PREVALENCE OF DENTAL CARIES AND THE INFLUENCE OF SOCIO-DEMOGRAPHIC FACTORS ON ORAL HEALTH OF SCHOOL CHILDREN

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ABSTRACT

Introduction/Aim. Oral health is a key segment of general human health. The main goal of the research was to establish the prevalence of dental caries in children aged 12-15 years, as well as to determine possible risk factors contributing to the current state of oral health of this age children. Methods. A study was conducted in the year 2023 involving 381 children aged 12-15 from Sarajevo. Clinical examinations were conducted to identify the number of carious, extracted teeth and teeth with fillings and to determine the value of the DMFT index (decayed, missing, and teeth with fillings). Socio-demographic data were collected via survey questionnaires filled out by all respondents. Results. The mean DMFT index was 4.12 ± 3.361, while the Significant caries index (SiC) was 7.93. Filling comprised the largest proportion of the DMFT index at 52.3%, followed by teeth with dental caries (41.9%). Among the participants, 211 (55.4%) were caries-free. Conclusion. The values of the parameter used to assess the state of oral health indicate poor oral health of children aged 12-15 years. Age, gender, mother's level of education and the area of residence of the subject emerged as significant predictors of the DMFT index. The increased proportion of teeth with fillings indicates moderate awareness of oral health importance. It is necessary to motivate school children about the importance of oral health while developing preventive programs that are key to improving oral health.

Key words: oral health, dental caries, DMFT index, SiC index

Introduction

Impaired oral health represents a significant public health concern, considering its potential to cause major consequences and impact to overall well-being. Oral diseases represent the most widespread diseases on a global level. According to its incidence, oral diseases are just behind the diseases of the upper respiratory tract and diarrheal syndromes within the 3rd category of diseases on the Global Burden of Diseases list for 2019 (GBD). According to the prevalence, untreated dental caries of permanent teeth in school children stands out as the predominant disease of the 4th category of the Global Burden of Diseases list [1,2,3]. The onset of oral diseases in childhood, especially dental caries, can result in tooth loss, impair the chewing condition and function and increase the risk of chronic non-communicable diseases over the lifespan [4,5]. More developed European countries have recorded a decrease in the prevalence of caries among the population in recent years, while the situation remains unsatisfactory in Eastern European countries, including Bosnia and Herzegovina [6].

The influence of socio-demographic factors on the occurrence and progression of dental caries in children is particularly interesting [7]. This research has indicated that children living in rural areas often exhibit a higher prevalence of dental caries compared to their peers from urban areas [8]. It has also been established that the level of parents' education represents an important factor in children's oral health, where children whose parents possess a higher level of education demonstrate a lower incidence of dental caries [9]. While gender does not appear to be an important factor influencing the occurrence of dental caries according to some research, it has been established that the DMFT index tends to increase with age [8,10]. The socio-economic status of the family influences the prevalence of dental caries in a such manner that children from families with a higher socio-economic status show a lower prevalence of dental caries [11].

In the past decade, research focusing on the assessment and analysis of oral health parameters among school-aged children in Bosnia and Herzegovina has been scarce, resulting in a lack of data on children 's oral health, hindering the development of suitable approaches to enhance the status of oral health [12,13,14]. In this regard, this research aims to determine the prevalence of dental caries among school-aged children and define possible risk factors influencing the current state of oral health of children of this age.

Methods

The research was conducted as an epidemiological, observational study involving school-aged children in the Sarajevo Canton. Approval for the study was obtained from the Public Health Centre and the Centre for Education and Scientific Research (01-06-33-2-3237-2/23). A total of 381 school-age children (184 boys and 197 girls, average age 13.34 ± 1.073) were included in the study. The Scalex SP calculator was used to determine the required sample size, using an assumed prevalence of dental caries in school-aged children of 55%, a margin of error of 5% (0.05), and a level of confidence of 95% [15,16,17]. Throughout the study, adherence to the principles of good scientific and professional practice and compliance with the Declaration of Helsinki was maintained. Parents or guardians of children were informed about the nature of the research, data collection procedure and other aspects of the study through informative materials. Only children whose parents or guardians provided written consent to use the personal data for research purposes were included in the study process.

