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Correlation between Oral Health and Body Mass Index (BMI) in 2071 Primary School Pupils

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Abstract
High weight and obesity represent risk factors for numerous diseases. Correlations between body mass index (BMI) and carious lesions have also been described. In the present study, a possible association between caries prevalence and high weight ranges were examined in 2071 primary school pupils (51.8 % girls, 48.2 % boys), aged 6 to 10 years. A dental examination including the assessment of carious lesions (df-t + DF-T) was followed by measurements of height and weight in order to determine the BMI.

The evaluation showed that 6.8 % of the elementary school children were underweight, 76.4 % had a normal weight, and 10.5 % were overweight and 6.3 % obese.

Underweight children showed healthy teeth in 50 % of the cases, 47.4 % with normal weight showed naturally healthy teeth, while overweight and obese children displayed naturally healthy teeth in 41.5 % and 38.3 % of the cases, respectively.

In primary school pupils, a significant association between the caries frequency and the BMI was found. A low BMI showed a correlation with the absence of carious lesions ($p < 0.0001$), and a high BMI was linked to a high number of caries lesions (df-t + DF-T values; $p = 0.0021$). However, no gender-related differences, regarding the prevalence rates for high weight and obesity, could be established.

The significant correlation between the BMI and caries frequency persisted even after adjustment to the age of the children.

Key words: adiposity, body mass index, caries prevalence

Introduction

Within the last 20 years, a significant increase in the number of obese children, adolescents and adults could be observed in industrialized countries as well as in countries with a rising economy.

Decreased physical activity, a sedentary life style, the great popularity of computer games / TV as well as changes in the dietary and consumption habits have to be regarded as the initial factors for the strong rise in obesity [8]. In most of the countries, the prevalence for obesity experienced a growth of 10-50 % over the last 10 years. According to the WHO report (1998), 10 to 20 % of the male population, and up to 30 % of the female population are obese. An ever-increasing number of the population prefers fast food products to a balanced and healthy diet [9]. There are many reasons for the obesity epidemic. Fast food contributes to a high-energy consumption, and a sedentary lifestyle reduces energy expenditure. Indeed, many of the foods, including soft drinks and refined-wheat breads, are low in micronutrients. Bes-Rastrollo et al. [2] reported of the need for societal changes in diet; however, attention to physical activity is also required. Astrup et al. [1] asked what makes fast food fattening. Considering the convenience, low price, and high-energy format of fast food he said "Human beings have only a weak innate ability to recognize foods with high energy density and to down regulate the bulk eaten to meet energy requirements appropriately." Cupples et al. [5] stated that body weight is closely regulated under most conditions; a failure in energy balance can have severe consequences for the organism.

A large amount of literature for dietary recommendations and guidelines for a healthy diet is freely accessible; however, the food that is presently available in fast food chains does not take these recommendations into account. In a study that was carried out with preschool children, living in Aachen, the German Society of Child - and Adolescent Psychiatry (DGKJP) was able to document an impressive increase in the children's weight over the last 30 years. While in 1969 only 10 % of the children were overweight, this figure rose to 33.1 % in the boys and to 27 % in the girls [11]. This study was able to prove that every third boy and every fourth girl is overweight. In 1969, only 3 % of the children were obese when entering school while in 1999 15.7 % of the boys and 11.3 % of the girls were obese. This equals an increase by 350 %.

However the study by Flegal et al. [9] that was carried out in the USA and is based on data from the "National Health and Nutrition Examination Survey (NHANES)" (National Center for Health Statistics, Centers for Disease Control and Prevention) shows a relatively stable percentage in the prevalence of overweight and obesity in a time span between 1960 and 1980. The percentage of obese children (aged: 6-11 years) in the USA with a BMI larger than P95 has more than doubled (from 6.5 to 15.8 %) over the last 20 years (time span: 1980 to 2002) while that of adolescents has more than tripled (from 5.0 to 16.1%).

