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ZNAČAJ MIKRONUTRIJENATA U USNOJ DUPLJI

IMPORTANCE OF MICRONUTRIENTS IN THE ORAL CAVITY

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Sažetak

Mikronutrijenti igraju moćnu ulogu u funkcionisanju različitih sistema organizma. Za održanje optimalnog stanja usne duplje neophodno je održati adekvatan status mikronutrijenata.

Deficit vitamina B12, kalijuma, bakra, selen i fluora povećava rizik od pojave karijesa. Veoma često ljudi koji pate od hroničnog inflamatornog oboljenja creva imaju deficit vitamina B12 i kalijuma, dok pacijenti sa hroničnim oboljenjem bubrega gube značajnu količinu selen, te su stoga predisponirani za pojavu karijesa.

Vitamini C, B9 i E, kalcijum, cink, bakar i gvožđe poseduju antiinflamatorna svojstva i deluju kao antioksidansi. Nedostatak ovih mikronutrijenata glavni je krivac za razvoj parodontopatije.

Deficit vitamina C i B9 povećava krvarenje iz desni i narušava normalni proces formiranja kolagena. Osobe sa hroničnim inflamatornim oboljenjem creva, kao i deca, trudnice/dojilje obično su deficitarni u ovim vitaminima.

Vitamini D, C, E i A, gvožđe, cink, bakar i selen neophodni su za adekvatno funkcionisanje imunog sistema. Oni koji su podložni deficitu ovih mikronutrijenata trebalo bi da obrate pažnju na prevenciju oralnih infekcija.

Konačno, vitamin D i kalcijum potrebni su za normalan razvoj tvrdih tkiva organizma. Njihova deficitarnost ne samo da sprečava metabolizam minerala u gleđi i dentinu, već smanjuje i gustinu kostiju. Na taj način se smanjuje sposobnost sidrenja alveole što može usloviti gubitak zuba.

Ključne reči: malnutricija, antioksidans, inflamacija, parodontopatija, karijes

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Abstract

Micronutrients play a potent role in the functioning of the different systems of the organism. It is necessary to sustain an adequate status of the micronutrients for maintaining the optimal condition of the oral cavity.

Deficiency of vitamin B12, potassium, copper, selenium and fluorine increases the risk of dental caries. Usually, people suffering from chronic inflammatory bowel disease lack vitamin B12 and potassium, while patients with chronic kidney failure lose a lot of selenium, so they are likely to have dental caries.

Vitamins C, B9, E, calcium, zinc, copper and iron have anti-inflammatory properties and act as antioxidants as well. Lack of these micronutrients is the main culprit for the development of periodontitis.

Deficiency of vitamins C and B9 increases bleeding of the gums and interrupt the normal process of collagen formation. People with chronic inflammatory bowel disease as well as children and pregnant/breastfeeding women usually lack these vitamins.

Vitamins D, C, E, A, iron, zinc, copper and selenium are necessary for the adequate functioning of the immune system. Those who are prone to deficiencies in these micronutrients should especially carefully follow preventive measures against oral infections.

Finally, vitamin D and calcium are required for the normal development of hard tissues of the organism. Their deficiency not only impedes mineral metabolism in dentine and enamel but also decreases the mineral density of the bones. This leads to decreased anchoring capability of the alveoli and may result in tooth loss.

Key words: malnutrition, antioxidant, inflammation, periodontitis, caries

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Uvod

Dovoljna količina mikronutrijenata od ključnog je značaja za zdravo oralno okruženje. Na primer, brzi imuni odgovor značajan je ukoliko postoji zapaljenski proces. To je moguće obezbediti ukoliko je telo snabdeveno odgovarajućom ishranom¹. In vitro studijama je pokazano da vitamini i supstance u tragovima imaju značajnu ulogu u svim aspektima imunološke funkcije i da njihov deficit može narušiti imunološku funkciju². Konzumiranje dovoljne količine proteina i amino-kiselina može sprečiti različita oboljenja usne duplje, s obzirom na to da njihova deficijencija može dovesti do disfunkcije pljuvačnih žlezdi³, promeniti antibakterijska svojstva pljuvačke i promeniti sposobnost zaceljenja mekih oralnih tkiva⁴. Zapravo, pljuvačka se može koristiti i kao medijum za praćenje rizika za nastanak karijsa⁵. Drugu sličnu patologiju čine oboljenja parodontijuma, kao što su gingivitis i parodontopatija, koja imaju sličan trend progresije. Osim toga, mikronutrijenti deluju kao katalizatori metaboličkih reakcija. Budući da se samo malo vrsta hrane zapravo sastoji iz mikronutrijenata, od krucijalnog je značaja održati njihov balans, što se često postiže dodavanjem suplemenata⁶. Drugi zanemareni problemi su emocionalne i psihološke smetnje povezane sa kvalitetom života osoba sa oboljenjima usne duplje^{7,8}.

I pored značajnih uloga mikronutrijenata, veliki deo populacije je u njihovom deficitu. Na primer, Svetska zdravstvena organizacija (SZO) identifikovala je to da su u mnogim zemljama regiona Srednjeg Istoka, naročito deca i žene u reproduktivnom periodu deficitarni u kalcijumu, gvožđu, cinku, vitaminima A i D, i folatima. Slično, statistika pokazuje to da je oko 33% ljudi, uglavnom žena, deficitarno u gvožđu. Nadalje, 13,2 miliona predškolske dece ima nivo serumskog retinola ispod 0,7 $\mu\text{mol/L}$, i znatno niže od toga, te da oko 800 000 ljudi pati od noćnog slepila⁹.

U cilju poboljšanja kvaliteta života, trebalo bi dobro proceniti unos ugljenih hidrata, proteina i mikronutrijenata¹⁰ naročito kod dece¹¹. Međutim, treba naglasiti to da se uprkos dobro izbalansiranoj ishrani, može desiti da pojedinac i dalje ne unese preporučene dnevne doze mikronutrijenata. Pored nedovoljnog unosa usled nepravilne ishrane, do deficijencije može doći i usled poremećaja u apsorpciji, interakcijama sa lekovima, drugih hroničnih oboljenja^{12,13}. Pored inherentnog rizika od deficijentnog stanja, dugoročne posledice smanjenog unosa vitamina i elemenata mogu se odraziti na fiziološke funkcije, mogu dovesti do ćelijske neispravnosti i povećanja rizika od nastanka hroničnih oboljenja¹³⁻¹⁵.

