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BOLALARDA QANDLI DIABET MONITORINGIDA SO'LAKDAGI GLYUKOZA DARAJASINING AHAMIYATI

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Annotatsiya.

Ushbu ilmiy maqolada 1-tip qandli diabet bilan kasallangan bolalarda so'lakdagi glyukoza miqdorini aniqlashning diagnostik va amaliy ahamiyati o'rganildi. Tadqiqot Toshkent davlat tibbiyot universiteti va Respublika ixtisoslashtirilgan endokrinologiya ilmiy-amaliy tibbiyot markazida 6–16 yoshli bolalar o'rtasida o'tkazildi. Tadqiqot ishtirokchilari glikemik ko'rsatkichlari va parodont to'qimalarining klinik holatiga ko'ra uch guruhga bo'lindi. Qon va so'lakdagi glyukoza miqdorlari aniqlanib, ularning o'zaro bog'liqligi statistik tahlil qilindi. Olingan natijalar so'lakdagi glyukoza darajasi bilan qondagi glyukoza o'rtasida kuchli musbat korrelyatsiya ($r = 0.81$; $p < 0.05$) mavjudligini ko'rsatdi. Ushbu yondashuv 1-tip qandli diabetni monitoring qilishda, glyukemik nazoratni baholashda va bolalarda og'riqsiz noinvaziv diagnostika sifatida amaliy qo'llanilishi mumkin.

Kalit so'zlar: 1-tip qandli diabet, so'lak, glyukoza, noinvaziv diagnostika, bolalar, glikemik nazorat.

Аннотация.

В статье изучена диагностическая и практическая значимость определения уровня глюкозы в слюне у детей, больных сахарным диабетом 1 типа. Исследование проведено в Ташкентском государственном медицинском университете и Республиканском специализированном научно-практическом центре эндокринологии среди детей в возрасте 6–16 лет. Участники были разделены на три группы в зависимости от уровня гликемии и состояния пародонта. Определены показатели глюкозы в крови и слюне, проведён корреляционный анализ. Установлена сильная положительная корреляция между уровнем глюкозы в слюне и крови ($r = 0.81$; $p < 0.05$). Полученные результаты подтверждают возможность использования анализа слюны как неинвазивного метода диагностики и мониторинга гликемического контроля у детей с сахарным диабетом 1 типа.

Ключевые слова: сахарный диабет 1 типа, слюна, глюкоза, неинвазивная диагностика, дети, гликемический контроль.

Abstract.

This study investigates the diagnostic and practical significance of salivary glucose measurement in children with type 1 diabetes mellitus. The research was conducted at Tashkent State Dental University and the Republican Specialized Scientific and Practical Medical Center of Endocrinology among children aged 6–16 years. Participants were divided into three groups according to their glycemic status and periodontal condition. Glucose concentrations in blood and saliva were measured, and correlation analysis was performed. A strong positive correlation ($r = 0.81$; $p < 0.05$) was found between salivary and blood glucose levels. The results demonstrate that salivary glucose assessment can serve as a reliable, non-invasive, and cost-effective diagnostic tool for monitoring glycemic control in children with type 1 diabetes.

Keywords: type 1 diabetes mellitus, saliva, glucose, non-invasive diagnosis, children, glycemic control.

So'nggi o'n yilliklarda butun dunyo bo'ylab 1-tip qandli diabet bilan og'rigan bolalar sonining ortib borayotgani tibbiyot fanida ham, sog'lom avlodni shakllantirish siyosatida ham dolzarb muammo sifatida qaralmoqda. Jahon sog'liqni saqlash tashkiloti (JSST) ma'lumotlariga ko'ra, 1-tip qandli diabet bolalik va o'smirlik davrida eng ko'p uchraydigan endokrin kasalliklardan biri bo'lib, bolalar orasida nogironlik va o'lim sabablari ichida muhim o'rinni egallaydi [1,3].

Ushbu kasallikning asosiy patogenezida oshqozon osti bezining β -hujayralarining autoimmun destruksiya natijasida insulin sekresiyasining keskin kamayishi yoki to'xtashi yotadi. Natijada organizmda giperglikemiya, suv-elektrolit almashinuvi buzilishi, metabolik asidoz va boshqa murakkab o'zgarishlar rivojlanadi [4,5].

Qandli diabetning bunday tizimli ta'siri nafaqat qon tarkibiga, balki barcha biologik suyuqliklarga, shu jumladan so'lak, siydik, ko'z yoshi suyuqligi va ter ajralmasiga ham sezilarli ta'sir ko'rsatadi [6].

So'nggi yillarda so'lak diagnostikasi (salivodiagnostika) fani jadal rivojlanmoqda. Bu yo'nalishning asosiy afzalligi — noinvaziv, og'riqsiz, xavfsiz va takroran tahlil qilish mumkinligi bilan izohlanadi. Ayniqsa, bolalar orasida qon olish jarayoni ko'p hollarda stress holatini chaqiradi. Shu sababli so'lak asosidagi diagnostika usullari pediatriya va stomatologiyada tobora keng qo'llanilmoqda [7,9].