Obese children, and especially girls, are at a very high risk of suffering from severe obesity in adult-

hood. While the relative risk that a 7-year-old child becomes obese in adulthood lies by 4 %, this figure rockets to 70 % in 10- to 13-year-old children that are already obese [7]. The various consequences of obesity like diabetes mellitus, hypertension, hyperinsulinemia or impaired lung function can already be a problem during childhood [13]. According to long-term investigations, obesity in childhood correlates with an increased mortality in adulthood [12].

Since obese children are often stigmatized by their peers, the resulting psychosocial consequences are not to be neglected. Due to their fear of being bullied and therefore excluded from the group, these children often choose not to participate in the swimming and sports classes. According to DGKJP, this development has resulting consequences for adulthood. Young adults suffering from obesity, and especially girls, are often disadvantaged in their job and financially. The aim of the present study was to determine a possible correlation between the BMI and the caries frequency in a large group of elementary school children living in a medium sized German city.

Material and Methods

A total of 2071 elementary school children aged 6 to 10 years were enrolled in this study. Children from 5 different elementary schools in the city of Mainz were investigated as a means of an annual check up. The dental examination (performed by 8 calibrated dentists of the Department of Operative Dentistry, University Mainz) was non-invasive (mirror, dental probe, cotton roll), included optimal illumination of the oral cavity and the determination of visual caries as no x-rays were used. Prior to the dental examination, the children were instructed to clean their teeth as usual. The dental and physical examinations of the children were only conducted with the written consent of the parents and/or guardian.

Carious lesions that were treated invasively as well as restorations with secondary caries were declared as carious. They are defined as clearly visible cavities that suggest a demineralization or undermining caries. In order to document the prevalence of caries the df-t and DF-T values were evaluated. The number of missing teeth (m/M = missing) could not be regarded in the study because the investigated children were gradually receiving their second dentition so that no proper statement on the reason for the loss of the teeth could be made in this short period of time.

The advantage of the DF-T / df-t values is the determination of the total of carious lesions independent of the type of the dentition. Due to organizational and/or missing indication criteria, no X-rays were taken. Other anamnestic data, like the regular development of the children, the deviation in growth, and the body mass index were recorded by qualified physicians of the Department of Pediatrics. The height of the children was measured with a portable measuring unit. The weight was established with a portable digital scale, and the weight was always rounded off to the nearest 100-gram value. The body mass index (BMI = body weight / body height^2 (kg / m^2) was used. The internationally recognized classification of BMI into low weight, normal weight, high weight, and obesity was conducted with special tables from the obesity consortium for children and adolescents [9].

Results

2071 elementary school children, 1073 girls and 998 boys were enrolled and investigated in this interdisciplinary study that was conducted in cooperation with the Dental Hospital and the Department of Paediatrics of the Johannes Gutenberg University of Mainz as well as with the Association of Dental Health of the State of Rhineland Palatinate. In this study only elementary school children aged from 6 to 10 years, were included. 242 children (8.9 %) were 6 years old, 537 children (25.9 %) were aged 7, 507 children (24.5 %) were 8 years old, 489 children (23.6 %) were aged 9 and 296 children (14.3 %) were 10 years old.

A small percentage of the children was underweight (n = 140; 6.8 %), 218 children (10.5 %) were overweight and 131 children (6.3 %) were obese. Thus, 16.8 % of the children (n = 349) had a BMI that equaled or was greater than the 90th age- and gender-specific percentile. The majority of the children had a normal weight (n = 1582, 76.4 %) (Fig.1).

A high percentage of the elementary school children (n = 950; 45.9 %), 490 of the 1073 girls (45.7 %) and 460 of the 998 boys (46.1 %), proved to have caries-free dentitions. In the group of 6-year old children 59.5 % of the boys and 61.2 % of the girls, in the 7-year olds 45.3 % of the boys and 49.1 % of the girls were caries free. In the 8-year olds, these figures were 48.5 % for the boys and 43.7 % for the girls; 44.4 % of the 9- year-old boys had a d/D-T-value of zero, as opposed to 36.7 % of the girls. In the 10-year-old elementary school children, 34.5 % of the boys and 41.1 % of the girls could be established as caries-free. There was an inverse correlation of age and caries-free dentitions, with increasing age the percentage of caries-free dentitions decreased.

