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DYNAMICS, CHANGES AND FACTORS INFLUENCING THE DMFT INDEX IN CHILDREN FROM URBAN AND RURAL AREAS IN THE REPUBLIC OF NORTH MACEDONIA

ДИНАМИКА, ПРОМЕНИ И ФАКТОРИ ШТО ВЛИЈААТ ВРЗ КЕП ИНДЕКСОТ КАЈ ДЕЦА ОД УРБАНИ И РУРАЛНИ СРЕДИНИ ВО РЕПУБЛИКА СЕВЕРНА МАКЕДОНИЈА

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Abstract

Introduction: Oral health in children is an important indicator of their growth, development, and access to health care. The DMFT index allows for an objective assessment of the prevalence and severity of caries, especially when the same group of children is followed over a longer period of time. **Objective:** This study aimed to assess the dynamics of the DMFT index and to determine the factors that influence oral health in children living in urban and rural areas in the Republic of North Macedonia, specifically in the Municipality of Resen. In addition, the impact of the COVID-19 pandemic on access to dental care and the general condition of children's oral health was examined. **Material and method:** The research was conducted as a longitudinal study with a duration of nine years, which included 60 children born in 2009, divided into two subgroups: children from urban areas (30) and children from rural areas (30), followed up at the ages of 7, 10, and 15 years (2016, 2019, and 2025). The examinations were carried out according to the diagnostic criteria for dental caries of the World Health Organization (WHO) from 2013, and the data were statistically processed with the SPSS program, using the t-test and ANOVA tests. **Results:** The average values of the DMFT index showed a continuous increase with age, with children from rural areas having significantly higher values (DMFT = 6.6) compared to children from urban areas (DMFT = 3.9). The analysis showed that the education and employment of parents, especially mothers, have a significant impact on the values of the index. The COVID-19 pandemic has further worsened access to dental services, which has resulted in an increase in untreated caries. **Conclusion:** The results indicate the need for long-term public health measures and targeted prevention programs, with a particular emphasis on rural areas, emphasizing the need to establish sustainable systems for dental prevention even in conditions of health crises. **Keywords:** oral health, DMFT index, dental caries, urban and rural environment, COVID-19.

Апстракт

Вовед: Оралното здравје кај децата е важен индикатор за нивниот раст, развој и пристап до здравствена заштита. КЕП-индексот овозможува објективна проценка на преваленцата и на сериозноста на кариесот, особено кога истата група деца се следи подолг временски период. **Цел:** Целта на ова истражување беше да се процени динамиката на КЕП-индексот и да се утврдат факторите што влијаат врз оралното здравје кај децата што живеат во урбани и во рурални средини во Република Северна Македонија- Општина Ресен. Дополнително, беше испитано влијанието на пандемијата COVID-19 врз пристапот до стоматолошка заштита и врз општата состојба на забите кај децата. **Материјал и метод:** Истражувањето е спроведено како лонгитудинална студија со времетраење од девет години, во која се вклучени 60 деца родени во 2009 година, поделени во две подгрупи: деца од урбани средини (30) и деца од рурални средини (30), следени на возраст од 7, 10 и 15 години (2016, 2019 и 2025 година). Прегледите се спроведени според дијагностичките критериуми за кариес на Светската здравствена организација (СЗО) од 2013 година, а податоците се статистички обработени со програмата SPSS, користејќи го t-тестот и ANOVA анализата. **Резултати:** Просечните вредности на КЕП-индексот покажаа континуирано зголемување со возраста, при што децата од руралните средини имаат значително повисоки вредности (КЕП-6,6) во споредба со децата од урбаните средини (КЕП-3,9). Анализата покажа дека образованието и вработувањето на родителите, особено мајките, имаат значително влијание врз вредностите на индексот. Пандемијата COVID-19 дополнително го влоши пристапот до стоматолошки услуги, што резултираше со зголемување на нетретираниот кариес. **Заклучок:** Резултатите укажуваат на потребата од долгорочни мерки за јавно здравје и насочени превентивни програми, со посебен акцент на руралните средини, нагласувајќи ја потребата од воспоставување одржливи системи за стоматолошка превенција дури и во услови наздравствени кризи. **Клучни зборови:** орално здравје, DMFT-индекс, дентален кариес, урбана рурална средина, COVID-19.

