UNIVERSIDADE FEDERAL DE MINAS GERAIS
Faculdade de Odontologia
Colegiado de Pós-Graduação em Odontologia

Anna Carolina Rye Sato Kimura

CÁRIE DENTÁRIA E ALTERAÇÕES PERIODONTAIS EM CRIANÇAS E ADOLESCENTES COM RESPIRAÇÃO BUCAL: *UMA REVISÃO SISTEMÁTICA*

Belo Horizonte
2025

Anna Carolina Rye Sato Kimura

CÁRIE DENTÁRIA E ALTERAÇÕES PERIODONTAIS EM CRIANÇAS E ADOLESCENTES COM RESPIRAÇÃO BUCAL: *UMA REVISÃO SISTEMÁTICA*

Dissertação apresentada ao Colegiado de Pós-Graduação em Odontologia da Faculdade de Odontologia da Universidade Federal de Minas Gerais, como requisito parcial à obtenção do grau de Mestre em Odontologia – área de concentração em Odontopediatria.

Orientador: Prof. Lucas Guimarães Abreu

Belo Horizonte
2025

Ficha Catalográfica

K49c 2025 T

Kimura, Anna Carolina Rye Sato.
Cárie dentária e alterações periodontais em crianças e adolescentes com respiração bucal: uma revisão sistemática / Anna Carolina Rye Sato Kimura. -- 2025.

92 f. : il.

Orientador: Lucas Guimarães Abreu.

Dissertação (Mestrado) -- Universidade Federal de Minas Gerais, Faculdade de Odontologia.

1. Cárie dentária. 2. Respiração bucal. 3. Doenças periodontais. 4. Transtornos respiratórios. 5. Metanálise. I. Abreu, Lucas Guimarães. II. Universidade Federal de Minas Gerais. Faculdade de Odontologia. III. Título.

BLACK - D047

Elaborada por Miriam Cândida de Jesus - CRB 6/2727.

UNIVERSIDADE FEDERAL DE MINAS GERAIS

FACULDADE DE ODONTOLOGIA

COLEGIADO DO CURSO DE PÓS-GRADUAÇÃO EM ODONTOLOGIA

FOLHA DE APROVAÇÃO

CÁRIE DENTÁRIA E ALTERAÇÕES PERIODONTAIS EM CRIANÇAS E ADOLESCENTES COM RESPIRAÇÃO BUCAL: UMA REVISÃO SISTEMÁTICA

ANNA CAROLINA RYE SATO KIMURA

Dissertação submetida à Banca Examinadora designada pelo Colegiado do Programa de Pós-Graduação em ODONTOLOGIA, como requisito para obtenção do grau de Mestre em ODONTOLOGIA, área de concentração ODONTOPEDIATRIA.

Aprovada em 09 de julho de 2025, pela banca constituída pelos membros:

Prof. Lucas Guimarães Abreu - Orientador
Faculdade de Odontologia da UFMG

Prof. Heitor Marques Honório
USP - Bauru

Profa. Mariane Carolina Faria Barbosa
Faculdade de Odontologia da UFMG

Belo Horizonte, 09 de julho de 2025.

Documento assinado eletronicamente por **Heitor Marques Honório**, **Usuário Externo**, em 09/07/2025, às 11:15, conforme horário oficial de Brasília, com fundamento no art. 5º do Decreto nº 10.543, de 13 de novembro de 2020.

Documento assinado eletronicamente por **Mariane Carolina Faria Barbosa**, **Usuário Externo**, em 09/07/2025, às 11:15, conforme horário oficial de Brasília, com fundamento no art. 5º do Decreto nº 10.543, de 13 de novembro de 2020.

Documento assinado eletronicamente por **Lucas Guimaraes Abreu**, **Professor do Magistério Superior**, em 09/07/2025, às 11:17, conforme horário oficial de Brasília, com fundamento no art. 5º do Decreto nº 10.543, de 13 de novembro de 2020.

A autenticidade deste documento pode ser conferida no site https://sei.ufmg.br/sei/controlador_externo.php?acao=documento_conferir&id_orgao_acesso_externo=0, informando o código verificador **4298574** e o código CRC **237C62F1**.

AGRADECIMENTOS

Agradeço ao meu orientador Prof. Dr. Lucas Guimarães Abreu pelo apoio, pela disponibilidade e pelas oportunidades oferecidas ao longo do mestrado. Suas contribuições foram fundamentais para o desenvolvimento deste trabalho e para minha formação acadêmica e profissional. Agradeço por ser uma grande inspiração como professor, pesquisador e como pessoa.

À minha família, Denise, Fábio, Rodrigo, Tibi, Batiam e Ditiam, agradeço pelo apoio constante durante toda essa caminhada. A confiança, o incentivo e a compreensão diante dos desafios foram essenciais para que eu pudesse me dedicar ao mestrado. O cuidado de cada um fez toda a diferença para que eu mantivesse firme até a conclusão deste trabalho. Sou muito grato por poder contar com vocês em cada etapa dessa jornada.

Ao Colegiado de Pós-Graduação da Faculdade de Odontologia da UFMG, agradeço pelo suporte institucional. Em especial, aos colaboradores Victor, Luciene e Valéria, e às representantes discentes Ana Clara Paiva e Jennifer Oliveira.

Agradeço aos professores do Departamento de Saúde Bucal da Criança e do Adolescente (SCA) da Faculdade de Odontologia da UFMG pelo ambiente de aprendizado, pelos ensinamentos e pelo apoio ao longo da formação. Destaco, especialmente, os professores Saul Paiva e Paulo Martins-Júnior pelas contribuições e orientações durante o percurso acadêmico.

Aos companheiros de jornada que compartilharam esta etapa ao meu lado, agradeço pela convivência, parceria e troca de conhecimentos. Em especial, agradeço a Thaliny, Widla, Maria Luiza, Jennifer, Fabiana, Eliane, José Gabriel, Pedro, Luisa, Raphaela, Izabela e Thiago.

Por fim, agradeço à Coordenação de Aperfeiçoamento de Pessoal de Nível Superior (CAPES) e ao Conselho Nacional de Desenvolvimento Científico e Tecnológico (CNPq) pelo apoio financeiro, que permitiu a minha dedicação ao mestrado. Estendo o agradecimento às demais agências de fomento pelo papel fundamental no fortalecimento da pesquisa científica no país.

“Todos os nossos sonhos podem se tornar realidade, se tivermos a coragem de persegui-los.

Walt Disney

RESUMO

A respiração bucal é identificada quando uma porção significativa do ar é inalado pela boca ao invés do nariz, em decorrência de patologias e/ou obstruções nas vias aéreas. Essa condição, além de impactar funções cognitivas e de aprendizagem, também leva a uma maior propensão ao desenvolvimento de más oclusões e comprometimento da qualidade de vida. A literatura também aponta que respiradores bucais apresentam maior predisposição a desequilíbrios no pH salivar, acúmulo de biofilme e, consequentemente, maior risco para cárie, doenças periodontais e gengivite. Este estudo buscou avaliar as possíveis associações entre a respiração bucal com as principais manifestações odontológicas em crianças e adolescentes: cárie dentária e alterações periodontais. Esta revisão foi registrada no PROSPERO (CRD42024536891). Para os critérios de elegibilidade, o estudo buscou responder à pergunta de pesquisa “Crianças e adolescentes com respiração bucal são mais propensos a apresentar cáries dentárias e distúrbios periodontais do que crianças e adolescentes com respiração nasal?”, estruturada pela PECOS: P(população): crianças e adolescentes, de ambos os sexos, com idade igual ou inferior a 19 anos; E(exposição): respiração bucal; C(comparação): ausência de respiração bucal; O(desfechos): cárie dentária e alterações periodontais; S(estudos): estudos observacionais. As buscas foram realizadas em cinco bases de dados: *PubMed, Embase, OVID, Scopus* e *Web of Science*, buscas também foram realizadas no *Google Scholar* e *OpenGrey*, sem restrição quanto ao idioma e ano de publicação dos artigos. O risco de viés dos estudos foi analisado através da *Newcastle-Ottawa Scale*. Metanálises foram realizadas e seus resultados foram apresentados através da Diferença Média Estandardizada (DME), com intervalo de confiança (IC) de 95%. A certeza das evidências foi obtida através do GRADE. Inicialmente, durante o período de abril de 2024 à dezembro de 2024, foram recuperados 838 estudos e 11 estudos transversais foram incluídos na revisão. Após análises, os resultados qualitativos revelaram que indivíduos com respiração bucal apresentaram maiores alterações quanto o sangramento gengival, acúmulo de placa e alterações gengivais. Em relação a cárie dentária, as alterações foram observadas em lesões iniciais e para os escores 5 e 6 do ICDAS. Para os resultados quantitativos, as metanálises indicaram uma maior, porém não significativa, média para o Índice de Placa (DME=2.46 [95% IC: -0.04–4.96], I^2=98%) e para o Índice de Inflamação Gengival (DME=0.47 [95% IC: -1.33–2.26], I^2=97%) em respiradores bucais. Em conclusão, crianças e adolescentes com respiração bucal podem ser associados as alterações gengivais e acúmulo de placa. Para a cárie dentária, as evidências, mesmo que limitadas, sugerem uma associação as lesões de cárie iniciais e avançadas.

Palavras-chave: cárie dentária; respiração bucal; saúde bucal; doenças periodontais; transtornos respiratórios; metanálises.

ABSTRACT

Dental caries and periodontal outcomes in mouth-breathing children and adolescents: a systematic review

Mouth breathing is identified when a significant portion of air is inhaled through the mouth instead of the nose due to pathologies and/or airway obstruction. This condition, in addition to affecting cognitive and learning functions, also leads to a greater propensity for the development of malocclusions and a compromised quality of life. Furthermore, the literature indicates that mouth breathers have a greater predisposition to salivary pH imbalance, biofilm accumulation, and, consequently, a higher risk of dental caries, periodontal diseases, and gingivitis. This study aimed to evaluate the possible associations between mouth breathing and the main dental manifestations in children and adolescents: dental caries and periodontal outcomes. This review was registered in PROSPERO (CRD42024536891). For eligibility criteria, the study attempted to find answers to the research question: "Are children and adolescents with mouth breathing more likely to exhibit dental caries and periodontal disorders than children and adolescents with nose breathing?", structured according to the PECOS framework: P (Population): children and adolescents, of both sex, aged 19 years or younger; E (Exposure): mouth breathing; C (Comparison): no mouth breathing; O (Outcomes): dental caries and periodontal outcomes; S (Study design): observational studies. The review was registered in PROSPERO (CRD42024536891). Searches were conducted in five databases: PubMed, Embase, OVID, Scopus, and Web of Science, as well as in Google Scholar and OpenGrey, with no restrictions regarding the language or year of publication. The risk of bias in the studies was assessed using the Newcastle-Ottawa Scale. Meta-analyses were performed, and results were presented as standardized mean differences (SMD) with 95% confidence intervals (CI). Certainty of evidence was assessed using GRADE. Initially, 838 studies were retrieved, and 11 cross-sectional studies were included in the review. Individuals with mouth breathing showed greater alterations in gingival bleeding, plaque accumulation, and gingival changes. Regarding dental caries, alterations were observed in initial lesions and in ICDAS scores 5 and 6. Meta-analyses indicated a higher, albeit not statistically significant, mean Plaque Index (SMD=2.46 [95% CI: -0.04–4.96], I^2=98%) and Gingival Inflammation Index (SMD=0.47 [95% CI: -1.33–2.26], I^2=97%) in mouth breathers. In conclusion, children and adolescents with mouth breathing may be associated with gingival changes and plaque accumulation. For dental caries, the evidence, although limited, suggests an association with initial and advanced caries lesions.

Keywords: dental caries; mouth breathing; oral health; periodontal diseases; respiration disorders; meta-analyses.

LISTA DE FIGURAS

ARTIGO

LISTA DE TABELAS

DISSERTAÇÃO

ARTIGO

LISTA DE ABREVIATURAS E SIGLAS

CPI	Índice Periodontal Comunitário
CNPq	Conselho Nacional de Desenvolvimento Científico e Tecnológico
CAPES	Coordenação de Aperfeiçoamento de Pessoal de Nível Superior
DME	Diferença Média Estandardizada
GBD	Global Burden of Disease
GUN	Gengivite Ulcerativa Necrosante
HIV	Vírus da Imunodeficiência Humana
HPV	Papilomavírus Humano
IADR	International Association for Dental Research
IC	Intervalo de Confiança
ICDAS	International Caries Detection and Assessment System
PRISMA	Preferred Reporting Items for Systematic Reviews and Meta-Analysis
PROSPERO	International Prospective Register of Systematic Reviews
NHANES	National Health and Nutrition Examination Survey
SAOS	Síndrome da Apneia Obstrutiva do Sono
SRB	Síndrome do Respirador Bucal

SUMÁRIO

1 CONSIDERAÇÕES INICIAIS

A respiração nasal é uma das primeiras funções fisiológicas desenvolvidas pelo corpo humano, sendo considerada como fator importante para todo o sistema estomatognático. Entretanto, em virtude de diferenças no processo de desenvolvimento anatômico e fisiológico infantil, alterações no padrão respiratório podem ocorrer, levando a uma compensação dessa função pela cavidade oral com o objetivo de suprir a necessidade respiratória do indivíduo (Prado Jr *et al*., 2010; Ballikaya *et al*., 2018; Paolantonio *et al*., 2019; Felix *et al*., 2022).

Por definição, a respiração bucal é determinada quando de 25% a 30% do ar inalado é conduzido pela boca ao invés do nariz, podendo ou não estar associada a uma obstrução das vias aéreas superiores (Lin *et al*., 2022). Isso ocorre principalmente por uma obstrução causada pelas tonsilas palatinas e faríngeas e/ou pela presença de outras patologias respiratórias, como a rinite e a asma (Huynh *et al*., 2014). A literatura também mostra que o desenvolvimento da respiração bucal está ligado a uma perda da vedação labial e da subversão de todo complexo neurológico, ósseo e muscular na região (Santos Neto *et al*., 2009).

Como consequência, mudanças passam a ocorrer nos tecidos e estruturas adjacentes à cavidade oral, uma vez que essa passa a desenvolver um papel maior no processo respiratório. Como características marcantes temos a diminuição do pH intraoral durante o sono, ressecamento dos lábios, desidratação dos tecidos periodontais e acúmulo de placa (Choi *et al*., 2016; Mummolo *et al.,* 2018).

Anatomicamente, o indivíduo respirador bucal pode apresentar o palato duro mais estreito ao nível dos segundos pré-molares/segundos molares decíduos e primeiros molares e mais profundo ao nível dos segundos pré-molares/segundos molares decíduos (Berwig *et al*., 2011). Desta forma, estudos apontam que crianças respiradoras bucais passam a ter uma maior propensão para o desenvolvimento de problemas de oclusão. Alterações periodontais, principalmente a gengivite, e lesões de cárie também podem acometer indivíduos com a respiração alterada (Al-ghutaimel *et al*., 2014; Choi *et al.*, 2016). Com isso, a respiração bucal pode trazer consequências negativas não apenas para a saúde bucal, mas também pode levar a uma piora da qualidade de vida dos seus portadores e familiares nos âmbitos ambientais, físicos e psicológicos quando comparados aos indivíduos respiradores nasais (Nagae *et al*., 2013).

Estudos epidemiológicos conduzidos em municípios brasileiros revelaram uma prevalência de 55,2% de crianças respiradoras bucais de 9 e 10 anos (Menezes *et al*., 2007), 55% entre crianças de 3 a 9 anos de idade (Abreu *et al*., 2008) e 56,8% em crianças do 1ª ao 4ª ano do ensino fundamental (entre 6 e 9 anos) (Felcar *et al*., 2010). Entretanto, estudos feitos em outros países demonstraram resultados distintos em relação aos encontrados nas cidades brasileiras, dentre eles um que mostra uma prevalência de respiração bucal de 6,6% entre crianças de 5 a 13 anos em Delhi, Índia (Kharbanda *et al*., 2003) e um outro apontando que 63% de uma amostra de crianças venezuelanas entre 5 a 14 anos apresentavam a alteração (Parra *et al*., 2004).

Portanto, a respiração bucal pode ser considerada um problema de saúde pública e por isso, estudos e recursos para o seu diagnóstico e manejo são necessários, principalmente devido a sua alta prevalência no Brasil e suas possíveis associações a doenças e desenvolvimento com características que podem impactar negativamente a saúde bucal dos pacientes afetados (Nagae *et al*., 2013).

A literatura atual sobre a associação entre doenças periodontais, cárie dentária e pacientes com respiração bucal ainda é restrita, apesar de todas as suas consequências para o indivíduo afetado. Diferentes desenhos de estudos foram feitos até o presente momento para testar essa associação e os resultados são discrepantes; ainda não há um trabalho que englobe todas as informações disponíveis na literatura e aponte a existência da associação ou não.

Desta forma, este estudo tem como objetivo analisar e comparar os resultados obtidos nos diferentes artigos já publicados e, com isso, nortear futuras pesquisas sobre o assunto. Isso será feito através de uma revisão sistemática, uma vez que tais estudos se encontram no topo da pirâmide de evidências científicas (Murad *et al.,* 2016).

2 REVISÃO DE LITERATURA

2.1 Cárie Dentária

De acordo com o Grupo de Pesquisa sobre Cariologia da *International Association for Dental Research* (IADR), a cárie é considerada uma doença mediada pelo biofilme, modulada pela dieta, de caráter multifatorial, não transmissível e dinâmica, que leva à perda mineral dos tecidos dentários. Seu desenvolvimento também está relacionado aos fatores comportamentais, biológicos, psicológicos e ao meio onde o indivíduo vive (Machiulskiene *et al*., 2020). A literatura atual também indica que fatores sociais, como o nível socioeconômico, o acesso ao serviço e a autopercepção também possuem uma associação importante com experiência de cárie e com o aparecimento inicial de lesões em crianças (Cortellazzi *et al.,* 2008; Cypriano *et al.*, 2011). Com isso, todos esses são fatores, que, de forma individual ou combinados, podem aumentar o risco à cárie dentária, caso mudanças não sejam feitas ao longo de um determinado tempo (Machiulskiene *et al*., 2020).

Atualmente, a doença cárie é considerada um problema de saúde pública a nível global. De acordo com o estudo *Global Burden of Disease* (GBD) 2015, em 2010, lesões de cárie não tratadas em dentes decíduos estavam entre as dez doenças mais prevalentes do mundo, afetando 9% da população infantil mundial. Já para dentes permanentes, a prevalência de cárie não tradadas afetava 35% da população global total, estando em primeiro no ranking de condições de saúde (Kassebaum *et al*., 2017; Peres *et al*., 2019).

Um estudo americano *National Health and Nutrition Examination Survey* (NHANES) (2011-2016) revelou que 12,7% dos adolescentes entre 12 e 15 anos apresentavam lesões de cárie não tratadas. O mesmo estudo relatou que, para a faixa etária de 16 a 19 anos, a porcentagem de lesões de cárie sem tratamento sobe para 20,4% (Dye *et al.,* 2019). No Brasil, resultados do SB Brasil 2023 mostraram que as crianças de cinco anos possuem uma prevalência de 41,18% de um ou mais dentes com lesões de cárie não tratadas; já para adolescentes de 12 anos a prevalência foi de 49,88% e 43,73% em adolescentes de 15 a 19 anos (Brasil, 2023).

Sob o ponto de vista bioquímico, as lesões são determinadas pela destruição dos tecidos duros do dente (esmalte e dentina) através da acidificação do meio por bactérias que utilizam os sacarídeos consumidos na dieta para sua

fermentação e produção de ácidos, o que leva a um desequilíbrio do pH oral e do processo de desmineralização e remineralização. Com isso, a cavidade oral se torna um ambiente propício para a dissolução dos tecidos dentários e dos minerais que a compõe (Peres *et al*., 2019).

Clinicamente, seu diagnóstico é feito através dos critérios de progressão, atividade da lesão, presença ou ausência de cavitação, integridade da superfície, textura, translucidez/opacidade, localização da lesão e cor da superfície, sendo sua identificação correta essencial para a escolha da melhor forma de tratamento (Nyvad; Machiulskiene; Baelum, 2003). Além disso, exames complementares, como as radiografias, são importantes e auxiliam no fechamento do diagnóstico (Slayton, 2015).

Já o tratamento ocorre em três esferas: identificação e retirada dos fatores de risco, eliminação do foco da doença e a prevenção. Por isso, decisões clínicas devem ser tomadas de acordo com o risco de cárie do paciente, a idade e do engajamento dos pais/cuidadores para adotar as estratégias de prevenção (Corrêa-Faria *et al.*, 2020). Os métodos preventivos são aplicados para evitar a formação de novas lesões, e envolvem processos que são aplicados de forma individual, como a higiene bucal e controle da dieta, ou em nível populacional, como cumprimento de políticas públicas (Fejerskov *et al.*, 1997; Slayton, 2015).