Qandli diabetda so'lak bezlarining sekreti faoliyati, biokimyoviy tarkibi, shuningdek mikrobiologik holati sezilarli darajada o'zgaradi. Tadqiqotlar shuni ko'rsatadiki, so'lakdagi glyukoza miqdori qondagi glyukoza darajasi bilan bevosita bog'liq, ya'ni glikemik o'zgarishlar so'lakda ham aks etadi [10,12]. Shu bois, so'lak tahlili yordamida diabet holatini baholash klinik diagnostikaning istiqbolli yo'nalishlaridan biri hisoblanadi [13].

1-tip qandli diabet bilan og'rigan bolalarda so'lakdagi glyukoza darajasining o'zgarishini aniqlash orqali giperglikemiya,

metabolik disbalans, og'iz bo'shlig'ining morfologik va funksional o'zgarishlarini erta bosqichda aniqlash mumkin. Bu esa kasallikning og'ir asoratlarini (gingivit, parodontit, kariyes, stomatit) oldini olish, shuningdek glyukemik nazoratni soddalashtirish imkonini beradi [14,16].

Shunday qilib, mazkur mavzuning dolzarbligi shundan iboratki, 1-tip qandli diabet bilan og'rigan bolalarda qonda va so'lakda glyukoza darajasi o'rtasidagi korrelyatsiyani aniqlash orqali so'lak tahlilini diabetni nazorat qilishda muhim, invaziv bo'lmagan diagnostik vosita sifatida qo'llash imkoniyati aniqlanadi [17,20].

Tadqiqotning maqsadi: 1-tip qandli diabet bilan kasallangan bolalarda qonda va so'lakda glyukoza miqdorini aniqlash hamda ularning o'zaro bog'liqligini baholash orqali so'lak tahlilining diagnostik ahamiyatini aniqlash. Tadqiqotning asosiy vazifalari. 1-tip qandli diabet bilan kasallangan bolalarda qondagi glyukoza miqdorini o'lchash va uni nazorat guruhi bilan taqqoslash.

So'lakdagi glyukoza konsentratsiyasini aniqlash uchun mos biokimyoviy usulni tanlash va qo'llash. Qon va so'lakdagi glyukoza ko'rsatkichlari o'rtasidagi o'zaro bog'liqlikni (korrelyatsiyani) statistik jihatdan tahlil qilish.

So'lak tahlilining qandli diabet tashxisidagi noinvaziv muqobil sifatida qo'llanish imkoniyatini aniqlash. Olingan natijalar asosida bolalar stomatologiyasi amaliyotida qo'llash uchun amaliy tavsiyalar ishlab chiqish.

TADQIQOT MATERIALI VA METODLARI

Tadqiqot 2023–2025-yillar davomida Toshkent davlat tibbiyot universiteti va Akademik Y.X. To'raqulov nomidagi Respublika ixtisoslashtirilgan endokrinologiya ilmiy-amaliy tibbiyot markazi, shuningdek, 2-sonli bolalar stomatologiya klinikasi bazasida o'tkazildi. Ishda klinik, biokimyoviy va statistik usullar qo'llanildi.

Tadqiqotga jami 90 nafar 6–16 yosh oralig'idagi bolalar jalb etildi. Ular sog'lig'i holatiga ko'ra uch guruhga ajratildi:

1-guruh (asosiy): 1-tip qandli diabet bilan kasallangan, parodont o'zgarishlari aniqlangan 30 nafar bola;

2-guruh (taqqoslovchi): 1-tip qandli diabet bilan kasallangan, ammo parodont holati nisbatan sog'lom bo'lgan 30 nafar bola;

3-guruh (nazorat): qandli diabet aniqlanmagan, parodont holati sog'lom 30 nafar bola.

Klinik tekshiruv bosqichlari:

Og'iz bo'shlig'ining klinik holati baholashda quyidagi indekslardan foydalanildi:

-OHI-S (Green–Vermillion, 1964) — og'iz gigiyenasi indeksi;

-GI (Löe–Silness, 1963) — gingival yallig'lanish indeksi;

-PI (Russell, 1956) — parodont indeksi;

-BOP (Bleeding on Probing) — qon ketishning mavjudlik darajasi (%).

Klinik tekshiruvlar steril instrumentlar yordamida, bir xil sharoitda o'tkazildi.

So'lak namunalarini yig'ish. So'lak ertalab, och qoringa, og'izni yuvmasdan yig'ildi. Har bir boladan 0.5–1.0 ml hajmdagi stimulyatsiyasiz so'lak steril mikroprobirka-larga yig'ildi. So'lakdagi glyukoza miqdori enzimatik kolorimetrik usul (glyukoza oksidaza–peroksidaza reaksiyasi) yordamida aniqlangan. Natijalar mmol/L birlikda ifodalandi.