All subjects underwent dental examinations in the dental practice of the Public Health Centre, following the criteria set by the World Health Organization (WHO) for epidemiological research in oral health. The procedures were conducted using artificial lighting, a flat dental mirror and the WHO periodontal probe (CPI) [18]. Clinical examinations of all subjects were carried out by a single dentist (the author of the paper). The objective was to determine the values of the parameter used to assess oral health, namely the DMFT index. According to WHO methodology, the DMFT index represents the average sum of carious, extracted and filled teeth. Additionally, based on the DMFT index, the Significant Caries Index (SiC index) was calculated. The SiC index reflects the average DMFT index value among one-third of the subjects with the highest

DMFT index values [18]. To ensure the reliability of the researcher, the *kappa* statistic was applied. The reliability of the researcher was tested on 10% of the total sample to obtain high inter-observer reliability in diagnosing dental caries. In addition to the dental examination, all children were surveyed using a specially designed questionnaire conducted in the form of an interview. [18]

This questionnaire was recommended by the WHO for research purposes and contains questions to obtain the data on socio-demographic characteristics of the children [18].

The data obtained from this research were analyzed using SPSS PASW Statistics program 18.0, as well as STATA for Windows. The results were further analyzed using descriptive statistical analysis, Kruskal Wallis, Mann-Whitney U test, regression models and binary logistics regression. A significance level of $p<0.05$ was considered statistically significant. Considering the sample size, the Kolmogorov-Smirnov test was used to test the normality of the distribution of variables.

Results

The sample involved 381 school children, aged 12-15, consisting of 184 boys and 197 girls. The average age of the children of the observed children was 13.34 ± 1.073 (median=13, range=12-15). The socio-demographic characteristics of the participants are detailed in Table 1. The presence of dental caries was observed in 44.6% of respondents. Based on the analysis, the mean DMFT index was 4.12 ± 3.361, while the value of the SiC index was 7.93. Fillings constituted the largest proportion of the DMFT index (52.3%) followed by decayed teeth (41.9%), and extracted teeth (5.8%) (Table 2).

Kruskal-Wallis and Mann-Whitney U tests revealed statistically significant differences in the values of the DMFT index across the following socio-demographic characteristics: area of residence, father's level of education, mother's level of education and mother's employment status.

A statistically significant difference was observed in the value of the DMFT index among respondents from urban (2.94 ± 2.809), peri-urban (4.88 ± 3.556) and rural areas (6.00 ± 3.260).

When it comes to parents' education levels, a statistically significant difference in DMFT index value was registered between respondents with parents holding secondary education qualifications (father=4.80 ± 3.430, mother=5.38 ± 3.252) and those children whose parents had higher education qualifications (father =2.41 ± 2.541, mother=2.26 ± 2.406).

Characteristics	Respondents n (%)
Gender	
Male	184 (48.3%)
Female	197 (51.7%)
Area of residence	
Urban area	202 (53.0%)
Peri-urban area	89 (23.4%)
Rural area	90 (23.6%)
Father's education level	
Elementary school	1 (0.3%)
High school	260 (68.2%)
Associate degree or higher vocational school	2 (0.5%)
University	114 (29.9%)
Without a male person in the household	4 (1.0%)
Mother's education level	
Elementary school	6 (1.6%)
High school	211 (55.4%)
Associate degree or higher vocational school	2 (0.5%)
University	160 (42,0%)
Without a female person in the household	2 (0.5%)
Father's employment status	
Employed	371 (97.4%)
Unemployed	6 (1.6%)
Without father	4 (1.0%)
Mother's employment status	
Employed	313 (82.2%)
Unemployed	66 (17.3%)
Without mother	2 (0.5%)

