REVIEW ARTICLES PREGLEDNI ČLANCI

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THE ROLE OF NUTRITION IN CARIES PREVENTION AND MAINTENANCE OF ORAL HEALTH DURING PREGNANCY

ULOGA ISHRANE U PREVENCIJI KARIJESA I OČUVANJU ORALNOG ZDRAVLJA U TRUDNOĆI

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Summary

Introduction. Pregnancy may pose an increased risk for the development of caries and other oral health problems. Continuous screening of oral health status, implementing appropriate preventive measures (particularly oral hygiene, healthy diet plans and education) is of paramount importance not only for oral health but also for the general health status of the future mother and her offspring. Effects of Food on Caries Development. Caries prevention through healthy diet implicates the reduction in frequency and amount of intake of cariogenic food, above all of refined carbohydrates, i.e. sugars and sweets. Foods known to have caries-prophylactic effects should predominate in healthy diet plans. They mainly include solid foods, which have mechanical effects on teeth cleaning, as well as foods providing sufficient amounts of vitamins (A, C, D) and a variety of elements and compounds (calcium, phosphates, fluorides) favoring the preservation and remineralization of tooth structures. Education of Pregnant Women on Healhy Deit. In accomplishing these goals, education and direct positive communication between the educator and the pregnant woman play a crucial role. Educative approach is always individual and determined by the patient's specific cultural and socioeconomic features and status, as well as her habits, motivation and willingness to accept relevant recommendations. Accomplishing the aforementioned goals requires the appropriate organization and professional competence within the preventive dental service and its close cooperation with the relevant medical institutions and social support in the framework of public health protection. Conclusion. Preserving of oral health during pregnancy is predominantly influenced by the following factors: 1) healthy diet, 2) oral hygiene, 3) patients' education, 4) regular control of oral health, 5) appropriate organization of dental services and 6) community engagement.

Keywords: Dental Caries; Preventive Dentistry; Oral Health; Pregnancy; Mass Screening; Diet; Nutrition Policy; Public Health, Dentistry; Tooth Remineralization; Oral Hygiene; Diet, Cariogenic; Food Habits; Health Education, Dental

Sažetak

Uvod. Tokom trudnoće rizik za nastanak karijesa zuba i drugih poremećaja oralnog zdravlja je povećan. Redovni skrining stanja oralnog zdravlja, sprovođenje odgovarajućih preventivnih mera (prvenstveno oralne higijene, zdrave ishrane i edukacije) veoma su značajni ne samo za oralno zdravlje nego i za opšte zdravstveno stanje buduće majke i njenog potomstva. Uticaj hrane na razvoj karijesa. U prevenciji karijesa zdravim načinom ishrane treba redukovati učestalost i količinu unosa kariogene hrane, prvenstveno rafinisanih ugljenih hidrata, odnosno šećera i slatkiša. U zdravoj ishrani prednost ima hrana sa profilaktičkim dejstvom na karijes. Ovde spada čvršća hrana, koja ima mehanički efekat u odnosu na čišćenje zuba, kao i hrana koja obezbeđuje dovoljan unos vitamina (A, C, D) i određenih elemenata i jedinjenja (kalcijuma, fosfata, fluorida) koji pomažu u očuvanju i remineralizaciji građe zuba. Edukacija trudnica o zdravoj ishrani. U postizanju ovih ciljeva pomaže edukacija uz direktnu i pozitivnu komunikaciju između edukatora i trudnice. Edukativni pristup je individualan jer svaka trudnica ima specifična kulturološka i socioekonomska obeležja i status, uz različite navike, motivisanost i spremnost za prihvatanje datih preporuka. Za ostvarivanje pomenutih ciljeva potrebna je odgovarajuća organizacija i stručnost stomatološke preventivne službe i njena saradnja sa drugim medicinskim službama, uz društvenu podršku u okviru javnog zdravlja. Zaključak. U očuvanju oralnog zdravlja tokom trudnoće važne uloge imaju: 1. zdrav način ishrane, 2. oralna higijena, 3. edukacija trudnica, 4. redovne stomatološke kontrole, 5. organizacija stomatološke službe i 6. društveno angažovanje.

Ključne reči: Karijes; Preventivna stomatologija; Oralno zdravlje; Trudnoća; Skrining; Ishrana; Pravila ishrane; Javno zdravlje, stomatologija; Remineralizacija zuba; Oralna higijena; Kariogena ishrana; Navike u ishrani; Zdravstveno obrazovanje, stomatologija

Acknowledgments. This paper was supported by the grant No. TR31095 of the Ministry of Education, Science and Technological Development of the Republic of Serbia.