For the evaluation of the oral status, the numbers of the carious lesions and of the filled teeth for both the first (df-t) and the second dentition (DF-T) were added. The mean df-t + DF-T value was 1.4 in the 6-year-old elementary school children, but was with a value of 2.2 significantly higher in the 7-year-olds. The mean df-t + DF-T value of 8- year-old children was 2.3. The highest mean value of df-t + DF-T (2.6) was found in 9-year-old girls. In the 10-year-old elementary school children, the mean value of df-t + DF-T was 2.4.

The evaluation of the percentage of caries-free dentitions in weight classes showed in underweight children (n = 129) the highest proportion of healthy dentitions (50 %). Obese children had with 38.3 % the lowest percentage of caries-free dentitions (Fig.3). Every second underweight child, but only every third obese child in the age group between 6 and 10 years was free of caries. Elementary school children with normal weight proved to be caries free in 47.4 % (n = 1582) while this applied only to 38.3 % (n = 218) of the obese children (Fig. 3). The mean df-t + DF-T values in weight classes increased significantly from the

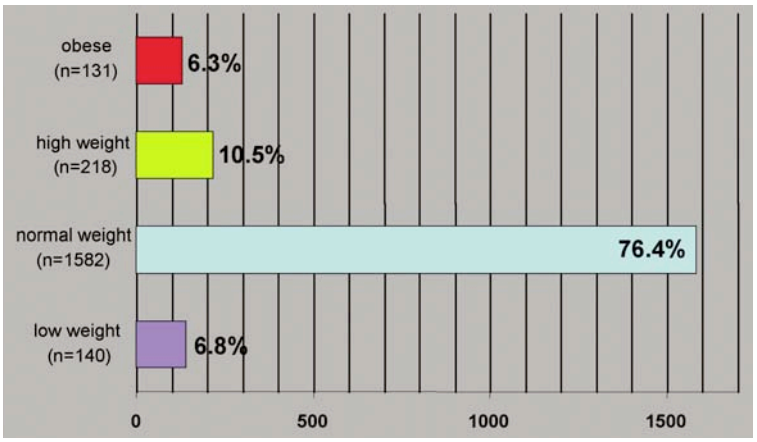

Fig. 1. Percentage and number of children within the respective weight ranges.

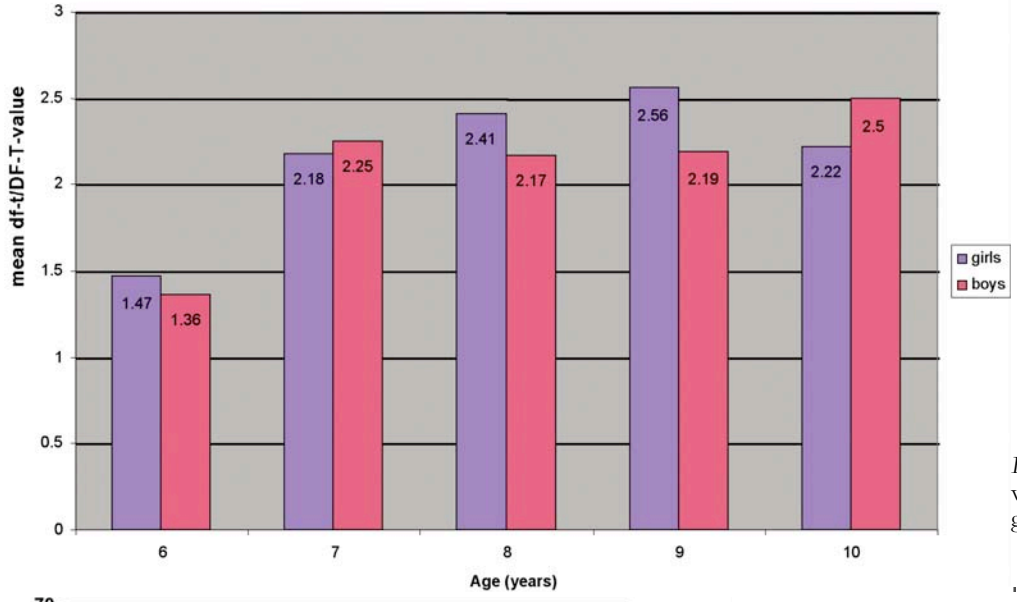

Fig. 2. Mean df-t/DF-T-values according to age groups (n = 2071).

