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# Dental Caries Level and Sugar Consumption in 12-Year-Old Children from Poland

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**A** – research concept and design; **B** – collection and/or assembly of data; **C** – data analysis and interpretation; **D** – writing the article; **E** – critical revision of the article; **F** – final approval of article

## Abstract

**Background.** The frequent and high consumption of sugar products, particularly sucrose, is one of the causative factors of dental caries. Meta-analyses assessing the relationship between sugar intake and dental caries revealed that a restricted sugar intake to less than 10% of the daily energy intake results in substantial health benefits. Sugar consumption in Poland is 2-fold higher than recommended by the WHO. As change in dietary habits is slow, knowledge of whether a gradual reduction of sugar consumption influences beneficially the dental condition is important.

**Objectives.** Assessment of the relationship between caries experience and sugar consumption in 12-year-old children.

**Material and Methods.** The data obtained from the Statistical Agricultural Yearbooks of the Central Statistical Office in Poland regarding the average yearly sugar intake by a person in the years 1995–2013, and caries prevalence (frequency and DMFT) resulting from the national epidemiological studies of the 12-year-old children conducted by the Ministry of Health in those years were analyzed. The data was analyzed by linear regression. Regression function parameters and coefficients of determination were assessed for a possible link between sugar consumption and dental caries frequency and severity was expressed as DMFT value.

**Results.** The mean yearly sugar intake by a statistical Pole ranged from 43.6 kg (2002) to 35.3 kg (2006). Despite a slight trend to lower the sugar consumption, its mean intake in 1995 and 2013 was the same (41.9 kg). Caries frequency and DMFT decreased in 2012 compared to 1995 from 90.5% to 79.6% and from 4.3 to 3.53 kg in 2012, respectively. The increased sugar intake by 1 kg/year caused the increase of caries frequency by 1% and DMFT value by 0.2.

**Conclusions.** Even a relatively low decrease in sugar consumption can exert some beneficial influence on the dental condition in adolescents, particularly upon the severity of caries (**Adv Clin Exp Med 2016, 25, 3, 545–550**).

**Key words:** dental caries, sugar consumption, children, tracheotomy in children.

At present, the negative effect of frequent and excessive intake of fermentable carbohydrates, particularly mono- and disaccharides, upon the human health, is beyond any doubt [1–6]. Carbohydrates are not only responsible for dental caries, but also for obesity and metabolic syndrome. The intake of sugar – sucrose (table sugar), is determined in kg/person/year or expressed as a percentage of the energy provided daily for the body (%E), calculated for sucrose (4 kcal/g). It has been assumed that the average daily energy requirement is ca. 2,000 kcal. According to the current WHO guideline, sugar intake should be restricted to the amount providing less than 10% of the daily energy requirement, i.e., below 20 kg of sugar per year. The focus is also directed to the fact that the energy restriction to below 5% provides additional health benefits [4–6]. However, the mean sugar consumption in the EU countries is high at 39.0 kg/person/year, and in Poland, it is high at 42.5 kg/year (2012 data) [7, 8]. Unfortunately, Poland is listed among the countries with a high percentage of the popu-

lation affected by dental caries and also by overweight or obesity. According to the WHO criteria at the age of 11–12 years 13.8% of subjects are overweight and 14.7% obese, but less at the age of 17–18, 7.8% and 5.0%, respectively [9].

