Clustering of Obesity and Dental Caries with Lifestyle Factors Among Danish Adolescents

Ayse Basak Cinar[a] /Lisa Boge Christensen[a] / Borge Hede[b]

Purpose: To assess any clustering between obesity, dental health, and lifestyle factors (dietary patterns, physical activity, smoking, and alcohol consumption) among adolescents.

Material and Methods: A cluster sample of 15-year-old Danish adolescents (DA) from eight municipalities was selected. Self-reported questionnaires for adolescents and their mothers to assess body-mass index (BMI), socioeconomic and lifestyle factors, and clinical examinations to examine adolescents' dental status (DMFT) were used. Descriptive statistics, chi-square tests, and factor analysis were applied.

Results: The mean DMFT was 2.03 and mean BMI was 21.30 among DA. Of the whole sample, 62% experienced caries (DMFT > 0) and 16% were classified as obese. No association appeared between obesity and DMFT (p > 0.05). Most adolescents were likely to have breakfast every day (76%), but their daily consumption of fruit was lower (38%). More than half of adolescents reported having physical exercise (66%) and no alcohol consumption (57%). Smokers were more likely to consume alcohol (80%) but less likely to exercise (44%) than nonsmokers (alcohol consumption, 55%; exercise, 68%), (p < 0.05). Principal component analysis revealed that DMFT and obesity were interrelated in DA.

Conclusion: In line with earlier studies, obesity and dental caries share common lifestyle factors among adolescents, regardless of nationality and different health-care systems. Thus, it seems that dental health is a global health concern. There is a need for collaboration between dental and general health-care providers to manage both obesity and dental caries in adolescents by using a holistic approach.

Keywords: obesity, dental caries, lifestyle, adolescents.

During the last decades, changes in diet and lifestyles have accelerated with industrialization, urbanization, economic development, and market globalization. This has had a significant impact on the health and nutritional status of populations (WHO, 2003). While standards of living have improved, food availability has expanded and become more diversified, and in general, access to health services has also increased. However, there have also been significant negative consequences in terms of inappropriate dietary habits, decreased physical activity, and increased tobacco use, and at the same time a corresponding increase in diet-related chronic diseases at the global level (WHO, 2003). Young people in Europe are currently facing rapid societal change and globalization, accompanied by health risks, such as decline in consumption of healthy food and physical activity and increase in alcohol use and startign smoking at early ages, all of which show an increasing trend by age (WHO, 2009a).

Childhood obesity and dental caries are among the chronic diseases with a growing global pandemic occurrence (Edelstein, 2006; Larson et al, 2007), afflicting both developed and developing countries (WHO, 2002). These two major public health problems are related to common lifestyle factors, such as unhealthy eating habits, skipping breakfast, and smoking among children (Bruno-Ambrosius et al,

a Associate Professor, Community Dental Health Department, Institute of Odontology, University of Copenhagen, Denmark.

b Community Dental Health Department, Institute of Odontology, University of Copenhagen; Department of Special Care Dentistry, City of Copenhagen, Denmark.

Correspondence: *Ayse Basak Cinar, Community Dental Health Department, Institute of Odontology, University of Copenhagen, Denmark. Norre Alle 20, 2200 Kopenhagen N, Denmark. Tel: +45-3532-6583, Fax: +45-3532-6505. e-mail: aci@sund.ku.dk*

2005; Fasting et al, 2008). These maladapted habits track into later life as predictors of increased risk of obesity (Viner et al, 2006) and higher rates of caries (Bruno-Ambrosius et al, 2005). Physical inactivity seems to act as a mediating agent between obesity and poor lifestyle factors. Children who are physically inactive are more likely to consume sweetened drinks and snacks and skip breakfast, and are therefore more likely to be obese (Craig et al, 2009; Nagel et al, 2009). However, the possible relationship between caries and physical activity has so far been neglected.

Another lifestyle factor that has developed unfavourably during recent years among adolescents is alcohol intake (Croezen et al, 2009). A few studies described the relationship between alcohol consumption and overweight in adolescents (Berkey et al, 2008; Croezen et al, 2009); it is interrelated with increased consumption of sugary products and negative attitudes towards dental health (Petersen et al, 2008). However, the relationship between alcohol use and dental health among adolescents is unknown.