Introduction

Sufficient supply of micronutrients is the key to having a healthy oral environment. For instance, a quick immune response is important if there is an inflammatory process. This is possible provided that the body is supplied with proper nutrition¹. It has been proved in-vitro that vitamins and trace components play an important role in all aspects of immune function and their deficiency can lead to impaired immune function². Consuming enough amounts of proteins and amino acids can prevent different diseases of the oral cavity because deficiency of them can lead to dysfunction of salivary glands³, change in an antibacterial property of saliva and wound healing capacity of soft oral tissue⁴. Indeed, saliva can be used as monitoring medium for determining the risk for caries development⁵. Other similar pathologies are diseases of the periodontium, like gingivitis and periodontitis, which have a similar course of progression. Furthermore, micronutrients act as a catalyst for all metabolic reactions. Since only a small amount of food actually consists of micronutrients, it is crucial to maintain its balance, sometimes by administering food supplements⁶. Other underestimated problems are the emotional and psychological distraught associated with the quality of life due to the oral damage^{7,8}.

Despite the important functions of the micronutrients, a big chunk of population is lacking them. For example, WHO has identified that in many countries in the Middle East region, especially children and women of reproductive age to be deficient in calcium, iron, zinc, vitamin A, vitamin D and folate⁹. Similarly, statistics show that about 33% of people, the majority of whom are women, lack iron. Furthermore, 13.2 million preschool children have their retinol serum level below 0.7 $\mu\text{mol/L}$, and even worse, about 800.000 of them are suffering from night blindness⁹.

In order to improve the quality of life, the nourishment in the form of carbohydrate, proteins and micronutrients should be well assessed¹⁰, especially in the case of children¹¹. But it is to be noted that, despite a properly balanced diet, an individual can still fall short of meeting recommended micronutrient allowances. In addition to insufficient micronutrient intakes due to poor diet, deficiencies can still be a problem due to inherent risk for deficiency states, the long-term consequence of decreased intake of vitamins and elements can be linked with physiological performance, cellular malfunction and increased risk for chronic disease¹³⁻¹⁵.

Efekti mikronutrijenata u usnoj duplji***Efekti makroelemenata i elemenata u tragovima******Magnezijum***

Postoje dokazi da deficit magnezijuma povećava rizik od pojave parodontopatija. Netretirana parodontopatija takođe može usloviti probleme na drugim organima organizma. Analiza zasnovana na populacionoj studiji pokazala je to da dodatak magnezijuma u vidu suplemenata može poboljšati zdravlje parodontijuma, redukujući gubitak periodontalnog pripoja¹⁷. Slično, magnezijum pomaže u aktiviranju vitamina D, koji za uzvrat reguliše homeostazu kalcijuma i fosfata koji utiču narast o održanje kostiju. Na sličan način, magnezijum utiče na stabilnost ćelijske funkcije, sintezu RNK i DNK, ćelijski oksidacioni status i ćelijsku reparaciju. Takođe, magnezijum ima značajnu ulogu u aktivaciji značajnih transporta i enzima¹⁸ i smatra se da je njegova deficijencija okidač za apoptozu¹⁹. Slično ovome, studije pokazuju to da postoji međuzavisni odnos između konzumiranja magnezijuma i karijesa²⁰.

Kalcijum

Sledeći značajan element je kalcijum. Prema podacima trećeg Nacionalnog ispitivanja zdravstvenog stanja i ishrane (NIZSI III), nizak unos kalcijuma može rezultirati težom formom parodontalnog oboljenja, a takođe može uticati i na gustinu minerala i jačinu potpornih struktura zuba²¹. Prema studiji sprovedenoj u SAD na civilnoj neinstitucionalizovanoj populaciji, povezanost niskog unosa kalcijuma sa parodontalnim oboljenjem najčešće je pronađena kod mladih muškaraca i žena (starosti 20 do 39 godina) i starijih muškaraca (starosti 40 do 59 godina)²². Druga povezanost ogleda se između niskog nivoa kalcijuma i visokog nivoa fosfata u krvi nastalog usled neadekvatne niske koncentracije parathormona (PTH). Regularan tretman hipoparatiroidizma može uključiti aktivirani vitamin D i/ili kalcijum suplemetaciju, ali ova terapija ne može u potpunosti zameniti funkciju PTH i može usloviti kratkotrajne probleme (kao što su hipokalcijemija, hiperkalcijemija i povećano izlučivanje kalcijuma putem urinarnog trakta), te je zamena PTH prikazana kao nova opcija lečenja²³. S druge strane, primarni hipoparatiroidizam može povećati nivo kalcijuma u serumu sa neprimereno nesupresioniranim nivoom PTH. Hiperkalcijemija, koja se razvija kao rezultat primernog hiperparatiroidizma, dovodi do pojave osteoporoze (Slika 1), nefrolitijaze,

Effects of micronutrients in the oral cavity***Effects of macro and trace elements******Magnesium***

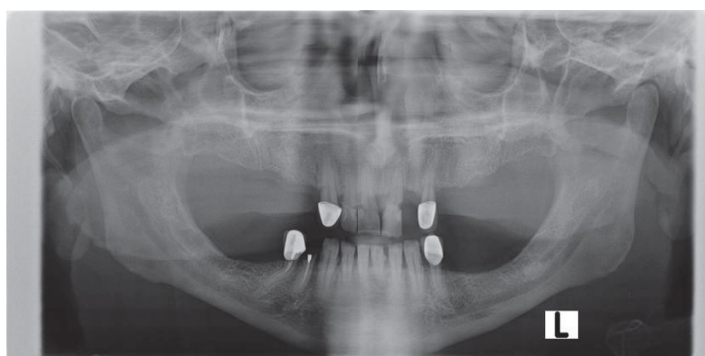
There is a piece of evidence that magnesium deficiency increases the risks for the development of periodontitis. Periodontitis, if untreated, can cause health problems in other parts of the body as well¹⁶. A population-based analysis revealed that nutritional magnesium supplementation may improve periodontal health, reducing periodontal attachment loss¹⁷. Similarly, magnesium helps in activating vitamin D, which in turn regulates calcium and phosphate homeostasis to influence bone growth and maintenance. In the same way, stability of cell function, RNA and DNA synthesis, cell's oxidation status and cell repairs are performed by magnesium. It has also a vital role in activating important transports and enzymes¹⁸, and it has been suspected that its deficiency can trigger apoptosis¹⁹. Similarly, studies show that there is an intricate link between magnesium consumption and dental caries²⁰.