Many studies have provided evidence for the role of sugar consumption in the development of dental caries. This has been proved both in epidemiological and interventional studies. A significant increase in caries incidence has been noted in isolated populations with a traditional lifestyle, following the introduction of sugar and other fermentable carbohydrates into their diet. An example of this trend was observed among the Inuits in Alaska, and the inhabitants on the Tristan da Cuhna, Atlantic rocky island [10, 11]. Contrarily, dental caries reduction was observed directly during and shortly after the war due to decreased sugar consumption, and its rise was noted when sugar was available and its consumption increased [12]. A low caries experience occurs in patients with congenital fructose intolerance, who, due to a lack of aldolase B, must exclude fructose and sucrose from their diet [13]. The Hopewood House study in Australia conducted in the years 1948–1953 showed that in the orphanage children receiving a lacto-vegetarian diet (refined sugar and other refined carbohydrates were excluded from the diet), the caries experience was very low despite their poor oral hygiene. However, on leaving the orphanage and starting the normal diet containing various types of sugars, they developed caries of a similar level as the total population [14]. In the interventional study conducted in Vipelholm, Sweden, for over 15 years (1945–1953), patients in a mental hospital received various carbohydrate products according to different schemes. The results of the study showed, among other things, the relationship between dental caries and the frequency, retention and consistency of consumed carbohydrates [15]. Another interventional study was performed in Turku (Turku Sugar Study, 1972–1974) based on almost the total replacement of sucrose in the adult diet by xylitol or fructose. Two years later, no increase in dental caries was noted in the xylitol group whereas the DMFS value had increased by 7.2 in the sucrose group and by 3.8 in the fructose group [16]. Nutritional errors concerning excessive sugar intake, frequent consumption of sweet snacks and sugar-sweetened beverages are widespread among children and adolescents. According to the WHO report on health behavior in school-aged children (HBSC study), which originated from 2009/2010 survey [17], sugar-sweetened drinks were consumed daily by 18%, 23% and 25% of young subjects at the age of 11, 13 and 15 years, respectively. In Poland, the respective daily figures were: 21% of girls and 28% of boys at the age of 11 years, 23% of girls and 31% of boys at the age of 13 years, 23% of girls and 31% of boys at the age of 15 years. Simultaneously, oral hygienic habits of the young Polish population were similar to those in other countries. Toothbrushing was carried out more than once daily by 64%, 64% and 65% teenagers at 11, 13 and 15 years of age in the countries subject to providing questionnaires. In Poland, the respective figures were 69% of girls and 58% of boys at the age of 11 years, 73% of girls and 53% of boys aged 13 years, 85% of girls and 59% of boys at the age of 15 years [17].

The relationship between dental caries and sugar consumption seems to be most evident in young population. Sugar intake reduced to the recommended level and a change in nutritional habits would most probably be of an advantage to the dental condition in the Polish population. It is, however, an evolutionary process demanding education in oral health and motivation to a change in the lifestyle. The argument based on the scientific evidence might be that any restriction to limit sugar intake will positively affect the dental health condition.

The aim of the paper is to assess the relationship between dental caries incidence and general consumption of sugar in 12-year-old children.

## Material and Methods

The study material consisted of the data published in the Statistical Yearbooks of Agriculture of the Central Statistical Office in Poland over the years 1995–2013, and the results of the national epidemiological studies conducted by the Ministry of Health within the department project in 1995, and in frame of the oral health care monitoring surveys of index age groups in 1997–2012 [18–26]. The analysis included these epidemiological studies, which fulfilled the WHO criteria for the national pathfinder survey within the country (the number of provinces, urban and rural regions), had representative character of the study group (the stratified sampling), and were carried out by trained and calibrated examiners. The data regarding caries frequency and DMFT values (i.e. number of decayed, missing and filled teeth) for 12-year-old children as well as the number of the examined subjects were obtained from the surveys carried out in 1995, 1997, 1999, 2000, 2001, 2002, 2003, 2005, 2007, 2010 and 2012. However, it turned out that the study performed in 2002 did not completely fulfill the WHO criteria of the national survey due to the number of the involved provinces and, therefore, it was excluded from the

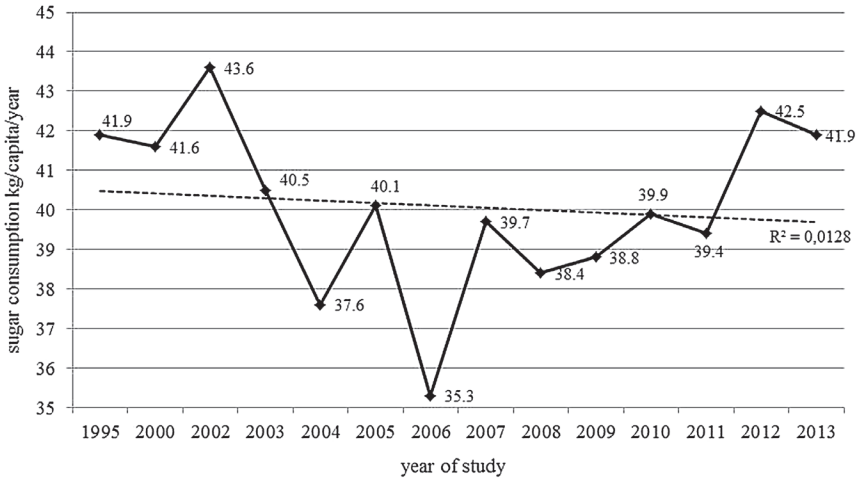


**Fig. 1.** Yearly sugar consumption per person in Poland (1995–2013)

analysis. The Statistical Yearbooks of Agriculture were used to collect the data on the mean yearly sugar intake per capita in the years 1995–2013 [8].