There is growing interest in the association between children's weight and dental caries (Macek et al, 2006; Pinto et al, 2007a; Willerhausen et al, 2007), but only one study has explored their common contributors in terms of dietary habits and TV-viewing among children (Cinar and Murtomaa, 2008). The aim of the present study was to assess any clustering between obesity, dental health, and lifestyle factors (dietary patterns, physical activity, smoking, and alcohol consumption) among adolescents.

MATERIALS AND METHODS

Study population and method

The present data are taken from an earlier study by Christensen et al (2010), which analyzed oral health of children under the Public Dental Health Service (PDHS) in Denmark. Cluster sampling, used for identification of participants, was explained in detail previously (Christensen et al, 2010). The clusters were Danish municipalities selected for the purpose of representing various geographical areas of the country and various degrees of urbanization. Eight municipalities were selected for the study. The mean concentration of fluoride in the drinking water varied from 0.1 to 0.2 ppm (parts per million) in the municipality with the lowest level,

and 0.3 to 1.9 ppm in the municipality with the highest level. From eight municipalities (15-year-old population ranging from 84 to 2211 individuals), nearly 100 adolescents aged 15 years, stratified with respect to gender, were randomly selected. The sampling procedure, carried out by the government agency for civil registration numbers, is explained in Christensen et al (2010). Such a sample design was calculated to permit identification of differences between different socioeconomic groups. Data on caries experience, DMFT (decayed, missing and filled teeth in the permanent dentition), were obtained from nationally aggregated data collected in a database established and administered by the National Board of Health since 1972 (Helm, 1973). The criteria for caries agree with standards set by the World Health Organization for the presence of initial and manifest caries (WHO, 2003). In the present study, caries occurrence was recorded at the cavity level.

According to the directives from the Danish health authorities, registration of data on oral health is mandatory by 15 years of age. In the present study, the number of reported clinical data was obtained from 76% of the study population. Information on socioeconomic and sociocultural factors, oral health, and related behaviour of the family was collected by postal questionnaires mailed to the 15-year-old adolescents and their parents. The questions to the parents were based on questionnaires used by the World Health Organization (Petersen, 1994) and the questions to the adolescents were based on a Swedish study on oral health behaviour and attitudes among teenagers (Ostberg, 2002). Information was collected on the parents' socioeconomic status, the parents' assessment on their children's oral and general health, lifestyle habits including oral hygiene habits, and their children's height and weight. Furthermore, data on the parents' assessments of their own oral and general health, lifestyle habits, and height and weight were obtained. The adolescents' questionnaires included their self-assessment of oral and general health, smoking habits, alcohol intake, exercise, and eating habits.