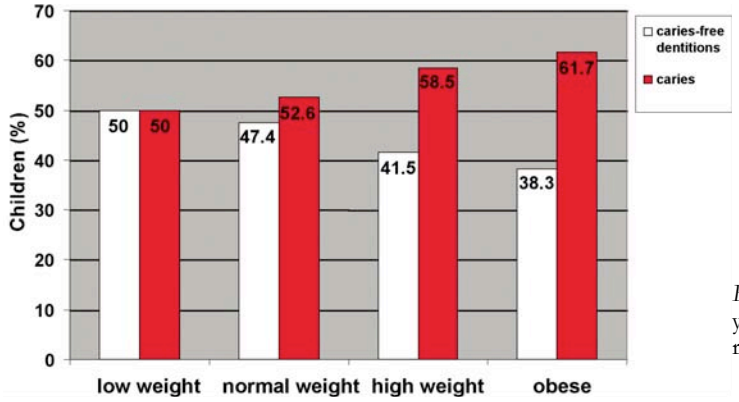

Fig. 3. Percentage of caries-free dentitions in 6- to 10-year old primary school pupils according to weight ranges (n = 2071).

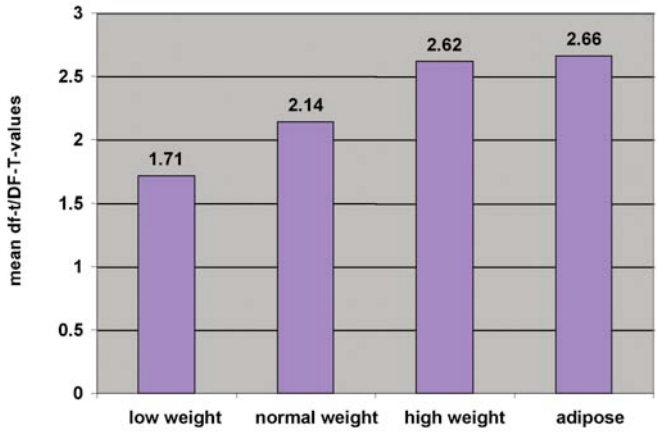

Fig. 4. Mean df-t/DF-T-values according to weight ranges.

underweight children to those with normal weight or overweight up to those suffering from obesity ($p = 0.0021$). Underweight children (n = 140) had a mean df-t + DF-T value of 1.67, those with normal weight (n = 1582) had a value of 2.15, overweight children (n = 218) had an average value of 2.64, and obese elementary school children (n = 131) had a mean value of 2.7 (Fig.4).

Discussion

It has been documented that the frequent and excessive consumption of fast food products carries a host of risk factors for the general health such as obesity, diabetes mellitus or cardiovascular diseases. The frequent consumption of food high in energy density e.g. fast food, can lead to a significant increase in the daily intake of energy and fat. A proven scientific fact for the risk of obesity and overweight is presently only available for an exercise-free life style as well as an increased intake of foods with a high energy density [13]. A low social status and income, parents that are overweight, life style and genetic dispositions are further discussed to be possible risk factors [6, 12]. When comparing the results of studies that determined the prevalence of obesity in children based on the reference system of the AGA with the results of the present study, one is able to determine comparable values for the elementary school children.

In a study by Böhm et al. [3] from the Region of Brandenburg (n = 10612), 9.5 % of the boys aged 6-7 years and 12.4 % of the girls were overweight. 5.2 % of the boys and 5.6 % of the girls were declared as obese. The values that were established in Mainz are in concordance to those found in Brandenburg. In the 6- to 7- year olds, between 8 and 9.3% of the boys and 10 to 12.1 % of the girls were overweight. About 6.1 % of the 6- to 7-year-old boys and about 5.1 % of the girls were obese. In a further study with 842 elementary school children, we found that 12.9 % of the pupils were overweight and 13.2 % were obese [16].

