DOI: 10.17816/KMJ2021-389

Medical and economic efficiency of dental caries prevention through the use of fluoride sealant in schoolchildren

N.I. Shaymieva[1]*, R.Sh. Khasanov[1], V.N. Olesova[2]

[1]Kazan State Medical Academy-Branch of the Russian Medical Academy of Continuing Professional Education, Kazan, Russia
[2]Medical and Biological University of Innovation and Continuous Education of the State Research Center — Burnasyan Federal Medical Biophysical Center of Federal Medical Biological Agency

Abstract

Aim. To study the medical and economic efficiency of the program for the prevention of dental caries using UltraSeal XT among schoolchildren of Kazan.

Methods. In 2013, 200 schoolchildren from Kazan seen in the Republican Dental Clinic of the Ministry of Health of the Republic of Tatarstan (100 boys and girls aged 7–8) were selected. All patients were divided into two groups with similar distributions of sex and age: the test (main) group and control group. In the test group "Sealants", the fissures of the first permanent molars were sealed with a composite fluorine-containing sealant according to the manufacturer's instructions. The control group was formed from children without dental sealants. The oral health assessment of children is reflected in the Examination Cards. Average indices of the severity of dental caries were determined (the number of decayed, filled and missing primary/permanent teeth — dmft/DMFT). Re-examination of children was carried out in 2016 with the determination of the same indicators. The economic analysis was carried out using the method of mathematical modeling. Statistical processing was performed in Microsoft Office Excel 2017.

Results. The use of sealants at the age of 7–8 years provided a lower level of caries severity in deciduous teeth (4.09±3.0; $p < 0.01$). There was no statistically significant difference between the DMFT score of permanent teeth in children aged 7–8 years in the test group and the dmft score of deciduous teeth of children in the control group ($p > 0.05$). The DMFT score in the permanent teeth of children in the test group of this age cohort (7–8 years old) was 0.66±0.95. The mean severity of dental caries DMFT index of 12-year-olds children with permanent dentition in the test group was 0.77±1.07, which is 1.52 more healthy teeth than in the control group — DMFT score 2.29±1.59 ($t = 4.01$; $p < 0.01$). The medical and economic efficiency of the fluoride prevention of dental caries in 12-year-olds schoolchildren through the use of a composite fluorine-containing sealant is expressed in the eradication of caries (less than 1 affected tooth according to the World Health Organization classification) and amounts to 437.38 rubles of notional saved costs per child for sealing versus dental treatment.

Conclusion. The use of a fluoride composite material reduces the severity of dental caries in children and the notional saved costs for sealing teeth.

Keywords: fluoride prophylaxis of caries, sealing of teeth fissures, medical and economic effect, dmft/DMFT indices.

For citation: Shaymieva N.I., Khasanov R.Sh., Olesova V.N. Medical and economic efficiency of dental caries prevention through the use of fluoride sealant in schoolchildren. *Kazan Medical Journal.* 2021; 102 (3): 389–394. DOI: 10.17816/KMJ2021-389.

Background. Dental care planning at all levels of provision, including measures for primary prevention, is based on the results of a systematic analysis obtained through the collection of epidemiological data within 5–10 years prior to planning. Monitoring of the implemented targeted preventive programs allows determination of measurable goals for achieving a desired level of dental health [1].

The study of the epidemiology of dental diseases has its own characteristics. Due to the extremely high prevalence of dental diseases, a pilot (exploratory) method for assessing the epidemio-

For correspondence: nailya.shaymieva@mail.ru Received 08.05.2021; accepted 24.05.2021.

logical situation in key age groups in children and adults (6–7, 12, 15, and 35–44 years and 60 years and older) is used in research. A series of World Health Organization (WHO) trials in various countries has shown that a sample of 25 to 50 people in each key age group is sufficient to assess the dental status of a population. The exploratory method contributed to obtaining unified and reliable information about the dental status of a population. One of the indicators that provide information on global trends in dental health is the average value of the intensity of dental caries in children aged 12 [2].

Epidemiological studies in dentistry conducted over the past decades have been mainly carried out in certain regions of Russia. Moreover, they do not allow situational analysis to scientifically justify the development of socially oriented dental care programs due to long time intervals, laboriousness of collecting information, and significant financial costs. The rationale for such programs should be based on broad epidemiological studies at the regional level [3].

Data on the prevalence and intensity of dental caries among the people of the Republic of Tatarstan are presented in a number of works [4–6]. In most of these publications, a consistently high prevalence of dental caries in both children and adults has been noted. In order to study a specific problem of an applied nature, many scientists conducted sporadic studies on the prevalence of dental diseases among certain groups of the population [7–9].