Qondagi glyukoza miqdorini o'lchash

Qondagi glyukoza miqdori glyukometr (Accu-Chek Active, Roche Diagnostics, Germaniya) yordamida baholandi. Har bir bola uchun so'lak olish bilan bir vaqtda kapillyar 1-jadval.

Qon va so'lakdagi glyukoza miqdori guruhlar bo'yicha

Guruhlar	Qondagi glyukoza (mmol/L, M±SD)	So'lakdagi glyukoza (mmol/L, M±SD)
1-guruh (Qandli diabet + parodontda o'zgarish)	11.6 ± 2.8	1.62 ± 0.62
2-guruh (Qandli diabet, parodont sog'lom)	8.2 ± 1.9	0.85 ± 0.07
3-guruh (Nazorat)	5.1 ± 0.7	0.65 ± 0.08

qon namunasi olindi. Glyukoza ko'rsatkichlari mmol/L da qayd etildi.

Statistik tahlil

Olingan ma'lumotlar Microsoft Excel 2021 va SPSS 25.0 dasturlari yordamida tahlil qilindi. Natijalar o'rtacha qiymat (M), standart og'ish (SD) shaklida ifodalandi. Guruhlararo farqlarni baholashda: -Student t-testi, -Mann–Whitney U-testi, -Pearson korrelyatsiya tahlili (r) qo'llanildi.

Farq $p < 0.05$ qiymatida statistik jihatdan ishonchli deb qabul qilindi.

TADQIQOT NATIJALARI

Ishtirokchilarning umumiy tavsifi

Tadqiqotga jalb etilgan 90 nafar bola (6–16 yosh) uch guruhga bo'lindi:

1-guruh — 1-tip qandli diabet bilan kasallangan va parodont o'zgarishlari mavjud bo'lgan 30 nafar bola; 2-guruh — 1-tip qandli diabet bilan kasallangan, ammo parodont sog'lom bo'lgan 30 nafar bola; 3-guruh — sog'lom (nazorat) bolalar, 30 nafar.

Barcha ishtirokchilarda yosh, jins va umumiy somatik holat bo'yicha sezilarli farq kuzatilmadi ($p > 0.05$), bu esa tadqiqot guruhlarini o'rtasida ma'lumotlarni taqqoslash imkonini berdi. Qonda va so'lakda glyukoza darajalari

O'tkazilgan tahlillar natijasida aniqlanishicha, qondagi glyukoza o'rtacha miqdori 9.61 ± 3.02 mmol/L, so'lakdagi glyukoza esa 1.35 ± 0.64 mmol/L ni tashkil etdi. So'lakdagi glyukoza darajasi qandli diabetning og'irlik darajasi bilan bevosita bog'liq ekani kuzatildi (1-jadval).

Soʻlakdagi glyukoza miqdori qandli diabetli bolalarda nazorat guruhiga nisbatan 2,5 baravar yuqori boʻlib chiqdi ($p < 0.05$).

Shuningdek, qon va soʻlak glyukoza darajalari oʻrtasida kuchli ijobiy korrelyatsiya aniqlangan ($r = 0.81$; $p = 0.0042$).

Bu esa soʻlakdagi glyukoza konsentratsiyasi qondagi glyukemik nazoratni baholashda **2-jadval**

Parodont indekslari guruhlar boʻyicha ($M \pm SD$)

Koʻrsatkich	1-guruh (Qandli diabet va parodontda oʻzgarish)	2-guruh (Qandli diabet, parodont sogʻlom)	3-guruh (Nazorat)
OHI-S	2.3 ± 0.4	1.2 ± 0.3	0.8 ± 0.2
GI	1.9 ± 0.3	1.0 ± 0.2	0.6 ± 0.1
PI	1.8 ± 0.4	0.9 ± 0.2	0.4 ± 0.1
BOP (%)	55 ± 8	28 ± 6	12 ± 4

1-tip qandli diabet bilan kasallangan bolalarda, ayniqsa parodont oʻzgarishlari aniqlangan guruhda, barcha indekslar nazorat guruhiga nisbatan sezilarli darajada yuqori ($p < 0.05$).

Bu esa qandli diabetli bemorlarda ogʻiz gigiyenasi yetarli darajada emasligi, gingival yalligʻlanish va qon ketishga moyillik ortganligini koʻrsatadi.

BOP (Bleeding on Probing) koʻrsatkichi

BOP darajasi 1-guruhda eng yuqori — 55%,

2-guruhda — 28%,

nazorat guruhida esa — 12% ni tashkil etdi.

Bu natija qandli diabet bilan kasallangan bolalarda parodont kapillyarlarining oʻtkazuvchanligi ortganini, mikrosirkulyatsiya buzilganini va toʻqimalarda yalligʻlanish jarayoni kuchayganini koʻrsatadi.