Table 1
Socio-demographic characteristics of participants in the study

Parameters of DMFT	(%)	$\bar{x}$ ± SD; median (min-max)
Decay	41.9	1.72 ± 2.656; 0 (0 - 20)
Extracted teeth	5.8	0.23 ± 0.763; 0 (0-5)
Teeth with fillings	52.3	2.15 ± 2.344; 2 (0-10)
DMFT	100	4.12 ± 3.361; 4 (0-20)
$\bar{x}$- mean value, SD – standard deviation		

Table 2
Teeth with decay, extracted, and teeth with fillings, DMFT value

Variables	DMFT index $\bar{x}$ ± SD; median (min-max)	Significance (p)
Gender		
Male	3.74 ± 3.084; 4 (0 – 16)	[a]0.056
Female	4.47 ± 3.573; 4 (0 – 20)	
Area of residence		
Urban area	2.94 ± 2.809; 2 (0 – 12)	
Peri-urban area	4.88 ± 3.556; 4 (0 – 16)	[b]0.000*
Rural area	6.00 ± 3.260; 5.5 (0 – 20)	
Father's education level		
Elementary school	6.00; 6 (6)	
High school	4.80 ± 3.430; 4 (0 – 20)	
Associate degree or higher vocational school	4.00 ± 0.0; 4 (4-4)	[b]0.000*
University	2.41 ± 2.541; 2 (0 – 12)	
Without a male person in the household	7.75 ± 1.251; 8 (6-9)	
Mother's education level		
Elementary school	7.16 ± 5.076; 7.5 (0 – 14)	
High school	5.38 ± 3.252; 4 (0 – 20)	[b]0.000*
Associate degree or higher vocational school	4.50 ± 0.707; 4.5 (4 – 5)	
University	2.26 ± 2.406; 2 (0 – 12)	
Without a female person in the household	10.00 ± 2.828; 10 (8 12)	
Father's employment status		
Employed	4.08 ± 3.363; 4 (0 – 20)	
Unemployed	3.83 ± 3.188; 3.5 (0 – 8)	[a]0.889
Mother's employment status		
Employed	3.79 ± 3.260; 4 (0 – 20)	[a]0.000*
Unemployed	5.50 ± 3.333; 4 (0 – 16)	

*statistically significant; a Mann-Whitney U test, b Kruskal Wallis, $\bar{x}$ - mean value; SD – standard deviation

Table 3
DMFT index distribution - children 12-15 years of age

Additionally, a statistically significant difference in the value of the DMFT index was identified between respondents with employed mothers (3.79 ± 3.260) and those with unemployed mothers (5.50 ± 3.333).

No statistically significant difference was observed in the value of the DMFT index regarding gender and the father's employment status (Table 3).

When analyzing the influence of socio-demographic characteristics on the DMFT index, the effects of the respondents' gender and age, area of residence and parents' education and employment were examined. All independent variables of interest, except for age, are of a qualitative type and are incorporated into linear regression models through dummy variables representing initial categories. The result of the Ramsey RESET test (p=0.2058) suggests the correct functional form indicating the relationship between the dependent and independent variables. According to the White test for assessing homoscedasticity (p=0.5347), it is concluded that the model does not exhibit heteroskedasticity. The average variance growth factor is 1.6, indicating that the model does not have the problem of multicollinearity of independent variables.

Based on the conducted diagnostic tests, it can be concluded that the model satisfies all the key assumptions of the multiple regression model. The

Variables	Multiple linear regression		
	+B (95% CI)	SD	Significance (p)
Age	0.555	0.140	0.000*
Gender – male	-0.646	0.258	0.031*
Area of residence – urban	-1.275	0.469	0.007*
Area of residence – periurban	-1.134	0.437	0.010*
Father's education level – university education	-0.387	0.437	0.377
Mother's education level – university education	-2.402	0.477	0.000*
Father's employment status – employed	-0.133	0.948	0.889
Mother's employment status - employed	-0.057	0.429	0.895
*statistically significant; +unstandardized coefficient B; CI – confidence interval; SD – standard deviation			

Table 4
Multiple linear regression for DMFT index

adjusted R-squared value is 0.2622, indicating that 26.22% of the variation in the DMFT index variable can be explained by the variation of the independent variables included in the model.