2.2 Doença Periodontal em crianças e adolescentes

O periodonto é composto pelos tecidos de suporte dos dentes que incluem: gengiva, cemento, osso alveolar e ligamento periodontal. Durante a dentição decídua, esses tecidos diferem da dentição permanente principalmente quanto as características fisiológicas: gengiva mais vascularizada e flácida, o ligamento periodontal com fibras mais largas e em menor quantidade e osso alveolar com menor nível de calcificação, consequentemente, com menor densidade. Histologicamente, é uma região com altos índices de diferenciação celular devido a presença dos odontoclastos, células que estão diretamente relacionadas ao processo de reabsorção de raízes durante as etapas de esfoliação dos dentes decíduos (Al-ghutaimel *et al*., 2014; Harokopakis-Hajishengallis, 2007).

O desenvolvimento da doença periodontal ocorre quando há a presença de quadros infecciosos nesses tecidos de suporte, causados principalmente por uma

desordem bacteriana e por um acúmulo do biofilme nessas regiões. A gravidade da doença é classificada de acordo com a sua capacidade ou não de irreversibilidade, sendo a gengivite, quadro reversível, o mais prevalente em crianças e adolescentes (Pihlstrom; Michalowicz; Johnson, 2005).

No mundo, a doença periodontal severa possui uma prevalência mundial de 19% em pessoas com idade superior a 15 anos, o que representa mais de um bilhão de casos pelo mundo (WHO, 2022). Para o Brasil, segundo os dados fornecidos pela Pesquisa Nacional de Saúde Bucal (SB Brasil 2023), 27,77% dos adolescentes brasileiros de 12 anos apresentaram sangramento gengival, sendo essa a condição periodontal de maior prevalência, enquanto para cálculo dentário, a prevalência foi de 23,72%. Já em adolescentes de 15 a 19 anos, o cálculo dentário foi a condição periodontal de maior prevalência (35,29%), seguido do sangramento gengival (34,36%) (Brasil, 2023).

A literatura atual mostra que a gengivite nessa população tem como causas principais a inflamação gengival durante o processo de erupção, gengivite na puberdade relacionada aos hormônios gonadotróficos, a respiração bucal, o crescimento gengival induzido pelo uso de medicamentos, desnutrição e outras patologias como a GUN (gengivite ulcerativa necrosante) e a gengivite herpética primária pelo vírus HPV (papiloma vírus humano) (Al-ghutaimel *et al*., 2014).

Já o desenvolvimento da periodontite, forma mais agressiva da doença, em crianças e adolescentes está associada principalmente a manifestações sistêmicas (ex: diabetes, HIV (Vírus da Imunodeficiência Humana)), doenças e síndromes (ex: leucemia e Síndrome de Down) (Clerehugh; Tugnait, 2001). O trauma dentário também pode estar relacionado ao surgimento de problemas periodontais, devido ao envolvimento dos tecidos de suporte, sendo mais comum os fenômenos de reabsorção e perda de estrutura óssea (Drummond; Brosnan; Leichter, 2017). Contudo, estudos epidemiológicos mostram uma prevalência de 0,2 a 0,5% da forma mais agressiva da doença em crianças e adolescentes, sendo esse um valor considerado baixo (Califano *et al*., 2003).

O controle das alterações periodontais é determinado pela sua classificação e gravidade. Em muitos casos o tratamento para gengivite se dá através da higienização bucal e controle de placa, podendo estar associado ao uso de medicamentos específicos para as doenças correlacionadas. Em quadros mais graves, como a periodontite, é necessária uma avaliação minuciosa para a tomada de

decisão de tratamento, entre elas a terapia não cirúrgica, uso da terapia medicamentosa e a terapia cirúrgica (Kini *et al*., 2016).

2.3 Respiração bucal

A respiração bucal é determinada quando a respiração de um indivíduo passa a ser predominantemente pela cavidade bucal ao longo do seu dia a dia (de 25% a 30% do ar inalado é conduzido pela boca ao invés do nariz) (Prado Jr *et al*., 2010; Felix *et al*., 2022; Lin *et al*., 2022). Essa mudança ocorre devido a uma obstrução que leva à diminuição da abertura das vias aéreas superiores, ocasionada principalmente pela hipertrofia das tonsilas faríngeas e palatinas ou pelo congestionamento dessas vias durante episódios de crises asmáticas ou rinites alérgicas/crônicas. É considerada uma forma de adaptação do próprio organismo para suprir a dificuldade respiratória (Ballikaya *et al*., 2018; Huynh *et al*., 2014).

Os primeiros sinais aparecem logo na infância, principalmente pelo fato de as tonsilas infantis serem duas vezes maiores quando comparadas as tonsilas de um adulto. Com isso, há uma prevalência significativa de crianças respiradoras bucais e que, caso não haja a regressão esperada, passam pela puberdade e pela fase adulta lidando com as consequências do hábito (Lee; Yang, 2021).

Dados epidemiológicos mostram que a prevalência da respiração bucal em crianças pelo mundo é de 11% a 57% (Lin *et al.*, 2022). Já no Brasil, a prevalência em crianças de seis a nove anos é de 56,8%, e entre em crianças entre nove e dez anos a prevalência é de 55,2% (Soares *et al.*, 2024).

Estudos atuais demonstraram que o sono é uma das áreas mais afetadas pela respiração bucal, estando essa relacionada também com a Síndrome da Apneia Obstrutiva do Sono (SAOS) (Davidovich *et al*., 2022). Outra consequência é a diminuição do pH intraoral dos indivíduos afetados durante o sono, quando esses são comparados com pacientes respiradores nasais. Essa diminuição de pH, a longo prazo, pode levar a uma maior propensão a erosão dentária e o aparecimento de lesões de cárie (Choi *et al*., 2016).

Crianças com respiração bucal apresentam um conjunto de características faciais relevantes, configurando, assim, a Síndrome do Respirador Bucal (SRB). Essas características são: o terço inferior da face aumentado, lábios ressecados, narinas pequenas, nariz achatado e falta de selamento labial (Prado Jr *et al*., 2010;

Santos Neto *et al.,* 2009). Particularidades da SRB também estão relacionadas com uma maior desidratação dos tecidos de suporte dos dentes devido a uma maior passagem de ar pela cavidade bucal, o que gera maiores taxas de evaporação de saliva. Como consequência, respiradores bucais podem ser mais propensos ao acúmulo de placa e ao desenvolvimento de alterações periodontais, principalmente a gengivite (Mummolo *et al*., 2018; Lin *et al*., 2022).

A deterioração da qualidade de vida de crianças portadoras da SRB também vem sendo alvo de discussões em razão da associação entre a respiração, mastigação, deglutição e fala. Fisiologicamente, os indivíduos utilizam caminhos semelhantes para realizarem as funções alimentação e respiração. A faringe é a parte comum entre o Sistema Respiratório e o Sistema Digestório, por isso, esses movimentos devem ser realizados de forma coordenada para que ocorram corretamente, sem que haja interferência de uma função com relação às outras (Matsuo; Palmer, 2009). Como consequência, desequilíbrios nos padrões respiratórios poder gerar dificuldades nos processos mastigatórios, de deglutição e da fala e um menor desempenho das funções orais (Ballikaya *et al*., 2018; Masutomi; Goto; Ichikawa, 2024).

Além disso, problemas esqueléticos são comuns em crianças portadoras da síndrome. Muitas crianças respiradoras bucais possuem uma retroflexão da cabeça em relação a coluna cervical como forma de adequação da própria estrutura física para permitir uma melhor respiração. Grande parte desses pacientes são classificados como indivíduos portadores de má oclusão Classe II de Angle (Vukićević *et al.*, 2017), sendo a mordida aberta e a mordida cruzada posterior muito frequentes entre esses indivíduos (Grippaudo *et al*., 2016).

A literatura também indica que quadros de diminuição de oxigenação associados aos distúrbios do sono podem levar a problemas de comportamento e de cognição. Já estudos mostram que escolares respiradores bucais apresentam uma maior dificuldade para o desenvolvimento da escrita e compreensão da leitura quando comparados aos respiradores nasais. Isso se deve principalmente pelo fato de os respiradores bucais possuírem uma maior dificuldade e desconforto respiratório durante partes importantes do dia a dia, como o sono e em afazeres que exijam um maior controle respiratório, como em atividades físicas, o que, em última instância, podem trazer prejuízos para seu desenvolvimento físico e psicológico (Chervin et *al*., 2003; Chedid *et al*., 2004). Tais hipóteses corroboram o fato de a respiração bucal

trazer consequências para comportamento infantil como: a hiperatividade, agressividade e problemas de socialização, aprendizagem e atenção (Ali; Pitson; Stradling, 1993).

Dessa forma, devido as inúmeras consequências da síndrome e todas as patologias relacionadas a ela, a respiração bucal passa a ser considerada um problema de saúde pública (Nagae *et al*., 2013). Em razão disso, é necessário que o cirurgião-dentista tenha o conhecimento quanto aos principais sinais, sintomas e consequências da respiração bucal, uma vez que ele(ela) é o(a) profissional responsável por manejar problemas na cavidade oral.

3 OBJETIVOS

3.1 Objetivo Geral

- Avaliar as possíveis associações entre a respiração bucal com as principais manifestações odontológicas em crianças e adolescentes: cárie dentária e alterações periodontais.

3.2 Objetivos Específicos

- Avaliar a presença/ausência de associação entre a respiração bucal e a cárie dentária em seus diferentes estágios de gravidade em crianças e adolescentes.

- Avaliar a presença/ausência de associação entre a respiração bucal e alterações periodontais, com ênfase na gengivite em crianças e adolescentes.

4 METODOLOGIA EXPANDIDA

4.1 Delineamento do estudo

O estudo foi desenvolvido através de uma revisão sistemática.

4.2 Protocolo e Registro

Esta revisão sistemática foi elaborada de acordo com o guia de orientações do PRISMA (*Preferred Reporting Items for Systematic Reviews and Meta-Analysis*) (Page *et al*., 2021). Logo após, foi feito o registro de protocolo no *"International Prospective Register of Systematic Reviews*" (PROSPERO) (CRD42024536891) **(ANEXO A).**

4.3 Critérios de Elegibilidade

Nesta revisão foram incluídos os estudos que buscaram uma associação entre a respiração bucal com alterações periodontais e/ou da doença cárie em crianças e adolescentes. Não houve restrição quanto ao idioma, data de publicação ou população investigada.

A pergunta de pesquisa "Crianças e adolescentes com respiração bucal são mais propensos a apresentar cáries dentárias e distúrbios periodontais do que crianças e adolescentes com respiração nasal?" foi respondida através do formato PECOS:

Participants (participantes): crianças e adolescentes (com idade ≤ a 19 anos) (*World Health Organization*, 2006)
Exposure (exposição): presença da respiração bucal
Comparison (comparação): ausência de respiração bucal
Outcome (desfecho): doença cárie e/ou doença periodontal e desfecho relacionados a essas duas manifestações bucais.
Study (desenho de estudo): estudos observacionais

Estudos observacionais apresentados na forma de resumos de congressos, editoriais e opiniões de *experts* e estudos que avaliaram pacientes com necessidades especiais foram excluídos.

4.4 Fontes de informação

Uma busca eletrônica foi conduzida pelos pesquisadores nas seguintes bases de dados: *PubMed (National Library of Medicine), OVID (Wolters Kluwer), Web of Science (Clarivate Analytics), SCOPUS (Elsevier) e EMBASE (Elsevier)*. Buscas no *Open Grey e no Google Scholar* também foram realizadas. Nessas duas últimas bases, houve uma restrição às primeiras 300 referências (Haddaway *et al*., 2015) (**Anexo B**).

4.5 Busca

Nas bases de dados foram utilizadas estratégias de busca específicas para cada base eletrônica. As estratégias de busca foram compostas por uni-termos unidos por operadores Booleanos.

Uma busca manual na lista de referências dos artigos incluídos também foi feita para a identificação de estudos que podem não ter sido identificados durante a busca nas bases de dados eletrônicas. As referências foram recuperadas e exportadas para o programa *Endnote Online* (*Clarivate Analytics*, Londres, Reino Unido). As duplicatas identificadas foram removidas. As estratégias de busca expandidas para cada base de dados foram descritas na **Tabela 1.**

Tabela 1 - Estratégia de busca empregada nas bases de dados

Bases de dados	**Estratégia de busca expandida**
Web of Science	mouth breathing OR mouth breather (All Fields) and dental caries OR dental decay OR caries disease OR root caries OR tooth caries OR tooth decay OR dental fissure OR dmfc OR dmft OR ICDAS OR periodontal disease OR gingival disease OR pyrrha OR gum disease OR periodontitis OR gingivitis OR paradontosis OR periodontal pocket OR periodontal abscess OR dental plaque OR probing depth

	OR bleeding on probing OR plaque index OR gingival index OR periodontal index OR attachment level OR gingival bleeding (All Fields)
Scopus	(ALL ("mouth breathing" OR "mouth breather") AND ALL ("dental caries" OR "dental decay" OR "caries disease" OR "root caries" OR "tooth caries" OR "tooth decay" OR "dental fissure" OR dmfs OR dmft OR icdas OR "periodontal disease" OR "gingival disease" OR pyorrhea OR "gum disease" OR periodontitis OR gingivitis OR parodontosis OR "periodontal pocket" OR "periodontal abscess" OR "dental plaque" OR "probing depth" OR "bleeding on probing" OR "plaque index" OR "gingival index" OR "periodontal index" OR "attachment level" OR "gingival bleeding")
OVID	((mouth breathing or mouth breather) and (dental caries or dental decay or caries disease or root caries or tooth caries or tooth decay or dental fissure or dmfs or dmft or ICDAS or periodontal disease or gingival disease or pyorrhea or gum disease or periodontitis or gingivitis or parodontosis or periodontal pocket or periodontal abscess or dental plaque or probing depth or bleeding on probing or plaque index or gingival index or periodontal index or attachment level or gingival bleeding)).af.
PubMed	("mouth breathing"[MeSH Terms] OR ("mouth"[All Fields] AND "breathing"[All Fields]) OR "mouth breathing"[All Fields] OR (("mouth"[MeSH Terms] OR "mouth"[All Fields] OR "mouths"[All Fields] OR "mouth s"[All Fields] OR "mouthed"[All Fields] OR "mouthful"[All Fields] OR "mouthfuls"[All Fields] OR "mouthing"[All Fields]) AND ("breather"[All Fields] OR "breathers"[All Fields]))) AND ("dental caries"[MeSH Terms] OR ("dental"[All Fields] AND "caries"[All Fields]) OR "dental caries"[All Fields] OR ("dental caries"[MeSH Terms] OR ("dental"[All Fields] AND "caries"[All Fields]) OR "dental caries"[All Fields] OR ("dental"[All Fields] AND "decay"[All Fields]) OR "dental decay"[All Fields]) OR (("carie"[All Fields] OR "dental caries"[MeSH Terms] OR ("dental"[All Fields] AND "caries"[All Fields]) OR "dental caries"[All Fields] OR "caries"[All Fields]) AND ("disease"[MeSH Terms] OR "disease"[All Fields] OR "diseases"[All Fields] OR "disease s"[All Fields] OR "diseased"[All Fields])) OR ("root caries"[MeSH Terms] OR ("root"[All Fields] AND "caries"[All Fields]) OR "root caries"[All Fields]) OR ("dental caries"[MeSH Terms] OR ("dental"[All Fields] AND "caries"[All Fields]) OR "dental caries"[All Fields] OR ("tooth"[All Fields] AND "caries"[All Fields]) OR "tooth caries"[All Fields]) OR ("dental caries"[MeSH Terms] OR ("dental"[All Fields] AND "caries"[All Fields]) OR "dental caries"[All Fields] OR ("tooth"[All Fields] AND "decay"[All Fields]) OR "tooth decay"[All Fields]) OR ("dental fissures"[MeSH Terms] OR ("dental"[All Fields] AND "fissures"[All Fields]) OR "dental fissures"[All Fields] OR ("dental"[All Fields] AND "fissure"[All Fields]) OR "dental fissure"[All Fields]) OR "dmfs"[All Fields] OR "dmft"[All Fields] OR "ICDAS"[All Fields] OR ("periodontal diseases"[MeSH Terms] OR ("periodontal"[All Fields] AND "diseases"[All Fields]) OR "periodontal diseases"[All Fields] OR ("periodontal"[All Fields] AND "disease"[All Fields]) OR "periodontal disease"[All Fields]) OR ("gingival diseases"[MeSH Terms] OR ("gingival"[All Fields] AND "diseases"[All Fields]) OR "gingival diseases"[All Fields] OR ("gingival"[All Fields] AND "disease"[All Fields]) OR "gingival disease"[All Fields]) OR ("periodontal diseases"[MeSH Terms] OR ("periodontal"[All Fields] AND "diseases"[All Fields]) OR "periodontal diseases"[All Fields] OR "pyorrhea"[All Fields] OR "pyorrhoea"[All Fields]) OR ("gingival diseases"[MeSH Terms] OR ("gingival"[All Fields] AND "diseases"[All Fields]) OR "gingival diseases"[All Fields] OR ("gum"[All Fields] AND "disease"[All Fields]) OR "gum disease"[All Fields]) OR ("periodontal"[All Fields] OR "periodontally"[All Fields] OR "periodontically"[All

	Fields] OR "periodontics"[MeSH Terms] OR "periodontics"[All Fields] OR "periodontic"[All Fields] OR "periodontitis"[MeSH Terms] OR "periodontitis"[All Fields] OR "periodontitides"[All Fields]) OR ("gingiva"[MeSH Terms] OR "gingiva"[All Fields] OR "gingival"[All Fields] OR "gingivally"[All Fields] OR "gingivals"[All Fields] OR "gingivitis"[MeSH Terms] OR "gingivitis"[All Fields] OR "gingivitides"[All Fields]) OR ("periodontal diseases"[MeSH Terms] OR ("periodontal"[All Fields] AND "diseases"[All Fields]) OR "periodontal diseases"[All Fields] OR "parodontosis"[All Fields]) OR ("periodontal pocket"[MeSH Terms] OR ("periodontal"[All Fields] AND "pocket"[All Fields]) OR "periodontal pocket"[All Fields]) OR ("periodontal abscess"[MeSH Terms] OR ("periodontal"[All Fields] AND "abscess"[All Fields]) OR "periodontal abscess"[All Fields]) OR ("dental plaque"[MeSH Terms] OR ("dental"[All Fields] AND "plaque"[All Fields]) OR "dental plaque"[All Fields]) OR (("probe"[All Fields] OR "probe s"[All Fields] OR "probed"[All Fields] OR "probes"[All Fields] OR "probing"[All Fields] OR "probings"[All Fields]) AND ("depth"[All Fields] OR "depths"[All Fields])) OR (("bleedings"[All Fields] OR "hemorrhage"[MeSH Terms] OR "hemorrhage"[All Fields] OR "bleed"[All Fields] OR "bleeding"[All Fields] OR "bleeds"[All Fields]) AND ("probe"[All Fields] OR "probe s"[All Fields] OR "probed"[All Fields] OR "probes"[All Fields] OR "probing"[All Fields] OR "probings"[All Fields])) OR ("dental plaque index"[MeSH Terms] OR ("dental"[All Fields] AND "plaque"[All Fields] AND "index"[All Fields]) OR "dental plaque index"[All Fields] OR ("plaque"[All Fields] AND "index"[All Fields]) OR "plaque index"[All Fields]) OR ("periodontal index"[MeSH Terms] OR ("periodontal"[All Fields] AND "index"[All Fields]) OR "periodontal index"[All Fields] OR ("gingival"[All Fields] AND "index"[All Fields]) OR "gingival index"[All Fields]) OR ("periodontal index"[MeSH Terms] OR ("periodontal"[All Fields] AND "index"[All Fields]) OR "periodontal index"[All Fields]) OR (("attach"[All Fields] OR "attachable"[All Fields] OR "attached"[All Fields] OR "attachement"[All Fields] OR "attaches"[All Fields] OR "attaching"[All Fields] OR "attachment"[All Fields] OR "attachments"[All Fields]) AND ("level"[All Fields] OR "levels"[All Fields])) OR ("gingival hemorrhage"[MeSH Terms] OR ("gingival"[All Fields] AND "hemorrhage"[All Fields]) OR "gingival hemorrhage"[All Fields] OR ("gingival"[All Fields] AND "bleeding"[All Fields]) OR "gingival bleeding"[All Fields]))
Embase	('mouth breathing'/exp OR 'mouth breathing' OR 'mouth breather') AND ('dental caries' OR 'dental decay' OR 'caries disease' OR 'root caries' OR 'tooth caries' OR 'tooth decay' OR 'dental fissure' OR dmfs OR dmft OR icdas OR 'periodontal disease' OR 'gingival disease' OR pyorrhea OR 'gum disease' OR periodontitis OR gingivitis OR parodontosis OR 'periodontal pocket' OR 'periodontal abscess ' OR 'dental plaque' OR 'probing depth' OR 'bleeding on probing' OR 'plaque index' OR 'gingival index' OR 'periodontal index' OR 'attachment level' OR 'gingival bleeding')

4.6 Seleção de Estudos

A seleção dos estudos foi realizada por dois autores (ACRSK e LGA) em duas fases. Na Fase 1, todos os títulos/resumos das referências recuperadas na

busca eletrônica foram avaliados. As referências, cujos títulos/resumos atendiam os critérios gerais de elegibilidade seguiram para a Fase 2. Na Fase 2, os dois autores (ACRSK e LGA) realizaram uma discussão e uma leitura detalhada dos textos completos das referências selecionadas na Fase 1. Os artigos, cujos textos completos atenderam aos critérios de elegibilidade, foram incluídos na revisão sistemática. A concordância entre os dois autores na Fase 1 e na Fase 2 foi dada pelo cálculo do coeficiente Kappa (Herzog *et al*., 2013).