The parental questionnaire included the number of children in the family (ranging from 0 to 8), parental education (ranging from "7 years or less" to "12 years or more"), and total family annual income (ranging from "under 100,000 DKK" to "over 600,000 DKK"), scored as low = 0, moderate = 1, and high = 2 by using the 33rd percentile as the cut off. That is, low was defined as variable ≤ 33rd per-
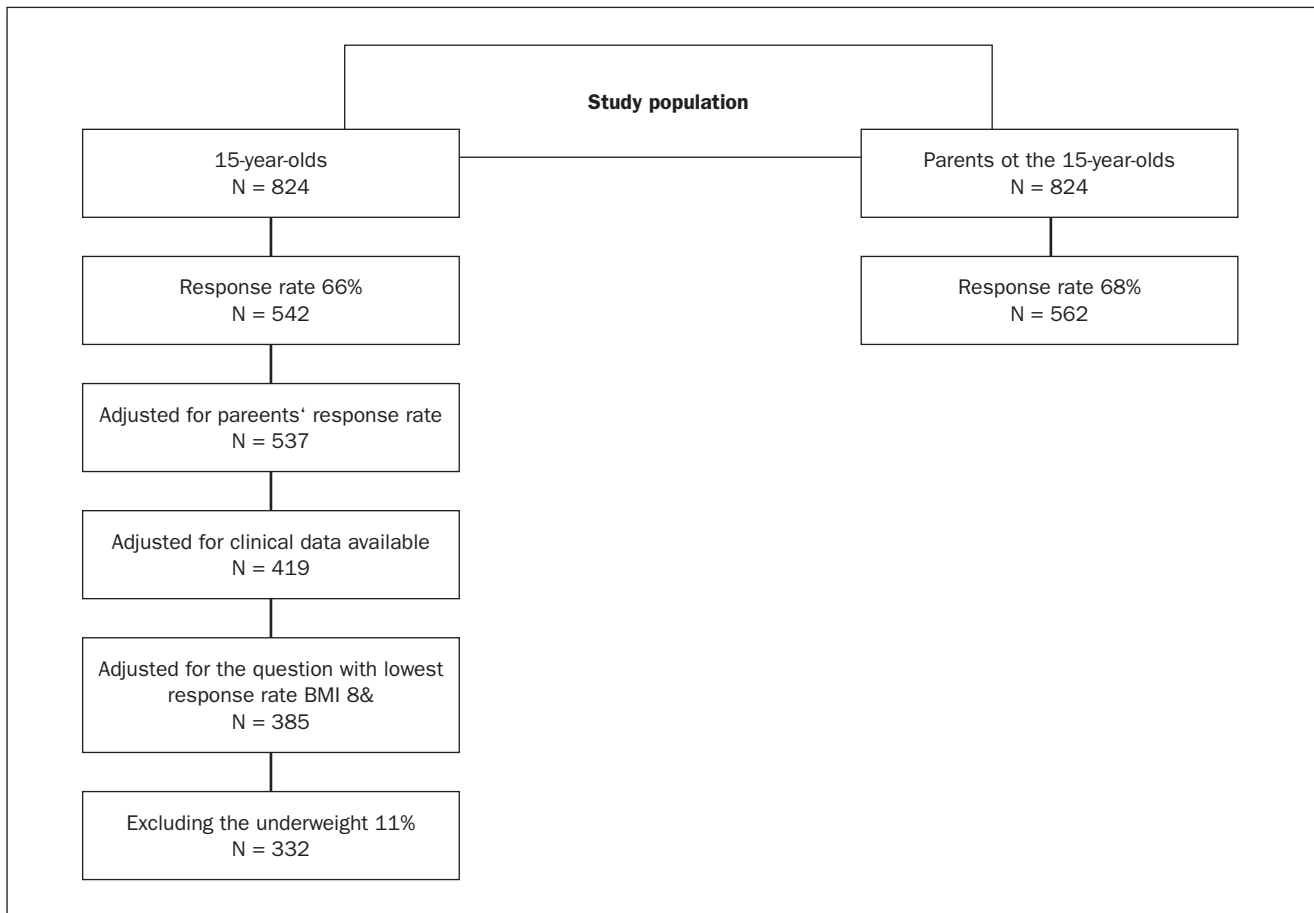
Fig 1 Sampling procedure and response rates

centile ("9 years or less" education, below 300,000 DKK), moderate as 33rd percentile < variable ≤ 66th percentile ("10 years" education, 300,000 DKK to 500,000 DKK), and high as 66th percentile < variable ("12 years or more" education, 500,000 DKK or more). The variable "number of children" was dichotomized according to mean (mean or above, i.e., ≥3 children = 1; below mean, i.e., 1 to 2 children = 2). A score of 1 indicates a "low" family context, whereas a score of 2 refers to a "moderate or high" family context, as low numbers of children indicate a better family context, namely better socioeconomic status (Chittleborough et al, 2006; Cinar et al, 2008). All these variables taken together define the socioeconomic status (SES) and are categorized as low, moderate, and high SES by using the 33rd percentile as a cut off: variable ≤ 33rd percentile (low), 33rd percentile < variable ≤ 66th percentile (moderate), 66th percentile < variable (high).

The following variables were extracted from the adolescent questionnaire: lifestyle factors; dietary habits: daily breakfast (favorable = 1), consuming fruit several times per day (favorable = 1) (US Department of Agriculture, US Department of Health and Human Services 1995); regular exercise (favorable = 1), not currently smoking (favorable = 1), not currently drinking alcohol (favorable = 1).

Sixty-eight percent of the parents and 66% of the adolescents completed and returned the questionnaires. Data on caries experience were merged with the questionnaire data for analysis by means of SPSS (Statistical Program for the Social Sciences). Figure 1 shows the sampling procedure and the participation rate.