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Introduction

Pregnancy is associated with an increased risk for development of dental caries and other oral health problems [1–5]. Specific alterations of hormonal status in pregnant women such as the increase and change in progesterone and estrogen levels as the most prominent ones stimulate fluid retention in the body that may result in gingival swelling (edema). These changes are responsible for the increased sensitivity of the gums, hyperemia and tendency for bleeding, gingivitis, periodontitis, pyogenic granuloma, increased tooth mobility, plaque formation as well as substantial colonization of bacteria involved in caries pathogenesis [2, 4, 6–8].

Minozzi et al. [9] have identified the following major etiologic factors which play a role in caries development during pregnancy: 1) modified saliva composition (elevated acidity and mucin levels) that favors the formation of bacterial plaque; 2) changes in dietary habits (smaller but more frequent meals to prevent nausea, vomiting and hypoglycemia); 3) inadequate dietary intake of minerals, vitamins and other protective compounds; 4) erosive effects of gastric acid (frequent vomiting and regurgitation); 5) poor oral hygiene, and 6) inadequate dental surveillance and monitoring.

Dental caries is a change of multifactorial etiology defined as the demineralization of the inorganic portion and destruction of the organic structure of the tooth [10]. Demineralization of the enamel and dentin, which make a solid inorganic portion of the tooth, is caused by organic acids produced in dental plaque as a byproduct of anaerobic sugar degradation by bacteria from the diet of the host. Besides the sugar and specific bacteria, the caries development is determined by bacterial species, tooth resistance, quality of the saliva and salivary secretion rate. The saliva contains substantial amounts of calcium and phosphates, and the pH range of pH7 (neutral) promotes the enamel remineralization process. However, the acid environment resulting from the elevated acidity of the saliva during pregnancy enhances the demineralization, which then predominates over remineralization process, thus stimulating the caries development [1, 2, 4, 6]. The tooth demineralization is attributed to organic acids, which increase the solubility of calcium hydroxyapatite in the dental hard tissues. Furthermore, the factors that may contribute to the development of caries during pregnancy include poor quality (composition) of food and inadequate dietary regimen as well as inadequate oral hygiene [1, 2, 6, 9, 11].

It is of vital importance to preserve and improve oral health in pregnancy not only because of the pregnant woman herself, but for the outcome of pregnancy, health and development of the newborn baby. In that respect, periodontitis in pregnant women can be associated with premature birth, low birth weight of the newborn [2, 9, 12–15] as well as preeclampsia [15, 16]. Furthermore, cariogenic bacteria (including *Streptococcus mutans*) from the oral cavity of the mother with caries can be transmitted to her baby's mouth, which is significantly related to the prevalence or incidence of caries in the child [1, 2, 9]. Adequate dental health protection in pregnant women is indispensable and it should encompass the implementation of preventive and therapeutic measures and regular check-ups during pregnancy, as well as the active involvement of pregnant woman in preserving and maintenance of her oral health. The aforementioned practices are of multiple benefits for both oral health of the woman and pregnancy outcome, prenatal health and reduced incidence of caries in her child [9, 17–20]. The active involvement of the pregnant woman and her close cooperation with the dentist, gynecologist and other specialists are of crucial importance for the ac-complishment of these goals [3–5, 9]. The abovementioned measures and activities contribute to the improvement of health status among the general population. To reach the final positive outcome in this sphere, interdisciplinary health care practices and cooperation should be linked with identifying the role of the existing environmental risk factors and novel approaches and new aspects in dentistry, medicine, pharmacy and other fields related to public health [21–24].

The integrated prenatal health care and protection should encompass preventive measures and control of oral health of a pregnant woman; however, it is often neglected in everyday practice [2]. Solving of this problem is supported and improved by a range of relevant handbooks and guidelines offering recommendations on the preservation and improvement of oral health during pregnancy [3, 6, 7, 11, 19, 25].

Effects of Food on Caries Development in Pregnant Women

"Cariogenic" Food and its Impact

Some foods may increase the risk of caries formation during pregnancy, which should be taken into consideration when planning the diets for pregnant woman.