Introduction

Oral health is an important part of every child's physical, psychological, and social well-being. According to the World Health Organization (WHO), oral health is not only the absence of disease of the teeth and soft tissues in the mouth, but also the ability to chew, speak, and socially interact without pain or discomfort[1]. The condition of teeth in early childhood has a long-term impact on nutrition, speech, and quality of life. At the same time, oral health in childhood sets the foundation for oral health in adulthood[2]. Dental caries, as one of the most common chronic diseases, is a significant public health problem in both developed and developing countries. According to the latest global data, over 2.5 billion people have untreated caries. The number of children with untreated caries expressed in percentages ranges between 60–90%, i.e.,almost every child before the age of 12 has at least one decayed tooth[1,3]. The DMFT index, which summarizes the number of carious, extracted, and filled teeth, is a standard epidemiological measure for assessing the state of oral health. Its analysis allows for monitoring trends in the development of caries, as well as the impact of economic, educational, and health factors on caries prevalence. According to GBD (Global Burden of Disease) data, untreated caries in permanent teeth is the most common disease globally, and in children aged 6–12 years, caries in primary teeth affects over 500 million children[3]. Within Europe, a review of data from the European Platform for Better Oral Health indicates significant differences between countries[4]. In Sweden and the Netherlands, the average DMFT index in 12-year-old children is below 1.0, while in Eastern and Southern Europe it ranges between 4–6. These differences are explained primarily by health policies, socio-economic conditions, population education and the implementation of preventive programs. In the Republic of North Macedonia, the latest national survey shows an average DMFT index of 4.7 in 12-year-old children, which places the country in the high-risk zone according to WHO criteria[5]. Research shows that the largest jump in the DMFT index occurs in the period from 11–15 years of age, especially in populations where dental intervention is limited or irregular[6]. In this regard, monitoring the DMFT index over a certain, longer period of time in the same group of children enables an understanding of the dynamics of the occurrence, progression, and treatment of caries, as well as the impact of education, urbanization, and public health policies. According to the study by Skeie et al.[7], the mother's education is the strongest indicator of the dental condition of children aged 5 to 10 years. In addition, unstable employment, low income, and rural location are associated with irregular and insufficient dental services, irregular check-ups, and low rates of dental treatment[8]. The differences between urban and rural areas in terms of dental care are particularly pronounced in countries with uneven health infrastructure. Children in rural areas often face limited access to dental services and a lower level of education among parents. With the emergence of the COVID-19 pandemic, access to dental care has further deteriorated. Fear of infection, limited appointments, and closure of health facilities, as well as the interruption of regular systematic examinations and preventive activities, have led to reduced dental care. The analysis of these factors is necessary to develop targeted interventions and overcome health inequalities. This longitudinal study aimed to show the movement of the incidence of dental caries by determining oral health indicators depending on the environment, socioeconomic status, and parental education, as well as the impact of the COVID-19 pandemic on access to dental services and oral health, especially during the critical period of development of the permanent dentition.

Material and methods

The study was conducted as longitudinal descriptive-analytical research, following the same group of children in three time intervals – at 7, 10, and 15 years of age. The research included a total of 60 children born in 2009, divided into two equal groups according to their place of residence: 30 from urban and 30 from rural areas in the Municipality of Resen. Data for 2016 and 2019 were collected retrospectively from the children's dental records, with the approval of the Health Center – Resen, while in 2025, a clinical examination was performed by two calibrated dentists. For each respondent, carious (K), extracted due to caries (E), and restored (filled/repaired)teeth (P) were recorded, based on which the DMFT index for 2025 was calculated. and DMFT and DMFT indices for 2019 and 2016.