BMI-for-age [(weight in kilograms)/(height in meters)^2] percentiles, developed and used as a growth and nutrition reference by the WHO, are dependent on gender- and age-specific weight-for-height charts for the ages 5 to 19 years (WHO, 2007). According to these charts, "non-obese", "at risk for overweight", and "overweight" were defined, respectively, as 5th percentile< BMI-for-age < 85th percentile, 85th percentile ≤ BMI-for-age < 95th percentile, and BMI-for-age ≥ 95th percentile (Macek et al,

2006). Those who are underweight and at risk of underweight, defined as BMI-for-age ≤ 15th percentile (Levin et al, 2003), among Danish adolescents (11%, n=53) were extracted from further data analysis in order to compare non-obese and obese adolescents. The adolescents "at risk for overweight" and "overweight" were assigned to the "obese" group (Pinto et al, 2007b).

Statistical methods

Factor analysis can be used to hypothesize an underlying construct by the principal component analysis (PCA) approach; thus, it is used to find a few combinations of variables, called components or clusters, that adequately explain the overall observed variation, thereby reducing the complexity of the data. In the present study, factor analysis was applied to the variables by using PCA and Varimax rotation to analyze not the associations but the interrelationships (connection by sharing the common background factors), and common underlying dimensions among dental health, obesity, and lifestyle factors. These variables were classified into discriminative clusters (latent variables) for Danish adolescents based on factorial loadings, ranging from highest to lowest values. Loadings below 0.35 were extracted for ease of communication. The clusters are named based on the variable with highest loading. Factors were extracted according to meeting the Kaiser criterion of eigenvalue greater than 1.

Descriptive statistics, frequency distributions, the contingency coefficient for determining associations between variables, and binary logistic regression were applied. In addition, chi-square tests by cross-tabulation were applied to compare proportions, and the corresponding odds ratios were calculated. Statistical significance was set at $p < 0.05$.

RESULTS

Dental health and BMI measures

Adolescents' mean DMFT was 2.03 [standard deviation (SD) = 3.01], made up of 0.57 (SD = 1.12) decayed mean and 1.45 (SD=1.91) filled teeth. Of the whole sample, 62% of adolescents experienced caries (DMFT > 0). Mean BMI was 21.30 (SD = 3.62), and 16% of the participants were classified as obese. No association appeared between obesity and DMFT ($p > 0.05$).

Lifestyle factors

Most adolescents were likely to have breakfast every day (76%), but their daily consumption of fruit was lower (38%). More than half the adolescents reported getting physical exercise (66%), and no alcohol consumption was reported by 57%. Smoking was less frequent among these young people (10%).

Adolescents who did not have breakfast every day were more likely to be smokers (19%, Odds Ratio (OR) = 2.79: Confidence Interval (CI): 95%:1.34-5.80) and to consume alcohol (71%, OR = 2.21: CI: 95%: 1.28-3.81) than were those who regularly ate breakfast (8%, 53% respectively), ($p < 0.05$). Those who were smokers were more likely to consume alcohol (80%, OR = 2.87: CI: 95% 1.28-6.40) but less likely to exercise (44%, OR = 0.88: CI: 95% 0.81-0.95) than nonsmokers (consumption of alcohol, 55%; exercise, 68%), ($p < 0.05$).

Socioeconomic factors

Socioeconomic characteristics of adolescents are shown in Table 1. Health measures, DMFT, and BMI were not associated with any of the socioeconomic variables ($p > 0.005$).

Clustering between DMFT and BMI

Principal component analysis revealed that DMFT and obesity were interrelated in Danish adolescents (Table 2). The relatively high loadings (maximum 1.0) on component one ("Health cluster") by the variables "DMFT" (0.695), "BMI" (0.598), "daily fruit consumption" (0.411) and "nonsmoking" (0.428) may reveal that those having no dental caries were also not obese, nonsmokers, and daily fruit consumers. Component two, namely "lifestyle factors I cluster", revealed that adolescents who had breakfast and ate fruit every day were more likely to less frequently consume alcohol.