Calcium

The next important element is calcium. According to data from the third National Health and Nutrition Examination Survey (NHANES III), low dietary intake of calcium may result in more severe periodontal disease as well as affect bone mineral density and strength to anchor tooth structure²¹. According to a study in U.S. civilian non-institutionalized population, the relation of lower dietary calcium intake with periodontal disease was found more often in young males and females (20 to 39 years of age), and in older males (40 to 59 years of age)²². Another assessable issue is low calcium levels and high phosphate levels in the blood due to inadequate low concentrations of parathyroid hormone (PTH). Regular treatment for hypoparathyroidism may include activated vitamin D and/or calcium supplements, but this treatment may not fully replace the functions of PTH and can lead to short-term problems (such as hypocalcaemia, hypercalcaemia and increased urinary calcium excretion), so PTH replacement has been demonstrated as a new treatment option²³. On the other hand, primary hyperparathyroidism may elevate serum calcium level with an inappropriately non suppressed PTH level. The hypercalcemia that develops as a result of primary hyperparathyroidism leads to osteoporosis (Picture 1), nephrolithiasis,

pankreatitisa i neurokognitivnih deficita kao što su poteškoće sa memorijom, koncentracijom i spavanjem²⁴. Morfometrijske analize pokazuju to da je slučajna primena PTH (40 µg/kg) uspela da zaštiti zub od koštane resorpcije izazvane parodontopatijom. Prema studiji sprovedenoj u Kini, uočen je potencijal intermitentnog PTH da stimuliše cementogenezu. Intermitentni PTH ograničio je inhibiciju cementogeneze i diferencijacije cementoblasta. Oba ova nalaza sugerišu to da se intermitentni PTH može terapijski koristiti za poboljšanje prognoze resorpcije korena zuba²⁵.

pancreatitis, and neurocognitive deficits such as difficulty with memory, concentration and sleep²⁴. The morphometric analysis demonstrates that random PTH administration (40 µg/kg) was able to protect the tooth site from periodontitis-induced bone resorption. According to a study conducted in China, the potential of intermittent PTH to promote cementogenesis was observed. Intermittent PTH restrained the inhibition of cementogenesis and cementoblast differentiation by a mechanical strain. Taken together, these findings suggest that intermittent PTH can be therapeutically exploited to improve the prognosis of tooth root resorption²⁵.



Slika 1. Osteoporoza se uočava kao razređenje kostiju i proređivanje korteksa²⁶
Picture 1. Osteoporosis seen as rarefying of the bone and thinning of the cortex²⁶

Gvožđe

Gvožđe deficitarna anemija uključuje atrofiju jezičnih papila, peckanje i crvenilo jezika, angularni stomatitis, disfagiju, bledilo oralnih tkiva nastalog usled anemije²². Plummer-Vinsonov sindrom (Slika 2) je genetsko stanje povezano sa deficitom gvožđa, i manifestuje se angularnim stomatitisom, glositisom i disfagijom²⁸.

Iron

Iron deficiency anaemia includes atrophy of the lingual papillae, burning and redness of the tongue, angular stomatitis, dysphagia, and the pallor of the oral tissues due to underlying anaemia²⁷. Plummer-Vinson syndrome (Picture 2) is a genetic condition related to the deficiency of iron and presents with angular stomatitis, glossitis, and dysphagia²⁸.



Slika 2. Slučaj Plummer-Vinsonovog sindroma pokazuje angularni heilitis i gladak jezik sa gubitkom normalnih papilla jezika²⁹
Picture 2. A case of Plummer-Vinson syndrome showing angular cheilitis and smooth tongue with loss of the normal tongue papillae²⁹

Cink i bakar

Deficit cinka može dovesti do promena u epitelu jezika, povećanja broja ćelija, poravnanja filiformnih papila, pojave ulceracija i kserostomije²⁷. Cink poboljšava čulo ukusa i apetit; stoga deficit cinka može smanjiti čulo ukusa, što može biti povezano sa problemom malnutricije²⁵. Takođe smatra se da se može dovesti u vezu sa karijesom³¹. Cink takođe može da obezbediti zarastanje rane³² tako što učestvuje u svakoj fazi procesa zarastanja rane od reparacije membrane, koagulacije, angiogeneze, oksidativnog stresa, inflamacije imunološke odbrane, do formiranja fibroze³³. S druge strane apsorpcija bakra je direktno proporcionalna koncentraciji cinka³⁴. Postoji nekoliko dokaza da nedostatak bakra može povećati rizik od pojave karijesa. U studiji, koja je obuhvatila 60 pacijenata, uzrasta od 3 godine do 15 godina, pacijenti su bili podeljeni u dve grupe, grupu dece sa aktivnim karijesom i drugu grupu dece bez karijesa. Zapaženo je da deca bez karijesa imaju viši nivo bakra³⁵. Na glodarima je pokazano to da bakar inhibira enzime koji sadrže S-H, što može otežati proizvodnju kiselina u dentalnom plaku i stvaranje karijesa³¹. Deficit cinka i bakra povećava rizik od pojave infektivnih stanja³⁷.

Staviše, nedostatak cinka može potisnuti antiinflamatorni i imunološki odgovor mekih tkiva usne duplje²¹.

Selen

Studija sprovedena u Finskoj, gde je nedostatak selena široko rasprostranjen, pokazala je to da dodatak ovog ultramikroelementa ima sposobnost smanjenja karijesa kod mladih Finaca, jer je kolagen najvažnija komponenta organskog matriksa zuba, a selen može da zameni sumpor u vezama kolagena i smanjuje zubni karijes³⁹.

Fluor

Fluor sprečava pojavu karijesa³⁹ uglavnom svojim lokalnim dejstvom. Tokom izloženosti kiselinama fluoridi se apsorbuju za površinu kristala hidroksiapatita inhibirajući demineralizaciju (Figura 1(a), Figura 1(b)). Kada se pH ponovo uspostavi, mala količina fluorida u rastvoru učiniće rastvor visokoprezasićenim povećavajući proces remineralizacije. Na sličan način, mineral koji nastaje pod dejstvom nukleacije delimično rastvorenih minerala preferencijalno će sadržati fluor i uzimaće karbonat, čineći ga otpornijom na buduće kisele izazove⁴⁰. Osim toga, osim sprečavanja nastanka sekundarnog karijesa, fluor deluje i antimikrobno⁴¹. Stoga, stomatolozi koriste fluoride u lečenju karijesa⁴².

Zinc and Copper

Deficiency of zinc may cause changes to the epithelium of the tongue, increase cell numbers, flatten filiform papillae, cause ulcers and xerostomia²⁷. Zinc can improve taste and appetite; thus, deficiency of zinc also may cause a decrease in taste sensation, which can be related to the malnutrition problem³⁰. It is also considered to be associated with dental caries³¹. Zinc also can promote the healing of wounds³² by taking part in each phase of the wound healing process, ranging from membrane repair, coagulation, angiogenesis, oxidative stress, inflammation and immune defence, to fibrosis formation³³. On the other hand, the absorption of copper is inversely proportional to the concentration of zinc³⁴. There is a shred of evidence that the lack of copper can increase the risks of caries. In the study conducted on 60 patients aged 3-15 years, patients were divided into two groups: one with active caries and the other without caries. The observation showed that the caries-free group had a higher level of copper³⁵. It has been shown to inhibit S-H containing enzymes on rodents, which may impede acid production in dental plaque and caries³⁶. Deficiency of zinc and copper increases the risk of infectious diseases³⁷. Moreover, zinc deficiency can depress anti-inflammatory and immune response of oral soft tissue²¹.