The examinations were performed with a dental mirror and probe, without radiographic examinations, according to WHO standards. In addition, a questionnaire was applied regarding the hygiene habits of the respondents, as well as sociodemographic data on the use of dental services during the COVID-19 pandemic.

The data were statistically processed with the SPSS 25.0 program, using the t-test for comparison of mean values and ANOVA for analysis of variation between groups. The level of statistical significance was set at p=0.05.

Results

Values of the DMFT index by year and environment.

The analysis of data from three time periods (2016, 2019 and 2025) shows that there is a clear trend of a decrease in the value of the DMFT index at an early age (from 7 to 10 years), but at the same time a dramatic increase in DMFT values up to the age of 15 years, especially among children from rural areas.

Among rural children, the DMFT index decreased from 6.1 to 3.6 between 2016 and 2019, which indicates partial success of dental interventions at an early age. However, at the age of 15, the value of the DMFT index increases to 6.6 – the highest in the entire analysis. This indicates that children did not receive adequate continuous dental care during the critical period of eruption of permanent teeth.

In urban areas, the trend is more subtle. The value of the DMFT index decreases from 5.26 (in 2016) to 1.9 (in 2019), while the value of the DMFT index in 2025 reaches 3.9, which is significantly lower than that among children from rural areas. These data confirm that children from urban areas have better access to dental services and better oral health.

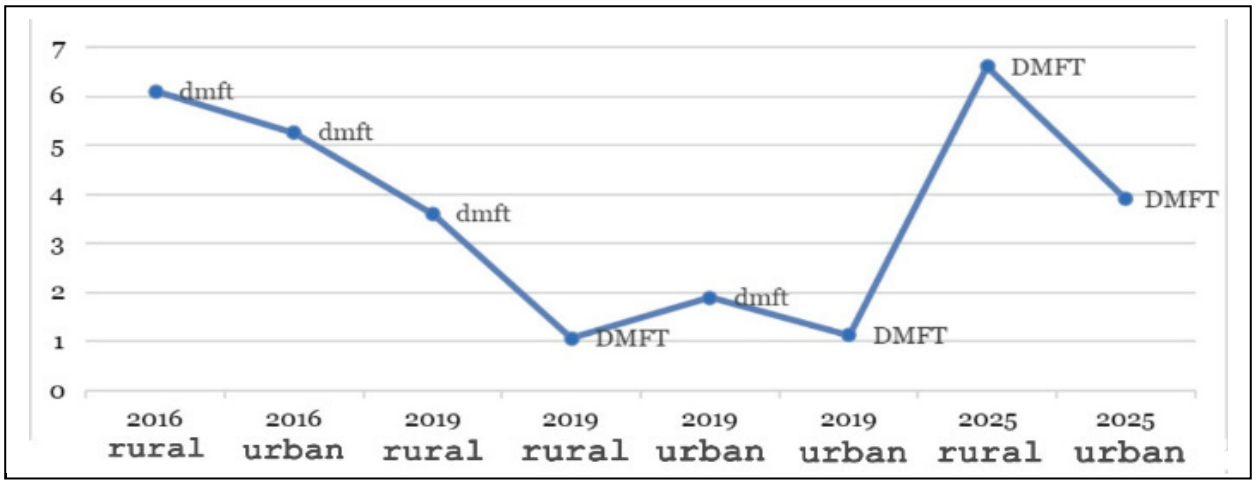
These data confirm that children from urban areas have better access to dental services and better oral health. These differences are graphically displayed in Line Chart 1, which visualizes the progression or regression of the indices in the two subgroups.

The development line for children from rural areas shows a V-shaped pattern – initial improvement, followed by drastic deterioration, while for urban children, the line is more gradual, with a slight increase until 2025.

Table 1. Average values of the DMFT index by age andtype of environment

Year	Environment	Index	Value
2016	rural	dmft	6.1
2016	urban	dmft	5.26
2019	rural	dmft	3.6
2019	rural	DMFT	1.07
2019	urban	dmft	1.9
2019	urban	DMFT	1.13
2025	rural	DMFT	6.6
2525	urban	DMFT	3.9

The results showed a gradual increase in the DMFT index with increasing age in all respondents. The difference between urban and rural children is consistent and statistically significant in all three time intervals.