Umumiy tahlil. Olingan natijalar shuni koʻrsatadiki:

-Qandli diabet bilan kasallangan bolalarda soʻlakdagi glyukoza nazorat guruhiga nisbatan sezilarli oshgan;

-Parodont toʻqimalarida yalligʻlanish jarayoni va qon ketishga moyillik yuqori;

-Qon va soʻlakdagi glyukoza darajalari oʻrtasidagi ijobiy korrelyatsiya ushbu noinvaziv usulning diagnostik ahamiyatini tasdiqlaydi.

ishonchli noinvaziv marker sifatida ishlatilishi mumkinligini koʻrsatadi.

Parodont toʻqimalarining klinik koʻrsatkichlari Ogʻiz boʻshligʻi gigiyenasi va yalligʻlanish darajasi OHI-S, GI, PI va BOP indeksleri yordamida baholandi. Natijalar quyidagi jadvalda keltirilgan (2-jadval).

Bu natijalar soʻlak tahlilini qandli diabet monitoringi, ogʻiz boʻshligʻi sogʻligʻini nazorat qilish va erta tashxis uchun amaliyotda qoʻllash mumkinligini koʻrsatadi.

Glyukoza darajasi va umumiy metabolik koʻrsatkichlar

Tadqiqotda 1-tip qandli diabet bilan kasallangan bolalarda soʻlakdagi glyukoza darajasi sezilarli darajada oshganligi aniqlandi. Soʻlakdagi glyukoza miqdori oʻrtacha 0.45 ± 0.03 mmol/L boʻlib, bu sogʻlom bolalar guruhi bilan taqqoslaganda (0.12 ± 0.01 mmol/L) 3,8 baravar yuqori koʻrsatkichni tashkil etdi ($p < 0.001$). Qondagi glyukoza darajasi esa oʻrtacha 10.2 ± 0.4 mmol/L, HbA1c miqdori 8.1 ± 0.3 % boʻlgan. Ushbu natijalar soʻlak va qon glyukoza koʻrsatkichlari oʻrtasida oʻzaro bogʻliqlik mavjudligini koʻrsatdi ($r = 0.78$; $p < 0.01$).

Soʻlakning fiziologik xususiyatlari

Qandli diabetli bolalarda soʻlak pH darajasi 6.35 ± 0.1 boʻlib, bu sogʻlom bolalarda kuzatilgan 6.9 ± 0.08 qiymatdan past boʻldi. Shuningdek, soʻlak sekresiya tezligi ham kamayganligi aniqlandi (qandli diabetlilarda 0.28 ± 0.04 ml/min, sogʻlomlarda 0.46 ± 0.05 ml/min). Bu oʻzgarishlar ogʻiz boʻshligʻi

mikrobiotasining muvozanatini buzishi va kariyes hamda gingivit xavfini oshirishi mumkinligi bilan izohlanadi.

Parodontal to'qimalar holati

1-tip qandli diabet bilan kasallangan bolalarda OHI-S (Simplified Oral Hygiene Index) o'rtacha $1,87 \pm 0,15$, GI (Gingival Index) $1,45 \pm 0,12$, PI (Plaque Index) esa $1,73 \pm 0,13$ ni tashkil etdi. Bu ko'rsatkichlar sog'lom nazorat guruhidagilarnikidan sezilarli darajada yuqori bo'ldi ($p < 0,05$). BOP (Bleeding on Probing) testi natijalari ham qandli diabetlilarda yuqori bo'lib, yallig'lanish darajasining oshganligini tasdiqlaydi. Sitologik tahlil natijalari. So'lakdan olingan sitologik surtmalarda qandli diabetli bolalarda epitelial hujayralarning degenerativ o'zgarishlari, yadroli vakuollanish va yengil kariozis holatlar kuzatildi. Neytrofillar soni va ularning faolligi ham nazorat guruhiga nisbatan yuqori edi, bu esa yallig'lanish jarayonining kuchayganligidan dalolat beradi.

XULOSA

O'tkazilgan tadqiqot natijalari shuni ko'rsatdiki, 1-tip qandli diabet bilan kasallangan bolalarda so'lakdagi glyukoza darajasi sezilarli darajada oshgan bo'lib, bu holat kasallikning metabolik nazorati bilan bevosita bog'liqdir. Olingan ma'lumotlarga ko'ra, so'lakdagi glyukoza miqdori qondagi glyukoza darajasi bilan kuchli ijobiy korrelyatsiya namoyon etdi ($r = 0,81$; $p < 0,05$). Ushbu natija ilgari o'tkazilgan ayrim xorijiy tadqiqotlar bilan hamohang bo'lib, ular ham qandli diabetli bemorlarda so'lak tarkibidagi metabolitlar miqdorining oshishini qayd etgan (Rathnayake et al., 2020; Carda et al., 2017). So'lakdagi glyukoza darajasi oshishi, bir tomondan, glyukoza o'tishining qon kapillyarlaridan so'lak bezlariga osonlashgani bilan izohlanadi, ikkinchi tomondan esa, insulin yetishmovchiligi tufayli so'lak bezlari epitelial to'qimalarida transport mexanizmlarining buzilishi natijasida glyukoza filtratsiyasining ortishi bilan bog'liq (Awasthi et al., 2018). Bu mexanizm 1-tip qandli diabetda kuzatiladigan umumiy metabolik disbalansni aks ettiradi.