DISCUSSION

The present data were obtained from eight different municipalities. Data regarding oral health were based on the Danish standardized recording system for oral health and were obtained from databases systematically stored and administered by

Table 1 The socioeconomic characteristics of Danish adolescents with good health and favourable lifestyle$^{\Omega}$

	Distribution among all adolescents %	No dental caries %	Non-obese %	Daily breakfast %	Daily fruit consump-tion %	Non-smoking %	No alcohol use %	Regular exercise %
Number of children								
≥3 children	25	43	15	80	47*	91	43	72
1-2 child	75	36	16	75	34	90	33	64
Parental education								
Low	12	31	82	74	33	82	54	59
Average	43	37	96	72	34	89	41	68
High	45	41	90	80	41	92	41	65
Family income								
Low	25	32	14	73	38	82*	51*	60
Average	29	38	18	75	34	96	47	65
High	46	42	15	78	39	90	35	69
Socioeconomic status								
Low	35	36	14	69*	36*	83	53	58*
Average	44	39	18	70	29	91	47	57
High	21	39	15	82	44	90	41	71

$^{\Omega}$ Distribution of each category of a socioeconomic measure by favourable health and lifestyle variables is given in each row. The percentage of an unfavourable lifestyle factor plus that of its corresponding healthy lifestyle factor = 100% (eg, 43% no dental caries means 57% dental caries, yielding 100%). *P < 0.05

Table 2 Factor analysis for assessing lifestyle clusters of DMFT (no dental caries experience vs caries experience) and BMI (nonobese vs obese) among Danish adolescents by Varimax rotated solution†

	Component 1	Component 2	Component 3
	Health	**Lifestyle factors I (no alcohol consumption)**	**Lifestyle factors II (regular physical exercise)**
DMFT	0.695	*	*
BMI	0.538	*	*
Daily breakfast	*	0.561	*
Daily fruit consumption	0.411	0.452	0.387
Nonsmoking	0.428	*	0.494
No alcohol consumption	*	0.800	*
Regular physical exercise	*	*	0.863

The clusters in the study group, in total, accounted for 51.8% of the total variance (composed of component 1: 18.2%, component 2: 17.1% and component 3: 16.2%). † All lifestyle variables (daily breakfast and fruit consumption, smoking, alcohol use, physical exercise) classified as favourable (1) and unfavourable (0) along with health measures (no dental caries experience = 1, non-obese = 1). *Loadings below 0.35 extracted for ease of communication. The clusters are named based on the variable with highest loading.

Danish health authorities (Helm, 1973). The recording system is based upon a relatively simple coding method and standardized criteria for clinical registration that provides information on the DMF-T index. Hausen et al (2001) have suggested that data collected from public health records are not substantially inferior to those obtained from examinations by trained examiners. Consequently, the underlying data were considered of acceptable reliability.

Clinical data were available for 76% of the study population. Missing clinical data from 25% of the study population may have caused some selection bias; however, the most likely reason for the missing data is the extended intervals of dental examination to more than one year for children and adolescents with no caries incidence for years. Consequently, no data were available on these "dentally healthy" children during the study period. This may indicate that the mean figures for caries in the present results are too pessimistic. On the other hand, analysis of caries experience in the group whose parents did not respond to the questionnaire showed somewhat higher levels of caries experience than in the children of the respondents.

The response rate among parents and adolescents were 68% and 66%, respectively, which is considered satisfactory. However, questions on weight and height may be sensitive and fewer persons replied to these specific questions. The results of this study may therefore not be fully representative of the Danish adolescent population in general; nevertheless, a tendency can be shown.

The interest in the interrelation between obesity and poor dental health has been growing. In line with earlier studies (Cinar and Murtomaa, 2008; Cinar and Murtomaa, 2010), the clustering of these two health parameters among Danish adolescents, not necessarily implying an association between them, may provide further evidence that DMFT and obesity are connected by sharing some common underlying lifestyle factors, and both refer to a common parameter, namely health. 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" (WHO, 2009b). The intake of unhealthy food (eg, soft drinks, snacking) is increased in a diet where the healthy dietary habits such as daily consumption of fruit and regularly eating breakfast are reduced (Utter et al, 2007a; Verzeletti et al, 2009). Such an unhealthy diet among adolescents is directly related to smoking (Giannakopoulos et al, 2009); both of which may contribute to obesity (Bibiloni et al, 2009; Cinar and Murtomaa, 2010; Utter et al, 2007b) and dental caries (Bruno-Ambrosius et al, 2005; Cinar and Murtomaa, 2008). This is in line with the present findings that Danish adolescents who were more likely to smoke and less frequently consume fruit were more likely to become overweight and experience dental caries.