Selenium

A study conducted in Finland, where selenium deficiency is widespread, demonstrated that the supplementation of this ultra-trace element has the capability to reduce caries in young Finns since collagen is the most important component of the organic matrix of the teeth and selenium can replace sulphur in bonds of collagen and reduce dental caries³⁹.

Fluorine

Fluorine prevents tooth decay³⁹ mainly by its topical effect. During the acidic challenge, fluoride is absorbed to the surface of the apatite crystals which inhibits demineralization (Fig. 1(a), 1(b)). When the pH is re-established, a small amount of fluoride in solution will make it highly supersaturated in comparison with hydroxyapatite, increasing the process of remineralization. Similarly, the mineral formed under the nucleating action of the partially dissolved minerals will then preferentially include fluoride and exclude carbonate, rendering the enamel more resistant to future acidic challenges⁴⁰.

Istovremeno, treba da budemo svesni toksičnih efekata fluoride, koji mogu dovesti do pojave fleka na zubima od blagih, bele boje (Slika 3), do ekstremno izraženih, braonkaste prebojenosti i doprineti formiranju rupica u gleđi³⁶. Kao što je pomenuto, nedostatak fluorida može dovesti do povećanja zubnog karijesa, ali ne utiče na sluzokožu.

Moreover, besides preventing secondary caries⁴¹, it also has an antimicrobial action. So dental professionals use fluorides in caries management⁴².

At the same time, we should be aware of toxic effects of fluorides that can lead to mottling of the enamel ranging from mild white flecks (Picture 3) to extreme brown discoloration and enamel pitting⁴³. As mentioned, deficiency of fluorides can lead to increase indental caries but it does not affect mucous membranes.

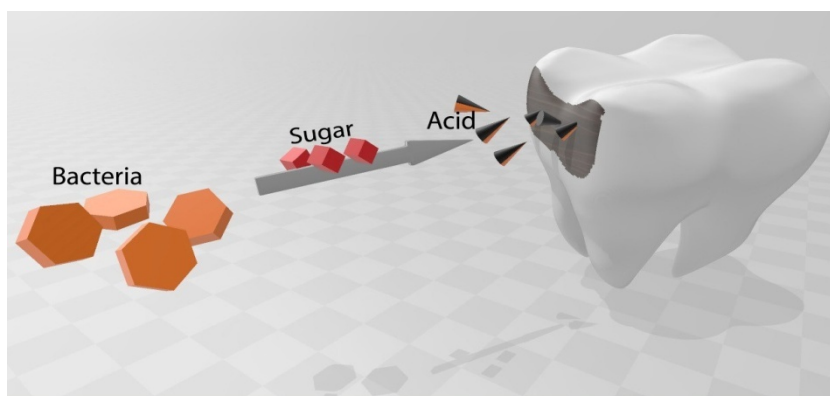


Figura 1 (a). Kiselina, prodire u običan sloj hidroksiapatita ($\text{Ca}_{10}(\text{PO}_4)_6(\text{OH})_2$), uslovljavajući pojavu karijesa

Figure 1 (a). Acid, penetrating the usual layer of hydroxyapatite ($\text{Ca}_{10}(\text{PO}_4)_6(\text{OH})_2$), eventually leading to caries

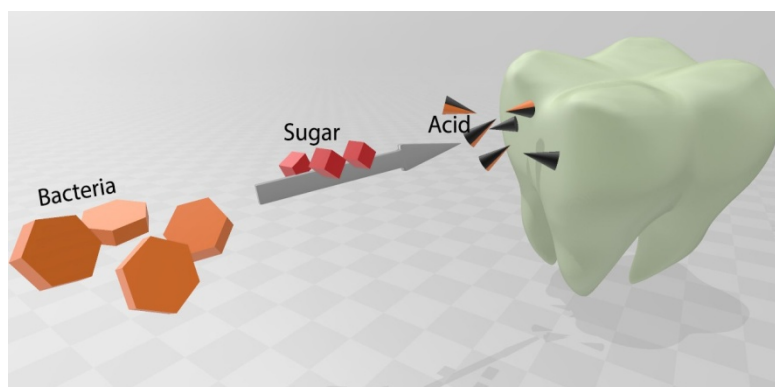


Figura 1 (b). Kiselina, nesposobna da prodre u film fluorapatita ($\text{Ca}_{10}(\text{PO}_4)_6\text{F}_2$), što na prvom mestu sprečava formiranje karijesa

Figure 1 (b). Acid, unable to penetrate the film of fluorapatite ($\text{Ca}_{10}(\text{PO}_4)_6\text{F}_2$), preventing the formation of caries in the first place



Slika 3. Bele mrlje kao rezultat prekomernog unosa fluorida⁴⁴
Picture 3. White flecks as a result of fluorine overdose⁴⁴

Efekti vitamina

Folna kiselina

Deficit folne kiseline je učestala pojava. Prema Vogelu i sar. deficit folne kiseline povezuje se sa teškom formom inflamacije gingive⁴⁵. Osim toga, epitelne ćelije ne mogu efikasno da se dele bez folne kiseline⁴⁶. Iako povezanost između folne kiseline i formiranja i razvoja parodontalnih džepova još uvek nije dovoljno jasna, prema nekim studijama upotreba folne kiseline može biti od značaja za prevenciju inflamacije gingive⁴⁷ i patoloških promena na jeziku koje su vezi sa time kao što su poremećaj govora i mastikacije⁴⁸. Folna kiselina takođe može redukovati patološke promene na jeziku kao što su glositis i papilarna atrofija⁴⁹. Prema Esakiju i sar., povezanost upotrebe folne kiseline i krvarenja gingive u grupi nepušača u Japanu pokazala je da upotreba folne kiseline može biti značajan indikator krvarenja gingive kod odraslih osoba i može obezbediti promociju zdravlja gingive⁵⁰.

Vitamin B₁₂

Kohortna studija koju su sproveli Zong i sar., pokazala je to da je serumski vitamin B₁₂ obrnuto povezan sa progresijom parodontalnog oboljenja i gubitkom zuba⁵¹. Druga studija preseka sprovedena na deci uzrasta od 10 do 14 godina pokazala je to da sistemski deficit vitamina B₁₂ je bio glavni krivac porasta karijesa zuba kod dece i istaknuta je povezanost sa gingivalnim problemima kod ove dece⁵². Slično ovome, deficit vitamina B₁₂ odgovoran je i za pojavu glositisa, kao i atrofiju filiformnih papila²¹.

Vitamin C

Vitamin C takođe ima značajnu ulogu u protekciji parodontalnih tkiva (Slika 4). Amaliya i sar. pronašli su negativnu povezanost nivoa askorbata u plazmi i oštećenja parodonta⁵³.