Easily digestible carbohydrates (mainly sugars) are considered potential factors that may provoke caries formation because acid by-products of their bacterial decomposition attack and damage the dental enamel and tooth structure. Monosaccharides, glucose, and disaccharides (including saccharose and lactose) are direct substrates in this process. Maltodextrin, broken down by salivary amylase into the aforementioned "aggressive" mono- and disaccharides, also plays a role in caries formation [1, 11]. Frequent and abundant intake of standard sugar (saccharose) and products containing substantial amounts of sugar and honey (sweets) are considered important risk factors in the caries development [6]. Other risk factors encompass prolonged keeping of carbohydrates in the mouth, especially when taking sticky candies that tend to adhere to the teeth. Some food of plant origin such as corn flakes and similar

processed cereals mostly used for breakfast demonstrate similar properties. Such products are rich in polysaccharides, thus easily decomposed by bacteria into acid compounds.

Restriction of concentrated carbohydrates in the diet has positive effects on not only oral health, but also on the prevention of overweight/obesity and diabetes and related health conditions and complications, which nowadays represent critical healthcare issues in both pregnant women and general populations [26–28].

Consuming abundant amounts of foods containing organic acids, such as fruit juice, yoghurt, fermented milk and cream may contribute to caries formation. Harmful effects of these foods manifest as direct demineralization of tooth surface and consequent erosion of dental enamel. Fruit juices have particularly high cariogenic potential as they contain both acids and carbohydrates (glucose, fructose, saccharose). To that end, fruit juices should not be consumed between meals. Taking fruit juices and beverages at mealtime (immediately before/after or during the meal) is recommendable because their cariogenic effects are less pronounced. Lemonade has the highest cariogenic potential of all fruit juices since it contains both sugar and citric acid. Due to their cariogenic nature, some dairy products (yoghurt, fer-mented milk, cream and sour milk cheese) are strongly recommended to be consumed during meals in order to reduce their own cariogenic effects [3–5].

The increased acidity in the mouth during pregnancy is commonly due to the presence of gastric acid produced by frequent vomiting at the initial stage of pregnancy and gastric reflux during the later pregnancy stages. Acute acid reflux into the mouth results from a decreased esophageal sphincter tone and movement of the acid contents of the stomach because of the increased abdominal pressure caused by the enlarged uterus [3-5, 7]. The presence of gastric acid in the mouth can provoke erosion of dental enamel; therefore, immediate rinsing of the mouth with water is highly recommendable. After vomiting, the acid neutralization can be accomplished by rinsing the mouth with sodium bicarbonate solution (1 teaspoon of baking soda in a glass of water) [3–5]. Some pregnant women avoid frequent tooth brushing because of nausea and vomiting tendency as well as because of vulnerable gums prone to bleeding and pain in contact with the toothbrush, which adds to the persistent acidity of the mouth and its negative effects [3-5]. Some pregnant women tend to take frequent smaller meals (because of nausea), yet without teeth brushing after the meal, thus promoting intensive bacterial activity and carbohydrate decomposition and consequent increase of mouth acidity [7].

Frequent Intake of Foods Contributing to Development of Caries

Besides consuming large amounts of sugar in one meal, frequent intake of sugar, i.e. carbohydrates throughout the day puts pregnant women at a substantial risk. The practice of taking sweet

snacks between the main meals causes prolonged retention of carbohydrate in the mouth for a long period. Thus, besides the type and amount of dietary carbohydrates, one should take into consideration the frequency of their intake as well as the duration of retention of food in the mouth [6]. Some authors recommend to reduce the number of highsugar meals to fewer than four, with a maximum sugar amount of less than 60 g/day [20]. Moynihan P and Petersen PE from the WHO Collaborating Centre for Nutrition and Oral Health recommend that the frequency of consumption of foods containing free sugars should be limited to a maximum of 4 times per day along with tooth brushing with fluoride toothpaste at least twice a day. These authors also encourage the production of sugar-free products and candies containing artificial sweeteners as an alternative to the products rich in concen-trated and free sugars [29]. Such strategy may pre-vent both dental and other health problems, such as overweight, which is quite a common condition during pregnancy. Promoting healthy food and dietary habits needs to be appropriately addressed through adequate marketing strategies [26, 27].

Caries-Prophylactic Effects of Some Foods

Cariogenic food, i.e. food rich in carbohydrates and acids, should be avoided while encouraging caries-preventive diets in order to reduce the risk of caries development. Prophylactic effects on dental caries is best accomplished with diets providing sufficient amounts of vitamins, minerals and specific elements and compounds such as vitamins A, C, D, calcium, phosphate and fluoride. Furthermore, some foods exert a positive mechanical cleansing action on teeth, thus representing a potential protective factor in caries prevention [6].