The present study found that smoking was associated with irregular breakfast consumption, alcohol consumption, and inadequate physical exercise, which agrees with previous studies (Frazier et al, 2000; Paavola et al, 2004). That may indicate that smoking may have a mediating effect between unhealthy dietary habits, irregular physical activity, and alcohol use. This needs further attention regarding the separate clustering of smoking and physical exercise as one lifestyle cluster, and alcohol consumption as another group in the present study. The interrelation between smoking and physical activity among Danish adolescents may reveal the socially networked structure of physical activity and smoking. Surprisingly, the social networks formed by adolescents involved in sports activities may provide increased opportunities for peer support of cigarette use, since the young athletes view cigarettes as a symbol of victory (Frazier et al, 2000). Conversely, other authors have found that physical activity has a protective effect against smoking (Charilaou et al, 2009) and a promoting impact on healthy eating (Kelder et al, 1994), which was found in the present study as the clustering of regular physical activity, nonsmoking, and fruit consumption.

The separate clustering of alcohol consumption along with regular breakfast and fruit consumption may highlight the significance of parental modeling. Regular breakfast consumption is a health enhancing behaviour learned by parental modeling; the adolescents whose parents skip breakfast are more likely to have infrequent breakfasts themselves (Keski-Rahkonen et al, 2003). Fruit consumption is related to family eating habits, as found previously among Turkish and Finnish preadolescents (Cinar and Murtomaa, 2008) and Danish adolescents (Krolner et al, 2009); hence, it is a behaviour learned in the family. Parental drinking is also a role model for adolescents and has been found to be a prototype that can be transmitted to adolescents (Gerrard et al, 1999). Regular alcohol intake is a common custom in families in Denmark (Bloomfield et al, 2008). Danish adolescents may thus model their parents for not only for breakfast and alcohol consumption, but also for consumption of fruit.

It is noteworthy that the findings of the present study for healthy dietary habits (daily breakfast and fruit consumption, 76% and 38%, resp), no alcohol use (57%), and nonsmoking (90%), resemble those of the HBSC (WHO Health Behaviour Survey for School-aged Children) (64%, 38%, 68%, 85%) which

follows an increasing pattern starting from the age of 11 years (WHO, 2008). Danish adolescents in the present study engage in either health enhancing or health detrimental behaviours, as already found earlier (Donovan, 1993; Aas et al, 1995), lead to improvement or endangerment of their health. Therefore, it is important that health professionals and health educators combine their efforts to promote the message of healthy eating, anti-smoking and anti-alcoholic beverages. The dental team, with its regular and periodic recall of adolescents, has a unique opportunity to promote healthy eating and anti-tobacco messages.

CONCLUSION

It may be concluded that, based on the findings of this and earlier studies, obesity and dental caries share common lifestyle factors among adolescents, regardless of nationality and different health-care systems. Thus, it seems that dental health is becoming a global health concern, and further multinational and cultural studies are needed. Improvement of dental health and general well-being of adolescents requires active collaboration between dental and general health-care providers and the implementation of health promotion strategies targeting management of both obesity and dental caries for young persons by using a holistic approach.

ACKNOWLEDGMENTS

REFERENCES

1. Aas H, Klepp KI, Laberg JC, Aaro LE. Predicting adolescents' intentions to drink alcohol: outcome expectancies and self-efficacy. J Stud Alcohol 1995;56:293-299.

2. Berkey CS, Rockett HR, Colditz GA. Weight gain in older adolescent females: the internet, sleep, coffee, and alcohol. J Pediatr 2008;153:635-639.

3. Bibiloni MD, Martinez E, Llull R, Juarez MD, Pons A, Tur JA. Prevalence and risk factors for obesity in Balearic Islands adolescents. Br J Nutr 2009;103:1-8.