Effects of vitamins

Folic acid

Deficiency of folic acid is a common issue. According to Vogel et al., folic acid deficiency is related to severe gingival inflammation⁴⁵. Besides it, epithelial cells do not divide properly without folic acid⁴⁶. Although the relation among folic acid, the periodontal pocket formation and development is not quite understood, according to some studies, use of folic acid could be important for the prevention of gingival inflammation⁴⁷ and pathologies related to it, like impeded speech or mastication⁴⁸. Folic acid can also reduce pathologies of the tongue like glossitis and papillary atrophy²¹. A healthy gingiva maintains a healthy periodontal condition⁴⁹. According to Esaki et al., a correlation between intake of folate and gingival bleeding in the non-smoking group in Japan revealed that intake of folic acid could be an important indicator of gingival bleeding in adults and may provide a lead to promote gingival health⁵⁰.

Vitamin B₁₂

In a cohort study conducted by Zong et al., it was revealed that serum vitamin B₁₂ was inversely associated with periodontal progression and risk of tooth loss⁵¹. In another cross-sectional study done on children from 10 to 14 years old, it was found that systemic vitamin B₁₂ deficiency was the main culprit which increased dental caries and associated gingival problems in those children⁵². Similarly, lack of vitamin B₁₂ is also responsible for glossitis and filiform papillary atrophy²¹.

Vitamin C

Vitamin C may also play a significant role in the protection of periodontal tissues (Picture 4). Amaliya et al. have found a negative correlation between plasma ascorbate levels and periodontal breakdown⁵³.



Slika 4(a). Slika parodontalnog tkiva slikana pre davanja askorbinske kiseline. Uočava se rekurentno urastanje gingive nakon druge gingivektomije i pre davanja askorbinske kiseline. Bela polja ukazuju na tipična mesta rekurentnog gingivalnog urastanja⁵⁵

Picture 4(a). Periodontal images taken before ascorbic acid supplementation. Recurrent gingival overgrowth observed after the second gingivectomy and before ascorbic acid supplementation. The white arrows indicate typical sites of recurrent gingival overgrowth⁵⁵



Slika 4 (b). Slika parodontalnog tkiva slikanja 9 meseci nakon uzimanja askorbinske kiseline⁵⁵

Picture 4 (b): Periodontal images taken after 9 months of ascorbic acid supplementation⁵⁵

Paillaud i sar. pružili su drugi dokaz o povećanom riziku od nastanka parodontalnih oboljenja usled deficita vitamina C⁵⁴. Osim toga, pronađeno je to da blagi deficit vitamina C je povezan sa obimnim urastanjem gingive u prisustvu metaboličkog sindroma i teške parodontalne infekcije⁵⁵. Kao dodatak ovome, autori su pokazali i povezanost deficijencije vitamin C sa gingivitisom, ulceracijama u usnoj duplji, i nekoliko abnormalnosti gingive (sunderasta gingiva, krvarenje, izrazito crvena gingiva)^{21,53}. Deficit vitamina C takođe može biti značajan nezavisni faktor rizika od pojave oralne kandidijaze⁵⁶, međutim potrebno je više studija kako bi se utvrdo tačan uticaj pojedinačnog antioksidansa na prevenciju parodontopatije. Velika parodontalna studija sprovedena na Medicinskom i dentalnom univerzitetu u Tokiju pokazala je to da askorbinska kiselina može pojačati aktivnost i povećati ekspresiju $\alpha\beta 1$ integrina.

Paillaud et al. discovered another evidence of increased risks of periodontitis caused by vitamin C deficiency⁵⁴. Moreover, it has been found that mild deficiency of vitamin C is associated with extensive gingival outgrowth in the presence of metabolic syndrome and severe periodontal infection⁵⁵. In addition to it, authors have shown an association among deficiency of vitamin C and gingivitis, ulcer in the oral cavity and several gingival abnormalities (spongy, bleeding, abnormal redness)^{21,53}. Vitamin C deficiency can also be one of the most significant independent risk factors for oral candidiasis⁵⁶. But more studies are needed to understand the impact of every exact antioxidant in periodontitis prevention. In a huge study of periodontology atTokyo Medical and Dental University, it was found thatascorbic acid may enhance alkaline phosphatase activity in periodontal ligament cells and also may increase the expression of $\alpha\beta 1$ integrin.

To je veliki receptor za kolagen tip I, koji može da obezbedi osteoplastnu diferencijaciju ćelija parodontalnog ligamenta modulacijom interakcije kolagen tipa I- α 2 β 1 integrin⁵⁷. Shiga i sar., sugerišu to da askorbinska kiselina dovodi do novog pojačanja u nivou kolagane tip I, ali ne može da poveća aktivnost alkalne fosfataze ili osteoklaste m RNK u ćelijama parodontalnog ligamenta⁵⁸.

Vitamin A

Vitamin A je od značaja za očuvanje epitelnih tkiva, te njegova deficijencija može dovesti do gingivitisa, gingivalne hipoplazije, proliferacije vratnog epitela i resorpcije alveolarnih delova vilice⁵⁹. Prema Chapple i sar., ispitivanjem 11.480 odraslih osoba tokom trećeg Nacionalnog ispitivanja zdravstvenog stanja i ishrane (NIZSI III), utvrđeno je da je teška forma parodontopatije povezana sa likopenom, α -karotenom, β -karotenom, β -kriptoksantinom i deficitom vitamina A⁶⁰. Analiza četvrtog Korejskog Nacionalnog ispitivanja zdravstvenog stanja i ishrane pokazala je to da deficit vitamina A može biti povezana sa parodontopatijom kod mladih žena⁶¹. Proteini, malnutricija i deficit vitamin A mogu izazvati atrofiju pljuvačnih žlezda, što redukuje protok pljuvačke i puferski kapacitet pljuvačke, sa mogućim smanjenjem uloge pljuvačke u čišćenju usne duplje i puferskog uticaja na kiseline dentalnog plaka. Slično, tome deficit vitamina A, vitamina D i protein-energetska malnutricija (PEM) mogu se dovesti u vezu sa gleđnom hipoplazijom⁶². Deficit vitamina A može usloviti i kserostomiju, smanjiti otpornost na infekcije, narušiti antiinflamatorni odgovor i narušiti rast zuba^{21,43}. S druge strane, višak vitamina A dovodi do heilitisa, gingivitisa i narušava zarastanje rana⁶³.

Vitamin D

Primarna funkcija vitamina D je povećanje intestinalne apsorpcije kalcijuma i resorpcije kalcijuma na nivou bubrega, kao i regulacija metabolizma kostiju²⁴. Na sličan način vitamin D povećava mineralizaciju gleđi i dentina zuba. Vitamin D ne samo da utiče na mineralnu gustinu kostiju, već ima antiinflamatorna svojstva kao i sposobnost da stimuliše produkciju antiinflamatornih peptida⁶⁴. Slično tome, na razvoj karijesa u prisustvu ugljenih hidrata mogu uticati mikronutrijenti kao što je vitamin D₃.