Indispensable vitamins are primarily provided by the adequate intake of fruits and vegetables and related foods. Fresh fruits and some vegetables (though to a somewhat lesser extent) contain carbohydrates that may undergo bacterial fermentation and convert to acidic products; however, high water contents in such foods dilute the concentration and effects of carbohydrates while their fiber contents helps mechanical teeth cleaning thus reducing the risk of caries development.

Vitamin A plays an important role in the development of healthy bones and teeth and in the regeneration of mucosa, skin and other tissues as well. Major natural sources of vitamin A are orangecolored foods, melon, peach and some vegetables such as carrot, courgette, savoy cabbage (kale), spinach and red peppers. Milk and dairy products and eggs are also a good source of vitamin A [6].

Vitamin C offers a range of health benefits. Besides its role in collagen synthesis, vitamin C prevents gum bleeding, promotes iron and calcium resorption and has a powerful antioxidative potential. High vitamin C foods include rose hip, red currant, bilberry, lemon, orange, tangerine, grapefruit, kiwi, papaya, raspberry, strawberry, sour cherry, melon, watermelon, paprika, tomatoes, cabbage and other leafy vegetables, broccoli, cauliflower, kohlrabi, parsley, potatoes and other fruits and vegetables [6].

Vitamin D is essential for the adequate absorption and metabolism of calcium and phosphates, and it is of particular importance for the maintenance of bone and teeth density during pregnancy as well as for the proper development of the bones and teeth of the fetus. Good sources of vitamin D are milk and dairy products, fatty saltwater fish (salmon, tuna, sardines, herring, mackerel, and swordfish), fish oil and eggs. The human body is capable of synthesizing vitamin D in the skin cells through the sunlight-mediated pathway; however, only moderate and controlled exposure to sunlight is advisable during pregnancy [6].

Calcium, along with phosphorus and vitamin D, is an important component in the bone and teeth mineralization. The best food sources of calcium are milk and dairy products (cheese, yoghurt), sardines, salmon, leafy greens, beans, lentil, sesame seed, soybean, figs, fruit juices (strawberry), dried fruits, almond, hazelnut and grains [6].

Phosphorus is an integrative component of teeth and bones, and it is contained in milk, cheese, eggs (egg yolk), peanut butter, meat, fish and fish oil, barley, legumes, walnut, fruit juices (red currant and raspberry) and brown bread [6].

Liver, which is rich in vitamin D and vitamin A, calcium and phosphorus, has not been listed in the aforementioned sources because of its particularly high vitamin A content that (if consumed frequently) could negatively affect the development of the fetus [6].

Foods containing substantial amounts of dietary fibers (roughage) are of solid consistency and their mechanical mincing during chewing process enables mechanical cleansing of teeth, promotes blood circulation in the gums, improves defense capacity of periodontal tissues, improves the keratinization and tonus of gingival tissue and stimulates salivary secretion. This group of foods includes some vegetables (carrot, cucumber, radish, celery, cabbage, lettuce, etc.) and nuts. The major benefit of such foods is that they provide adequate intake of vitamins and minerals without an increased bacterial production of acid compounds in the oral cavity [6]. The mechanical effects of teeth cleansing can be attributed to some fruits of solid consistency (e.g. some apple varieties, pears, etc.).

Meat and fish are an important source of proteins as the major building block, so the adequate intake of these foods during pregnancy is essential. Meat and fish consumption does not induce acidity in the oral cavity, and thus it may help to prevent dental caries [6].

Hard cheese, as a good source of calcium and phosphates, manifests caries-prevention properties through its positive effects on mineralization and remineralization of teeth. Cheese is also a strong sialogogue [1, 29]. It does not increase the acidity in the oral cavity, on the contrary – it inhibits the acidification process in the mouth thus acting as a preventive agent against caries. Such positive effects are characteristic mainly for hard (mature) cheeses, whereas fresh and sour milk cheeses as well as yoghurt increase the acidity of the mouth; therefore their consumption should be limited to mealtime [12].

Mobley Č et al. recommend chewing sugar-free gum to protect and maintain oral health. The beneficial effects of chewing gum are manifested by mechanical teeth cleansing, improvement of gum tonus, stimulation of salivary secretion and reduction of acidity and bacterial count in the mouth [12]. Chour VG and Chour GR identified some leading factors contributing to caries development. Besides the refined carbohydrates and cariogenic bacteria, they emphasized the role of xerostomia (dry mouth), i.e. reduced secretion of the saliva, which can occur during pregnancy [30].