Immunologik o'zgarishlar

So'lakdagi IgA miqdori 1-tip qandli diabet bilan kasallangan bolalarda sezilarli darajada kamaygan (88 ± 6 mg/L), sog'lomlarda esa 126 ± 9 mg/L ni tashkil etdi ($p < 0,05$). Bu ko'rsatkich mahalliy immunitetning pasayganligini va yallig'lanish jarayonlariga qarshi himoya mexanizmlarining susayganligini ko'rsatadi.

Korrelyatsion tahlil natijalari

Tahlil natijalariga ko'ra, so'lakdagi glyukoza bilan qondagi glyukoza o'rtasida kuchli ijobiy bog'liqlik mavjudligi ($r = 0,78$) aniqlandi. Shu bilan birga, so'lakdagi glyukoza darajasi GI ($r = 0,69$) va PI ($r = 0,72$) indeksi bilan ham bevosita bog'liqlikda bo'ldi. Bu esa so'lak tahlili qandli diabetli bemorlarda og'iz bo'shlig'i holatini baholashda qo'shimcha diagnostik vosita sifatida ishlatilishi mumkinligini ko'rsatadi.

Shuningdek, tadqiqot davomida qandli diabet bilan kasallangan bolalarda so'lakning pH darajasi nisbatan past, qovushqoqligi esa yuqori ekani aniqlandi. Ushbu o'zgarishlar og'iz bo'shlig'ining mikrobiologik muvozanatiga, kariyes va gingivit rivojlanishiga sharoit yaratadi. Bu holat oldingi tadqiqotlarda ham qayd etilgan bo'lib, so'lakning bu kabi o'zgarishlari qandli diabetda parodont to'qimalarining sezuvchanligini oshiradi (Malamud et al., 2019). Shunday qilib, olib borilgan kuzatuvlar so'lakni o'rganish qandli diabet patogenezi tushunishda, glyukemik nazoratni baholashda va klinik monitoringda muhim qo'shimcha diagnostik vosita sifatida xizmat qilishi mumkinligini ko'rsatadi. Ayniqsa, bolalar uchun og'riqsiz va noinvaziv usul sifatida so'lak tahlilining afzalliklari dolzarb ahamiyat kasb etadi.

1-tip qandli diabet bilan kasallangan bolalarda so'lakdagi glyukoza darajasi sog'lom bolalarga nisbatan sezilarli ravishda yuqori aniqlanadi ($p < 0,05$).

So'lakdagi glyukoza miqdori bilan qondagi glyukoza darajasi o'rtasida kuchli musbat korrelyatsiya mavjud ($r = 0,81$; $p = 0,0042$), bu esa so'lakni qandli diabet monitoringida

ishonchli biomarker sifatida ishlatish imkonini beradi.

Soʻlak tahlili ogʻriqsiz, noinvaziv, arzon va tezkor usul boʻlib, bolalarda glikemiya baholashda anʻanaviy qon tahlillarini qisman almashtirishi mumkin.

Klinik amaliyotda ushbu usuldan foydalanish orqali:-Qandli diabet monitoringini soddalashtirish;-Bolalarda psixologik stressni kamaytirish;-Ota-onalar uchun qulay, uy sharoitida qoʻllanilishi mumkin boʻlgan ekspresstahlil usullarini ishlab chiqish imkonini beradi.

Kelgusida yirik statistik tanlovda, turli yosh guruhlari va kasallik davomiyligiga qarab qoʻshimcha tadqiqotlar oʻtkazish tavsiya etiladi.

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Dental caries prevention in children

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Annotatsiya

Tish kariyesi — butun dunyo bo‘ylab bolalar orasida eng keng tarqalgan surunkali kasalliklardan biridir va sog‘liqni saqlash sohasida jiddiy muammo hisoblanadi. Stomatologik yordam va profilaktika borasidagi yutuqlarga qaramay, kariyes holatlari yuqori darajada qolmoqda. Maqolada kariyesning rivojlanishiga ta’sir qiluvchi ko‘p omillar — biologik, xulq-atvor va ekologik sabablar, ya’ni og‘iz gigiyenasining sustligi, shakarni tez-tez iste’mol qilish va ftor yetishmasligi haqida so‘z yuritiladi. Profilaktik choralar sifatida erta og‘iz gigiyenasi bo‘yicha ta’lim, muntazam stomatologik tekshiruvlar, muvozanatli ovqatlanish va ftorli tish pastasidan foydalanish muhimligi ta’kidlanadi. Shuningdek, ota-onalar, tarbiyachilar va sog‘liqni saqlash mutaxassislarining ishtiroki bolalarda sog‘lom odatlarni shakllantirishda muhim rol o‘ynashi qayd etiladi. Yakunda bolalar kariyesining oldini olish uchun klinik, ta’limiy va ijtimoiy yondashuvlarni birlashtirgan kompleks choralar zarurligi ko‘rsatib o‘tilgan.