4.7 Extração de dados

A leitura completa dos artigos incluídos foi feita por dois pesquisadores (ACRSK e LGA). Nessa etapa foram extraídos os dados: nome dos autores, ano de publicação, país onde o estudo foi conduzido, desenho de estudo, número de participantes e características das amostras (sexo, idade), identificação dos grupos de comparação (crianças/adolescentes com respiração bucal e crianças/adolescentes sem respiração bucal), os desfechos analisados (doença periodontal e/ou doença cárie), métodos de avaliação e índices utilizados para avaliação dos desfechos, testes estatísticos escolhidos para a comparação entre grupos e resultados da comparação entre grupos. Os dados extraídos foram fornecidos nos ***Supplementary Files 2 and 3***.

4.8 Risco de viés

Dois autores avaliaram o risco de viés dos estudos incluídos, de forma independente, e as discordâncias foram discutidas até que houvesse um consenso. Para a avaliação do risco de viés, a Escala *Newcastle Ottawa* foi utilizada. Para a avaliação dos estudos transversais, foram considerados a representatividade da amostra, número de não respostas e a determinação da exposição (seleção). Os fatores de confusão também foram considerados na análise de comparações (comparação). Em relação ao desfecho, foram avaliados os resultados encontrados e os testes estatísticos utilizados para todos os desenhos de estudo (desfecho).

Para os estudos transversais, foram atribuídos no máximo cinco pontos para a seleção, dois máximos para a comparação e três pontos máximos para o desfecho (Herzog *et al*., 2013; Higgins *et al*., 2023; Wells *et al*., 2021). As análises do risco de viés foram fornecidas nos ***Supplementary Files 4 and 5****.*

4.9 Síntese narrativa

As características e os resultados dos estudos foram resumidos através de uma narrativa e apresentados em tabelas e figuras.

4.10 Diferença Média Estandardizada

A Diferença Média Estandardizada (DME) foi estimada utilizando o método de Cohen (Cohen, 1960) para avaliar o tamanho do efeito. Os tamanhos dos efeitos foram categorizados como pequeno (DME = 0,2), médio (DME = 0,5) e grande (DME = 0,8) (Faraone, 2008).

4.11 Síntese quantitativa (meta-análises)

Na presença de homogeneidade metodológica dos dados extraídos, foram realizadas meta-análises por meio do software *Review Manager* (RevMan 5.4). As análises abrangeram desfechos contínuos na mesma escala, adotando modelo de efeitos aleatórios. As medidas de efeito foram expressas através da diferença média estandardizada (DME) com intervalo de confiança de 95%. Havendo possibilidade, a heterogeneidade foi avaliada pela estatística Q (χ^2) e quantificada por tau-quadrado (τ^2) e I^2 (DerSimonian; Laird, 1986; Higgins; Thompson, 2002).

4.12 Força da evidência

A força da evidência, avaliada por meio do sistema GRADE *(Grading of Recommendations Assessment, Development, and Evaluation)* (Guyatt *et al*., 2008), foi aplicada para os desfechos para os quais meta-análises foram realizadas, conforme os critérios definidos neste protocolo. As análises foram fornecidas nos ***Supplementary File 6.***

5 ARTIGO

Dental caries and periodontal outcomes in mouth-breathing children and adolescents: a systematic review

Anna Carolina Rye Sato **Kimura**[1] (https://orcid.org/0000-0002-8011-5400)
José Alcides Almeida **de Arruda**[2] (https://orcid.org/0000-0002-6599-3950)
Victor Zanetti **Drumond**[3] (https://orcid.org/0000-0002-5270-3950)
Paulo Antônio **Martins-Júnior**[1](https://orcid.org/0000-0002-1575-5364)
Ricardo Alves **Mesquita**[3] (https://orcid.org/0000-0003-3207-4007)
Lucas Guimarães **Abreu**[1] (https://orcid.org/0000-0003-2258-8071)

[1]Department of Child and Adolescent Oral Health, School of Dentistry, Universidade Federal de Minas Gerais, Belo Horizonte, Brazil.
[2]Department of Oral Diagnosis and Pathology, School of Dentistry, Universidade Federal do Rio de Janeiro, Rio de Janeiro, Brazil.
[3]Department of Oral Surgery, Pathology, and Clinical Dentistry, School of Dentistry, Universidade Federal de Minas Gerais, Belo Horizonte, Brazil.

Abstract

Background: Mouth breathing may lead to changes in the oral cavity.

Aim: To compare dental caries and periodontal outcomes in children and adolescents with and without mouth breathing.

Design: This systematic review, registered in PROSPERO (CRD42024536891), included the following: *Population*: children and adolescents; *Exposure*: mouth breathing; *Comparison*: non-mouth breathing; *Outcome*: dental caries and periodontal/gingival conditions; *Study design*: observational studies. Electronic searches were conducted in five databases. Risk of bias was appraised using Newcastle-Ottawa Scale.

Results: Of the 838 records identified, 11 studies were included, comprising 11 cross-sectional studies. The studies showed low bias in exposure, outcomes, and statistical analyses, though few met criteria for non-response and sample size adequacy. Individuals with mouth breathing exhibited increased gingival bleeding, plaque

accumulation, and gingival alterations. Associations with dental caries were observed for initial lesions and for ICDAS scores 5 and 6. Meta-analyses indicated a higher, albeit not statistically significant, mean Plaque Index (SMD=2.46 [95% CI: -0.04–4.96], I^2=98%) and Gingival Inflammation Index (SMD=0.47 [95% CI: -1.33–2.26], I^2=97%) in mouth breathers.

Conclusion: Mouth breathing in children and adolescents might be associated with gingival outcomes and plaque accumulation. Regarding dental caries, limited evidence suggests that the association is confined to initial and advanced lesions.

Keywords: dental caries, mouth breathing, oral health, periodontal diseases, respiration disorders

1. Introduction

Mouth breathing is characterized by the passage of inhaled air through the mouth instead of the nose, often serving as an adaptive mechanism to maintain effective respiration when nasal breathing is compromised.[1] Its prevalence in the pediatric population ranges from 11% to 56%.[2] This alteration in breathing pattern is typically associated with upper airway obstructions or anatomical abnormalities, such as hypertrophy of the pharyngeal and palatine tonsils, allergic rhinitis, and asthma, which are among the main contributors to this condition.[2-4]

The consequences of mouth breathing extend beyond respiratory function, affecting multiple aspects of health and development.[2] Studies have also shown that mouth breathing may impair cognitive function and concentration,[5] potentially impacting tasks that require respiratory control, such as physical activities.[6] Moreover, children and adolescents with this condition may face challenges in academic performance, particularly in learning, writing skills, reading comprehension, and working memory.[7-9] Mouth breathing has also been linked to malocclusion, including misaligned teeth and abnormal maxillary skeletal growth, which can influence facial development.[10]

From an oral health perspective, the shift in airflow from the nasal passages to the oral cavity has significant implications. This alteration leads to a reduction in intraoral pH[11] and increased biofilm accumulation[12]—both critical factors in the pathogenesis of dental caries and periodontitis.[13] The bacterial profile in mouth-breathing individuals is often associated with higher cariogenic activity[13] and a greater progression of carious lesions.[14,15] Similarly, studies have documented a higher prevalence of gingivitis and periodontitis in this population.[16]

Despite growing evidence suggesting a relationship between mouth breathing and oral health outcomes, including dental caries and periodontitis,[2,17] no systematic synthesis of the literature has been conducted hitherto. Therefore, the purpose of the present systematic review was to compare dental caries and periodontal- and gingival-related outcomes between children and adolescents with and without mouth breathing. This study hypothesizes that children and adolescents who breath through the mouth are more susceptible to dental caries and periodontal conditions.

2. Materials and methods

2.1 Protocol and registration

This systematic review was conducted and reported in accordance with the PRISMA (Preferred Reporting Items for Systematic Reviews and Meta-Analysis) guidelines.[18] The protocol was registered in the International Prospective Register of Systematic Reviews (PROSPERO; CRD42024536891).

2.2 Eligibility criteria

Observational studies (longitudinal, cross-sectional with and without control groups, and case-control) were included if they compared children and adolescents (≤19 years)[19] with mouth breathing to their counterparts without mouth breathing in relation to dental caries and periodontal and/or gingival outcomes. Other study designs were excluded. No restrictions were applied regarding publication language or date.

For eligibility criteria, the study aimed to answer the research question: "Are children and adolescents who breathe through the mouth more likely to present with dental caries and periodontal disorders than those who breathe through the nose?", using the PECOS format:

P (Population): children and adolescents of any sex;

E (Exposure): mouth breathing;

C (Comparison): non-mouth breathing;

O (Outcome): dental caries and periodontal/gingival outcomes;

S (Study design): observational studies.

2.3 Databases and search strategy

Electronic searches were conducted in April 2024, with an update in December 2024, across Embase (Elsevier), MEDLINE/PubMed (National Library of Medicine), Web of Science (Clarivate Analytics), Ovid (Wolters Kluwer), and Scopus (Elsevier). Gray literature was searched using OpenGrey and Google Scholar (limited to the first 300 records).[20] Additionally, the reference lists of included articles were manually reviewed. Search strategies combined MeSH terms and free-text keywords using Boolean operators (AND, OR). Detailed search strategies are provided in **Table 1**.

Table 1. Search strategies employed in databases

Databases	Search strategy

Web of Science	mouth breathing OR mouth breather (All Fields) and dental caries OR dental decay OR caries disease OR root caries OR tooth caries OR tooth decay OR dental fissure OR dmfc OR dmft OR ICDAS OR periodontal disease OR gingival disease OR pyrrha OR gum disease OR periodontitis OR gingivitis OR paradontosis OR periodontal pocket OR periodontal abscess OR dental plaque OR probing depth OR bleeding on probing OR plaque index OR gingival index OR periodontal index OR attachment level OR gingival bleeding (All Fields)
Scopus	(ALL ("mouth breathing" OR "mouth breather") AND ALL ("dental caries" OR "dental decay" OR "caries disease" OR "root caries" OR "tooth caries" OR "tooth decay" OR "dental fissure" OR dmfs OR dmft OR icdas OR "periodontal disease" OR "gingival disease" OR pyorrhea OR "gum disease" OR periodontitis OR gingivitis OR parodontosis OR "periodontal pocket" OR "periodontal abscess" OR "dental plaque" OR "probing depth" OR "bleeding on probing" OR "plaque index" OR "gingival index" OR "periodontal index" OR "attachment level" OR "gingival bleeding")
OVID	((mouth breathing or mouth breather) and (dental caries or dental decay or caries disease or root caries or tooth caries or tooth decay or dental fissure or dmfs or dmft or ICDAS or periodontal disease or gingival disease or pyorrhea or gum disease or periodontitis or gingivitis or parodontosis or periodontal pocket or periodontal abscess or dental plaque or probing depth or bleeding on probing or plaque index or gingival index or periodontal index or attachment level or gingival bleeding)).af.
PubMed	("mouth breathing"[MeSH Terms] OR ("mouth"[All Fields] AND "breathing"[All Fields]) OR "mouth breathing"[All Fields] OR (("mouth"[MeSH Terms] OR "mouth"[All Fields] OR "mouths"[All Fields] OR "mouth s"[All Fields] OR "mouthed"[All Fields] OR "mouthful"[All Fields] OR "mouthfuls"[All Fields] OR "mouthing"[All Fields]) AND ("breather"[All Fields] OR "breathers"[All Fields]))) AND ("dental caries"[MeSH Terms] OR ("dental"[All Fields] AND "caries"[All Fields]) OR "dental caries"[All Fields] OR ("dental caries"[MeSH Terms] OR ("dental"[All Fields] AND "caries"[All Fields]) OR "dental caries"[All Fields] OR ("dental"[All Fields] AND "decay"[All Fields]) OR "dental decay"[All Fields]) OR (("carie"[All Fields] OR "dental caries"[MeSH Terms] OR ("dental"[All Fields] AND "caries"[All Fields]) OR "dental caries"[All Fields] OR "caries"[All Fields]) AND

("disease"[MeSH Terms] OR "disease"[All Fields] OR "diseases"[All Fields] OR "disease s"[All Fields] OR "diseased"[All Fields])) OR ("root caries"[MeSH Terms] OR ("root"[All Fields] AND "caries"[All Fields]) OR "root caries"[All Fields]) OR ("dental caries"[MeSH Terms] OR ("dental"[All Fields] AND "caries"[All Fields]) OR "dental caries"[All Fields] OR ("tooth"[All Fields] AND "caries"[All Fields]) OR "tooth caries"[All Fields]) OR ("dental caries"[MeSH Terms] OR ("dental"[All Fields] AND "caries"[All Fields]) OR "dental caries"[All Fields] OR ("tooth"[All Fields] AND "decay"[All Fields]) OR "tooth decay"[All Fields]) OR ("dental fissures"[MeSH Terms] OR ("dental"[All Fields] AND "fissures"[All Fields]) OR "dental fissures"[All Fields] OR ("dental"[All Fields] AND "fissure"[All Fields]) OR "dental fissure"[All Fields]) OR "dmfs"[All Fields] OR "dmft"[All Fields] OR "ICDAS"[All Fields] OR ("periodontal diseases"[MeSH Terms] OR ("periodontal"[All Fields] AND "diseases"[All Fields]) OR "periodontal diseases"[All Fields] OR ("periodontal"[All Fields] AND "disease"[All Fields]) OR "periodontal disease"[All Fields]) OR ("gingival diseases"[MeSH Terms] OR ("gingival"[All Fields] AND "diseases"[All Fields]) OR "gingival diseases"[All Fields] OR ("gingival"[All Fields] AND "disease"[All Fields]) OR "gingival disease"[All Fields]) OR ("periodontal diseases"[MeSH Terms] OR ("periodontal"[All Fields] AND "diseases"[All Fields]) OR "periodontal diseases"[All Fields] OR "pyorrhea"[All Fields] OR "pyorrhoea"[All Fields]) OR ("gingival diseases"[MeSH Terms] OR ("gingival"[All Fields] AND "diseases"[All Fields]) OR "gingival diseases"[All Fields] OR ("gum"[All Fields] AND "disease"[All Fields]) OR "gum disease"[All Fields]) OR ("periodontal"[All Fields] OR "periodontally"[All Fields] OR "periodontically"[All Fields] OR "periodontics"[MeSH Terms] OR "periodontics"[All Fields] OR "periodontic"[All Fields] OR "periodontitis"[MeSH Terms] OR "periodontitis"[All Fields] OR "periodontitides"[All Fields]) OR ("gingiva"[MeSH Terms] OR "gingiva"[All Fields] OR "gingival"[All Fields] OR "gingivally"[All Fields] OR "gingivals"[All Fields] OR "gingivitis"[MeSH Terms] OR "gingivitis"[All Fields] OR "gingivitides"[All Fields]) OR ("periodontal diseases"[MeSH Terms] OR ("periodontal"[All Fields] AND "diseases"[All Fields]) OR "periodontal diseases"[All Fields] OR "parodontosis"[All Fields]) OR ("periodontal pocket"[MeSH Terms] OR ("periodontal"[All Fields] AND "pocket"[All Fields]) OR "periodontal pocket"[All Fields]) OR ("periodontal abscess"[MeSH Terms] OR ("periodontal"[All Fields] AND "abscess"[All Fields])

	OR "periodontal abscess"[All Fields]) OR ("dental plaque"[MeSH Terms] OR ("dental"[All Fields] AND "plaque"[All Fields]) OR "dental plaque"[All Fields]) OR (("probe"[All Fields] OR "probe s"[All Fields] OR "probed"[All Fields] OR "probes"[All Fields] OR "probing"[All Fields] OR "probings"[All Fields]) AND ("depth"[All Fields] OR "depths"[All Fields])) OR (("bleedings"[All Fields] OR "hemorrhage"[MeSH Terms] OR "hemorrhage"[All Fields] OR "bleed"[All Fields] OR "bleeding"[All Fields] OR "bleeds"[All Fields]) AND ("probe"[All Fields] OR "probe s"[All Fields] OR "probed"[All Fields] OR "probes"[All Fields] OR "probing"[All Fields] OR "probings"[All Fields])) OR ("dental plaque index"[MeSH Terms] OR ("dental"[All Fields] AND "plaque"[All Fields] AND "index"[All Fields]) OR "dental plaque index"[All Fields] OR ("plaque"[All Fields] AND "index"[All Fields]) OR "plaque index"[All Fields]) OR ("periodontal index"[MeSH Terms] OR ("periodontal"[All Fields] AND "index"[All Fields]) OR "periodontal index"[All Fields] OR ("gingival"[All Fields] AND "index"[All Fields]) OR "gingival index"[All Fields]) OR ("periodontal index"[MeSH Terms] OR ("periodontal"[All Fields] AND "index"[All Fields]) OR "periodontal index"[All Fields]) OR (("attach"[All Fields] OR "attachable"[All Fields] OR "attached"[All Fields] OR "attachement"[All Fields] OR "attaches"[All Fields] OR "attaching"[All Fields] OR "attachment"[All Fields] OR "attachments"[All Fields]) AND ("level"[All Fields] OR "levels"[All Fields])) OR ("gingival hemorrhage"[MeSH Terms] OR ("gingival"[All Fields] AND "hemorrhage"[All Fields]) OR "gingival hemorrhage"[All Fields] OR ("gingival"[All Fields] AND "bleeding"[All Fields]) OR "gingival bleeding"[All Fields]))
Embase	('mouth breathing'/exp OR 'mouth breathing' OR 'mouth breather') AND ('dental caries' OR 'dental decay' OR 'caries disease' OR 'root caries' OR 'tooth caries' OR 'tooth decay' OR 'dental fissure' OR dmfs OR dmft OR icdas OR 'periodontal disease' OR 'gingival disease' OR pyorrhea OR 'gum disease' OR periodontitis OR gingivitis OR parodontosis OR 'periodontal pocket' OR 'periodontal abscess ' OR 'dental plaque' OR 'probing depth' OR 'bleeding on probing' OR 'plaque index' OR 'gingival index' OR 'periodontal index' OR 'attachment level' OR 'gingival bleeding')

2.4 Screening procedure

Study selection was conducted in two phases by two previously calibrated authors (A.C.R.S.K. and L.G.A.). In the first phase, the titles/abstracts of all retrieved

references were screened for eligibility. In the second phase, the full texts of the references selected in the first phase were assessed. References that met the eligibility criteria were included. Discrepancies were resolved through discussion. Inter-rater agreement in both phases was assessed using the Kappa coefficient.[21]

2.5 Data extraction

Two authors (A.C.R.S.K. and L.G.A.) independently extracted data from the eligible studies. The extracted data included: (i) study characteristics (first author, publication year, and country); (ii) sample details (sample size, sex, and age distribution); (iii) exposure assessment (methods used to identify mouth breathing); (iv) outcome assessment (methods and metrics used to evaluate dental caries and periodontal/gingival conditions); and (v) results (comparisons between mouth-breathing and non-mouth-breathing groups).