It is a major receptor of type I collagen, which can promote the osteoblastic differentiation of periodontal ligament cells by modulating type I collagen- α 2 β 1 integrin interaction⁵⁷. Shiga et al. suggest that ascorbic acid causes substantial enhancement in levels of type I collagen but is unable to increase alkaline phosphatase activity or osteocalcin messenger RNA in periodontal ligament cells⁵⁸.

Vitamin A

Vitamin A is important in maintaining the epithelial tissues and a deficiency of it can cause gingivitis, gingival hypoplasia, proliferation of crevicular epithelium and resorption of alveolar parts of jaws⁵⁹. According to Chapple et al., by examining 11.480 adults from the third National Health and Nutrition Examination Survey (NHANES III), severe periodontitis was associated with lycopen, α -carotene, β -carotene, β -cryptoxanthine and vitamin A deficiency⁶⁰. In an analysis of the Fourth Korean National Health and Nutrition Examination Survey, a deficiency of vitamin A could be associated with periodontitis in young women⁶¹. Protein, energy malnutrition and vitamin A deficiency can cause atrophy of the salivary glands, which reduces the flow of saliva and buffering capacity, eventually decreasing the cleansing action of saliva and ability to buffer plaque acids. Similarly, lack of vitamin A, vitamin D and protein-energy malnutrition (PEM) can be associated with enamel hypoplasia⁶². Vitamin A deficiency can also lead to xerostomia, reduced resistance to infections, depressed anti-inflammatory response and also impaired growth of the teeth^{21,43}. On the other hand, excess of vitamin A can lead to cheilitis, gingivitis and impaired healing⁶³.

Vitamin D

The primary function of vitamin D is to increase intestinal calcium absorption and calcium reabsorption from kidneys and to regulate bone metabolism²⁴. In the same way, vitamin D increases teeth dentin and enamel mineralization. Vitamin D not only affects bone mineral density but also has anti-inflammatory actions and the ability to stimulate the production of anti-microbial peptides⁶⁴. Similarly, the development of caries in the presence of carbohydrates may be influenced by micronutrients such as vitamin D₃.

Postoje dokazi da se vitamin D može dovesti u vezu i sa povećanim rizikom za pojavu hronične parodontopatije⁶⁵. Prema Van der Veldenu i sar., svakodnevno konzumiranje hrane koja sadrži dovoljno antioksidanasa, vitamina D i kalcijuma može sprječiti i lečiti parodontopatiju⁶⁶. Antiinflamatorni efekat vitamina D može pozitivno uticati na parodontalna tkiva, smanjiti parodontopatiju i gubitak zuba⁶⁷ (jačanjem potpornih struktura zuba²¹) kao i inflamacije gingive⁶⁸. Takođe, kalciferol poseduje imunomodulatornu aktivnost, koja može da utiče na parodontalno oboljenje, dok parodontopatija utiče na sistemski imuni odgovor⁶⁹.

Vitamin E

Vitamin E je antioksidans čiji nedostatak može biti povezan sa oralnim kancerom²⁷. Srećom, nedostatak vitamina E je retka pojava i simptomi nedostaka ovog vitamina retko se viđaju kod zdravih osoba koja dobijaju samo malu količinu vitamina E putem hrane⁷⁰. Deficit vitamina E, sekundarno u odnosu na abetalipoproteinemiju dovodi do problema kao što je slabost mišića, loša transmisija nervnih impulsa, i degeneracija retinala koja dovodi do slepila⁷¹. Slično tome njegova deficijencija može dovesti do supresije antiinflamatornog sistema i depresije imunog odgovora mekih oralnih tkiva²¹.

Rizične grupe od deficijencije mikronutrijentima

Postoji dosta mikronutrijenata koji su potrebni za normalno funkcionisanje usne duplje. Postoje određena stanja prilikom kojih određene grupe ljudi mogu biti u većem riziku od deficita specifičnih vitamina ili elemenata.

Grupa ljudi sa određenim bolestima

Velika deo ove grupe ljudi čine ljudi sa inflamatornim oboljenjem creva, kao što je Kronova bolest i celijakija ili osobe koje su podvrgnute hirurškim zahvatima na želucu. Ovi ljudi su uskraćeni za apsorpciju određenih nutrijenata unetih hranom i u čestom su deficitu kao što je bakar⁷², cink^{73,74}, kalijum⁷⁵, magnezijum⁷⁶, vitamin D⁷⁷, vitamin E⁶⁴, vitamin B₁₂⁷⁸, vitamin B₉⁷⁹, vitamin C⁸⁰ i vitamin B₁.

Osobe sa oboljenjem bubrega takođe su u deficitu od pojedinih nutrijenata na primer vitamin C⁸², vitamin B₆⁸³ i selen⁸⁴ imaju niže

There is an evidence that vitamin D can be related to increased risk of chronic periodontitis⁶⁵. According to Van der Velden et al., consuming enough daily nutrition that covers sufficient antioxidants, vitamin D and calcium can prevent and treat periodontitis⁶⁶. Anti-inflammatory effects of vitamin D may have positive effects in periodontal tissues, in decreasing periodontal disease and tooth loss⁶⁷ (by increasing strength to anchor tooth structure²¹) as well as gingival inflammation⁶⁸. Also, calciferols have an immunomodulatory activity that can affect the periodontal disease as well, while periodontitis influences the systematic immune response⁶⁹.

Vitamin E

Vitamin E is an antioxidant whose deficiency may be associated with oral cancer²⁷. Fortunately, vitamin E deficiency is a rare situation and deficiency symptoms have not been found in healthy people who obtain even little vitamin E from their diets⁷⁰. Vitamin E deficiency, secondary to abetalipoproteinemia causes problems like muscle weakness, poor transmission of nerve impulses, and retinal degeneration that leads to blindness⁷¹. Similarly, its deficiency can lead to suppressed anti-inflammatory system and depressed immune response of oral soft tissue²¹.

Risk groups for micronutrient deficiencies

There are a lot of micronutrients that are required for the proper functioning of the oral cavity. There exist certain conditions, when a particular group of people could be at higher risk of being deficit in specific vitamins or elements.

Groups with certain diseases

One of the major group of people is individual with inflammatory bowel disease, like Crohn's disease and celiac disease, or an individual who has undergone through gastric surgery. These people are abstained from absorbing proper nutrients from the consumed food and frequently lack copper⁷², zinc^{73,74}, potassium⁷⁵, magnesium⁷⁶, vitamin D⁷⁷, vitamin E⁶⁴, vitamin B₁₂⁷⁸, vitamin B₉⁷⁹, vitamin C⁸⁰ and vitamin B₁⁸¹.