The collected data was analyzed statistically using a linear regression. Regression function parameters and coefficients of determination were assessed for the dependence between the sugar consumption and dental caries frequency and DMFT values at the significance level of $p < 0.05$.

## Results

Some fluctuations in the mean sugar consumption per year by an average Polish citizen were observed (Fig. 1). The difference between the highest (2000) and lowest (2006) sugar intake was 8.3 kg. In spite of some trend to decrease the sugar intake, its mean consumption in 1995 and 2013 was found to be identical. The dental caries parameters also indicated some uneven decreasing trends, as the highest caries frequency (90.5%) and DMFT value (4.3) were in 1995 and the lowest frequency in 2012 (79.6%) and DMFT in 2007 (3.07) (Table 1). However, the analysis of sugar consumption per capita per year and the caries parameters revealed that the lowest values of DMFT in 2005 and 2007 were accompanied by evidently decreased sugar consumption in the previous years.

The statistical analysis confirmed the association between a decreasing yearly sugar intake with a decreasing percentage of caries-affected 12-year-olds and a decreasing DMFT value (Fig. 2, 3). The regression analysis showed that an increase in sugar intake by 1 kg per year resulted in an in-

**Table. 1.** Caries frequency and severity

| Study year | No. of subjects | Caries frequency (%) | DMFT value |
|---|---|---|---|
| 1995 | 1859 | 90.5 | 4.3 |
| 1999 | 3060 | 88.9 | 4.0 |
| 2000 | 3391 | 87.9 | 3.8 |
| 2001 | 919 | 89.1 | 3.8 |
| 2003 | 3338 | 87.1 | 3.9 |
| 2005 | 2435 | 83.6 | 3.3 |
| 2007 | 2337 | 80.7 | 3.07 |
| 2010 | 2782 | 82.7 | 3.5 |
| 2012 | 1868 | 79.6 | 3.53 |

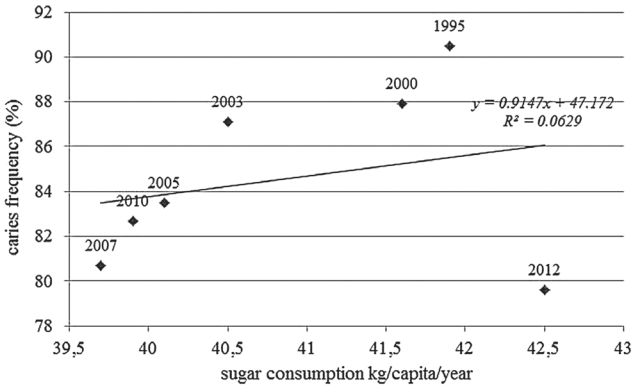


**Fig. 2.** Caries frequency and sugar consumption

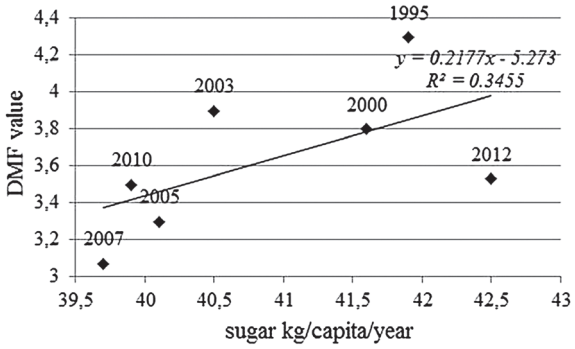


**Fig. 3.** Caries severity and sugar consumption

crease in caries frequency by almost 1% (0.915%) and DMFT value by over 0.2 (0.218). Therefore, coefficients of determination ($R^2$) indicated a higher influence of the sugar intake on the caries severity rather than the caries frequency.