2.6 Risk of bias assessment

Risk of bias was appraised using the Newcastle-Ottawa Scale for cross-sectional studies[22], which covers three domains: (i) selection – sample representativeness, sample size, non-response rate, and ascertainment of exposure (with a maximum of 1 point for each of the first three items and up to 2 points for the last item, totaling 5 points); (ii) comparability – methods used to control for confounding factors (maximum of 2 points); and (iii) outcome – assessment methods and statistical analyses (with a maximum of 2 points for the first item and 1 point for the second, totaling 3 points). Therefore, the maximum score for the entire scale was 10 points: 5 for selection, 2 for comparability, and 3 for outcome.[22,23] One author (A.C.R.S.K.) conducted the initial evaluation, and another (L.G.A.) cross-checked the results.

2.7 Narrative synthesis

Study characteristics and results were summarized narratively and presented in tables and figures to enhance clarity.

2.8 Standardized mean difference (SMD)

The SMD was estimated using Cohen’s method to assess the effect size. Effect sizes were categorized as small (SMD = 0.2), medium (SMD = 0.5), and large (SMD = 0.8).[24]

2.9 Quantitative synthesis (meta-analysis)

Meta-analyses were performed for studies demonstrating methodological homogeneity using Review Manager (RevMan, version 5.4; The Cochrane Collaboration, 2020). Meta-analyses of continuous data were conducted for outcomes reported on the same measurement scale. This approach ensured the comparability of effect estimates, minimized variability, and enhanced the robustness of the findings. Data on means, standard deviations (SD), and sample sizes were entered into the software. A random-effects model was applied to account for clinical heterogeneity and variation in effect sizes. The summary effect measure was reported as the standardized mean difference (SMD) with a 95% confidence interval (CI). For studies reporting arch-specific outcomes, pooled means and SD were calculated using weighted averages and variance pooling.[25] Heterogeneity was assessed using the *Q*-statistic (χ^2) and quantified by tau-square (τ^2) and I^2 statistics,[26] estimated via the DerSimonian and Laird method.[26]

2.10 Strength of evidence

The strength of the evidence was assessed using the Grading of Recommendations Assessment, Development, and Evaluation (GRADE) framework.[27]

3. Results

3.1 Study selection

The electronic searches yielded 838 articles, of which 11 met the eligibility criteria and were included in the qualitative synthesis.[4,28-37] A summary of the screening process is displayed in **Figure 1**. References excluded after full-text assessment, along with the reasons for exclusion, are fully available in **Supplementary File 1**. The Kappa coefficient for inter-rater agreement between authors was greater than 0.80.

3.2 Characteristics of included studies

Eight cross-sectional studies with control groups,[28-33,36,37] and three cross-sectional studies without control groups,[4,34,35] were included. Publication years ranged from 1973[28] to 2024[37], with most studies published in English, except for one in Portuguese.[31] The studies were conducted in Brazil,[30-32,37] Turkey,[4,36] Germany,[33]

South Korea,[34] India,[35] Sweden,[28] and the United Kingdom.[29] Further details on the extracted data are available in **Supplementary Files 2 and 3**.

3.2.1 Exposure assessment

In four studies[29,33-35] questionnaires were applicated for the assessment of the mouth breathing condition. In three studies[28,29,33], the mirror test was assessed. Observation was assessed in two[29,37] studies. In four studies[4,30,32,36], otolaryngologist examined the patients of the samples, and in two studies[31,32], speech therapist performed the exam. In two studies[30,32] mouth breathing was assessed thru parents/caregivers report. In one study[36] fiberoptic nasolaryngoscopy was performed, and in one study[35] Mallampati scale and Brodsky scale was applied. Details are available in **Supplementary Files 2 and 3**.

3.3 Sample characteristics

The total sample size of studies assessing dental caries was 3,941 individuals, while those evaluating periodontal outcomes included 1,585 participants. Three studies[4,30,36] assessed individuals as young as 3 years old. In three other studies,[31,34,35] the minimum age was 8 years. One study[29] evaluated individuals aged 11–14 years, and another[33] included participants aged 10–15 years. Two studies[28,32] evaluated individuals aged 6 years or older, while one study[37] focused on children aged 3–5 years.

3.4 Outcome assessment

3.4.1 Periodontal- and gingival-related outcomes

The gingival index was assessed in one study,[30] while three studies[4,28,36] evaluated the gingival inflammation index. One study[31] assessed the gingival bleeding index, and another[29] measured gingival redness and bleeding on probing as dichotomous outcomes (presence/absence).

The plaque index was reported in five studies.[4,28,30,32,35] In one study,[32] periodontal assessment was conducted using the Orofacial Myofunctional Evaluation with Scores (MBGR) protocol, while another[29] evaluated plaque accumulation as a dichotomous outcome. The Community Periodontal Index (CPI) was employed in one study.[33]

3.4.2 Dental caries

Five studies[4,31,34-36] assessed dental caries using the Decayed, Missing, and Filled Teeth for permanent (DMFT) and deciduous (dft) dentition. Three studies[4,33,37] employed the International Caries Detection and Assessment System (ICDAS), while one study[30] categorized dental caries through visual inspection into initial dental caries and cavitated lesions.

3.5 Results of individual studies

3.5.1 Association between periodontal- and gingival-related outcomes and mouth breathing

3.5.1.1 Cross-sectional studies with a control group

3.5.1.1.1 Plaque index, visible plaque, and plaque accumulation

In three studies,[29,30,36] no significant differences were found in plaque index scores[30,36] (small effect) or in visible plaque (small effect)[29] between individuals with mouth breathing and those with nasal breathing. However, in one study,[28] individuals with mouth breathing exhibited a higher plaque index, although no *p*-value was reported. In another study,[31] the prevalence of a plaque index ≥1 was similar between individuals with and without mouth breathing. One study[29] found that mouth breathers had significantly more sites with plaque accumulation (medium effect).

3.5.1.1.2 Gingival index, gingival inflammation index, and gingival breeding index

Regarding gingival index scores, one study[30] reported significantly higher values among mouth breathers for both anterior teeth (large effect) and posterior teeth (large effect). Among the two studies that evaluated the gingival inflammation index,[28,36] one found no significant difference between groups (medium effect)[36], while the other reported higher scores in mouth breathers, but did not provide *p*-values.[28] In one study,[31] no significant difference was observed between mouth and nasal breathers regarding the gingival bleeding index.

3.5.1.1.3 Bleeding on probing, profuse bleeding, and redness

For bleeding on probing, one study[29] found no significant difference between groups (medium effect). However, mouth breathers exhibited significantly greater profuse bleeding and gingival redness.

3.5.1.1.4 Regular gingival maintenance and CPI

One study[32] reported that mouth breathers were more likely to require regular gingival maintenance. In another study,[33] no significant differences were observed in CPI values between groups for tooth 11 and tooth 31.

3.5.1.2 Cross-sectional studies

In one cross-sectional study,[4] among the 150 participants with mouth breathing, 143 (95.3%) exhibited a moderate plaque index, while seven (4.7%) exhibited a minimal plaque index. Also, 134 (89.3%) participants exhibited a moderate gingival inflammation index, while 16 (10.7%) had a mild gingival inflammation index.

3.5.2 Association between dental caries and mouth breathing

3.5.2.1 Cross-sectional studies with a control group

In one study,[30] children with mouth breathing had significantly more surfaces with initial caries lesions in posterior teeth (large effect) and in all teeth combined (large effect), while no differences were noted in anterior teeth. Regarding the number of tooth surfaces with more severe caries lesions, no significant difference between groups was reported. In another study,[37] mouth breathers showed a higher prevalence of anterior dental caries when assessed using ICDAS. Three studies[31,33,36] found no significant differences between groups in DMFT/dmft or ICDAS scores (medium effect).[36]

3.5.2.2 Cross-sectional studies

One study[35] identified mouth breathing as a factor significantly associated with dental caries, while another[34] reported weak correlations between the Total Mouth Breathing Index (TMBI) and DMFT/dft scores. In one study, among participants with mouth breathing,[4] 62% presented with advanced caries lesions (ICDAS 5–6), 28% had moderate lesions (ICDAS 3–4), and 10% exhibited initial lesions (ICDAS 1–2); no individuals had sound teeth (ICDAS 0).

3.6 Risk of bias assessment

All included studies exhibited a low risk of bias for exposure ascertainment and outcome assessment. Most studies, with the exception of two,[28,29] also showed a low risk of bias in statistical analyses. However, only three studies[4,35,37] demonstrated a

low risk of bias related to non-response rates. Four studies[32,33,36,37] showed a low risk of bias concerning sample size **(Supplementary Files 4 and 5)**.

3.7 Quantitative synthesis

Data from three studies[28,30,36] were pooled, and meta-analyses were performed to compare periodontal outcomes between individuals with and without mouth breathing.

For the Plaque Index, the SMD was 2.46 **(Figure 2)**, indicating a higher plaque index among individuals with mouth breathing. However, the 95% CI, ranging from -0.04 to 4.96, crossed the effect size zero, rendering no statistically significant difference between groups. The *Q*-statistic was 98.5 (df=2, p<0.00001), with τ^2=4.77, and I^2=98%.

For the Gingival Inflammation Index, the SMD was 0.47 **(Figure 3)**, indicating a slight increase in gingival inflammation among mouth breathers. However, the 95% CI ranging from -1.33 to 2.26 crossed the effect size zero, denoting a non-significant difference. The *Q*-statistic was 32.17 (df=1, p<0.00001), with τ^2=1.62, and I^2=97%.

3.8 Strength of evidence assessment

The certainty of the evidence from the meta-analyses was rated as very low **(Supplementary File 6)**.

4. Discussion

The present systematic review reveals the unfavorable oral health outcomes associated with mouth breathing in children and adolescents, including increased gingival bleeding, plaque accumulation, and gingival alterations. Notably, the association between mouth breathing and dental caries was observed in initial lesions, anterior dental caries, and in cases classified as ICDAS scores 5 and 6, which represent advanced stages of carious lesions.

The findings align with existing literature, which demonstrates that young individuals with mouth breathing exhibit lower intraoral pH levels, a critical factor in the demineralization of dental enamel. An acidic oral environment promotes the progression of carious lesions by disrupting the equilibrium between demineralization and remineralization.[38] A study involving 672 Brazilian adolescents confirmed the association between lower salivary pH and higher DMFT scores,[38] underscoring

salivary pH as an important biomarker for dental caries risk.[39] Additionally, mouth breathing contributes to increased dehydration of the oral cavity and supporting tissues, thereby heightening susceptibility to gingivitis and periodontitis.[2,11,40]

The oral microbial composition further exacerbates the risk of dental caries and periodontitis in individuals with mouth breathing. Studies have shown that these individuals harbor higher concentrations of pathogenic bacteria, including *Streptococcus mutans*, *Lactobacillus spp.*, *Actinomyces*, *Alloprevotella*, and *Gemella*.[40-44] Specific species, such as *Actinomyces graevenitzii*, *Prevotella salivae*, and *S. mutans*, are notably more prevalent in the saliva of children with a history of carious lesions compared to those without.[45,46] Periodontal outcomes, including gingivitis, are predominantly linked to *Actinomyces viscosus*, *Streptococcus spp.*, and *Prevotella intermedia*.[47-49] These findings suggest that the oral microbiota of mouth breathers foster an environment conductive to dental caries and gingival inflammation, due to alterations in humidity, temperature, oxygen levels, and pH within the oral cavity.[40,42] Moreover, the interplay between microbial dysbiosis and salivary changes highlights the importance of targeted interventions aimed at restoring oral homeostasis.[42]

Aside from microbial and salivary alterations, mouth breathing may induce a pro-inflammatory state within the oral cavity. This observation aligns with findings on the inflammatory response in children with obstructive sleep apnea, for whom nocturnal mouth breathing is a hallmark symptom. Elevated levels of cytokines (e.g., IL-4, IL-6, IL-8, and IFN-γ) have been reported in chronic mouth breathers.[50,51] Meanwhile, increased concentrations of some of these cytokines have been detected in the saliva of children and adolescents with gingivitis and dental caries,[52] suggesting overlapping inflammatory pathways. While the mechanisms linking upper and lower airway dysfunctions remain under investigation, they are thought to involve the nasal-bronchial reflex and mouth breathing secondary to nasal obstruction. Many affected individuals rely on intranasal corticosteroids for symptom control.[53] Given this overlap, topical anti-inflammatory agents may help mitigate oral inflammation, particularly in mouth breathers with coexisting gingivitis/periodontitis. Conversely, chronic corticosteroid use has been anecdotally associated with an increased risk of periodontitis.[54] These suppositions warrant further investigations to clarify the effects of inflammatory modulation in this population.

The implications of these findings extend beyond oral health, as mouth breathing negatively impacts the quality of life in children and adolescents.[55] This condition affects multiple dimensions, including academic performance, social interactions, and speech development.[56,57] Physical consequences, such as postural deviations and musculoskeletal imbalances, have also been documented. For instance, a cross-sectional study found that mouth breathers relied more heavily on accessory muscles and exhibited misalignments in the shoulder and pelvic regions, impairing functional capacity during physical activities.[58]

Considering the broad spectrum of secondary effects associated with mouth breathing and their considerable impact on an individual's functional well-being, addressing this condition and its related comorbidities requires a holistic and multidisciplinary approach. Alterations in oral and craniofacial structures,[59] airway obstructions and sleep disorders,[60,61] speech impairments,[56] and psychopedagogical challenges[56,57] underscore the need for an integrated team of specialists, including otorhinolaryngologists, orthodontists, speech therapists, and psychologists. Coordinated interdisciplinary care can optimize diagnosis, intervention, and management strategies, ultimately improving patient outcomes.

This systematic review and meta-analysis have limitations regarding the methodological heterogeneity of the included studies. The use of different methods for outcome assessment, combined with variation in sample characteristics and sizes, restricted the ability to aggregate data across studies and, consequently, to perform more comprehensive quantitative analyses.[62] Even the two meta-analyses included in the quantitative synthesis incorporated data from small samples.[28,30,36] To minimize the risk of both Type I and Type II errors in the meta-analytic results, rigorous statistical methods were employed, including the use of a random-effects model and the DerSimonian and Laird method to estimate tau-square.[26,63] Future studies would benefit from standardizing diagnostic criteria and outcome measures to enhance the comparability and reliability of findings across different investigations.

Despite its limitations, this systematic review may contribute not only to clinical practice, but also to improving the quality of life of the studied population. Based on the findings, it is essential to emphasize the importance of guidance on oral hygiene and the potential need for more frequent dental visits in response to specific oral health demands. Another key point to highlight is that the management of patients with mouth breathing requires an interdisciplinary approach.[64] Therefore, it is crucial for dentists

to identify such cases early and advise patients and their families when referral to other healthcare professional is warranted.

In summary, mouth breathing in children and adolescents may be associated with periodontal and gingival outcomes, as well as dental caries, primarily due to alterations in salivary pH and changes in oral microbiota. Future research should prioritize the use of standardized diagnostic criteria and longitudinal study designs to establish causality and further elucidate the pathophysiological mechanisms underlying this condition. Incorporating routine screening for mouth breathing into clinical practice may contribute to early detection and improved overall outcomes.

Bullet points

Discusses the impact of mouth breathing on oral health: This article shows the relationship between mouth breathing and both dental caries and periodontal outcomes, aiding pediatric dentists in better understanding the specific oral health risks associated with this common condition in children and adolescents.

Provides guidance on prevention and treatment strategies: The findings provide practical approaches for preventing and treating dental caries and periodontitis in patients with mouth breathing, supporting pediatric dentists in enhancing the quality of care they provide.

Contributes to early intervention efforts: By emphasizing the long-term consequences of mouth breathing on oral health, this review reinforces the importance of early diagnosis and intervention, enabling pediatric dentists to implement preventive measures before significant damage occurs.

Promotes a multiprofessional approach to care: This review highlights the importance of collaboration among pediatric dentists, orthodontists, and other healthcare professionals in managing mouth breathing, encouraging a comprehensive treatment model that address both dental and respiratory health in children and adolescents.

References

1- Musseau D. Mouth breathing and some of its consequences. *Int J Orthod Milwaukee*. 2016;27(2):51-54.

2- Lin L, Zhao T, Qin D, Hua F, He H. The impact of mouth breathing on dentofacial development: a concise review. *Front Public Health*. 2022;10:929165. doi:10.3389/fpubh.2022.929165

3- Huynh NT, Emami E, Helman JI, Chervin RD. Interactions between sleep disorders and oral diseases. *Oral Dis*. 2014;20(3):236-245. doi:10.1111/odi.12152

4- Ballikaya E, Guciz Dogan B, Onay O, Uzamis Tekcicek M. Oral health status of children with mouth breathing due to adenotonsillar hypertrophy. *Int J Pediatr Otorhinolaryngol*. 2018;113:11-15. doi:10.1016/j.ijporl.2018.07.018

5- Jung JY, Kang CK. Investigation on the effect of oral breathing on cognitive activity using functional brain imaging. *Healthcare (Basel)*. 2021;9(6):645. doi:10.3390/healthcare9060645

6- Okuro RT, Morcillo AM, Ribeiro MÂ, Sakano E, Conti PB, Ribeiro JD. Mouth breathing and forward head posture: effects on respiratory biomechanics and exercise capacity in children. *J Bras Pneumol*. 2011;37(4):471-479. doi:10.1590/s1806-37132011000400009

7- Ali NJ, Pitson DJ, Stradling JR. Snoring, sleep disturbance, and behaviour in 4-5 year olds. *Arch Dis Child*. 1993;68(3):360-366. doi:10.1136/adc.68.3.360

8- Kuroishi RC, Garcia RB, Valera FC, Anselmo-Lima WT, Fukuda MT. Deficits in working memory, reading comprehension and arithmetic skills in children with mouth breathing syndrome: analytical cross-sectional study. *Sao Paulo Med J*. 2015;133(2):78-83. doi:10.1590/1516-3180.2013.7630011

9- Ribeiro GC, Dos Santos ID, Santos AC, Paranhos LR, César CP. Influence of the breathing pattern on the learning process: a systematic review of literature. *Braz J Otorhinolaryngol*. 2016;82(4):466-478. doi:10.1016/j.bjorl.2015.08.026

10- Grippaudo C, Paolantonio EG, Antonini G, Saulle R, La Torre G, Deli R. Association between oral habits, mouth breathing and malocclusion. Associazione fra abitudini viziate, respirazione orale e malocclusione. *Acta Otorhinolaryngol Ital*. 2016;36(5):386-394. doi:10.14639/0392-100X-770

11- Choi JE, Waddell JN, Lyons KM, Kieser JA. Intraoral pH and temperature during sleep with and without mouth breathing. *J Oral Rehabil*. 2016;43(5):356-363. doi:10.1111/joor.12372

12- Mummolo S, Nota A, Caruso S, Quinzi V, Marchetti E, Marzo G. Salivary markers and microbial flora in mouth breathing late adolescents. *Biomed Res Int*. 2018;2018:8687608. doi:10.1155/2018/8687608

13- Kianoush N, Adler CJ, Nguyen KA, Browne GV, Simonian M, Hunter N. Bacterial profile of dentine caries and the impact of pH on bacterial population diversity. *PLoS One*. 2014;9(3):e92940. doi:10.1371/journal.pone.0092940

14- Kuribayashi M, Kitasako Y, Matin K, Sadr A, Shida K, Tagami J. Intraoral pH measurement of carious lesions with qPCR of cariogenic bacteria to differentiate caries activity. *J Dent*. 2012;40(3):222-228. doi:10.1016/j.jdent.2011.12.013

15- Cunha-Cruz J, Scott J, Rothen M, et al. Salivary characteristics and dental caries: evidence from general dental practices. *J Am Dent Assoc*. 2013;144(5):e31-e40. doi:10.14219/jada.archive.2013.0159

16- Murakami S, Mealey BL, Mariotti A, Chapple ILC. Dental plaque-induced gingival conditions. *J Periodontol*. 2018;89 Suppl 1:S17-S27. doi:10.1002/JPER.17-0095

17- Surtel A, Klepacz R, Wysokińska-Miszczuk J. Wpływ toru oddechowego na jamę ustną [The influence of breathing mode on the oral cavity]. *Pol Merkur Lekarski*. 2015;39(234):405-407.

18- Page MJ, McKenzie JE, Bossuyt PM, et al. Updating guidance for reporting systematic reviews: development of the PRISMA 2020 statement. *J Clin Epidemiol*. 2021; 134:103-112. doi: 10.1016/j.jclinepi.2021.02.003

19- World Health Organization. Orientation programme on adolescent health forhealth care providers. 2006. https:// apps. who. int/ iris/ handle/10665/42868.