4. Bloomfield K, Grittner U, Rasmussen HB, Petersen HC. Socio-demographic correlates of alcohol consumption in the Danish general population. Scand J Public Health 2008;36:580-588.

5. Bruno-Ambrosius K, Swanholm G, Twetman S. Eating habits, smoking and toothbrushing in relation to dental caries: a 3-year study in Swedish female teenagers. Int J Paediatr Dent 2005;15:190-196.

6. Charilaou M, Karekla M, Constantinou M, Price S. Relationship between physical activity and type of smoking behavior among adolescents and young adults in Cyprus. Nicotine Tob Res 2009;11:969-976.

7. Chittleborough CR, Baum FE, Taylor AW, Hiller JE. A life-course approach to measuring socioeconomic position in population health surveillance systems. J Epidemiol Community Health 2006;60:981-992.

8. Christensen LB, Petersen PE, Hede B. Oral health in children in Denmark under different public dental health care schemes. Community Dent Health 2010;27:94-101.

9. Cinar B, Murtomaa H. Clustering of obesity and dental health with lifestyle factors amon Turkish and Finnish Pre-adolescents. Obesity Facts 2008;1:196-202.

10. Cinar AB, Murtomaa H. Interrelation between obesity, oral health and life-style factors among Turkish school children. Clin Oral Investig 2011;15:177-184.

11. Cinar A B, Murtomaa H, Tseveenjav B. The Life-course Approach in Assessment of Dental Health: A Cross Sectional Study among Finnish and Turkish Pre-adolescents. Eur J Dent 2008;2:153-160.

12. Cinar B, Murtomaa H. Clustering of Obesity and Dental Health with Lifestyle Factors among Turkish and Finnish Pre-Adolescents. Obes Facts 2008;1:196-202.

13. Craig LC, McNeill G, Macdiarmid JI, Masson LF, Holmes BA. Dietary patterns of school-age children in Scotland: association with socio-economic indicators, physical activity and obesity. Br J Nutr 2009;103:319-334.

14. Croezen S, Visscher TL, Ter Bogt NC, Veling ML, Haveman-Nies A. Skipping breakfast, alcohol consumption and physical inactivity as risk factors for overweight and obesity in adolescents: results of the E-MOVO project. Eur J Clin Nutr 2009;63:405-412.

15. Donovan JE. Young adult drinking-driving: behavioral and psychosocial correlates. J Stud Alcohol 1993;54:600-613.

16. Edelstein B L. The dental caries pandemic and disparities problem. BMC Oral Health 2006;6(suppl 1):S2.

17. Fasting MH, Nilsen TI, Holmen TL, Vik T. Life style related to blood pressure and body weight in adolescence: cross sectional data from the Young-HUNT study, Norway. BMC Public Health 2008;8:111.

18. Frazier AL, Fisher L, Camargo CA, Tomeo C, Colditz G. Association of adolescent cigar use with other high-risk behaviors. Pediatrics 2000;106:E26.

19. Gerrard M, Gibbons FX, Zhao L, Russell DW, Reis-Bergan M. The effect of peers' alcohol consumption on parental influence: a cognitive mediational model. J Stud Alcohol Suppl 1999;13:32-44.

20. Giannakopoulos G, Panagiotakos D, Mihas C, Tountas Y. Adolescent smoking and health-related behaviours: interrelations in a Greek school-based sample. Child Care Health Dev 2009;35:164-170.

21. Hausen K, Karkkainen S, Seppa L. Caries data collected from public health records compared witn data based on examinations by trained examiners. Caries Res 2001;35:360-365.

22. Helm S. National Statistics on caries and oral hygiene derived from the Danish Child Dental Health recording system. Community Dent Oral Epidemiol 1973;1:121-126.

23. Helm S. Recording system for the Danish Child Dental Health Services. Community Dent Oral Epidemiol 1973;1:3-8.

24. Kelder SH, Perry CL, Klepp KI, Lytle LL. Longitudinal tracking of adolescent smoking, physical activity, and food choice behaviors. Am J Public Health 1994;84:1121-1126.

25. Keski-Rahkonen A, Kaprio J, Rissanen A, Virkkunen M, Rose R J. Breakfast skipping and health-compromising behaviors in adolescents and adults. Eur J Clin Nutr 2003;57:842-853.