In 1997, a team of epidemiologists from the Moscow Medical Dental Institute (now the Evdokimov Moscow State University of Medicine and Dentistry) performed a study in a number of regions in Russia, which included the Republic of Tatarstan. The study belongs to the exploratory category, contributes to the overall results obtained in all regions of the country, and registers trends in the prevalence and intensity of dental caries among key age groups of the population. According to the 1997 epidemiological survey of some regions of Tatarstan carried out by a group of dentists under the leadership of E.M. Kuzmina, the average level of the KPU index (the number of carious, filled, and extracted teeth) in children aged 12 was 3.1 per child [10].

The dental morbidity problem in the Republic of Tatarstan population requires further study, system analysis, identification of a package of indicators for the development of preventive programs and their monitoring, and improvement of dental services, all on the basis of extensive epidemiological studies at the regional level [11]. To reduce dental morbidity in the region, the republican target programs for improving dental services in the Republic of Tajikistan for 1999–2002 and the program for the prevention of dental diseases among children in the Republic of Tajikistan for 2006–2008 were developed and approved at the state level. Subsequently, an epidemiological survey conducted in 2009 revealed a decrease in the average level of caries intensity in children aged 12, which amounted to 2.2 ± 2.1 per child [11, 12].

It has been proven that the prevalence and intensity of dental diseases in different regions depend on the concentration of fluoride in drinking water [13, 14]. There is an established difference in the effects of a deficiency in fluoride on adult and child populations, wherein a more acute effect on children was revealed [15, 16]. Many domestic and foreign studies have investigated the effectiveness of the local use of fluoride on the prevention and treatment of dental caries [17, 18]. Research results show the benefits of school-based prophylaxis programs using fissure sealing, especially in high-risk children. These methods exceed the cost of caries treatment. In a foreign study in 2014, the average annual economic benefit per filled tooth was US$6.29 [19]. Only a few economic evaluations of dental prevention programs have been conducted, making it difficult to assess their cost-effectiveness.

These circumstances become the basis for monitoring and analyzing the effectiveness of the implemented programs for the prevention of dental caries in children in conditions of a decrease in the initial level of caries intensity with local application of fluoride.

The aim of this study is to determine the medico-economic efficiency of the prevention of dental caries in schoolchildren using a fluoride sealant.

Material and methods. This study was conducted according to a design developed by WHO. The protocol was approved by the ethical committee of the Kazan State Medical Academy.

In 2013, 200 schoolchildren (100 boys and 100 girls aged 7–8) from Kazan who applied to the Republican Dental Clinic of the Ministry of Health of the Republic of Tatarstan were selected. Equally, by sex and age, all patients were divided into two groups: test (main) and control groups.

In the test group "Sealants," the fissures of the first permanent molars were sealed with a composite fluorine-containing sealant, UltraSeal XT, according to the manufacturer's instructions. The control group consisted of children without dental sealants.

The same 200 children were examined again in 2016. The states of their dental health were studied, and the costs of caries prevention and treatment of affected teeth were calculated.

For all children 7–8 years old in the test group "Sealants," a composite sealant that releases fluo-

Table 1. The numbers of surveyed schoolchildren in key age groups in Kazan

Study groups	Key age groups				
	7–8 years old		12 years old		Total
	Boys	Girls	Boys	Girls	
Test	50	50	50	50	200
Control	50	50	50	50	200
Total	100	100	100	100	400

ride, UltraSeal XT, was used to seal the fissures of their first permanent molars. Sealing was carried out according to the manufacturer's instructions.

All children were treated with the same materials as part of the compulsory health insurance program. Assessment of the condition of the teeth of children is reflected in the standardized examination cards proposed by WHO for this study (1995). To determine and evaluate the average indices of the intensity of dental caries at the level of the population of the children, development tables were compiled separately for the permanent (KPU) and temporary (kpu) occlusions.

Statistical data were processed using the Microsoft Office Excel 2017 software package. The arithmetic mean (M) and the standard error of the mean (m) were determined from the obtained indicators. To draw conclusions, the Student's test (t) was used to determine the statistical significance of the results (p).

Medical and economic analysis was carried out by the method of mathematical modeling per child as the difference in the values of the indices of the intensity of dental caries in the control and test groups multiplied by the difference in the rates of treatment and sealing of teeth according to the following formula:

$$\sum_E = (KPU_K - KPU_G) \times (Tl - Tg),$$

where $\sum_E$ = economic efficiency, Tl = the cost of dental treatment with the development of caries (prices in 2020), and Tg = sealing rate (prices in 2020).

Results and discussion. The numbers of examined children in key age groups of schoolchildren in Kazan are presented in Table 1.