20- Haddaway NR, Collins AM, Coughlin D, Kirk S. The role of google scholar in evidence reviews and its applicability to grey literature searching. *PLoS One*. 2015;10(9):e0138237. Published 2015 Sep 17. doi:10.1371/journal.pone.0138237

21- Herzog R, Álvarez-Pasquin MJ, Díaz C, Del Barrio JL, Estrada JM, Gil Á. Are healthcare workers' intentions to vaccinate related to their knowledge, beliefs

and attitudes? A systematic review. *BMC Public Health*. 2013;13:154. doi:10.1186/1471-2458-13-154

22- Wells G, Shea B, O'Connell D, et al. The Newcastle-Ottawa Scale (NOS) for assessing the quality of nonrandomised studies in meta-analyses. 2013. Accessed October 2, 2021. Available at: http://www.ohri.ca/programs/clinical_epidemiology/oxford.asp.

23- Higgins JPT, Thomas J, Chandler J, et al, eds. *Cochrane Handbook for Systematic Reviews of Interventions* version 6.4 (updated August 2023). Cochrane; 2023. Available from: www.training.cochrane.org/handbook.

24- Faraone SV. Interpreting estimates of treatment effects: implications for managed care. *P T*. 2008;33(12):700-711.

25- Higgins JP, Thompson SG. Quantifying heterogeneity in a meta-analysis. *Stat Med*. 2002;21(11):1539-1558. doi:10.1002/sim.1186

26- DerSimonian R, Laird N. Meta-analysis in clinical trials. *Control Clin Trials*. 1986;7(3):177-188. doi:10.1016/0197-2456(86)90046-2

27- Guyatt GH, Oxman AD, Vist GE, et al. GRADE: an emerging consensus on rating quality of evidence and strength of recommendations. *BMJ*. 2008;336(7650):924-926. doi:10.1136/bmj.39489.470347.AD

28- Jacobson L. Mouthbreathing and gingivitis. *J Periodontal Res*. 1973;8:269-277. doi:10.1111/j.1600-0765.1973.tb01115.x.

29- Wagaiyu EG, Ashley FP. Mouthbreathing, lip seal and upper lip coverage and their relationship with gingival inflammation in 11–14-year-old schoolchildren. *J Clin Periodontol*. 1991;18(9):698-702. doi:10.1111/j.1600-051x.1991.tb00112.x

30- Nascimento Filho E, Mayer MP, Pontes P, Pignatari AC, Weckx LL. Caries prevalence, levels of mutans streptococci, and gingival and plaque indices in 3.0- to 5.0-year-old mouth breathing children. *Caries Res*. 2004;38(6):572-575. doi:10.1159/000080589

31- Piva F, Moraes JK de, Vieira VR, et al. Avaliação da associação entre os indicadores de saúde bucal, os aspectos socioeconômicos e crianças com sinais clínicos orofaciais indicativos de respiração oral crônica. *Audiol Commun Res*. 2014;19(3):236-242. doi:10.1590/S2317-64312014000300006.

32- Milanesi JM, Berwig LC, Marquezan M, et al. Variables associated with mouth breathing diagnosis in children based on a multidisciplinary assessment. *Codas*. 2018;30(4):e20170071. doi:10.1590/2317-1782/20182017071

33- Alqutami J, Elger W, Grafe N, Hiemisch A, Kiess W, Hirsch C. Dental health, halitosis and mouth breathing in 10-to-15 year old children: A potential connection. *Eur J Paediatr Dent*. 2019;20(4):274-279. doi:10.23804/ejpd.2019.20.04.03

34- Lee DW, Kim JG, Yang YM. Influence of mouth breathing on atopic dermatitis risk and oral health in children: A population-based cross-sectional study. *J Dent Sci*. 2021;16(1):178-185. doi:10.1016/j.jds.2020.06.014

35- Sajjanar A, Rojekar N, Chavan P, et al. Influence of mouth breathing on oral health in children: A population-based cross-sectional study in Nagpur city. *Eur J Mol Clin Med*. 2020;7:2515-8260.

36- İnönü-Sakallı N, Sakallı C, Tosun Ö, Akşit-Bıçak D. Comparative evaluation of the effects of adenotonsillar hypertrophy on oral health in children. *Biomed Res Int*. 2021;2021:5550267. doi:10.1155/2021/5550267

37- Soares MEDC, Ramos-Jorge J, Lima LJS, et al. Mouth breathing is associated with a higher prevalence of anterior dental caries in preschool children. *Braz Oral Res*. 2024;38:e057. doi:10.1590/1807-3107bor-2024.vol38.0057

38- Braine NR, Centanini IA, Pontes LS, et al. Evaluation of the salivary pH and its correlation with dental caries in a population of Brazilian adolescents: Avaliação do pH salivar e sua correlação com a cárie dentária em uma população de adolescentes brasileiros. *CLIUM*. 2023;202423(6):430-439. doi:10.53660/CLM-1152-23D29.

39- Abou Neel EA, Aljabo A, Strange A, et al. Demineralization-remineralization dynamics in teeth and bone. *Int J Nanomedicine*. 2016;11:4743-4763. doi:10.2147/IJN.S107624

40- Al-Awadi RN, Al-Casey M. Oral health status, salivary physical properties and salivary *Mutans Streptococci* among a group of mouth breathing patients in comparison to nose breathing. *J Bagh Coll Dent*. 2013;25:152-159

41- Weiler RM, Fisberg M, Barroso AS, Nicolau J, Simi R, Siqueira WL Jr. A study of the influence of mouth-breathing in some parameters of unstimulated and stimulated whole saliva of adolescents. *Int J Pediatr Otorhinolaryngol*. 2006;70(5):799-805. doi:10.1016/j.ijporl.2005.09.008

42- Fan C, Guo L, Gu H, Huo Y, Lin H. Alterations in Oral-nasal-pharyngeal microbiota and salivary proteins in mouth-breathing children. *Front Microbiol*. 2020;11:575550. doi:10.3389/fmicb.2020.575550

43-Koga-Ito CY, Unterkircher CS, Watanabe H, Martins CA, Vidotto V, Jorge AO. Caries risk tests and salivary levels of immunoglobulins to Streptococcus mutans and Candida albicans in mouthbreathing syndrome patients. *Caries Res*. 2003;37(1):38-43. doi:10.1159/000068225

44-Mummolo S, Quinzi V, Dedola A, et al. Oral microbiota in mouth-breathing patients. *J Oral Hyg Health*. 2020;8:259. doi:10.4172/2332-0702.1000259.

45-Jiang S, Gao X, Jin L, Lo EC. Salivary Microbiome diversity in caries-free and caries-affected children. *Int J Mol Sci*. 2016;17(12):1978. doi:10.3390/ijms17121978

46-Vieira AR, Hiller NL, Powell E, et al. Profiling microorganisms in whole saliva of children with and without dental caries. *Clin Exp Dent Res*. 2019;5(4):438-446. doi:10.1002/cre2.206

47-Loesche WJ. Role of Streptococcus mutans in human dental decay. *Microbiol Rev*. 1986;50(4):353-380. doi:10.1128/mr.50.4.353-380.1986

48-Kinane DF, Stathopoulou PG, Papapanou PN. Periodontal diseases. *Nat Rev Dis Primers*. 2017;3:17038. doi:10.1038/nrdp.2017.38

49-Trombelli L, Farina R, Silva CO, Tatakis DN. Plaque-induced gingivitis: Case definition and diagnostic considerations. *J Clin Periodontol*. 2018;45 Suppl 20:S44-S67. doi:10.1111/jcpe.12939

50-Li AM, Lam HS, Chan MH, et al. Inflammatory cytokines and childhood obstructive sleep apnoea. *Ann Acad Med Singap*. 2008;37(8):649-654.

51-Zhang Z, Wang C. Immune status of children with obstructive sleep apnea/hypopnea syndrome. *Pak J Med Sci*. 2017;33(1):195-199. doi:10.12669/pjms.331.11959

52-Rinderknecht C, Filippi C, Ritz N, et al. Associations between salivary cytokines and oral health, age, and sex in healthy children. *Sci Rep*. 2022;12(1):15991. doi:10.1038/s41598-022-20475-2

53-Taramarcaz P, Gibson PG. Intranasal corticosteroids for asthma control in people with coexisting asthma and rhinitis. *Cochrane Database Syst Rev*. 2003;2003(4):CD003570. doi:10.1002/14651858.CD003570

54-Brasil-Oliveira R, Cruz ÁA, Sarmento VA, Souza-Machado A, Lins-Kusterer L. Corticosteroid use and periodontal disease: a systematic review. *Eur J Dent*. 2020;14(3):496-501. doi:10.1055/s-0040-1713954

55-Leal RB, Gomes MC, Granville-Garcia AF, Goes PS, de Menezes VA. Impact of breathing patterns on the quality of life of 9- to 10-year-old schoolchildren. *Am J Rhinol Allergy*. 2016;30(5):147-152. doi:10.2500/ajra.2016.30.4363

56-Hitos SF, Arakaki R, Solé D, Weckx LL. Oral breathing and speech disorders in children. *J Pediatr (Rio J)*. 2013;89(4):361-365. doi:10.1016/j.jped.2012.12.007

57-Ribeiro GC, Dos Santos ID, Santos AC, Paranhos LR, César CP. Influence of the breathing pattern on the learning process: a systematic review of literature. *Braz J Otorhinolaryngol*. 2016;82(4):466-478. doi:10.1016/j.bjorl.2015.08.026

58-Uhlig SE, Marchesi LM, Duarte H, Araújo MT. Association between respiratory and postural adaptations and self-perception of school-aged children with mouth breathing in relation to their quality of life. *Braz J Phys Ther*. 2015;19(3):201-210. doi:10.1590/bjpt-rbf.2014.0087

59-De Menezes VA, Leal RB, Pessoa RS, Pontes RM. Prevalence and factors related to mouth breathing in school children at the Santo Amaro project-Recife, 2005. *Braz J Otorhinolaryngol*. 2006;72(3):394-399. doi:10.1016/s1808-8694(15)30975-7

60-Festa P, Mansi N, Varricchio AM, et al. Association between upper airway obstruction and malocclusion in mouth-breathing children. *Acta Otorhinolaryngol Ital*. 2021;41(5):436-442. doi:10.14639/0392-100X-N1225

61-Kalaskar R, Bhaje P, Kalaskar A, Faye A. Sleep difficulties and symptoms of attention-deficit hyperactivity disorder in children with mouth breathing. *Int J Clin Pediatr Dent*. 2021;14(5):604-609. doi:10.5005/jp-journals-10005-1987

62-Higgins JP, Thompson SG, Deeks JJ, Altman DG. Measuring inconsistency in meta-analyses. *BMJ*. 2003;327(7414):557-560. doi:10.1136/bmj.327.7414.557.

63-Hedges LV, Pigott TD. The power of statistical tests in meta-analysis. *Psychol Methods*. 2001;6(3):203-217.

64-Chess LE, Gagnier JJ. Applicable or non-applicable: investigations of clinical heterogeneity in systematic reviews. *BMC Med Res Methodol*. 2016;16:19. Published 2016 Feb 17. doi:10.1186/s12874-016-0121-7

Figure legends

Figure 1. Flowchart illustrating the screening process for study selection.

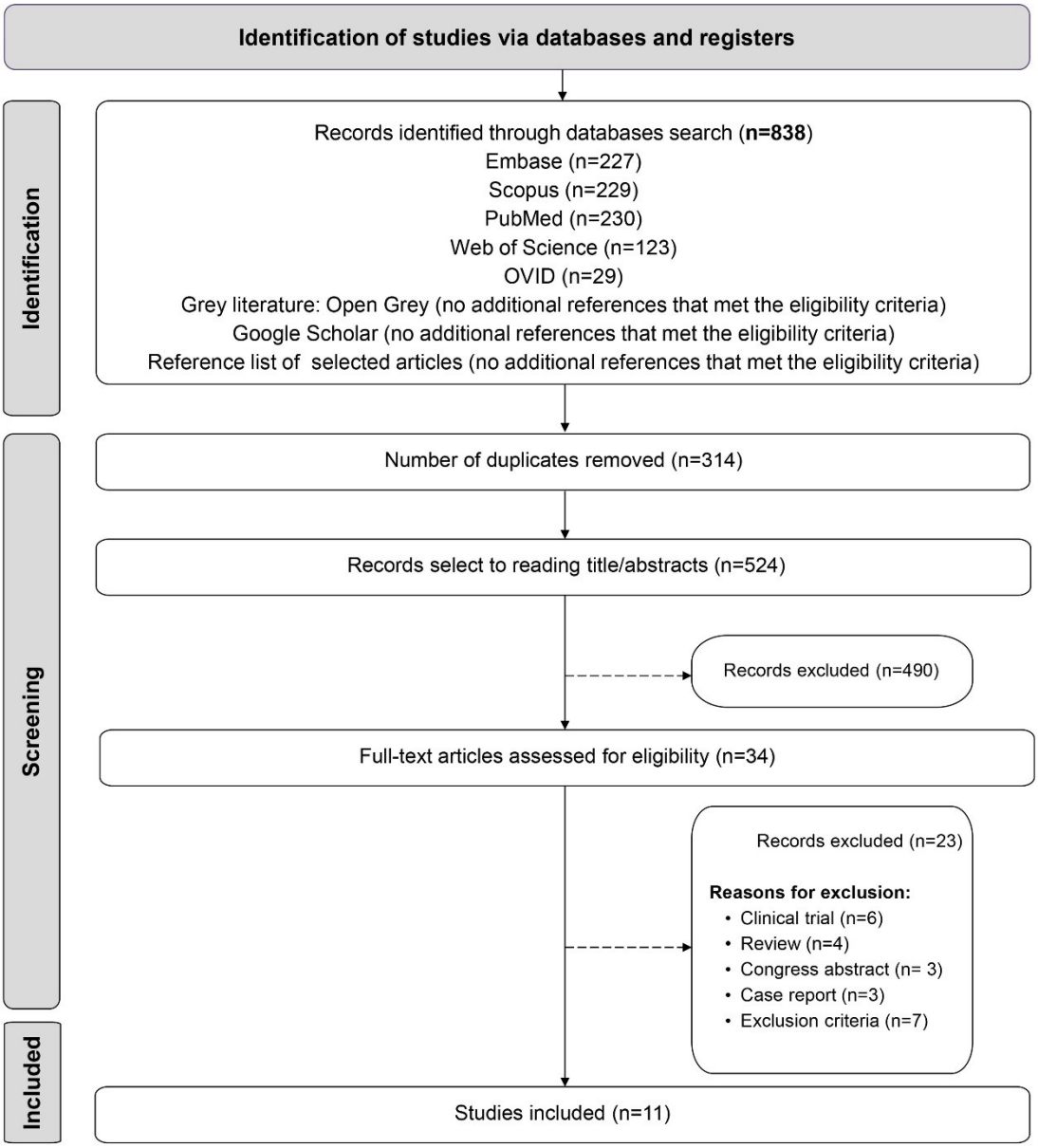


Figure 2. Forest plot comparing children and adolescents with and without mouth breathing in relation to the Plaque Index.

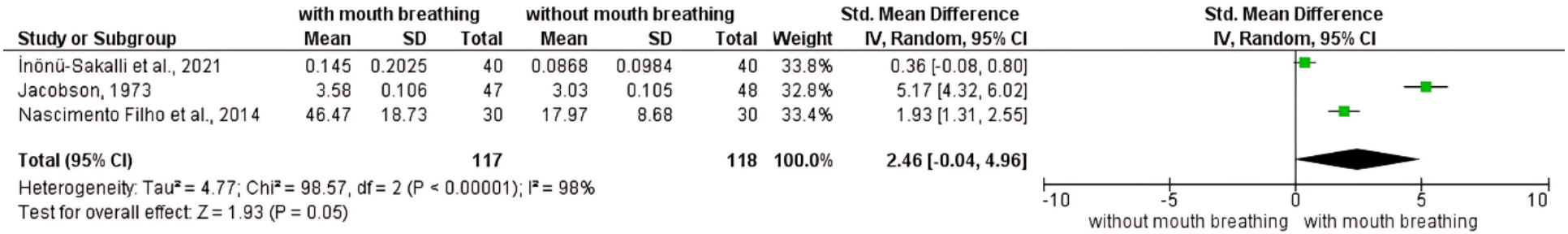
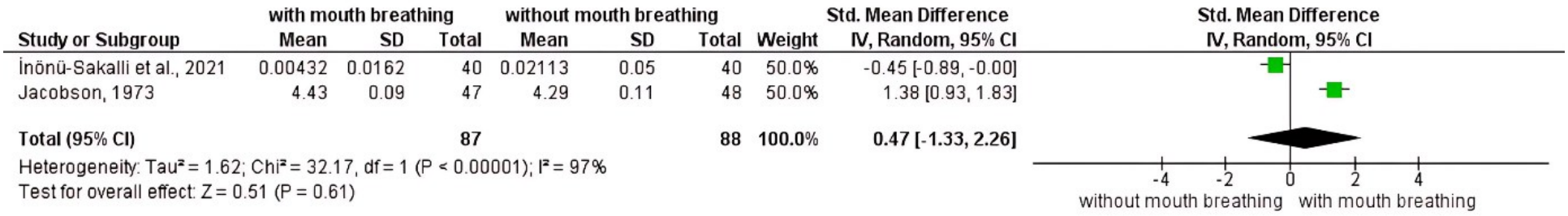


Figure 3. Forest plot comparing children and adolescents with and without mouth breathing in relation to the Gingival Inflammation Index.



Corresponding author: Anna Carolina Rye Sato Kimura. Department of Child and Adolescent Oral Health, School of Dentistry, Universidade Federal de Minas Gerais, Avenida Presidente Antônio Carlos, 6627, Belo Horizonte, Minas Gerais, Brazil. CEP: 31270-901. E-mail: annakimuraaa@gmail.com. Phone number: +55 (31)99931-3572

Acknowledgments: Coordenação de Aperfeiçoamento de Pessoal de Nível Superior –CAPES (Finance Code 001 and 88887.005535/2024-00), Fundação de Amparo à Pesquisa de Minas Gerais (FAPEMIG), and Conselho Nacional de Desenvolvimento Científico e Tecnológico – CNPq (305544/2022-5, 312830/2022-0, and 407364/2021-8). J.A.A.A. is a recipient of a research fellowship awarded by Fundação Carlos Chagas Filho de Amparo à Pesquisa do Estado do Rio de Janeiro (FAPERJ, E-26/200.330/2024 and E-26/200.331/2024), Brazil. L.G.A. and R.A.M. are research fellows of CNPq.

Funding sources: This research did not receive any specific grant from funding agencies in the public, commercial, or not-for-profit sectors.

Conflicts of interest: The authors declare that they have no conflict of interest.

Author contribution:

Anna Carolina Rye Sato Kimura: investigation, data curation, methodology, conceptualization and writing – original draft, visualization; **Victor Zanetti Drumond:** Writing – review and editing, data curation; **José Alcides Almeida de Arruda:** Writing – review and editing, data curation; **Paulo Antônio Martins Júnior:** Writing – review and editing, **Ricardo Alves Mesquita:** Writing – review and editing; **Lucas Guimarães Abreu:** Supervision, Project administration, formal analysis, methodology, conceptualization, writing – review and edit

Supplementary Files for Dental caries and periodontal outcomes in mouth-breathing children and adolescents: a systematic review

Contents

Supplementary File 1: References excluded after assessment of the full text.

1) Aksoy N, Aslan A. Gingival hiperplazi vakasi (ağizdan soluma nedeniyle) [Case of gingival hyperplasia due to mouth breathing]. Ankara Univ Hekim Fak Derg. 1990 Jan;17(1):119-21. Turkish.
   Reason: This article is a case report.

2) Castilho RL, Matsumoto LH, Castilho GL, Weber SAT. Breathing pattern, dental health, and sleep in children. Otolaryngol. Head Neck Surg. 2017; 157(1):270 10.1177/0194599817717250
   Reason: This reference reports a congress abstract.

3) de Calafell M, Esper M, Er M. Mouth breathing: Risk factor to gingival disease. In teenagers. Int Assoc Dent Res Argentine Div 1544-0591 C 2003; 82:17
   Reason: This reference reports a congress abstract.

4) Demir UL, Cetinkaya B, Karaca S, Sigirli D. The impacts of adenotonsillar hypertrophy on periodontal health in children: a prospective controlled pilot study. Am J Otolaryngol. 2013 Sep-Oct;34(5):501-4. doi: 10.1016/j.amjoto.2013.04.013.
   Reason: This article is a clinical trial.

5) Haytac MC, Oz IA. Atypical streptococcal infection of gingiva associated with chronic mouth breathing. Quintessence Int. 2007 Nov-Dec;38(10): E577-82.
   Reason: This article is a case report.