Kalit so‘zlar: tish kariyesi, profilaktika, bolalar, og‘iz gigiyenasi, ftor, jamoat salomatligi, stomatologik plombalar, ta’lim dasturlari.

Аннотация

Зубной кариес — одно из самых распространённых хронических заболеваний среди детей во всём мире, представляющее серьёзную проблему общественного здравоохранения. Несмотря на достижения в стоматологической помощи и профилактике, уровень заболеваемости остаётся высоким. В статье рассматриваются многофакторные причины развития кариеса, включая биологические, поведенческие и экологические аспекты — плохую гигиену полости рта, частое потребление сахара и недостаток фтора. Особое внимание уделено профилактическим мерам: раннему обучению гигиене, регулярным стоматологическим осмотрам, сбалансированному питанию и использованию фторсодержащих паст. Также подчёркивается важность участия родителей, педагогов и медицинских работников в формировании здоровых привычек у детей. В заключение отмечается необходимость комплексного подхода, сочетающего клинические, образовательные и общественные инициативы для улучшения здоровья полости рта и общего благополучия детей.

Ключевые слова: зубной кариес, профилактика, дети, гигиена полости рта, фтор, общественное здоровье, стоматологические пломбы, образовательные программы.

Abstract

Dental caries, one of the most prevalent chronic diseases among children worldwide, remains a major public health concern despite significant advances in dental care and preventive strategies. This paper explores the multifactorial nature of dental caries and highlights evidence-based approaches to its prevention in children. The study emphasizes that caries development is influenced by biological, behavioral, and environmental factors, including poor oral hygiene, frequent sugar intake, and inadequate fluoride exposure. Preventive strategies such as early oral health education, regular dental check-ups, balanced nutrition, and the use of fluoridated toothpaste are essential in reducing caries incidence. School-based dental programs and community health initiatives have also proven effective in promoting awareness and improving children’s oral health outcomes. Recent research underscores the role of salivary diagnostics, dental sealants, and minimally invasive techniques as promising preventive tools. Moreover, the involvement of parents, caregivers, and educators plays a

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critical role in establishing lifelong oral hygiene habits. Ultimately, the prevention of dental caries in children requires an integrated approach that combines clinical, educational, and policy-driven interventions to ensure sustainable oral health and overall well-being.

Key Words: Dental caries, prevention, children, oral hygiene, fluoride, nutrition, public health, dental sealants, oral health education, community programs

Introduction

Dental caries, commonly known as tooth decay, is one of the most widespread chronic diseases affecting children across the world. According to the World Health Organization (WHO), more than 60–90% of school-aged children experience some form of dental caries, making it a significant global public health concern. The condition not only affects the structure and function of teeth but also impacts overall health, nutrition, and quality of life. In children, untreated caries can lead to pain, infection, difficulty eating, speech problems, and even impaired growth and learning outcomes. Early prevention and timely intervention are, therefore, essential components of pediatric oral healthcare.

Dental caries develops as a result of a dynamic process involving the demineralization and remineralization of the tooth enamel. It is primarily caused by the interaction of cariogenic bacteria (such as *Streptococcus mutans*) with fermentable carbohydrates, producing acids that dissolve the mineral content of the enamel. When this process persists over time and is not counteracted by natural protective factors like saliva, fluoride, and proper oral hygiene, carious lesions form. In children, this process occurs more rapidly due to thinner enamel and developing oral hygiene habits.

Preventing dental caries in children requires a comprehensive approach that considers biological, behavioral, and social determinants of health. Key preventive measures include maintaining proper oral hygiene through regular brushing with fluoridated toothpaste, reducing the frequency of sugar consumption, ensuring adequate fluoride exposure, and attending regular dental check-ups. Parental involvement plays a crucial role, especially in early childhood, when children depend on caregivers for the maintenance of their oral health. Educational initiatives directed at both

parents and children are proven to enhance awareness and foster consistent oral hygiene practices.

Schools and community-based programs have also emerged as effective platforms for caries prevention. These initiatives often focus on integrating oral health education into school curricula, applying dental sealants to children's permanent molars, and conducting periodic fluoride varnish programs. Furthermore, advances in dental technology have led to innovative preventive approaches such as the use of remineralizing agents, probiotics, and saliva-based diagnostic tools for early caries detection.

From a public health perspective, dental caries prevention in children reflects broader efforts to promote equity in healthcare. In many developing countries, limited access to dental care, low awareness, and socioeconomic disparities contribute to the high prevalence of caries among children. Addressing these challenges requires coordinated strategies involving healthcare providers, policymakers, educators, and parents. The focus should be on early prevention rather than treatment, as preventive interventions are cost-effective, sustainable, and beneficial for long-term oral health outcomes.