The use of sealants at the age of 7–8 years resulted in a lower level of caries intensity in deciduous teeth (4.09 ± 3.0; $p < 0.01$). In this age group, there was no statistically significant difference between the values of KPU of permanent teeth and the level of KPU of deciduous teeth of children in the control group ($p > 0.05$). On the other hand, the values of the intensity of caries of the KPU of permanent teeth were 0.66 ± 0.95 in children of the test group. The values of the indices of the intensity of caries (kpu/KPU) of the test group in relation to the control group are shown in Table 2.

Determination of the differences between the CFU index in children of the test group (CFU = = 0.77 ± 1.07) and that in children of the control group (CFU = 2.29 ± 1.59; $p < 0.01$) was carried out.

Comparative data on the medical and economic analysis of the test and control groups of schoolchildren in Kazan are given in Table 2.

To determine the medico-economic efficiency of the sealant, a mathematical calculation was performed using the formula:

$$\sum_E = (KPU_K - KPU_G) \times (Tl - Tg) = (2.29 - 0.77) \times \times (882.65 - 594.9) = 1.52 \times 287.75 = 437.38 \text{ rubles}$$

In this study, with the use of the fluoride sealant UltraSeal XT for the prevention of dental caries at the age of 12 years, 1.52 more healthy teeth were registered in the test group (0.77 ± 1.07) in permanent occlusion than in the control group (2.29 ± 1.59), which is 437.38 rubles, representing the notional saved costs per child for sealing versus dental treatment.

This study considered the possibility of employing a method to achieve an adequate level of

Table 2. Comparative data of medical and economic analysis of test and control groups of schoolchildren in Kazan

Age	Index mean (± standard deviation)					
	Test group "Sealants"	Reliability of the difference of indicators t (Student's test)	p	Control group	The difference in the values of the indices kpu/KPU	Contingently saved costs for sealing teeth in comparison with treatment in rubles
kpu—intensity of caries of deciduous teeth						
7–8 years old	4.09 ± 3.0	1.91	< 0.01	6.48 ± 2.03	2.39	687.72
KPU—intensity of caries of permanent teeth						
7–8 years old	0.66 ± 0.95	0.2	> 0.1	1.03 ± 1.01	0.37	106.47
12 years old	0.77 ± 1.07	4.01	< 0.01	2.29 ± 1.59	1.52	437.38

Note: kpu/KPU—number of decayed, filled, and removed primary/permanent teeth.

dental health in the constituent entity of the Russian Federation as well as global goals proclaimed by the WHO World Health Assembly and improve dental care for the children of the Republic of Tatarstan. According to the WHO call, the KPU index by 2000 should not have exceeded three teeth either affected by caries or missing, and by 2020, it should have been no more than one affected tooth for 12-year-old children [20].

Domestic and foreign authors reported the effectiveness of therapeutic sealing of temporary molars, reducing the risk of caries development on teeth with pigmentation [8].

In this study, in accordance with the WHO recommendations, children aged 7–8 and 12 were examined. The 7- to 8-year-old age group is of interest in the determination of the level of intensity of tooth caries, changes in which occur within a relatively short period of time, compared with this indicator for permanent occlusion. At the age of 12, the formation of a permanent bite is completed. The level of caries in children of this age has been chosen by WHO as a standard global indicator of the prevalence of dental caries for its monitoring in different countries.

During implementation of targeted programs for the prevention of dental diseases in the Republic of Tatarstan using the fluorine-containing sealant UltraSeal XT for sealing fissures of permanent molars in 12-year-old children, data on the medical and economic efficiency of the method were obtained, and indicators determined by WHO were achieved.

CONCLUSION

The medical and economic efficiency of prophylaxis of dental caries in schoolchildren 12 years of age using a fluorine-containing composite sealant was expressed in the eradication of caries (less than one affected tooth according to the WHO classification) and amounted to 437.38 rubles of notional saved costs per child for sealing versus dental treatment.

Author contributions. N.I.Sh. — research concept and design, collection and processing of materials, text writing; R.Sh.Kh. — analysis of the received data; V.N.O. — literature review, text writing.

Funding. The funds of the Territorial Fund of the CHI in the Republic of Tatarstan were used.

Conflict of interest. The authors declare no conflict of interest.

REFERENCES

1. Leous P.A. Evidence-based oral health dental science in prevention of dental caries in children population. *Stomatologiya detskogo vozrasta i profilaktika*. 2008; 7 (2): 3–11. (In Russ.)

2. Kuzmina E.M. Clinico-economical analysis bulletin the epidemiologic oral health survey model based on world health organization criteria. *Problemy standartizatsii v zdravookhranenii*. 2007; (6): 13–16. (In Russ.)