Graph 1. *Average values of DMFT and DMFT indices in the two analyzed living environments*

Table 2. Percentage of K/k(%), E/e(%), P/p(%) components by age and environment

age	environment	K (%) к (%)	E (%) e (%)	P (%) p (%)
7 (2016)	urban	55.0	5.0	40.0
7 (2016)	rural	70.0	10.0	20.0
10 (2019) DMFT;dmft	urban	45.0	5.0	50.0
10 (2019) DMFT;dmft	rural	65.0	8.0	27.0
15 (2025)	urban	22.0	2.1	75.9
15 (2025)	rural	40.7	8.8	50.5

Table 3. Comparison of the average number of restored teeth (P-component)

environment	total DMFT - index	P-component representation (%)	average number of restored teeth (P)*	statistical significance (p)
urban	3.9	75.9%	2.96	p < 0.05
rural	6.6	50.5%	3.33	

In rural areas, the K-component (untreated caries) dominates with 40.7%, while in urban children, the P-component (fillings) dominates with 75.9%.

Relationship with parents' educational level:

The analysis of the values of the DMFT index depending on the education of the mother and father is shown in Table 4.

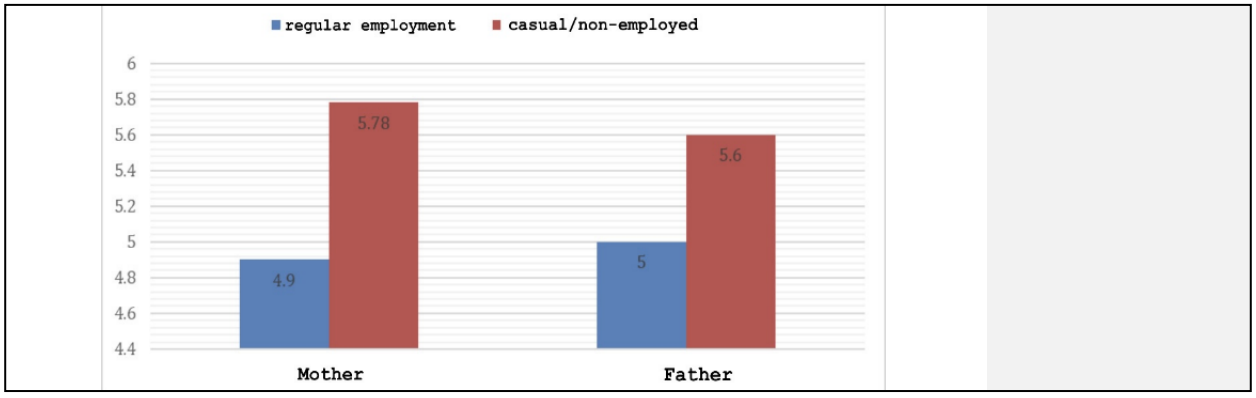
Children whose mothers have secondary education have the lowest average value of the index (4.71), while those whose mothers have higher education have a higher index value (6.46), with a predominance of the P-component. At the same time, among parents with primary education, the index is also high (5.63), but in this case, most of the value comes from the K and E components. This indicates that, although the average value may be similar, the nature of the problem is different – untreated caries in some, and more restorative treatments in others.

Relationship with parents' employment

The results showed that children whose mothers are in regular employment have a lower value of the DMFT index (4.9) compared to those whose mothers are in part-time employment or unemployed (5.78).

Table 4. Average value of the DMFT index by level of education

education of parents	mother (DMFT)	father (DMFT)
primary	5.63	4.5
secondary	4.71	4.84
higher	6.46	5.72
no data	5.5	6.33



Graph 2. Index according to the employment relationship of the mother and father

Table 5. Influence of mother's education on the value and structure of the DMFT - index

mother's education	average DMFT - index	dominant component in the structure	statistical significance (p)
primary	5.63	C (Caries) and E (Extractions))	p < 0.001
secondary	4.71	Mixed (lowest index)	
high	6.46	F (Fills/Repaired)	

The situation is similar regarding fathers' employment status, where the values are 5.0 for regular employees and 5.6 for part-time employees. This relationship is expected and supports numerous data from the literature: economic stability and access to health services directly affect the quality and frequency of dental interventions. A visual comparison of these values is presented in Graph 2.