## Discussion

The 12-year-old children are an especially important age group of population, as at this age all permanent teeth except the third molars will have erupted and they are easily available for dental examination by the primary school system. Therefore, the age of 12 years has been selected as the indicator age for global comparison. Sreebny [1] found, on the basis of data obtained from the World Health Organization's Global Oral Epidemiology Bank for 12-year olds and sugar supplies from Food Balance Sheet data prepared by the Food and Agriculture Organization of the United Nations for 47 countries, a significant positive correlation between the per capita availability of sugar and dental caries. He found that 52% of changes in the caries experience could be explained by the amount of sugar per one inhabitant. He also suggested that a 50 g daily sugar intake (ca. 18 kg/person/year) may be a "safe" or an "accepted" consumption limit. Miyazaki and Morimoto [27] reported a positive correlation ($p < 0.01$) between sugar availability and the DMFT value in 12-year-old children in Japan in the years 1957–1987 explaining it by an increase of sugar consumption after World War II. Analyzing the data on caries experience in 12-year-old children and sugar consumption in 90 countries, Woodward and Walker [2] noted an increasing trend in DMFT with a simultaneously rising sugar intake. They suggested that sugar availability was responsible for a 28% change in the caries level. However, a separate data analysis for 29 industrial countries did not show any correlation which suggested a contribution of other variables, for example the frequency of sugar consumption and exposure to fluorides. It has been found also that DMFT value < 3 in 12-year-old children was in 88% of countries in which the sugar availability was below 50 g/day and only in 50% of those with consumption above this level. However, in 78% of countries with a low sugar availability (< 10 kg/capita/year) the DMFT was < 2. According to Sheiham [28] widespread delivery of fluorides to the oral cavity was able to increase the resistance of teeth to sugar, and the acceptable level of sugars could increase to about 15 kg/person/year (i.e. 7.5%E). Our data also revealed a relationship between sugar consumption and caries experience as the rise of sugar intake by 1 kilogram/year caused an increase of caries frequency by 1%, and DMFT value by 0.2. However, the sugar intake in Poland is high, ranging from 35.3 to 42.5 kg/capita/year, i.e. 17.6 to 21.2%E.

The national statistics present data for sucrose availability; however, they do not take into account the sugar contained in dried fruits as well as other "non-milk extrisic sugars" having also cariogenic potential (maltose, glucose, fructose, gelatitized starch). Moreover, the calculated intake does not refer to the frequency of sugar intake during the day, which is an important factor in dental caries development. Nevertheless, even a rough assessment of sugar intake per capita per year like this provides valuable information on sugar consumption being one of the main causative factors of dental caries. Dental caries is an age-related, multifactorial and life-lasting disease existing in the whole population with varied severity; however, its initial stages can be stopped or may be reversible before the onset of decay formation (i.e. loss of hard dental tissues). In Poland, despite positive changes in oral hygiene habits and more widespread use of fluoride toothpastes, caries experience has shown a negligible decrease, and remains a major public health problem. In 1995, dental caries was diagnosed in 90.5% of 12-year olds, and the 2012 figure was 79.6%. The DMFT value in this age group slightly diminished, i.e. ca. 18% (from 4.3 in 1995 to 3.53 in 2012). Dental caries has been diagnosed in 57.2% of 3-year-old children; its frequency has increased up to 96.1% in the group of 18-year olds, and up to 99.9% in the population of 35–44 year-old subjects. The number of caries-affected permanent teeth (DMFT value) showed an increase from 0.15 in 6-year olds, 0.56 in 7-year olds, up to 3.53 in 12-year olds, 6.1 in 15-year olds, 8.0 in 18-year olds, 16.9 in persons at the age 35–44, and up to 29.0 in the age group of 65–74 years. The most dynamic progress in caries severity has been noted in the subjects between 12 and 18 years of age. Over only a mere six year period, DMFT value has increased twofold. Within ca. 25 years course life (i.e. from 12 to 35–44) the number of caries-affected teeth has increased over four times, and within ca. 50 years, its growth has proved to be over eight times as high (i.e. from 12 to 65–74) [18–26]. Traditionally, dental caries are considered to be a childhood disease developing dynamically in children and adolescents; however, the highest caries burden is found in adults, which is significant from the public health perspective. According to Sheiham and James [3], dental caries could develop both in resistant and susceptible children when the sugar intake is only 2% of energy, provided that the teeth are exposed to sugar in those over three years of age.

It is worth noting that exposure to high sugar consumption in the study groups of 12-year-olds lasted for many years. With the present average sugar consumption of ca. 40 kg per year, its decrease to 5%E or even below 10%E over a short period of time is a rather impossible condition. According to the data published by the Public Opinion Research Centre in 2010 [29], 69% of Poles from a randomly selected group of 1035 subjects, declared having a healthy diet, and 7% even a highly healthy diet. This conviction has not changed since 1998. The self-assessment, however, does not reflect the real nutritional habits. Sweets are consumed daily by 24% of the adult population, and 3% consume sweets three times daily. In another questionnaire study, the parents of children aged 6–12 years reported that their children consume at least two snacks between meals, and over 45%, even three extra snacks daily available at school shops, i.e. mainly juices and sweets [30]. Emphasizing the positive effect of a gradual reduction of sugar consumption seems to be a motivating factor to change the traditional dietary habits.

Even a relatively low level of sugar restriction can have a positive impact on the dental health in adolescents diminishing dental caries severity.

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