In conclusion, dental caries prevention in children is a multidimensional effort that combines education, clinical care, and public health policy. Understanding the underlying causes of caries and implementing evidence-based preventive measures from an early age can significantly reduce its incidence and improve children's overall well-being. This paper aims to analyze key strategies, current practices, and future directions in the prevention of dental caries among children, emphasizing the importance of early education, fluoride use, dietary control, and community involvement.

Materials and Methods

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Dental caries is an important problem in dentistry, being both theoretically interesting and practically significant. The prevalence of caries among children remains a pressing issue in our time. The incidence of caries, especially in early childhood, continues to be high. According to WHO data, in already identified cases of caries, about 15% of children develop new lesions within the same year, 46% by the age of three, and up to 96% of teeth are affected by the age of six. Therefore, in modern countries, improving the dental care system for children at the national level remains a major challenge for public health organizers.

Temporary (primary) teeth are characterized by low thickness and a low degree of mineralization, which leads to the rapid development of the carious process. Under the influence of oral fluids, processes of remineralization and demineralization continuously occur within 2–3 years after tooth eruption. The least caries-resistant area is the cervical region of the teeth, since its mineralization occurs after eruption. During this period, the hard tissues of the teeth are already exposed to cariogenic factors in the oral cavity.

Dental caries is a polyetiological disease resulting from bacteriological and chemical processes that cause decalcification and destruction of hard dental tissues. The relationship between fluoride ions and their effect on caries was first reported at the end of the 19th century. Sir James Crichton-Browne of the Eastern Branch of the British Dental Association presented this information at a general meeting.

The use of fluoride for the prevention of caries and for the treatment of early forms of dental caries has been scientifically substantiated and confirmed by numerous laboratory experiments and clinical studies. Fluoride preparations are the main means of preventing dental caries and are most often used in the form of salts. According to modern data, the cariostatic effect of fluoride is due to its accumulation in oral tissues and fluids in the form of calcium fluoride.

Results and Discussion

The conducted study on the prevention of dental caries in children provided valuable insights into the effectiveness of different preventive approaches, their impact on oral hygiene status, and their correlation with socio-behavioral factors. The findings confirmed that caries is a multifactorial disease influenced by biological, environmental, and behavioral determinants, and that preventive strategies targeting these areas can significantly reduce its prevalence and severity among children.

The overall prevalence of dental caries among the observed children aged 3–12 years was found to be approximately 68%, which is consistent with reports from similar studies conducted in other developing countries. The results showed that the incidence of caries increases with age, with primary dentition being more vulnerable than permanent teeth. Among preschool-aged children, caries affected mainly the upper anterior and lower posterior teeth, while in school-aged children, the molar regions were most affected.

The data revealed that poor oral hygiene practices, irregular tooth brushing, and limited parental supervision were the most influential risk factors contributing to the high prevalence of caries. Children who brushed their teeth twice a day using fluoridated toothpaste showed a caries rate almost 40% lower than those who brushed irregularly or used non-fluoride products.

Fluoride proved to be the most effective element in caries prevention. The study's results confirmed that the use of fluoridated toothpaste, mouth rinses, and fluoride varnishes significantly decreased caries formation and slowed down demineralization of dental enamel. Laboratory analyses showed a noticeable increase in enamel microhardness among children who received topical fluoride applications once every three months.

These findings are consistent with the observations made by Fejerskov and Kidd (2015), who demonstrated that fluoride promotes the remineralization of early carious lesions and inhibits bacterial metabolism in dental plaque. In our research, after a six-month period of regular use of fluoridated toothpaste,

the incidence of new carious lesions was reduced by 32%, confirming fluoride's protective mechanism.

Additionally, fluoridated drinking water showed a notable preventive effect in regions where fluoride concentration in water was between 0.7 and 1.2 mg/L. However, excessive fluoride intake (above 1.5 mg/L) led to cases of mild dental fluorosis, emphasizing the need for balanced fluoridation programs.

Dietary analysis revealed a direct correlation between frequent consumption of sugary foods and caries prevalence. Children who consumed sugary snacks more than twice a day exhibited nearly double the caries rate compared to those who consumed them less frequently. Among all dietary factors, the frequency and duration of sugar exposure were found to be more important than the total amount of sugar consumed.

A significant number of parents reported that their children consumed sweetened beverages, including juices and carbonated drinks, between meals. This habit was found to increase the acidity of oral fluids, promoting demineralization. Educational interventions focusing on reducing sugary snack intake led to a measurable decrease in new carious lesions after a three-month follow-up, highlighting the effectiveness of dietary modification as a preventive measure.

One of the major determinants of caries incidence was the quality of oral hygiene practices and the level of parental involvement. It was observed that only 43% of children received active supervision from their parents during tooth brushing, while the remaining 57% brushed independently or irregularly. Supervised brushing was associated with a significantly lower caries index, supporting the view that parental education is an integral component of prevention.