6) Kaur M, Sharma RK, Tewari S, Narula SC. Influence of mouth breathing on outcome of scaling and root planing in chronic periodontitis. BDJ Open. 2018 Nov 9; 4:17039. doi: 10.1038/s41405-018-0007-3.
   Reason: This article is a clinical trial.

7) Weiler RM, Fisberg M, Barroso AS, Nicolau J, Simi R, Siqueira WL Jr. A study of the influence of mouth-breathing in some parameters of unstimulated and stimulated whole saliva of adolescents. Int J Pediatr Otorhinolaryngol. 2006 May;70(5):799-805. doi: 10.1016/j.ijporl.2005.09.008.

Reason: This article is a clinical trial.

8) Bhatia A, Sharma RK, Tewari S, Narula SC. A randomized clinical trial of salivary substitute as an adjunct to scaling and root planing for management of periodontal inflammation in mouth breathing patients. J Oral Sci. 2015 Sep;57(3):241-7. doi: 10.2334/josnusd.57.241.
Reason: This article is a randomized clinical trial.

9) Eslami A, Sadeghi EM. Mouthbreather's gingivitis: a clinicopathologic review. Compendium. 1987 Jan;8(1):20-2, 24.
Reason: This article is a review.

10) Wedman J, Idema NK, Feenstra L. Habitueel mondademen [Habitual mouth breathing]. Ned Tijdschr Geneeskd. 1992 Nov 14;136(46):2269-71. Dutch.
Reason: This article is a review.

11) Ghafourifard R, Rashidi Maybodi F, Mousavi SA, Pourmirjafari A. Oral Health Status and Salivary Properties among Children before and after Tonsillectomy. Front Dent. 2023 Jul 9;20:24. doi: 10.18502/fid.v20i24.13168.
Reason: This article is a clinical trial.

12) Gadda D, Nosetti LM, Caprioglio A, Levrini L, Nespoli L. Oral modifications due to mouth breathing in children with sleep-disordered breathing (SDB). In *B73.* Pediatric sleep (pp. A3715-A3715). American Thoracic Society. 2011
Reason: This reference reports a congress abstract.

13) Sharma RK, Bhatia A, Tewari S, Narula SC. Distribution of gingival inflammation in mouth breathing patients: an observational pilot study. *J. Dent. Indones.* 2016;23:28–32. doi: 10.14693/jdi.v23i2.981
Reason: This study evaluates mouth breathing in adults.

14) Alexander AG. Habitual mouthbreathing and its effect on gingival health. *Parodontologie (1969)*. 1970;24(2):49-55.
Reason: This study evaluates mouth breathing in adults.

15) Sanders AE, Essick GK, Beck JD, Cai J, Beaver S, Finlayson TL, Zee PC, Loredo JS, Ramos AR, Singer RH, Jimenez MC, Barnhart JM, Redline S. Periodontitis and Sleep Disordered Breathing in the Hispanic Community Health Study/Study of Latinos. Sleep. 2015 Aug 1;38(8):1195-203. doi: 10.5665/sleep.4890.
Reason: This study evaluates mouth breathing in adults.

16) Richter JW. Hypertrophic gingivitis of mouth breathing. U S Nav Med Bull. 1945 Dec; 45:1147-50.
Reason: This article is a case report.

17) Lite T. Mouth breathing, a contributing factor in the etiology of gingival irritation. J Dent Med. 1949 Jan;4(1):13-20.
Reason: This article is a review.

18) Lite T, Dimaio DJ, Burman LR. Gingival pathosis in mouth breathers; a clinical and histopathologic study and a method of treatment. Oral Surg Oral Med Oral Pathol. 1955 Apr;8(4):382-91. doi: 10.1016/0030-4220(55)90106-7.
Reason: This article is a clinical trial.

19) Riar DS, Nanda TS, Kamlesh. Mouth breathing and gingival health. J Indian Dent Assoc. 1970 Jan;42(1):13-6.
Reason: This article is a review.

20) İlisulu SC, Birant S, Kasimoglu Y, Koruyucu M, Tuna İnce EB, Seymen F. Clinical assessment of deleterious oral habits and dental caries-periodontal parameters among Turkish twins. J Dent Sci. 2023 Oct;18(4):1859-1866. doi: 10.1016/j.jds.2023.05.009. Epub 2023 May 19.
Reason: This study was conducted with twins.

21) Jacobson L, Linder-Aronson S. Crowding and gingivitis: a comparison between mouthbreathers and nosebreathers. Scand J Dent Res. 1972;80(6):500-4. doi: 10.1111/j.1600-0722. 1972.tb00319. x.
Reason: This article compares results with mixed groups.

22) Ushanthika T, Sowmya K. Association between Mouth Breathing Habit and Dental Caries-A Retrospective Study. J Res Med Dent Sci. 2022. Feb; 10 (2):122-126. Available Online at: www.jrmds.in eISSN No. 2347-2367: pISSN No. 2347-2545

Reason: The age group assessed in the article does not apply to our research question.

23) Mummolo S, Nota A, Caruso S, Quinzi V, Marchetti E, Marzo G. Salivary Markers and Microbial Flora in Mouth Breathing Late Adolescents. Biomed Res Int. 2018 Mar 5; 2018:8687608. doi: 10.1155/2018/8687608.

Reason: The age group assessed in the article does not apply to our research question.

Supplementary File 2: Data extracted from included studies evaluating periodontal outcomes.

Authors, year, and country	Study design	Sample (Number of patients and sex)	Recruitment of patients	Patient's age	Periodontal outcomes assessment	Mouth Breathing assessment	Results of the comparison between mouth breathing and control
Alqutami *et al*., 2019 **Germany**	Cross-sectional study with control group	Total N=785 Children and adolescents with mouth breathing N=139 mean age: 12.0 ± 1.44 Sex Male: 83 (59.7%) Female: 56 (40.3%) Children and adolescents with nasal breathing N=646 mean age: 12.2 ± 1.54 Sex Male: 312 (48.4%) Female: 334 (51.6%)	Children and adolescents from Leipzig, Germany	Age 10 – 15 years old	**CPI:** Community Periodontal Index The clinical examination was performed on teeth 11 and 31	Questions from the Child Perceptions Questionnaire (CPQ-G) was used to investigate children's mouth breathing habits for the last three months. The accuracy of mouth breathing assessment was confirmed through a clinical examination, using the mirror test, with 10 nose breathing patients and 10 mouth breathing patients in Leipzig University Hospital	**<u>CPI score - N (%)</u>** Mouth Breathing group Tooth 11 CPI score 0: 97 (66.4%) CPI score 1+: 42 (33.3%) *p*=0.700 Tooth 31 CPI score 0: 59 (36.5%) CPI score 1+: 80 (63.5%) *p*=0.786 Nasal breathing group Tooth 11 CPI score 0: 431 (64.9%) CPI score 1+: 215 (35.1%) *p*=0.700 Tooth 31 CPI score 0: 249 (35.2%)

							CPI score 1+: 397 (64.8%) *p*=0.786 Logistic regression OR (95% CI) Tooth 11 CPI 1+ Mouth breathing group in relation to nasal breathing 0.92 (0.57 – 1.48) *p*=0.724 Tooth 31 CPI 1+ Mouth breathing group in relation to nasal breathing 1.20 (0.74 – 1.94) *p*=0.467
Ballikaya *et al*., 2018 **Turkey**	Cross-sectional with one group	Total N=150 Sex Male: 77 (51.3%) – mean age: 5.9 ± 2.6 years Female: 73 (48.7%)	Children with mouth breathing and adenotonsillar hyperthophy	Age 3 – 4 years: 51 (34.0%) 5 – 6 years: 47 (31.3%) 7 – 8 years: 37 (24.7%)	**PI:** plaque index **GI:** gingival inflammation index	The assessment of mouth breathing was made by means of an otorhinolaryngological evaluation by a doctor from the Department of Otorhinolaryngology at the Children's	**<u>PI – N (%)</u>** Anterior region none (<0.1): 1 (0.7%) minimal (0.1 – 1.0): 27 (18%) moderate (1.1 – 2.0): 108 (72%) heavy (2.1 – 3.0): 14 (9.3%)

				9 – 15 years: 15 (10.0%)		Hospital of a University in Ankara	mean (±SD): 1.4 ± 0.5 median: 1.5 Posterior region none (<0.1): 0 (0%) minimal (0.1 – 1.0): 10 (6.7%) moderate (1.1 – 2.0): 132 (88%) heavy (2.1 – 3.0): 8 (5.3%) mean (±SD): 1.7 ± 0.4 median: 1.8 Total none (<0.1): 0 (0 %) minimal (0.1 – 1.0): 7 (4.7%) moderate (1.1 – 2.0): 143 (95.3%) heavy (2.1 – 3.0): 0 (0%) mean (±SD): 1.5 ± 0.2 median: 1.5 **<u>GI – N (%)</u>** Anterior region none (<0.1): 2 (1.3%) mild (0.1 – 1.0): 57 (38%)

							moderate (1.1 – 2.0): 91 (60.7%) severe (2.1 – 3.0): 0 (0%) mean (±SD): 1.1 ± 0.3 median: 1.1 Posterior region none (<0.1): 1 (0.7%) mild (0.1 – 1.0): 19 (12.7%) moderate (1.1 – 2.0): 127 (84.7%) severe (2.1 – 3.0): 3 (2%) mean (±SD): 1.3 ± 0.3 median: 1.3 Total none (<0.1): 0 (0%) mild (0.1 – 1.0): 16 (10.7%) moderate (1.1 – 2.0): 134 (89.3%) severe (2.1 – 3.0): 0 (0%) mean (±SD): 1.4 ± 0.2 median: 1.5
Inönü-Sakallı *et al*., 2021	Cross-sectional with a control	Total N=120 Sex:	**Total** children attending	Total age 3 – 14 years old	**PI:** plaque index	Ear, nose, and throat were analyzed by an otolaryngologist at	**PI** *p*=0.176

Turkey	group, treatment group and patient group	Male: 67 (55.8%) Female: 53 (44.2%) *p*=0.9671 Patient group N=40 Sex: Male: 23 (57.5%) Female: 17 (42.5%) Control group: N=40 Sex: Male: 22 (55%) Female: 18 (45%)	consultations at the Near East University Hospital Otorhinolaryngology Patient group children who had adenotonsillar Control group children who had no adenotonsillar hypertrophy with nasal breathing	Patient group mean age 7.35 ± 3.55 Control group mean age 8.08 ± 2.89	**GI:** gingival inflammation index	Near East University Hospital Otorhinolaryngology. Adenoid and tonsils were visualized by a fiberoptic nasopharyngolaryngoscopy and palatine tonsils assessment was determined according to the Brodsky and Koch criteria	Patient group: 40 (100%) mean: 0.145 SD: 0.2025 SE: 0.03202 Plaque on the buccal surface of the anterior teeth: 24 (60%) Control group: 40 (100%) mean: 0.0868 SD: 0.0984 SE: 0.01555 Plaque on the buccal surface of anterior teeth: 24 (60%) **GI** *p*=0.134 Patient group: 40 mean: 0.00432 SD: 0.0162 SE: 0.00256 Control group: 40 (100%) mean: 0.02113 SD: 0.05 SE: 0.00791

Jacobson, 1973 **Sweden**	Cross-sectional with a control group	Total N=95 Sex: Female: 38 (40%) Male: 57 (60%) Mouth breathing group: N=47 Nose breathing group: N=48	Not reported	Total age 6 – 12 years old 12 years: 4 (4.0%) 11 years: 17 (18.0%) 10 years: 6 (6.0%) 9 years: 8 (8.0%) 8 years: 32 (34.0%) 7 years: 17 (18.0%) 6 years: 11 (12.0%) Mouth breathing group age 12 years: 1 (2%) 11 years: 8 (17%) 10 years: 2 (4%) 9 years: 5 (11%) 8 years: 19 (40%)	**GI:** gingival inflammation index **PII:** plaque index	Diagnosis of mouth breathing was made thought a cold mirror in front of the nose/mouth and observing the patient reaction after a closure of both nares and lips	**<u>GI - mean value ± SE</u>** Mouth breathing group N=47 upper lateral: 3.33 ± 0.10 upper anterior: 4.03 ± 0.13 lower lateral: 3.13 ± 0.11 lower anterior: 3.83 ± 0.08 Nose breathing group N=48 upper lateral: 2.72 ± 0.09 upper anterior: 3.22 ± 0.10 lower lateral: 2.80 ± 0.11 lower anterior: 3.40 ± 0.12 Difference (M – N): upper lateral: 0.61 ± 0.14 upper anterior: 0.81 ± 0.16 lower lateral: 0.33 ± 0.16

				7 years: 8 (17%) 6 years: 4 (9%) Nose breathing group age 12 years: 3 (6%) 11 years: 9 (19%) 10 years: 4 (8%) 9 years: 3 (6%) 8 years: 13 (27%) 7 years: 9 (19%) 6 years: 7 (15%)			lower anterior: 0.43 ± 0.14 **<u>PII - mean value ± SE</u>** Mouth breathing group N=47 upper lateral: 4.44 ± 0.09 upper anterior: 4.17 ± 0.08 lower lateral: 4.59 ± 0.09 lower anterior: 4.53 ± 0.10 Nose breathing group – N=48 upper lateral: 4.29 ± 0.11 upper anterior: 4.06 ± 0.08 lower lateral: 4.43 ± 0.10 lower anterior: 4.40 ± 0.15 Difference (M – N): upper lateral: 0.15 ± 0.15 upper anterior: 0.11 ± 0.11

							lower lateral: 0.16 ± 0.13 lower anterior: 0.13 ± 0.18
Milanesi *et al*., 2018 **Brazil**	Cross-sectional with control group	Total N=119 Sex Female: 55 (46.0%) Male: 64 (64.0%) Mouth breathing group: N=70 (59.0%) Nose breathing group: N=49 (41.0%)	Not reported	Total age 6 – 12 years old mean age 8.5 ± 1.62	Periodontal assessment was made by an orthodontist based on MBGR protocol criteria	Mouth breathing assessment was defined for three conditions: parents report, otorhinolaryngologic and speech therapist evaluation	**<u>Gingival maintenance-N(%)</u>** Good: 82 (69.0%) Bad: 10 (8.0%) Regular: 27 (23.0%) Single regression *p*=0.050 OR=2.59 95% CI: 1.99 – 6.79 Multiple regression *p*=0.039 OR=2.89 95% CI: 1.06 – 7.93 Regular gingival maintenance (OR 2.89) showing an association with mouth breathing diagnosis.

Nascimento Filho *et al.*, 2004 **Brazil**	Cross-sectional with a control group	Total N=60 Sex: not reported Study group N=30 (50.0%) Control group N=30 (50.0%)	**Total** children attending a public-school nursery Study group children diagnosed as mouth breathers Control group children diagnosed as nose breathers	Age 3 – 5 years old	Gingival index and plaque index divided in 4 groups: upper anterior, total anterior, posterior and total	The first assessment of mouth breathing was made through a report of parents, who considered if their children were predominantly mouth breathers for the last 3 months. For the final diagnosis, this group was submitted to an otorhinolaryngological examination	**<u>Plaque index – mean (SD)</u>** Mouth breathing group: upper anterior: 63.63 ± 24.57 *p*=0.965 total anterior: 60.33 ± 20.21 *p*=0.222 posterior: 40.03 ± 19.36 *p*=0.563 total (all teeth): 52.23 ± 18.11 *p*=0.391 Nose breathing group: upper anterior: 64.07 ± 19.30 *p*=0.965 total anterior: 54.83 ± 16.82 *p*=0.222 posterior: 36.13 ± 15.22 *p*=0.563 total (all teeth): 47.73 ± 13.89 *p*=0.391 **<u>Gingival index – mean (SD)</u>**

							Mouth breathing group: upper anterior: 49.50 ± 21.30 *p*=0.001 total anterior: 49.00 ± 20.54 *p*=0.001 posterior: 42.53 ± 23.21 *p*=0.001 total (all teeth): 46.47 ± 18.73 *p*=0.001 Nose breathing group: upper anterior: 18.97 ± 12.52 *p*=0.001 total anterior: 19.07 ± 9.65 *p*=0.001 posterior: 16.23 ± 11.79 *p*=0.001 total (all teeth): 17.97 ± 8.68 *p*=0.001

Piva *et al*., 2014 **Brazil**	Cross-sectional with a control group	Total N=55 Children with mouth breathing N=16 Sex: 9 Males (56.25%) 7 Females (43.75%) Control group N=39 Sex: 17 Males (47.30%) 22 Females (52.70%)	Children of a state school in Cachoeira do Sul	Children with mouth breathing age 8 – 12 years old 8-9 years: 8 (50%) 10 years: 5 (31.25%) 11-12 years: 3 (18.75%) Control group age 8 – 12 years old 8-9 years: 30 (54.5%) 10 years: 12 (21.8%) 11-12 years: 13 (23.6%).	**PI:** plaque index **ISG:** gingival bleeding index	Mouth breathing clinical signs were identify by a speech pathologist. The orofacial signs used were: deep dark circles, long and narrow face, difficult of lip seal, dry lips, atypical swallowing, hypotonic orofacial muscles, small and atrophy nares, jaw retrusion, facial asymmetry, and maxillary atresia	**ISG – N (%)** Children with mouth breathing ISG = 0: 11 (68.75%) ISG ≥ 1: 5 (31.25%) Control group ISG = 0: 26 (66.66%) ISG ≥ 1: 13 (33.34%) *p*=1.000 **IPV – N (%)** Children with mouth breathing IPV = 0: 8 (50%) IPV ≥ 1: 8 (50%) Control group IPV = 0: 12 (30.77%) IPV ≥ 1: 27 (69.23%) *p*=0.223

Wagaiyu & Ashley, 1991 **United Kingdom**	Cross-sectional with a control group	Total N=201 Sex: Females: 86 (43%) Males: 115 (57%) Children with mouth breathing N=65 (32%) Children with nose breathing N=136 (68%)	Pupils from first, second, and third years at an inner-city secondary school in London	Age 11 - 14 years old mean age (SD) 152.33 ± 10.34 months	Presence or absence of gingival redness, bleeding on probing and plaque accumulation of incisors and first molar or second molar in case of missing. Each participant had 12 teeth analyzed, 6 sites per element (mesio-buccal, mid-buccal, disto-buccal, mesio-lingual, mid-lingual and disto-lingual), with a total of 72 sites assessed	Mouth breathing assessment was made by means of observation of children, a questionnaire, and the mirror test	**Mean number of sites (SD)** Mouth breathing group N=65 **Plaque**: 39.54 (14.19) *p*=0.004 **Visible plaque**: 7.57 (9.24) *p*=0.455 **Bleeding on probing**: 39.97 (13.50) *p*=0.428 **Profuse bleeding**: 18.08 (12.32) *p*=0.011 **Redness:** 18.66 (12.95) *p*=0.049 Nose breathing group N=136 **Plaque**: 30.43 (14.76) **Visible plaque**: 5.79 (8.48) **Bleeding on probing**: 34.27 (13.96) **Profuse bleeding**: 12.26 (11.40) **Redness**: 13.34 (12.54)

Supplementary Files 3: Data extracted from included studies evaluating dental caries.