Education of Pregnant Women on Healthy Diet

Nutrition during pregnancy and its effects on caries development among the population of pregnant women and consequent caries in children is determined by a wide range of factors, including cultural and socio-economic ones [1–3, 12, 19]. Individual determinants such as behavioral orientation (characteristics, habits and education about nutrition), bad habits (smoking, repeated consumption of sweets and alcohol), actual oral health status, willingness and motivation of a pregnant woman to accept the recommendations are of great importance for preserving oral health during pregnancy. Furthermore, dietary recommendations should be tailored and adapted to the objective circumstances and family and social conditions of the pregnant woman's life [1, 2, 11, 20, 30].

The first step in creating healthy diet during pregnancy is to identify potential current nutritional imbalance. The subsequent step includes the correction and modification of dietary habits, that is, eliminating bad and promoting good eating habits. Having in mind specific cultural and socio-economic characteristics of pregnant women, their different habits, motivation and willingness to accept relevant recommendations, an individualized, patient-centered approach is of vital importance [1, 2, 11, 20, 30, 31].

In regard to individual educational approach, the direct contact between the counselor and pregnant woman and their adequate verbal and non-verbal positive communication are the most important moments. These methods should motivate the pregnant woman to participate actively in the education program and to accept the recommended routine. The counselor should show a certain degree of empathy and take the perspective of the patient, i.e. pregnant woman [19, 32].

Besides the personal contact, nutrition counseling of pregnant women may include a range of informative and educational materials as a useful education tool [19, 32, 33].

Education process is highly complex, encompassing initial assessment of the type and model of nutrition as well as recording of particular eating habits of the pregnant woman (in workshops, pregnancy courses, and specially designed questionnaires for statistical processing). The assessment and, if necessary, correction and modification of eating pattern including meal composition and number of meals taken per day play a major role in caries-prevention procedures. The strategy of healthy diet and nutrition education focus on reducing the amount and rate of consumed carbohydrates, i.e. sugars [1–3, 7, 11, 20, 30]. Whenever possible, adequate oral hygiene should be practiced after each meal containing sugars [1–3, 7, 11, 20, 32–34]. Besides the harmful effects of refined carbohydrates (sugars) on oral health, they pose a substantial risk of overweight in pregnant women, which is known to be related to the development of periodontitis [35].

In addition to the restricted consumption of refined carbohydrates as harmful factors, a sufficient intake of beneficial food ingredients that promote teeth remineralization (vitamins A, C, D, calcium, phosphates and fluorides) plays an important role in caries prevention. Substantial amounts of such elements are provided from organic milk and dairy products made using natural and healthy processing methods [36]. Education process should emphasize that healthy eating is of importance not only for oral health of pregnant woman but also for her general health condition, pregnancy course and health status of her baby, which will give her motivation to accept the recommendations and advice [11, 20].

Though not directly related to nutrition yet in the aspect of general healthcare, pregnant women are strongly encouraged to avoid alcohol and smoking. Negative and harmful effects of smoking on oral health of general population are well established, and they can contribute to the development of periodontitis, tooth loss, carcinoma, etc. In pregnant women, such harmful effects are even more aggravated [20, 37].

Highly complex nature of oral health issue in pregnant women and its relation to her overall health status, quality of life, pregnancy outcome and health of her baby requires a multidisciplinary approach and involvement of health professionals and specialists of different profiles, i.e. dentists, general practitioners and gynecologists. Such an approach is useful in all communities, and particularly among populations of lower cultural and educational status and poorer economical status characterized by higher incidence of

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Conclusion

The importance of following factors in preserving oral health during pregnancy should be emphasized: 1) healthy diet, 2) oral hygiene (regular teeth brushing), 3) education and motivation of pregnant women to practice appropriate procedures actively, 4) regular control of oral health status and potential introduction of relevant therapeutic measures, 5) appropriate organization and competence of preventive dental services and their cooperation with other medical care departments, and 6) community engagement and social support.

The aforementioned factors play an important role in the field of both dental health care (particularly preventive dentistry) and the healthcare system as a whole. They significantly affect and contribute to overall health status of the population. Evidently, systematic activities and initiatives undertaken by relevant decision makers in this field are of utmost importance for the improvement of both oral and general health status of the population.

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