All predictors included in the model, except for the father's education level and the employment status of both parents exhibit a statistically significant effect on the DMFT index. These predictors serve as risk factors and have a significant impact on oral health indicators.

It was determined that for each additional year of age, the average DMFT index value increases by 0.55. On average, male respondents have a DMFT index 0.6 lower than female respondents. Respondents from urban and peri-urban areas exhibit, on average, DMFT index values of 1.27 and 1.13 lower than respondents from rural areas, respectively. Additionally, respondents whose mothers have attained a higher education level demonstrate, on average, a DMFT index 2.40 lower compared to respondents whose mothers have completed high school (Table 4).

To assess the impact of selected independent variables on the likelihood of respondents falling into the category with the highest DMFT index (SiC) values, a logistic regression model was evaluated.

Based on the likelihood ratio test (p=0.000), it is evident that the evaluated model is statistically significantly superior to the empty model. McFadden's pseudo-R2 is 0.1696. The model specification was examined using the linktest. It is shown that _hat is statistically significant (p=0.000), while _hatsq is not statistically significant (p=0.287), affirming the correct specification of the model. The multicollinearity of the regressor variables was previously confirmed for the multiple linear regression case. The percentage of correct predictions based on the evaluated binary logistic model was also calculated and it is 72.70% for the model as a whole, while the sensitivity of the model is 53.44% and the specificity is 82.80%. With the key assumptions of the logistic regression model being satisfied, the statistical significance of the coefficients in the model was interpreted.

The age of respondents and their mother's education level have a statistically significant effect on the likelihood of ending up in the SiC category of respondents.

Since the value of the coefficients in the evaluated logit model is interpreted as changes in odds ratios, average marginal effects were calculated for greater interpretability.

Based on the obtained marginal effects for statistically significant variables, it is deduced that with each additional year of age, the probability of ending up in the SiC category increases by an average of 6.67%. Moreover, the respondents whose mothers have achieved a high (university degree) level of education have, on average, a 30.22% lower probability of being in the SiC category compared to respondents whose mothers have completed high school at most. Consequently, the odds of ending up

Variable	Binary logistical regression	
	+OR (CI)	Significance (p)
Age	1.449 (1.146-1.832)	0.002*
Gender – male	0.746 (0.462-1.204)	0.230
Area of residence – urban	0.628 (0.315-1.250)	0.185
Area of residence – peri-urban	0.556 (0.296-1.043)	0.067
Father's education level – university education	0.555 (0.245-1.258)	0.159
Mother's education level – university education	0.187 (0.84-0.413)	0.000*
Father's employment status – employed	0.542 (0.135-2.176)	0.388
Mother's employment status - employed	1.544 (0.842-2.831)	0.160

+Odds ratio (confidence interval) for inclusion in the SiC category per socio-demographic variables;
OR – odds ratio; CI – confidence interval; *statistically significant;

Table 5
Significant caries index

in the SIC category for respondents whose mothers have a secondary education are 5.3619 times higher than for respondents whose mothers have a university education (Table 5.).

Discussion

This research aimed to evaluate oral health by analyzing the DMFT index, SiC index and the prevalence of dental caries, as well as to identify socio-demographic factors with a significant impact on oral health.

The first comprehensive assessment of oral health in Bosnia and Herzegovina was conducted in 1987, revealing a DMFT index of 6.50 among twelve-year-old and 9.70 in fifteen-year-olds. In subsequent research conducted a year later, Vrbić reported a DMFT index value of 6.1 in 12-year-olds [19].

In this research, the DMFT index value was 4.12. According to WHO criteria, this value ranges between the moderate and high values of this index [20]. The significant disproportion between the obtained DMFT value and the WHO-recommended value for European countries is concerning, underlining the significance of the issue. Moreover, the WHO has set a goal for the DMFT index in Europe not to exceed 1.5 by the year 2020 [21]. The DMFT index values among the school children across the European Union member countries are often below 2, and in certain countries even below 1 [20,22]. This indicates varying trends in oral health and underscores the possibility for improvement for regions with higher DMTF index values. However, the recorded DMFT index value aligns with the earlier research, which has classified the Eastern European region as having a high risk, based on DMFT index values, with an average index value of 4.1 [22,23].