26. Krolner R, Due P, Rasmussen M, Damsgaard M T, Holstein B E, Klepp K I, Lynch J. Does school environment affect 11-year-olds' fruit and vegetable intake in Denmark? Soc Sci Med 2009;68:1416-1424.

27. Levin S, Lowry R, Brown DR, Dietz WH. Physical activity and body mass index among US adolescents: youth risk behavior survey, 1999. Arch Pediatr Adolesc Med 2003;157:816-820.

28. Macek MD, Mitola DJ. Exploring the association between overweight and dental caries among US children. Pediatr Dent 2006;28:375-380.

29. Nagel G, Wabitsch M, Galm C, Berg S, Brandstetter S, Fritz M, Klenk J, Peter R, Prokopchuk D, Steiner R, Stroth S, Wartha O, Weiland S K, Steinacker J. Determinants of obesity in the Ulm Research on Metabolism, Exercise and Lifestyle in Children (URMEL-ICE). Eur J Pediatr 2009;168:1259-1267.

30. Ostberg AL. On self-perceived oral health in Swedish adolescents. Swed Dent J Suppl 2002;155:1-87.

31. Paavola M, Vartiainen E, Haukkala A. Smoking, alcohol use, and physical activity: a 13-year longitudinal study ranging from adolescence into adulthood. J Adolesc Health 2004;35:238-244.

32. Petersen PE, Åstrøm AN. Principper og strategier for sundhesfremme i det 21. århundrede. Tandlægebladet 2008;112:30-41.

33. Petersen PE. Basic questionnaire for interviewing schoolchildren. Copenhagen: WHO Collaborating Centre for Community Oral Health Programmes and Research, 1994.

34. Pinto A, Kim S, Wadenya R, Rosenberg H. Is there an association between weight and dental caries among pediatric patients in an urban dental school? A correlation study. J Dent Educ 2007a;71:1435-1440.

35. US Department of Agriculture, US Department of Health and Human Services. Nutrition and your Health: dietory guidelines for Americans, 4th ed Washington, DC, US Government Printing Office, 1995 (Home and Garden Bulletin 232).

36. Utter J, Scragg R, Mhurchu CN, Schaaf D. At-home breakfast consumption among New Zealand children: associations with body mass index and related nutrition behaviors. J Am Diet Assoc 2007a;107:570-576.

37. Utter J, Scragg R, Schaaf D, Fitzgerald E, Wilson N. Correlates of body mass index among a nationally representative sample of New Zealand children. Int J Pediatr Obes 2007b;2:104-113.

38. Verzeletti C, Maes L, Santinello M, Baldassari D, Vereecken CA. Food-related family lifestyle associated with fruit and vegetable consumption among young adolescents in Belgium Flanders and the Veneto Region of Italy. Appetite 2010;54:394-397.

39. Viner RM, Cole TJ. Who changes body mass between adolescence and adulthood? Factors predicting change in BMI between 16 year and 30 years in the 1970 British Birth Cohort. Int J Obes (Lond) 2006;30:1368-1374.

40. WHO. Reducing risks, promoting healthy life. World Health Organization, Geneva. 2002

41. WHO. Diet, nutrition and the prevention of chronic diseases. World Health Organization, Geneva 2003:916.

42. WHO. BMI-for -age (5-19 years). 2007. Available via WHO. http://www.who.int/growthref/who2007_bmi_for_age/en/index. html. Accessed Feb 2 2009.

43. WHO. A snapshot of the health of young people in Europe. 2009a. European Commision Conference on Youth Health, Belgium.

44. WHO. Child Growth Standards. Backgrounder4. 2009b. Available via WHO. http://who.int/nutrition/media_page/backgrounders_4_en.pdf. Accessed Sep 2 2009.

45. WHO Europe. Inequalities in Young People's Health: Health Behaviour in School-Aged Children. International report from The 2005/2006 Survey. UK: WHO, 2008. Available: http://www.euro.who.int/Document/E91416.pdf

46. Willerhausen B, Blettner M, Kasaj A, Hohenfellner K. Association between body mass index and dental health in 1,290 children of elementary schools in a German city. Clin Oral Investig 2007;11:195-200.