The ANOVA analysis showed that maternal education was a significant predictor of the DMFT index values ($p<0.001$). Children whose mothers had secondary education had the lowest DMFT index values, while the highest DMFT index values were recorded in children whose mothers had only primary education.

Survey data – hygiene habits

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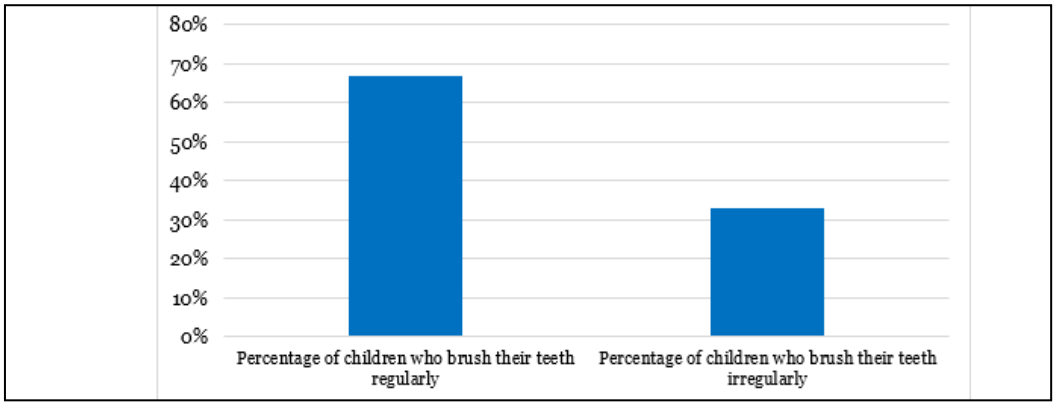
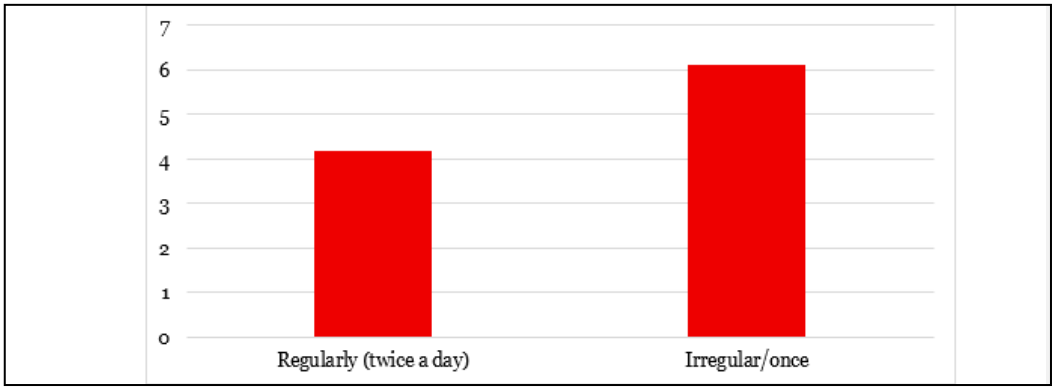
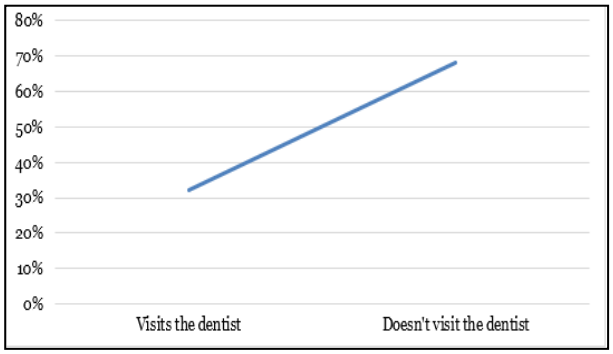