However, the determined DMFT index value demonstrates a moderate decrease compared to previous research conducted in Bosnia and Herzegovina. According to the latest studies, the DMFT index among school children was 7.18, whereas earlier research in 2013 indicated a DMFT index of 4.2 for twelve-year-old and 7.6 for fifteen-year-olds [24,25]. Another study conducted in Bosnia and Herzegovina in 2014 reported a DMFT index value of 4.16 for twelve-year-olds [14].

Contrary to previous research conducted in Bosnia and Herzegovina and the region, it was established that teeth with fillings have a majority share in the DMFT index [14,25,26]. The relatively high representation of teeth with fillings (52.3%) in

the DMFT index suggests a likelihood of moderate motivation among the subjects and a somewhat developed sense of oral health preservation. Additionally, it could also indicate the presence of an efficient healthcare system.

As anticipated, the determined value of the SiC index is significantly higher than the DMFT index. It has been observed that there is a subset of subjects in the sample with a DMFT index value notably greater than the average value of the DMFT index of the entire sample. Considering the global objective to achieve a SiC index value of 3.0 by the end of 2015., the obtained SiC index from this study (7.93) indicated unfavorable trends at the local level [27]. This value resembles the SiC index value obtained from national research on oral health in twelve-year-olds in Bosnia and Herzegovina [28], showing a substantial portion of the population with higher DMFT index values than the average.

The prevalence of dental caries in school children in this research was 44.6%, indicating a decrease compared to similar studies conducted earlier in Bosnia and Herzegovina [24, 28]. This value is slightly lower than the prevalence of dental caries in school children being around 52% in nine European countries [29], and lower than the prevalence of dental caries in school–aged children at a global level (53.8%), as reported in a conducted meta-analysis [30].

A significant aspect of this research focused on identifying the predictors or risk factors for a higher DMFT index in school children. This research has established that the age of the subjects has an impact on the DMFT index being consistent to the findings from research conducted by Moca et al. [10]. Likewise, the educational level of the mother emerged as a significant predictor of the DMFT value in school children. Similar observations were reported by Nebhwani, who found out that a higher level of education of the mothers correlates with increased awareness of the importance of oral health corresponding to the results obtained by Kamiab et al.[31,32].

Throughout the research, it has been determined that the subjects living in an urban environment have significantly lower DMFT values, compared to the subjects from peri-urban and rural environments. These findings are consistent with the conclusions of Perić et al., who determined that the number of carious and extracted teeth increases when moving from an urban to a rural environment [33]. One possible explanation for such an increase in the DMFT index could be connected with the reduced availability of healthcare services in rural areas compared to urban areas, as well as lower levels of awareness of children and their parents on the importance of oral health[9].

Although the mother's employment status has been identified as a significant predictor of dental caries occurrence in previous research, with employment having a negative impact on dental caries prevalence, in this study involving children aged 12-15, the mother's employment status was not identified as a statistically significant predictor of higher DMFT index and dental caries[34].

Conclusion

The results of the research show similar trends in the average DMFT index value compared to studies conducted in the region. However, considering all the research conducted since 1987, a positive shift in this regard was observed, although Bosnia and Herzegovina still lags behind the developed European countries. While many developed countries have recorded significant improvements in children's oral health, Bosnia and Herzegovina still falls short of meeting the objectives of the World Health Organization's "Health 21" strategy for Europe. It was found that socio-demographic factors influence the oral health of school children.

Therefore, it is imperative to initiate a campaign focusing on a curative approach to reduce the population affected by this disease. Simultaneously, preventive measures and activities aimed at raising awareness among both children and their parents about the importance of oral health must be implemented. These efforts are essential for achieving overall, long-term and sustainable improvement of children's oral health.

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