People suffering from kidney failures are also in the risk of lacking some nutrients.

serumske vrednosti kod pacijenta sa terminalnim bubrežnim oboljenjem jer se određena količina selena eliminiše hemodijalizom. Vitamin C i aktivna forma vitamina B₆ takođe ima pojačani gubitak putem mokraće kada je funkcija bubrega narušena^{82,83}.

Dijabetes je sledeće oboljenje koje može usloviti deficit u pojedinim nutrijentima. Kod dijabetičara, postoji povećani klirens vitamina B₁⁸⁵ i magnezijuma⁸⁶. Slično, pacijenti sa uznapredovalim karcinomima gube veliku količinu krvi, što dovodi do gubitka gvožđa⁸⁷. Osim toga, odrasle osobe mogu imati deficit vitamina B₁ usled smanjene apsorpcije^{88,89} odnosno vitamina D usled smanjene sposobnosti kože da ovaj vitamin sintetiše efikasno, kao što je to slučaj kod mlađih osoba⁹⁰.

Grupa ljudi sa posebnim fiziološkim stanjima

Veliki deo grupe ljudi sa posebnim fiziološkim stanjima čine trudnice i novorođenčad. Trudnice imaju veliku potrebu za određenim vitaminima i hranljivim sastojcima, koje, ako se ne nadoknade, lako mogu dovesti do deficita vitamina A⁹¹, vitamina B₉⁹², vitamina B₁₂⁹³, gvožđa⁹⁴ i cinka⁹⁵. S druge strane, novorođenčad ima mali depo nekih vitamina i hranljivih sastojaka, a zbog njihove specifične ishrane oni su u velikom riziku od nedostatka vitamina C⁹⁶, vitamina B₁₂⁹³, vitamina E⁹⁷, vitamina A^{98,100}, vitamina D¹⁰¹ i gvožđa^{102,103}.

Druge grupa pojedinaca povezana je sa široko rasprostranjenim društvenim problemom, alkoholizmom. Poremećaji upotrebe alkohola obično sprečavaju prekid metabolizma cinka¹⁰⁴, vitamina B₁¹⁰⁵, folata¹⁰⁶. Hronični alkoholizam takođe može dovesti do povraćanja, dijareje i bubrežne disfunkcije, što rezultira gubljenjem hranljivih sastojaka poput magnezijuma¹⁰⁷, folata¹⁰⁶. Konačno, metaboliti alkohola mogu se takmičiti sa aktivnim oblicima nekih vitamina, poput vitamina B₆, te postaje podložan hidrolizi¹⁰⁸.

Vegetarijanci i vegani

Nemoguće je zanemariti još jednu grupu, tačnije dve grupe, koje su u riziku od nedostatka mikroelemenata - vegetarijanci i vegani¹⁰⁹. Nedostatak ribe u ishrani u velikoj meri povećava rizik od nedostatka vitamina D kod vegana¹¹⁰. Vegetarijanci delimično ispunjavaju svoje potrebe za kalciferolom

For example, vitamin C⁸², vitamin B₆⁸³ and selenium⁸⁴ have lower serum concentration in the patients suffering from terminal kidney disease because some amount of selenium is removed in haemodialysis. Vitamin C and the active form of vitamin B₆ also have a high urinary loss if renal functions are impaired^{82,83}.

Diabetes is the next disease, which can cause a deficiency in some nutrients. In diabetic patients, there is increased clearance of vitamin B₁⁸⁵ and magnesium⁸⁶. Similarly, cancer patients with disintegrating tumour lose a high amount of blood, making them deficient in iron⁸⁷. Furthermore, older individuals can lack vitamin B₁ due to its decreased absorption^{88,89} and vitamin D due to the decreased ability of their skin to synthesize it as efficiently as the skin of young people⁹⁰.

Groups with certain physiological state

A major group of people with specific physiological states are pregnant women and infants. Pregnant women have a high demand for some vitamins and nutrients, if not replenished, they can easily have a deficiency of vitamin A⁹¹, vitamin B₉⁹², vitamin B₁₂⁹³, iron⁹⁴ and zinc⁹⁵. On the other hand, infants have small storage of some vitamins and nutrients, and due to their specific diet, they are at higher risk of having deficiency of vitamin C⁹⁶, vitamin B₁₂⁹³, vitamin E⁹⁷, vitamin A⁹⁸⁻¹⁰⁰, vitamin D¹⁰¹ and iron^{102,103}.

Another group of individuals is related to a widely spread social problem, alcoholism. The alcohol use disorder usually impedes the absorption of zinc¹⁰⁴, vitamin B₁¹⁰⁵, folate¹⁰⁶. Chronic alcoholism can also lead to vomiting, diarrhoea, and renal dysfunction, resulting in depletion of nutrients like magnesium¹⁰⁷ or folate¹⁰⁶. Finally, metabolites of alcohol can compete with active forms of some vitamins, like vitamin B₆, which makes it more susceptible to hydrolysis¹⁰⁸.

Vegetarians and vegans

It is impossible to ignore one more group, more precisely - two groups that have their own risks of micronutrient deficiencies - vegetarians and vegans¹⁰⁹. Lack of fish in the diet greatly increases the risk of vitamin D deficiency in vegans¹¹⁰. Vegetarians partially meet their calciferol needs with eggs¹¹¹. Although there is a risk of deficiency of vitamin D for people living in high latitudes with any diet¹¹².

konzumiranjem jaja¹¹¹. Takođe postoji rizik od nedostatka vitamina D kod ljudi koji žive na većim geografskim širinama bez obzira na ishranu¹¹².

Sa druge strane, nedostatak vitamina D značajno smanjuje apsorpciju kalcijuma, zbog čega vegani najverovatnije imaju manjak kalcijuma¹¹³. Štaviše, biljni derivati često sadrže fitinsku i oksalnu kiselinu, što sprečava apsorpciju kalcijuma, magnezijuma, cinka i drugih metala^{37,114,115}. Nasuprot tome, vegetarijanci imaju tendenciju da konzumiraju velike količine visokodostupnog kalcijuma¹¹⁶ i malo više vitamina D od vegana¹¹⁷. Vegetarijanci i vegani takođe su podložniji nedostatku selen^{118,119}.

Još jedan kritičan mikronutrijent za vegetarijance, a posebno za vegane je vitamin B₁₂. Ovaj vitamin se u biljkama ne akumulira u dovoljnim količinama. Stoga je jedini izvor za ljude hrana životinjskog porekla¹²⁰.

Postoje određene grupe ljudi sa određenim potrebama u ishrani, na primer dijabetičari i gojazni pacijenti zahtevaju znatno veće količine hroma i vanadijuma^{121,122}, a vegetarijanci i vegani imaju veću verovatnoću da imaju nedostatak ω -3 PUFAs¹²³ i joda^{124,125}, u odnosu na ljude na standardnom režimu ishrane. Međutim, nisu pronađeni značajni efekti ovih mikroelemenata na usnu duplju.