Graph 3. *Percentage of children who brush their teeth*



Graph 4. *Average DMFT index depending on tooth brushing frequency*

The survey questionnaire showed that 67% of children have regular tooth brushing habits (twice a day), while the remaining 33% brush once a day or irregularly. The average DMFT index in the first group is 4.2, while in the second group it is 6.1. This difference is statistically significant ($p<0.05$), which confirms the importance of personal hygiene in the prevention of caries. In addition, children who use fluoride toothpaste and visit the dentist at least once a year have a significantly better composition of the index (more P, less K). Impact of the COVID-19 pandemic.



Graph 5. *Access to a dentist during COVID-19 (2020 - 2022)*

In the period from 2020 to 2022, limited access to dental services was observed due to restrictions and priority of emergencies. According to the survey, 68% of parents stated that they did not visit a dentist during the pandemic, and in rural areas this percentage reached 80%. The values of the DMFT index showed higher values of the K and E components and a lower value of the P component, indicating an increased need for therapeutic interventions that were not implemented due to the situation. These results are particularly pronounced among respondents from rural areas, where access to a dentist, even under normal conditions, is limited.

Discussion

The analysis of the results of this longitudinal study allowed observation of the dynamics of changes in the DMFT index, i.e., the state of oral health, within the same group of children monitored at 7, 10, and 15 years of age. The study revealed not only changes in the values of the DMFT index with increasing age, but also significant differences according to socioeconomic and demographic factors, as well as the impact of the COVID-19 pandemic. These results confirm that oral health is significantly dependent on social and economic factors, as well as on the availability of dental services. A clear trend of increasing DMFT index values up to 15 years of age was observed, consistent with Pitts et al.[6], who reported that the most intensive appearance and progression of caries occur during puberty. The most drastic increase in the DMFT index is noted among respondents from rural areas, reaching an average value of 6.6, while among children from urban areas, it was 3.9. Children from rural areas have a higher DMFT index due to limited health infrastructure, but also due to certain financial barriers. These findings are consistent with the results of other studies in the South-Eastern European region[9].

The fact that the P-component is dominant among children from urban areas indicates a greater culture of maintaining oral hygiene and easier access to a dentist. On the contrary, untreated cases dominate in rural areas, which emphasizes the need for mobile dental teams and educational programs. Of particular concern is the fact that more than 40% of teeth of children from rural areas in 2025 had active, untreated caries, which indicates insufficient treatment and poor dental supervision. At the same time, children from urban areas showed a higher percentage of treated (restored) teeth (75.9%), which indicates better access to therapeutic services and regular dental check-ups. This is supported by the results of the survey, which showed that a

majority of children from urban areas have regular tooth brushing habits and regular dental care.

The COVID-19 pandemic has created an additional gap between the two groups. The reduced number of dental check-ups, closed practices, and interrupted preventive programs have contributed to the deterioration of the situation. Limited access to dental services in the period 2020–2022 led to a significant increase in the K and E components, especially among children from rural areas[10]. Over 68% of parents reported that they did not take their children to the dentist during the pandemic, which is directly reflected in the increased number of untreated caries. In summary, the results obtained confirm the hypothesis that the value of the DMFTindex increases with age, and that these dynamics is strongly influenced by socio-economic factors, health habits, and global circumstances. Such knowledge has important implications for planning preventive programs, especially aimed at the rural population and children with limited access to dental care. These data confirm that access to dental care must be sustainable even in times of crisis.

Conclusion

Oral health deteriorates with age if not supported by continuous dental care. The differences between urban and rural areas are significant and persistent. The studied group of children, at 15 years of age, has a moderate DMFT index in urban areas and a very high DMFT index in rural areas. In rural areas, regular preventive dental check-ups need to be intensified. The interruption of the work of preventive teams during the COVID-19 pandemic contributed to higher caries activity. The findings of this study emphasize the importance of continuous preventive dental services even in emergency conditions.

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