3. *Stomatologicheskaya zabolevaemost' naseleniya Rossii.* (Dental morbidity of the population of Russia.) Pod red. E.M. Kuz'minoy. M.: MGSMU. 2009; 236 p. (In Russ.)

4. Agafonov A.A., Blashkova S.L., Dautov F.F. Prevalence of dental caries and parodentium diseases among the workers of thermal power station. *Obshchestvennoe zdorov'e i zdravookhranenie*. 2011; (4): 42–44. (In Russ.)

5. Nizamov A.Kh., Yakimova Yu.Yu., Shakirov R.G., Khakimullin A.N., Sakharov R.A. Clinical-statistical analysis of dental diseases in children of preschool age living in large industrial city. *Kazan Medical Journal*. 2006; (1): 67–69. (In Russ.)

6. Shaydullin I.M., Khamitova N.Kh. Dental status of school children with physical development disorders who live in rural areas. *Kazan Medical Journal*. 2012; 93 (4): 632–633. (In Russ.) DOI: 10.17816/KMJ1558.

7. Iskorostenskaya O.V., Mikulinskaya-Rudich Yu.N., Mys' V.A., Oleynik E.S. Peculiarities of clinical manifestations of Down's syndrome in dental practice (literature review). *Vestnik problem biologii i meditsiny*. 2014; 3 (2): 20–29. (In Russ.)

8. Shakavets N.V. Efficacy of treatment of noncavitated lesions in infants and toddlers. *Sovremennaya stomatologiya (Minsk)*. 2018; (1): 47–51. (In Russ.)

9. Carey C.M. Focus on fluorides: update on the use of fluoride for the prevention of dental caries. *J. Evid. Based. Dent. Pract.* 2014; 14: 95–102. DOI: 10.1016/j.jebdp.2014.02.004.

10. Kuzmina E.M., Yanushevich O.O., Kuzmina I.N., Lapatina A.V. Tendency in the prevalence of dental caries among the russian population over a 20-year period. *Dental Forum*. 2020; (3): 2–8. (In Russ.)

11. Shaymieva N.I. Indicators of dental health monitoring of the population of the Republic of Tatarstan. *Prakticheskaya meditsina*. 2013; (4): 37–41. (In Russ.)

12. Shaymieva N.I. The remote efficiency of dental cavity prevention programs among children in Tatarstan Republic. *Obshchestvennoe zdorov'e i zdravoohranenie*. 2020; (1): 38–43. (In Russ.)

13. Kurbanov O.R., Garazha S.N., Alieva A.O., Khasaeva M.I., Omarov S.Z., Hubaev S.Z., Gadzhieva S.M., Salihova M.M. Dependence of dental morbidity of adult population in Chechen republic on fluorine content in drinking water. *Yug Rossii: ekologiya, razvitie*. 2018; 13 (1): 206–211. (In Russ.) DOI: 10.18470/1992-1098-2018-1-206-211.

14. Seow W.K. Early childhood caries. *Pediatr. Clin. North. Am*. 2018; 65 (5): 941–954. DOI: 10.1016/j.pcl.2018.05.004.

15. Iordanishvili A.K. Fluorides: their value for human health in modern conditions and prospects for their use. *Kursk scientific and practical bulletin "Man and his health"*. 2019; (2): 66–73. (In Russ.) DOI: 10.21626/vestnik/2019-2/07.

16. Klitinska O.V., Mukhina Y.A., Layosh N.V. Estimation stomatological to status of children there are 6–7 constantly resident in the conditions of biogeochemical deficit of fluorine and iodine. *Molodiy vcheniy.* 2016; (11): 82–85. (In Russ.)

17. Ahovuo-Saloranta A., Forss H., Walsh T., Hiiri A., Nordblad A., Mäkelä M., Worthington H.V. Sealants for preventing dental decay in the permanent teeth. *Cochrane Database Syst. Rev.* 2013; 3: CD001830. DOI: 10.1002/14651858.CD001830.pub4.

18. Aoun A., Darwiche F., Al Hayek S., Doumit J. The fluoride debate: the pros and cons of fluoridation. *Prev. Nutr. Food. Sci*. 2018; 23 (3): 171–180. DOI: 10.3746/pnf. 2018.23.3.171.

19. Griffin S.O., Naavaal S., Scherrer C., Patel M., Chattopadhyay S. Evaluation of school-based dental sealant programs: an updated community guide systematic economic review. *Am. J. Prev. Med*. 2017; 52 (3): 407–415. DOI: 10.1016/j.amepre.2016.10.004.

20. U.S. DHHS. *Healthy people 2020.* Topics and objectives. Oral health. http.www.healthypeople.gov/2020/topics-objectives/topic/oral-health (access date: 23.04.2021).