Slično tome, adekvatan unos mikroelemenata (cinka, bakara, vitamina C, vitamina A, vitamina E) ne samo da održava higijenu usne duplje, već održava i nivo antioksidansa, što smanjuje zapaljenski proces u usnoj duplji¹²⁶. Treba napomenuti to da ostatak mikronutrijenata ne treba zanemariti, jer svi oni imaju sistemski efekat, koji takođe na kraju utiče na usnu duplju. U članku smo razmotrili samo one mikroelemente koji imaju direktne efekte na usnu duplju i čiji su efekti dobro utvrđeni kliničkim studijama.

Vitamin D deficiency, on the other hand, significantly reduces calcium absorption, that's why vegans are likely to be calcium deficient¹¹³. Moreover, plant derivatives often contain phytic and oxalic acids, which impedes the absorption of calcium, magnesium, zinc and other metals^{37,114,115}. In contrast, vegetarians tend to consume large amounts of highly available calcium¹¹⁶ and a little more of vitamin D than vegans¹¹⁷. Vegetarians and vegans are also more prone to selenium deficiency^{118,119}.

One more critical micronutrient for vegetarians, and especially for vegans, is vitamin B₁₂. The vitamin is not accumulated in plants in enough amounts. Therefore, its only source for humans is animal-derived food¹²⁰.

There are certain groups of people with specific diet requirement. For instance, diabetic and obese patients require significantly higher amounts of chromium and vanadium^{121,122}, and vegetarians and vegans are more likely to be deficient in ω -3 PUFAs¹²³ and iodine^{124,125} than omnivores. However, the significant effects of these micronutrients on the oral cavity were not found.

Similarly, adequate intake of micronutrients (zinc, copper, vitamin C, vitamin A, vitamin E) not only sustain hygiene of the oral cavity but also maintain antioxidant level, which decreases inflammatory process in the oral cavity¹²⁶. It is to be noted that the rest of the micronutrients should not be ignored, since all of them have a systemic effect, which also eventually affects the oral cavity. The article has considered only those micronutrients which have direct effects on the oral cavity and whose effects have been well-established by clinical studies.

Zaključak

Zbog znatno većeg rizika od poremećaja u metabolizmu kalcijuma, usled nedostatka vitamina D i slabe apsorpcije kalcijuma u crevima, vegani bi trebalo da budu izuzetno oprezni u pogledu metabolizma minerala tvrdih zubnih tkiva. i nedostatak selena kod vegetarijanaca i vegana takođe povećava rizik od kvarenja zuba.

Deca, trudnice i dojilje takođe treba da budu svesni depresije antiinflamatornog i imunološkog odgovora mekih tkiva usne duplje, zato što su ove kategorije često u deficitu vitamina C, B₁₂, E, A, D i gvožđa.

Slično tome, ljudi koji konzumiraju alkohol trebalo bi da budu oprezni u pogledu statusa vitamina B₁, folata, cinka i magnezijuma i preduzmu odgovarajuće mere predostrožnosti, pre svega upotrebom suplemenata deficitarnih nutrijenta. Nedostatak vitamina B₉ i magnezijuma povećava rizik od parodontopatije a nedostatak cinka može prouzrokovati smanjenje osećaja ukusa, ulceracije, zaravnjenje filiformnih papila i kserostomiju.

Dalje, osobe sa hroničnim inflamatornim bolestima creva treba da budu svesne da su u deficitu sa cinkom, kalijumom, magnezijumom, vitaminima D, E, B₁₂, B₉, C i vitaminom B₁. Nedovoljna količina vitamina C, vitamina B₉, vitamina E, vitamina D i magnezijuma može dovesti do parodontalne bolesti, gingivitisa, ulceracija u usnoj duplji, pa čak i do depresije antiinflamatornog i imunološkog odgovora mekih tkiva usne duplje. S druge strane, angularni heilitis uzrokuje nedostatak vitamina B₁ i vitamina B₁₂, a rizik od oralnog karcinoma verovatno će biti povećan usled deficita vitamina B₉ i vitamina E. Dalje, kalijum je jedan od krivaca za nastanak karijesa, dok je cink krivac za zaravnjanje filiformnih papila, ulceraciju i kserostomiju.

Konačno, ljudi sa oboljenjem bubrega treba da vode računa o statusu vitamina C, vitamina B₆ i selena u cilju sprečavanja depresije antiinflamatornog i imunološkog odgovora mekih tkiva usne duplje, parodontalne bolesti i karijesa.

Dijabetičari se često mogu suočiti sa angularnim heilitisom, koji nastaje kao posledica deficit vitamina B₁. Još jedan čest problem kod dijabetičara je deficita magnezijuma, koji povećava rizik od pojave parodontopatije, naročito u ovoj populaciji.

Conclusion

Due to significantly higher risk of impaired calcium metabolism as a result of vitamin D deficiency, and poor absorption of calcium in the intestine, vegans should be extremely careful about mineral metabolism in hard tissues. Selenium deficiency also increases the risk of tooth decay in vegetarians and vegans.

Children, pregnant women and breastfeeding mothers should also be aware of depressed anti-inflammatory and immune response of oral soft tissues because they often lack vitamins C, B₁₂, E, A, D and iron.

Similarly, people who indulge in alcohol should be careful about their status of vitamin B₁, folate, zinc and magnesium, and take a preliminary precaution by taking their supplements. Lack of vitamin B₉ and magnesium increase risk of periodontitis, and zinc deficiency can cause a decrease in taste sensation, ulcers, flattened filiform papillae and xerostomia.

Furthermore, individuals with chronic inflammatory bowel diseases should be aware of developing zinc, potassium, magnesium, vitamin D, vitamin E, vitamin B₁₂, vitamin B₉, vitamin C and vitamin B₁ deficiency. Insufficient amount of vitamin C, vitamin B₉, vitamin E, vitamin D and magnesium can lead to periodontal disease, gingivitis, ulcer of the oral cavity and even depressed anti-inflammatory and immune response of oral soft tissues. On the other hand, angular cheilosis is caused by lack of vitamin B₁ and vitamin B₁₂, and oral cancer risk is likely to be increased in vitamin B₉ and vitamin E deficient state. Furthermore, potassium deficiency is one of the culprits for dental caries, while zinc deficiency is the culprit for flattened filiform papillae, ulcers, and xerostomia.

Finally, people with kidney diseases ought to take care of vitamin C, vitamin B₆ and selenium status for preventing depressed anti-inflammatory and immune response of oral soft tissues, periodontal disease and dental caries respectively.

Diabetic patients can often face with angular cheilosis due to vitamin B₁ deficiency. Another common problem among diabetic patients is magnesium deficiency, which increases periodontitis risks especially in this population.

Conflict of interest

Declarations of interest: none

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