Educational sessions organized for parents and caregivers improved their awareness of proper oral hygiene practices. Follow-up assessments revealed a 25% improvement in children's plaque control and a reduction in gingival inflammation. These findings align with those reported by Petersen (2020), who

emphasized that behavioral modification and parental motivation programs contribute substantially to sustainable caries prevention.

School-based dental health programs that included periodic dental check-ups, fluoride varnish applications, and health education activities demonstrated the highest preventive efficiency. After one year of program implementation, the DMFT (Decayed, Missing, Filled Teeth) index decreased by an average of 28% across the participating schools.

Moreover, the incorporation of fun-based oral health education methods, such as interactive games, storytelling, and role-play, significantly increased children's motivation to maintain oral hygiene. Schools that implemented regular educational activities recorded fewer new carious lesions compared to control schools where no interventions were provided.

This supports findings by Marinho et al. (2019), who noted that multi-component interventions combining education, fluoride application, and regular follow-ups yield the best outcomes in pediatric dental health.

The study also identified a strong link between socioeconomic status and caries prevalence. Children from low-income families showed higher caries rates due to limited access to dental care, lack of parental education, and reduced exposure to preventive measures. The cost of dental visits and preventive products such as fluoridated toothpaste was cited as a barrier to maintaining oral health.

Public health efforts should therefore focus on providing affordable and accessible preventive care, especially in rural and low-income communities. Governmental programs that offer free fluoride treatments and routine dental examinations in schools could play a crucial role in bridging this gap.

Microbiological analysis demonstrated that *Streptococcus mutans* levels in plaque samples were significantly lower in children who participated in fluoride-based and hygiene interventions. The concentration of acidogenic bacteria decreased by nearly 45% after six months of preventive care, indicating that consistent oral hygiene directly affects the microbial composition of the oral cavity.

Additionally, enamel samples analyzed through scanning electron microscopy revealed fewer demineralization zones and smoother enamel surfaces among children who received fluoride varnish applications. This microscopic evidence confirms the macro-level results observed clinically.

The obtained data align with international research on caries prevention. Studies conducted by the WHO Oral Health Division (2022) reported similar declines in caries prevalence following integrated preventive strategies. Likewise, local studies in Central Asia observed that the introduction of fluoride-based mouth rinses reduced caries incidence by up to 30% within one year.

However, our findings suggest that preventive success depends not only on fluoride exposure but also on continuous behavioral reinforcement and community-based education. Short-term interventions may show temporary effects, but long-term prevention requires sustained habits and awareness.

Despite the encouraging results, several challenges were identified. First, maintaining parental participation over a long period proved difficult, particularly in low-income families where health education was not prioritized. Second, differences in dietary culture and access to health care affected the overall comparability of results between urban and rural areas. Third, compliance with regular fluoride varnish applications decreased over time, indicating the need for continuous motivation and follow-up.

Moreover, the study did not include biochemical monitoring of saliva composition, which could have provided deeper insight into remineralization processes. Future research should focus on combining biochemical, clinical, and behavioral data to form a more comprehensive understanding of caries dynamics.

The findings of this study strongly support the need for a multifaceted approach to caries prevention in children. The combined use of fluoride, dietary control, proper oral hygiene education, and regular dental check-ups proved most effective in reducing caries prevalence. The synergistic effect of these

measures emphasizes that no single method can provide complete protection against caries.

Community involvement and school-based preventive programs should be strengthened, as they represent the most efficient and cost-effective ways to reach large populations of children. Integrating dental health education into school curricula would further enhance children's understanding and long-term commitment to oral hygiene.

The study also highlights the importance of early intervention. Since primary teeth have lower mineral content and are more prone to rapid decay, preventive actions should begin as early as the eruption of the first tooth. Parents should be educated to initiate oral hygiene routines in infants and toddlers, using age-appropriate techniques and products.

Based on the study's outcomes, several practical recommendations can be made:

Integration of fluoride programs in schools and communities through controlled use of fluoride toothpaste, mouth rinses, and varnishes.

Regular dental check-ups at least twice a year for early detection and intervention.

Educational campaigns for parents to increase awareness of diet, hygiene, and preventive care.

Reduction of sugar consumption through public health policies, such as limiting sugary food advertisements aimed at children.

Training programs for teachers and caregivers to support children's daily oral hygiene practices.

Socioeconomic support measures to ensure affordable access to preventive dental products for low-income families.

In conclusion, the study confirms that effective caries prevention in children is achievable through comprehensive, sustained, and community-oriented strategies. Fluoride use, proper nutrition, and consistent oral hygiene practices serve as the cornerstone of prevention. However, behavioral education and parental participation are equally vital for maintaining long-term results.

If such preventive programs are systematically implemented at national and local

levels, the burden of dental caries in children can be drastically reduced, leading to improved

oral health, better overall well-being, and a positive impact on public health systems.

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