In 2003, Ziroli and Döring [17] found that of 1427 children, aged 6-13 years living in Berlin, 8.7 % were overweight and 5.3 % were obese. In the present study, the percentages of children in these groups were slightly higher; 10.5 % of the 2071 elementary school children were overweight and 6.3 % were obese. The low values for overweight and obese children observed by Ziroli and Döring [17], might result from the fact that more than half of the investigated children (n = 824; 58 %) had attended classes with a special emphasis on physical education. These children had, in contrast to the other children, one hour of physical education per day. When comparing the prevalence values for overweight and obesity of the 6- to 13-year-old children in Berlin (n = 603) which had merely 3 hours of physical education per week, it becomes evident that these values are slightly higher than the ones determined in the present study. 10.8 % of the children attending classes that did not put a special focus on physical education were overweight and 7 % were obese. The majority of children investigated in Mainz had an average of 2 to 3 hours of physical education per week. Ziroli und Döring [17] were able to state significant differences between children attending sport- instead of non-sport-oriented classes. Only 11.4 % of the children attending classes that put a special focus on sport were overweight or obese, while their peers attending non-sport-oriented classes proved to have significantly higher values (17.8 %). The study by Ziroli and Döring [17] was able to state impressively the predominant role of physical activity as a means of weight control.

In August 2005, the latest results of the fourth German-wide DAJ-study on the oral health of children and adolescents was presented in Berlin [14]. In the year 2004, the mean dmf-t values of the 6- to 7-year-old children were between 11.6 (Baden-Württemberg) and 2.9 (Sachsen-Anhalt). The mean dmf-t value for the entire country in this age group was 2.16 in January 2004 as opposed to 2.21 in 2000 and 2.89 in the years 1994/1995. These results show a German-wide decrease of 25 % in carious prevalence within the last 10 years. The percentage of caries-free children in this age group for the years 2004 varies between 34.9 and 59.6 % in the different counties. In our study, the mean df-t + DF-T values of the elementary school children in Mainz were 1.4 for the 6-year olds and 2.2 for the children that were 7 years old. This results in a mean df-t + DF-T value of 1.8 for the 6-7 years old. In the present study, the number of missing teeth was not recorded.

Chen et al. [4] investigated the correlation between obesity and oral heath in a total of 5133 Chinese children at the age of 3 years. However, no significant correlation between BMI and the df-t values could be found. It seems to be important that caries induced by the consumption of cariogenic foods has a greater impact in the 6- to 10-year olds. It is possible that an increased prevalence in overweight and obese children becomes manifest at a later age. In very young children with high caries risk, the phenomenon of baby bottle caries might be a further reason why Chen et al. [4] could not establish a correlation between the BMI and the caries prevalence in the 3-year olds. Pain during the intake of food may also lead to a decrease in body weight. Whelton et al. [15] found also no correlation between BMI and caries prevalence. In the study they conducted in Ireland in the years 2001 and 2002, the statistical data on carious lesions from 12- (n = 3823) and 15-year-old children (n = 3458) were evaluated. In order to classify these children, Whelton et al. [15] preferred the recommendation of the WHO of adults to the percentile classification of Kromeyer-Hauschild [10]. As these two classification systems used different BMI values for the distinction into weight groups, the results for Ireland cannot be directly compared with those from Mainz. Both the obese and the normal or underweight 12-year olds in Ireland had a mean DMF-T value of 1.2. In Mainz, the average df-t + DF-T value for the 10-year olds was 2.35. The low values in Whelton et al. [15] and the values from Mainz that seem tremendously high at first glance result from various factors. Whelton et al. [15] regarded carious lesions only when cavitations were present. In the present study, subsurface lesions were also recorded. The main reason for the high values of df-t + DF-T results from the fact that the first dentition was considered in

the calculation.

The present study showed a significant correlation between dental health and obesity, and underlines the challenge that is imposed on preventive programs. In future preventive programs, the importance of nutrition should not only be considered with regard to general but also to dental health. Besides nutrition, the lack of physical activities seems to be one of the main reasons for the increase in the number overweight and obese children. Therefore, preventive programs especially in schools are necessary in order to avoid a further increase in these figures.

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