Authors, year, and country	Study design	Sample (Number of patients and sex)	Recruitment of patients	Patient's age	Dental caries assessment	Mouth Breathing assessment	Results of the comparison between mouth breathing and control
Alqutami *et al*., 2019 **Germany**	Cross-sectional study with control group	Total N=785 Children and adolescents with mouth breathing N=139 Sex Male: 83 (59.7%) Female: 56 (40.3%) Children and adolescents with nasal breathing N=646 Sex Male: 312 (48.4%) Female: 334 (51.6%)	Children and adolescents from Leipzig, Germany	Total age 10 – 15 years old Children and adolescents with mouth breathing mean age 12.0 ± 1.44 Children and adolescents with nasal breathing mean age 12.2 ± 1.54	**ICDAS scores**: international caries detection and assessment system The clinical examination was performed on teeth 11 and 31	Questions from the Child Perceptions Questionnaire (CPQ-G) was used to investigate children's mouth breathing habits for the last three months. The accuracy of mouth breathing assessment was confirmed through a clinical examination, using the mirror test, with 10 nose breathing patients and 10 mouth breathing patients in Leipzig University Hospital	**<u>ICDAS score – N(%)</u>** Mouth Breathing group Tooth 11 ICDAS score 0: 104 (72.4%) ICDAS score >1: 35 (27.6%) *p*=0.662 Tooth 31 ICDAS score 0: 118 (86.6%) ICDAS score >1: 17 (13.4%) *p*=0.979 Nasal breathing group Tooth 11 ICDAS score 0: 488 (74.3%) ICDAS score >1: 158 (25.7%) *p*=0.662 Tooth 31 ICDAS score 0: 563 (86.5%) ICDAS score >1: 83 (13.5%)

							p=0.979 Logistic regression – OR (95% CI) Tooth 11 ICDAS score >1 Mouth breathing group in relation to nasal breathing 1.16 (0.72 – 1.88) *p*=0.532 Tooth 31 ICDAS score >1 Mouth breathing group in relation to nasal breathing 0.88 (0.46 – 1.69) *p*=0.703
Ballikaya *et al*., 2018 **Turkey**	Cross-sectional with one group	Total N=150 Sex Male: 77 (51,3%) – mean age: 5.9 ± 2.6 years Female: 73 (48.7%)	Children with mouth breathing and adenotonsillar hyperthophy	Age 3 – 4 years: 51 (34%) 5 – 6 years: 47 (31.3%) 7 – 8 years: 37 (24.7%) 9 – 15 years: 15 (10%)	**ICDAS scores**: international caries detection and assessment system **DMFT/dmft:** decayed, missing, and filled teeth **DMFS/dmfs:** decayed, missing, and filled surface	The assessment of mouth breathing was made through an otorhinolaryngological evaluation by a doctor from the Department of Otorhinolaryngology at Childrens Hospital of a University in Ankara	**dmft (X ± SD)** 3.8 ± 3.6 median: 3 *p*=0.5 **dmfs (X ± SD)** 9.7 ± 10.7 median: 7 *p*=0.3 **DMFT (X ± SD)** 0.4 ± 1.0 median: 0.41 *p*=0.2

							DMFS (X ± SD) 0.6 ± 1.5 median: 0 *p*=0.3 **ICDAS** *p*=0.969 0 (sound): 0 (0%) 1 – 2 (initial): 15 (10%) 3 – 4 (moderate): 42 (28%) 5 – 6 (advanced): 93 (62%)
İnönü-Sakallı *et al*., 2021 **Turkey**	Cross-sectional with a control group, treatment group and patient group	Total N=120 Sex: Male: 67 (55.8%) Female: 53 (44.2%) *p*=0.9671 Patient group N=40 Sex: Male: 23 (57.5%) Female: 17 (42.5%) Control group: N= 40 Sex: Male: 22 (55.0%)	**Total** children attending consultations at the Near East University Hospital Otorhinolaryngology Patient group children who had adenotonsillar hypertrophy with mouth breathing Control group hildren who had	Total age 3 – 14 years old Patient group mean age 7.35 ± 3.55 Control group: mean age 8.08 ± 2.89	**DMFT/dmft:** decayed, missing, and filled teeth **DMFS/dmfs:** decayed, missing, and filled surfaces	Ear, nose, and throat were analyzed by an otolaryngologist at Near East University Hospital Otorhinolaryngology. Adenoid and tonsils were visualized by a fiberoptic nasopharyngolaryngoscopy and palatine tonsils assessment was determined according to the Brodsky and Koch criteria	**dmft – N (%)** *p*=0.288 Patient group: 33 (82.5%) mean: 2.51515 SD: 2.9593 SE: 0.51515 Control group: 34 (85%) mean: 3.58824 SD: 3.1249 SE: 0.53591 **dmfs – N (%)** *p*=0.338 Patient group: 33 (82.5%) mean: 3.69697 SD: 4.74 SE: 0.82513 Control group: 34 (85%)

		Female: 18 (45.0%)	no adenotonsillar hypertrophy with nasal breathing				mean: 4.91176 SD: 4.6343 SE: 0.79478 **DMFT – N (%)** *p*=0.124 Patient group: 23 (57.5%) mean: 1.73913 SD: 2.4162 SE: 0.50381 Control group: 32 (80%) mean: 0.4375 SD: 0.9483 SE: 0.16763 **DMFS – N (%)** *p*=0.145 Patient group: 23 (57.5%) mean: 2.26087 SD: 3.2783 SE: 0.68357 Control group: 32 (80%) mean: 0.625 SD: 1.4756 SE: 0.26085

Lee *et al*., 2020 **Republic of Korea**	Cross-sectional without a control group	Total N=1,507 Sex: 730 Female (48.44%) 777 Male (51.56%) TMBI Mouth breathing children N = not informed Sex: Female: not informed Male: not informed	Children of four elementary schools in Jeonju	Age 8 – 11 years old 8 years: 34 (2.26%) 9 years: 570 (37.82%) 10 years: 476 (31.59%) 11 years: 427 (28.33%) TMBI Mouth breathing children N = not informed Age 8 – 11 years old	**dft:** decayed and filling deciduous teeth **DMFT:** decayed, missing and filling permanent teeth	Mouth breathing assessment was conducted with a questionnaire to investigate mouth breathing habits daytime (MBD) or during sleep (MBS). All 1,507 individuals responded the questionnaire. During data analysis, a stepwise selection was used to analyze the significant factors for mouth breathing. The total mouth breathing (TMB) score results represent the sum of the MBD and MBS score	**dft (mean ± standard deviation; Pearson r)** total sample: 2.53 ± 2.5 TMBI: 0.022 *p*=0.3872 **DMFT (mean ± standard deviation; Pearson r)** total sample: 0.95 ± 1.44 TMBI: 0.024 *p*=0.337

Nascimento Filho *et al*., 2004 **Brazil**	Cross-sectional with a control group	Total N=60 Sex: not reported Study group N=30 (50.0%) Control group N=30 (50.0%)	**Total** children attending a public-school nursery Study group children diagnosed as mouth breathers Control group children diagnosed as nose breathers	Age 3 – 5 years old	Diagnosis of dental caries was made by visual inspection and divided as an initial caries lesion, demineralized surface of a white-opaque color without cavitation, and manifestation of caries lesion, presence of cavitation	The first assessment of mouth breathing was made through a report of parents, who considered if their children were predominantly mouth breathers for the last 3 months. For the final diagnosis, this group was submitted to an otorhinolaryngological examination	**<u>Initial lesions – mean (SD)</u>** Mouth breathing group: upper anterior: 3.43 ± 2.66 *p*=0.300 total anterior: 5.77 ± 4.49 *p*=0.209 posterior: 6.50 ± 3.03 *p*=0.005 total (all teeth): 12.27 ± 6.25 *p*=0.009 Nose breathing group: upper anterior: 2.60 ± 1.71 *p*=0.300 total anterior: 3.77 ± 2.37 *p*=0.209 posterior: 4.17 ± 2.57 *p*=0.005 total (all teeth): 7.93 ± 3.35 *p*=0.009 **<u>Manifestation of lesions – mean (SD)</u>** Mouth breathing group: upper anterior: 0.30 ± 1.15 *p*=0.313 total anterior: 0.33 ± 1.15 *p*=0.394 posterior: 3.97 ± 4.43 *p*=0.561

							total (all teeth): 4.30 ± 5.11 *p*=0.577 Nose breathing group: upper anterior: 0.10 ± 0.55 *p*=0.313 total anterior: 0.17 ± 0.75 *p*=0.394 posterior: 4.63 ± 4.43 *p*=0.561 total (all teeth): 4.80 ± 4.84 *p*=0.577
Piva *et al.*, 2014 **Brazil**	Cross-sectional with a control group	Total N=55 Children with mouth breathing N=16 Sex: 9 Males (56.25%) 7 Females (43.75%) Control group N=39 Sex: 17 Males (47.30%) 22 Females (52.70%)	Children of a state school in Cachoeira do Sul	Children with mouth breathing age 8 – 12 years old 8-9 years: 8 (50%) 10 years: 5 (31.25%) 11-12 years: 3 (18.75%) Control group age 8 – 12 years old 8-9 years: 30 (54.5%) 10 years: 12 (21.8%)	**CPOD:** decayed, missing, and filled permanent teeth **ceo:** decayed, missing, and filled deciduous teeth Dental caries assessment was the sum of CPOD and ceo	Mouth breathing clinical signs were identify by a speech pathologist. The orofacial signs used were: deep dark circles, long and narrow face, difficult of lip seal, dry lips, atypical swallowing, hypotonic orofacial muscles, small and atrophy nares, jaw retrusion, facial asymmetry, and maxillary atresia	**<u>Dental caries: N (%)</u>** Children with mouth breathing dental caries = 0: 6 (37.50%) dental caries ≥ 1: 10 (62.50%) Control group dental caries = 0: 15 (37.50%) dental caries ≥ 1: 24 (62.50%) *p*=1.000

				11-12 years: 13 (23.6%).			
Sajjanar *et al*., 2020 **India**	Cross-sectional without a control group	Total N=1,007 Sex: not reported	Children of four elementary schools in Nagpur city	Age 8 – 11 years old	**dft:** decayed and filled deciduous teeth **DMFT:** decayed, missing, and filled permanent teeth	A questionnaire was used to investigate children's mouth breathing habits during daytime (MBD) and during sleep (MBS). The sum of the scores MBD and MBS was defined as TMB (total score of mouth breathing). The association between TMB and dental caries was given after a multivariable linear regression. Mallampati classification and Brodsky classification were used to evaluate the size of the tongue and the palatine tonsil, respectively	**<u>Dental caries: non-standardized coefficient (standard error):</u>** TMB score 0.955 (0.12) *p*=0.00

Soares *et al*., 2024 **Brazil**	Cross-sectional with a control group	Total N=257 Sex Male: 118 (46%) Female: 139 (54%) Children with mouth breathing N=40 (15.6%) Children with nasal breathing N=217 (84.4%)	Children from a public daycare center and preschool, Diamantina, Minas Gerais	Age 3-5 years old mean age 4.1 (± 0.7)	**ICDAS II scores**: international caries detection and assessment system The clinical examination was performed on incisors and canines	Mouth breathing clinical signs were identify by observing the the characteristic commonly associated with mouth breathing (child seated in front of the examiner for 5 minutes). The orofacial signs used were: tongue with raised dorsum and lowered tip; tongue on the floor of the mouth or interposed anteriorly between the arches; thick and everted lower lip; hyperfunction of the mentalis muscle; sagging lips, tongue, and cheeks; atypical swallowing; facial asymmetries; noisy breathing; increase in face height; maxillary atresia; malocclusion; narrow or ogival palate	**<u>ICDAS II scores - N(%)</u>** Mouth Breathing group with dental caries: 16 (23.9%) without dental caries: 24 (12.6%) Nasal breathing group with dental caries: 51 (76.1%) without dental caries: 166 (87.4%) *p*=0.029 Logistic regression – PR (95% CI) Anterior dental caries Not adjusted PR 1.7 (1.08 – 2.66) *p*=0.020 Adjusted PR 1.57 (1.01 – 2.46) *p*=0.04

Supplementary File 4. Newcastle-Ottawa Scale for critical appraisal of cross-sectional studies assessing periodontal outcomes.

Study	Selection*				Comparability**	Outcome***	
	Representativeness of the sample[1]	Sample size[2]	Non-respondents[3]	Ascertainment of exposure[4]	The subjects in different outcome groups are comparable based on the study design or analysis and confounding factors are controlled[5]	Assessment of outcome[6]	Statistical test[7]
Alqutami *et al*., 2019	☆	☆		☆☆	☆☆	☆☆	☆
Ballikaya *et al*., 2018			☆	☆☆		☆☆	☆
İnönü-Sakallı *et al*., 2021	☆	☆		☆☆		☆☆	☆
Jacobson, 1973	☆			☆☆		☆☆	
Milanesi *et al*., 2018		☆		☆☆		☆☆	☆
Nascimento Filho *et al.,* 2004	☆			☆☆		☆☆	☆
Piva *et al*., 2014				☆☆	☆☆	☆☆	☆
Wagaiyu & Ashley, 1991				☆☆	☆	☆☆	

Note: *A maximum of 1 point for the first three items and a maximum of 2 for the last item, with a total of 5 points. **A maximum of 2 points for each item. ***A maximum of 2 points for the first item and a maximum of 1 for the last item, with a total of 3 points.

☆: 1 Point.

[1]a) Truly representative of the average in the target population ☆; b) Somewhat representative of the average in the target population ☆; c) Selected group of users; d) No description of the sampling strategy.

[2]a) Justified and satisfactory ☆; b) Not justified.

[3]a) Comparability between respondents' and non-respondents' characteristics is established, and the response rate is satisfactory ☆; b) The response rate is unsatisfactory, or the comparability between respondents and non-respondents is unsatisfactory; c) No description of the response rate or of the characteristics of the responders and the non-responders.

[4]a) Validated measurement tool ☆☆; b) Non-validated measurement tool, but the tool is available or described ☆; c) No description of the measurement tool.

[5]a) The study controls for the most important factor ☆; b) The study control for any additional factor ☆.

[6]a) Independent blind assessment ☆☆; b) Record linkage ☆☆; c) Self report ☆; d) No description.

[7]a) The statistical test used to analyze the data is clearly described and appropriate, and the measurement of the association is presented, including confidence intervals and the probability level (*p* value) ☆; b) The statistical test is not appropriate, not described or incomplete.

Supplementary File 5. Newcastle-Ottawa Sacle for critical appraisal of cross-sectional studies assessing dental caries.

Study	Selection*				Comparability**	Outcome***	
	Representativeness of the sample[1]	Sample size[2]	Non-respondents[3]	Ascertainment of exposure[4]	The subjects in different outcome groups are comparable based on the study design or analysis and confounding factors are controlled[5]	Assessment of outcome[6]	Statistical test[7]
Alqutami *el al*., 2019	☆	☆		☆☆	☆ ☆	☆☆	☆
Ballikaya *et al*., 2018			☆	☆☆	☆	☆☆	☆
İnönü-Sakallı *et al*., 2021	☆	☆		☆☆		☆☆	☆
Lee *et al*., 2020	☆			☆	☆☆	☆☆	☆
Nascimento Filho *et al*., 2004	☆			☆☆		☆☆	☆
Piva *et al.,* 2014				☆☆	☆☆	☆☆	☆
Sajjanar *et al*., 2020	☆		☆	☆☆		☆☆	☆
Soares *et al.,* 2024	☆	☆	☆	☆☆	☆☆	☆☆	☆

Note: *A maximum of 1 point for the first three items and a maximum of 2 for the last item, with a total of 5 points. **A maximum of 2 points for each item. ***A maximum of 2 points for the first item and a maximum of 1 for the last item, with a total of 3 points.

☆: 1 Point.

[1]a) Truly representative of the average in the target population ☆; b) Somewhat representative of the average in the target population ☆; c) Selected group of users; d) No description of the sampling strategy.

[2]a) Justified and satisfactory ☆; b) Not justified.

[3]a) Comparability between respondents' and non-respondents' characteristics is established, and the response rate is satisfactory ☆; b) The response rate is unsatisfactory, or the comparability between respondents and non-respondents is unsatisfactory; c) No description of the response rate or of the characteristics of the responders and the non-responders.

[4]a) Validated measurement tool ☆☆; b) Non-validated measurement tool, but the tool is available or described ☆; c) No description of the measurement tool.

[5]a) The study controls for the most important factor ☆; b) The study control for any additional factor ☆.

[6]a) Independent blind assessment ☆☆; b) Record linkage ☆☆; c) Self report ☆; d) No description.

[7]a) The statistical test used to analyze the data is clearly described and appropriate, and the measurement of the association is presented, including confidence intervals and the probability level (*p* value) ☆; b) The statistical test is not appropriate, not described or incomplete

Supplementary File 6. Grading of Recommendations, Assessment, Development, and Evaluation (GRADE) analysis: children and adolescents with mouth breathing compared to children and adolescents without mouth breathing in relation to periodontal-related continuous outcomes.

Certainty assessment							Number of participants		Effect		Certainty
Number of studies	*Study design*	*Risk of bias*	*Inconsistency*	*Indirectness*	*Imprecision*	*Publication bias*	***Mouth Breathing***	***Control***	***Relative (95% CI)***	***Absolute (95% CI)***	
Plaque Index											
3	Observational studies	Very serious	Very serious	Serious	Serious	Not suspected	117	118	-	SMD 2.46 SD (-0.04 to 4.96)	⨁◯◯◯ Very low
Gingival Inflammation Index											
2	Observational studies	Very serious	Very serious	Serious	Very serious	Not suspected	87	88	-	SMD 0.47 SD (-1.33 to 2.26)	⨁◯◯◯ Very low

6 CONSIDERAÇÕES FINAIS

A presente revisão sistemática revelou desfechos adversos à saúde bucal associados à respiração bucal em crianças e adolescentes. Para os desfechos periodontais, associações foram encontrados em relação ao aumento do sangramento gengival, acúmulo de placa e alterações gengivais. Já para a associação entre respiração bucal e cárie dentária foi observada em lesões iniciais, cárie em dentes anteriores e em casos classificados com escores 5 e 6 do ICDAS, que representam estágios avançados de lesões cariosas.

Este estudo buscou abordar os impactos da respiração bucal na saúde bucal de crianças e adolescentes, evidenciando sua associação com a cárie dentária, sangramento gengival, acúmulo de placa e alterações periodontais. Ao apresentar esses achados, esta revisão contribui para o entendimento dos riscos específicos que essa condição representa para a saúde oral, permitindo que cirurgiões-dentistas reconheçam os principais sinais associados a respiração bucal, em crianças e adolescentes.

A revisão também reforça a importância da intervenção precoce, destacando as possíveis consequências de longo prazo da respiração bucal, não apenas para a saúde bucal, mas também, alterações no desenvolvimento facial, desvios posturais e prejuízos na fala, desempenho escolar e interações sociais.

Com isso, este estudo preconiza que pesquisas futuras sobre o tema sejam realizadas, priorizando o uso de critérios diagnósticos padronizados e delineamento de estudos longitudinais, afim de estabelecer a causalidade e elucidar melhor os mecanismos fisiopatológicos associados a essa condição.

Ainda, a incorporação da observação, na prática clínica, como uma rotina, para a identificação dos sinais associados a respiração bucal pode contribuir para a intervenção precoce. Por fim, é importante ressaltar a relevância de uma abordagem multiprofissional no manejo da condição, incentivando a integração entre odontopediatras, ortodontistas e outros profissionais de saúde, a fim de oferecer um tratamento que contemple não apenas os aspectos bucais e respiratórios dos pacientes com respiração bucal, mas também promova a melhora na qualidade de vida desses indivíduos.

REFERÊNCIAS

ABREU, Rubens Rafael et al. Prevalence of mouth breathing among children. **Jornal de pediatria**, Porto Alegre, v. 84, p. 467-470, 2008. DOI: 10.2223/JPED.1806

AL-GHUTAIMEL, Hayat et al. Common periodontal diseases of children and adolescents. **International journal of dentistry**, London, v. 2014, 2014. DOI: 10.1155/2014/850674

ALI, N. J.; PITSON, D. J.; STRADLING, JR. Snoring, sleep disturbance, and behaviour in 4–5-year-olds. **Archives of disease in childhood**, London, v. 68, n. 3, p. 360-366, 1993. DOI: 10.1136/adc.68.3.360

BALLIKAYA, Elif et al. Oral health status of children with mouth breathing due to adenotonsillar hypertrophy. **International Journal of Pediatric Otorhinolaryngology**, Amsterdam, v. 113, p. 11-15, 2018. DOI: 10.1016/j.ijporl.2018.07.018

BERWIG, Luana Cristina et al. Hard palate dimensions in nasal and mouth breathers from different etiologies. **Jornal da Sociedade Brasileira de Fonoaudiologia**, São Paulo, v. 23, p. 308-314, 2011. DOI: 10.1590/s2179-64912011000400004

BRASIL. Ministério da Saúde. Secretaria de Atenção Primária à Saúde. Departamento de Estratégias e Políticas de Saúde Comunitária. **SB Brasil 2023**: Pesquisa Nacional de Saúde Bucal: relatório final. Brasília: Ministério da Saúde, 2024. Livro. (537 p.), il. ISBN 978-65-5993-702-8. Disponível em: https://biblioteca.saude.gov.br/TerminalWeb/acervo/detalhe/72340.

CALIFANO, Joseph V. et al. Position paper: periodontal diseases of children and adolescents. **Journal of periodontology**, Chicago, v. 74, n. 11, p. 1696-1704, 2003. DOI: 10.1902/jop.2003.74.11.1696

CORRÊA-FARIA, Patrícia *et al.* Recommended procedures for the management of early childhood caries lesions–a scoping review by the Children Experiencing Dental Anxiety: Collaboration on Research and Education (CEDACORE). **BMC oral health**, Londres, v. 20, p. 1-11, 2020. DOI: 10.1186/s12903-020-01067-w

CORTELLAZZI, K. L. et al. Risk indicators of dental caries in 5-year-old Brazilian children. **Community dental health**, London, v. 25, n. 4, p. 253, 2008.

