled surfaces with obesity in 15-year-olds and found a positive correlation between these two factors.

In this study, only caries at the approximal tooth surfaces was registered and not caries in pits and fissures. The reason for this was that children in this study generally had fissure sealants applied to all permanent molars shortly after eruption²⁵. The occlusal caries prevalence

was therefore very low and, as a result, approximal caries might be the main problem for 15year-olds. Most previous studies of BMI versus caries have only included cavities and fillings. In this investigation, however, initial approximal lesions, scored on bitewing radiographs, were included in the analyses, thereby providing a more complete picture of the total approximal caries situation, because up to 80–90% of decayed approximal surfaces are reported to be initial caries^{17,26}.

Recently, Bratthall²⁷ presented the so-called Significant Caries Index (SiC Index), which means that one-third of the population with the highest caries scores should be analysed separately (as a risk group). In this study, the $DFa \ge 4$ group corresponds to 32% of the population and is thus in line with the SiC Index. In Scandinavia, 10–15% of the population with the highest caries scores are usually regarded as a 'risk group'. This corresponds to $DFa \ge 8$ in this study and represents 14% of the population. We therefore used three cut-off points for the statistical analysis, that is, DFa = 0, $DFa \ge 4$, and $DFa \ge 8$. In the 'highest caries prevalence group' $(D_{i+m}Fa)$ \geq 8), 30% were overweight/obese (isoBMI \geq 25) and 11% were obese (isoBMI \geq 30), compared with 15% and 2%, respectively, in the caries-free group $(D_{i+m}Fa = 0)$. These results point to the fact that children with overweight and obesity seem to have an increased risk for developing approximal caries lesions. However, this conclusion is based on a group level and there were some exceptions; 3 of 14 children in the obese group were completely free from approximal caries. It is possible to speculate about the reason why overweight and obese children have more caries than normal-weight children. One reason could be the frequent consumption of sugarcontaining products, which may result in an increased number of cariogenic microorganisms. Barkeling et al.²⁸ showed that the mutans streptococcus count was correlated with BMI and to a higher intake of sweet foods.

The observation that there is an association between the frequent consumption of caries-risk products at an early age (1–3 years) and approximal caries at 15 years of age is in accordance with a previous long-term Finnish study by Mattila *et al.*²⁹ They reported that the daily intake of sweets at the age of 3 years was associated with

caries increment between 7 years and 10 years. Ruottinen *et al.*⁷ followed children's sucrose intake from infancy to 10 years of age, and found that once a high-sucrose intake is adopted in early childhood, changes later in life are unlikely. Furthermore, previous analyses of caries-related factors in this population showed that cariesassociated dietary habits during infancy are maintained throughout early childhood³⁰. Consequently, we assume that early established behaviour with a high-sucrose intake appears to persist during childhood and adolescence. Additionally, a previous study of the same population¹⁶ shows that childhood caries experience before 3 years of age had a greater predictive value than childhood caries experience between 3 years and 6 years of age when it came to approximal caries at 15 years of age. All these studies point to the fact that preventive measures are of the utmost importance, especially before 3 years of age.

Both dental caries and obesity are multifactorial diseases related to dietary habits. The triangular association of 'sugar-caries-obesity' needs to be further explored. Future preventive measures should include strategies to prevent and reduce obesity and dental caries in the young population. This means that health professionals should work in a multidisciplinary manner with these patients with the aim of establishing good dietary habits. In addition, specific preventive measures, such as toothbrushing with fluoride toothpaste twice a day and physical activities, are also of great importance in this respect.

Conclusions

It is possible to draw the following conclusions from the result of this investigation: i) Dental caries and obesity are multifactorial diseases related to dietary habits. It is important to identify patients at risk in early childhood, and future preventive measures should therefore include strategies to prevent and reduce both obesity and dental caries. ii) Because obesity and caries have common determinants, paediatric dentists should be involved in this multidisciplinary teamwork and should make recommendations for both 'healthy teeth' and 'healthy weight'.

What this paper adds

- This study shows that overweight and obese adolescents have a higher approximal caries prevalence (mainly initial caries) than normal-weight adolescents.
- The results of this study indicate that the early establishment of frequent consumption of caries-risk products is associated with approximal caries at 15 years of age.

Why this paper is important to paediatric dentists

- These results stress the importance of health programmes including strategies to prevent and reduce both obesity and dental caries at an early age.
- Paediatric dentists should be involved in the multidisciplinary teamwork with overweight and obese children, and make recommendations for both 'healthy teeth' and 'healthy weight'.

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