CLEREHUGH, Valerie; TUGNAIT, Aradhna. Diagnosis and management of periodontal diseases in children and adolescents. **Periodontology 2000**, Hoboken, v. 26, n. 1, p. 146-168, 2001. DOI: 10.1034/j.1600-0757.2001.2260108.x

CHEDID, Kátia et al. A influência da respiração oral no processo de aprendizagem da leitura e escrita em crianças pré-escolares. **Rev. Psicopedagogia**, São Paulo, 2004;21(65):157-163. DOI: 10.1097/00004583-200302000-00014

CHERVIN, Ronald D. et al. Conduct problems and symptoms of sleep disorders in children. **Journal of the American Academy of Child & Adolescent Psychiatry**, Amsterdam, v. 42, n. 2, p. 201-208, 2003. DOI: 10.1097/00004583-200302000-00014

CHOI, J. E. et al. Intraoral pH and temperature during sleep with and without mouth breathing. **Journal of oral rehabilitation**, Hoboken, v. 43, n. 5, p. 356-363, 2016. DOI: 10.1111/joor.12372

COHEN, Jacob. A coefficient of agreement for nominal scales. **Educational and psychological measurement**, Thousand Oaks, v. 20, n. 1, p. 37-46, 1960.

CYPRIANO, Silvia *et al.* Fatores associados à experiência de cárie em escolares de um município com baixa prevalência de cárie dentária. **Ciência & saúde coletiva**, Rio de Janeiro, v. 16, p. 4095-4106, 2011. DOI: 10.1590/S1413-81232011001100015

DAVIDOVICH, E. et al. Dental, oral pH, orthodontic and salivary values in children with obstructive sleep apnea. **Clinical oral investigations**, Berlin, p. 1-9, 2022. DOI: 10.1007/s00784-021-04218-7

DERSIMONIAN R, Laird N. Meta-analysis in clinical trials. **Control Clinical Trials.** Amsterdam, 1986;7(3):177-188. doi:10.1016/0197-2456(86)90046-2. DOI: 10.1016/0197-2456(86)90046-2

DRUMMOND, Bernadette K.; BROSNAN, Michael G.; LEICHTER, Jonathan W. Management of periodontal health in children: pediatric dentistry and periodontology interface. **Periodontology 2000**, Hoboken,v. 74, n. 1, p. 158-167, 2017. DOI: 10.1111/prd.12195

DYE, Bruce A. et al. Overview and quality assurance for the oral health component of the National Health and Nutrition Examination Survey (NHANES), 2011–2014. **BMC Oral Health**, London, v. 19, p. 1-11, 2019. DOI: 10.1186/s12903-019-0777-6

FARAONE, Stephen V. Interpreting estimates of treatment effects: implications for managed care. **Pharmacy and Therapeutics**, Cranbury, v. 33, n. 12, p. 700, 2008.

FEJERSKOV, Ole. Concepts of dental caries and their consequences for understanding the disease. **Community dentistry and oral epidemiology**, Hoboken, v. 25, n. 1, p. 5-12, 1997. DOI: 0.1111/j.1600-0528.1997.tb00894.x

FELCAR, Josiane Marques et al. Prevalence of mouth breathing in children from an elementary school. **Ciencia & saude coletiva**, Rio de Janeiro, v. 15, n. 2, p. 427, 2010. DOI: 10.1590/S1413-81232010000200020

FELIX, Brenda Feder et al. Tratamento do paciente respirador bucal: um relato de caso Treatment of the mouth breathing patient: a case report. **Brazilian Journal of Development**, São Paulo, v. 8, n. 6, p. 46478-46490, 2022. DOI: 10.34117/bjdv8n6-253

GRIPPAUDO, Cristina et al. Association between oral habits, mouth breathing and malocclusion. **Acta Otorhinolaryngologica Italica**, Pisa, v. 36, n. 5, p. 386, 2016. DOI: 10.14639/0392-100X-770

GUYATT, Gordon H. et al. An emerging consensus on rating quality of evidence and strength of recommendations. **BMJ**, London, v. 336, n. 7650, p. 924-6, 2008. DOI: 10.1136/bmj.39489.470347.AD

HADDAWAY, Neal Robert et al. The role of Google Scholar in evidence reviews and its applicability to grey literature searching. **PloS one**, San Francisco, v. 10, n. 9, p. e0138237, 2015. DOI: 10.1136/bmj.39489.470347.AD

HAROKOPAKIS-HAJISHENGALLIS, Evlambia. Physiologic root resorption in primary teeth: molecular and histological events. **Journal of oral science**, Tóquio, v. 49, n. 1, p. 1-12, 2007. DOI: 10.2334/josnusd.49.1

HERZOG, Raúl et al. Are healthcare workers' intentions to vaccinate related to their knowledge, beliefs and attitudes? A systematic review. **BMC public health**, London, v. 13, p. 1-17, 2013. DOI:10.1186/1471-2458-13-154

HIGGINS, JPT; THOMAS, J.; CHANDLER, J. et al., eds**.** *Cochrane Handbook for Systematic Reviews of Interventions version 6.4 (updated August 2023)*. London: **Cochrane**, 2023. Disponível em: <www.training.cochrane.org/handbook>

HIGGINS, JP; THOMPSON, SG**.** Quantifying heterogeneity in a meta-analysis. **Statistics in Medicine**, Chichester, v. 21, n. 11, p. 1539-1558, 2002. DOI: 10.1002/sim.1186. DOI: 10.1002/sim.1186

HUYNH, N. T. et al. Interactions between sleep disorders and oral diseases. **Oral diseases**, Chichester, v. 20, n. 3, p. 236-245, 2014. DOI: 10.1111/odi.12152

KASSEBAUM, Nicholas J. et al. Global, regional, and national prevalence, incidence, and disability-adjusted life years for oral conditions for 195 countries, 1990–2015: a systematic analysis for the global burden of diseases, injuries, and risk factors. **Journal of dental research**, Chichester, v. 96, n. 4, p. 380-387, 2017. DOI: 10.1177/0022034517693566

KHARBANDA, O. P. et al. Oral habits in school going children of Delhi: a prevalence study. **Journal of the Indian Society of Pedodontics and Preventive Dentistry**, Mumbai, v. 21, n. 3, p. 120-124, 2003.

KINI, Vineet et al. Diagnosis and management of periodontal disease in children and adolescents: A brief review. **Journal of Dental & Allied Sciences**, Mumbai, v. 5, n. 2, 2016. DOI: 10.4103/2277-4696.192978

LEE, Dae-Woo; KIM, Jae-Gon; YANG, Yeon-mi. Influence of mouth breathing on atopic dermatitis risk and oral health in children: A population-based cross-sectional study. **Journal of Dental Sciences**, Taipei, v. 16, n. 1, p. 178-185, 2021. DOI: 10.1016/j.jds.2020.06.014

LIN, Lizhuo et al. The impact of mouth breathing on dentofacial development: A concise review. **Frontiers in public health**, Lausanne, v. 10, p. 929165-929165, 2022. DOI: 10.3389/fpubh.2022.929165

MACHIULSKIENE, Vita et al. Terminology of dental caries and dental caries management: consensus report of a workshop organized by ORCA and Cariology Research Group of IADR. **Caries research**, Basileia, v. 54, n. 1, p. 7-14, 2020. DOI: 10.1159/000503309

MATSUO, Koichiro; PALMER, Jeffrey B. Coordination of mastication, swallowing and breathing. **Japanese Dental Science Review**, Tóquio, v. 45, n. 1, p. 31-40, 2009. DOI:10.1016/j.jdsr.2009.03.004

MASUTOMI, Yukako; GOTO, Takaharu; ICHIKAWA, Tetsuo. Mouth breathing reduces oral function in adolescence. **Scientific reports**, Londres, v. 14, n. 1, p. 3810, 2024. DOI: 10.1038/s41598-024-54328-x

MENEZES, Valdenice Aparecida de et al. Influência de fatores socioeconômicos e demográficos no padrão de respiração: um estudo piloto. **Revista brasileira de otorrinolaringologia**, São Paulo, v. 73, p. 826-834, 2007. DOI: 10.1590/S0034-72992007000600014

MUMMOLO, Stefano et al. Salivary markers and microbial flora in mouth breathing late adolescents. **BioMed research international**, Londres, v. 2018, 2018. DOI: 10.1155/2018/8687608

MURAD, M. Hassan et al. New evidence pyramid. **BMJ Evidence-Based Medicine**, London, v. 21, n. 4, p. 125-127, 2016. DOI: 10.1136/ebmed-2016-110401

NAGAE, Mirian Hideko et al. Life quality for mouth and oronasal breathing subjects/Qualidade de vida em sujeitos respiradores orais e oronasais. **Revista CEFAC: Atualizacao Cientifica em Fonoaudiologia e Educacao**, São Paulo, v. 15, n. 1, p. 105-111, 2013. DOI: 10.1590/S1516-18462012005000048

NYVAD, Bente; MACHIULSKIENE, V.; BAELUM, Vibeke. Construct and predictive validity of clinical caries diagnostic criteria assessing lesion activity. **Journal of dental research**, Alexandria, v. 82, n. 2, p. 117-122, 2003. DOI: 10.1177/154405910308200208

PAGE, M. J. *et al.* Updating guidance for reporting systematic reviews: development of the PRISMA 2020 statement. **Journal of Clinical Epidemiology, [S.l.**], Amsterdam, v. 134, p. 103–112, 2021. DOI: 10.1016/j.jclinepi.2021.02.003.

PAOLANTONIO, E. G. et al. Association between oral habits, mouth breathing and malocclusion in Italian preschoolers. **European journal of paediatric dentistry**, Carimate, v. 2019, n. 20/3, p. 204-208, 2019. DOI: 10.23804/ejpd.2019.20.03.07

PARRA, Yahaira. El paciente respirador bucal una propuesta para el estado Nueva Esparta 1996-2001. **Acta odontológica venezolana**, Caracas, v. 42, n. 2, p. 97-106, 2004.

PERES, Marco A. et al. Oral diseases: a global public health challenge. **The Lancet**, Londres, v. 394, n. 10194, p. 249-260, 2019. DOI: 10.1016/S0140-6736(19)31146-8

PIHLSTROM, Bruce L.; MICHALOWICZ, Bryan S.; JOHNSON, Newell W. Periodontal diseases. **The lancet**, Londres, v. 366, n. 9499, p. 1809-1820, 2005. DOI: 10.1016/S0140-6736(05)67728-8

PRADO Jr, Jose Carlos et al. Cadernos de Atenção Básica n.25 - Doenças Respiratórias Crônicas. p. 15-16, 2010

SANTOS NETO, Edson Theodoro dos et al. Factors associated with onset of mouth breathing in early child development. **Journal of Human Growth and Development**, Marília, v. 19, n. 2, p. 237-248, 2009.

SLAYTON, Rebecca L. Clinical decision-making for caries management in children: an update. **Pediatric dentistry**, Chicago, v. 37, n. 2, p. 106-110, 2015.

SOARES, Maria Eliza da Consolação et al. Mouth breathing is associated with a higher prevalence of anterior dental caries in preschool children. **Brazilian Oral Research**, v. 38, p. e057, 2024. DOI:10.1590/1807-3107bor-2024.vol38.0057

VUKIĆEVIĆ, Vladanka et al. Radiographic cephalometry analysis of head posture and craniofacial morphology in oral breathing children. **Vojnosanitetski pregled**, Belgrado, v. 74, n. 11, p. 1048-1053, 2017. DOI: 10.2298/VSP160127297V

WAN, Xiang et al. Estimating the sample mean and standard deviation from the sample size, median, range and/or interquartile range. **BMC medical research methodology**, London, v. 14, p. 1-13, 2014. DOI: 10.1186/1471-2288-14-135

WELLS, G.A et al. The Newcastle-Ottawa Scale (NOS) for assessing the quality of nonrandomised studies in meta-analyses. 2013. Accessed on October 2, 2021. Available at: http://www.ohri.ca/programs/clinical_epidemiology/oxford.asp

WORLD HEALTH ORGANIZATION. **Orientation Programme on Adolescent Health for Health-care Providers** 2006. https://apps.who.int/iris/handle/10665/42868 Accessed September 16, 2018.

WORLD HEALTH ORGANIZATION. **Global oral health status report: towards universal health coverage for oral health by 2030**. World Health Organization, 2022.

ANEXO A – Protocolo de submissão a plataforma PROSPERO

NIHR | National Institute for Health Research

PROSPERO
International prospective register of systematic reviews

Dental caries and periodontal outcomes in children and adolescents with mouth breathing: a systematic review and meta-analysis

To enable PROSPERO to focus on COVID-19 submissions, this registration record has undergone basic automated checks for eligibility and is published exactly as submitted. PROSPERO has never provided peer review, and usual checking by the PROSPERO team does not endorse content. Therefore, automatically published records should be treated as any other PROSPERO registration. Further detail is provided here.

Citation

Anna Kimura, Lucas Guimarães Abreu. Dental caries and periodontal outcomes in children and adolescents with mouth breathing: a systematic review and meta-analysis. PROSPERO 2024 CRD42024536891 Available from: https://www.crd.york.ac.uk/prospero/display_record.php?ID=CRD42024536891

Review question

Are children and adolescents with mouth breathing more likely to exhibit dental caries and periodontal disorders than children and adolescents with nose breathing?

Searches

Electronic searches will be conducted in the following databases from the date of inception to the date of the search: Embase, PubMed, Web of Science, Ovid, and Scopus. OpenGrey and Google Scholar will be assessed, with searches limited to the first 300 records. A manual search will be conducted in the reference list of the included articles. The records retrieved from databases will be managed with EndNote Web (Clarivate Analytics). A search strategy will be initially built for PubMed and will be adapted to each electronic database's syntax.

The following string will be used:

mouth breathing OR mouth breather

AND

dental caries OR dental decay OR caries disease OR root caries OR tooth caries OR tooth decay OR dental fissure OR dmfs OR dmft OR ICDAS OR periodontal disease OR gingival disease OR pyorrhea OR gum disease OR periodontitis OR gingivitis OR parodontosis OR periodontal pocket OR periodontal abscess OR dental plaque OR probing depth OR bleeding on probing OR plaque index OR gingival index OR periodontal index OR attachment level OR gingival bleeding.

Types of study to be included

Longitudinal studies and cross-sectional studies with and without control groups. Case-control studies will be eligible as well.

Condition or domain being studied

The presence of mouth breathing is identified when a person spends most of his/her time breathing through the oral cavity. This habit is considered as an adaptation of the body to ensure the effectiveness of breathing, due to the presence of another pathology that precludes nose breathing. It is a common outcome in children and is influenced by factors

Strategy for data synthesis

A qualitative and narrative synthesis will be conducted using the data gathered from the studies included after the screening process. For the quantitative synthesis, a meta-analysis will be performed to pool the data of primary studies. For studies that share clinical and methodological homogeneity, meta-analysis will be conducted. Inconsistency will be appraised using I^2.

Analysis of subgroups or subsets

We are anticipating subgroup analyses for individuals' age (children/adolescents) and sex (male/female).

Contact details for further information

Anna Carolina Rye Sato Kimura

annakimuraaa@gmail.com

Organisational affiliation of the review

Universidade Federal de Minas Gerais

Review team members and their organisational affiliations

Miss Anna Kimura. Universidade Federal de Minas Gerais

Lucas Guimarães Abreu. Universidade Federal de Minas Gerais

Type and method of review

Epidemiologic, Meta-analysis, Systematic review

Anticipated or actual start date

08 April 2024

Anticipated completion date

07 April 2025

Funding sources/sponsors

There is no funding involved in the present systematic review

Conflicts of interest

Language

English

Country

Brazil

NIHR | National Institute for Health Research

PROSPERO
International prospective register of systematic reviews

Stage of review

Review Ongoing

Subject index terms status

Subject indexing assigned by CRD

Subject index terms

MeSH headings have not been applied to this record

Date of registration in PROSPERO

29 April 2024

Date of first submission

16 April 2024

Stage of review at time of this submission

Stage	Started	Completed
Preliminary searches	Yes	No
Piloting of the study selection process	No	No
Formal screening of search results against eligibility criteria	No	No
Data extraction	No	No
Risk of bias (quality) assessment	No	No
Data analysis	No	No

The record owner confirms that the information they have supplied for this submission is accurate and complete and they understand that deliberate provision of inaccurate information or omission of data may be construed as scientific misconduct.

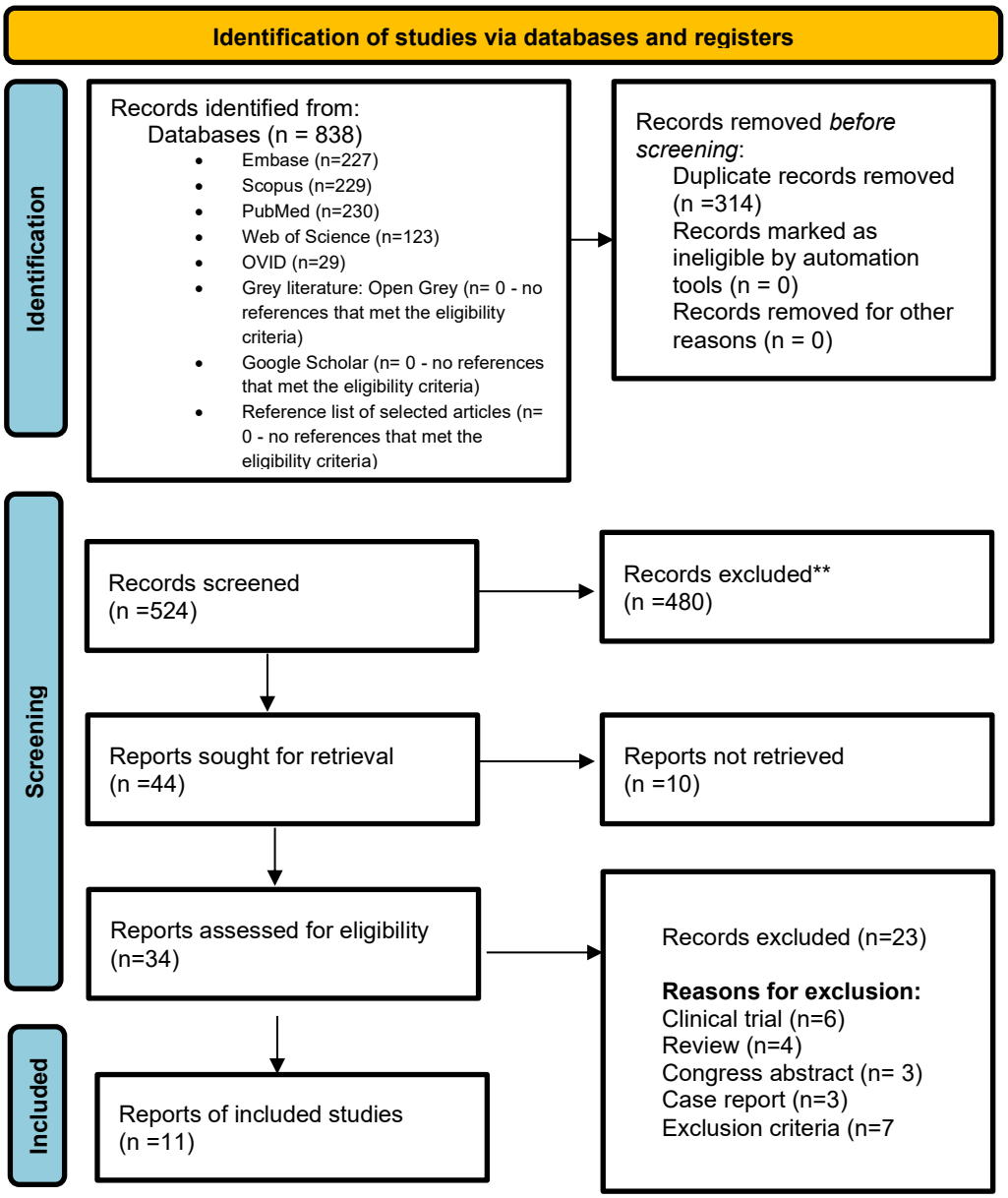
The record owner confirms that they will update the status of the review when it is completed and will add publication details in due course.

Versions

29 April 2024

29 April 2024

ANEXO B - PRISMA 2020 flow diagram for new systematic reviews which included searches of databases and registers only



*Consider, if feasible to do so, reporting the number of records identified from each database or register searched (rather than the total number across all databases/registers).
**If automation tools were used, indicate how many records were excluded by a human and how many were excluded by automation tools.

Source: Page MJ, et al. BMJ 2021;372:n71. doi: 10.1136/bmj.n71.