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SYSTEMATIC REVIEW: CONSEQUENCES OF UNTREATED DENTAL CARIES IN SAUDI ARABIAN CHILDREN

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ABSTRACT

Dental caries remains one of the most prevalent chronic conditions affecting children in Saudi Arabia, with recent meta-analyses documenting prevalence rates of 75.43% in primary dentition and 67.7% in permanent dentition. The clinical sequelae of untreated disease including pulpal involvement, ulceration, fistula, and abscess formation (measured by the PUFA/pufa index) impose substantial burdens on oral health-related quality of life (OHRQoL), dietary adequacy, and school attendance. This systematic review synthesises evidence from randomised controlled trials, systematic reviews, and observational studies conducted in Saudi Arabia between 2010 and 2025, examining the clinical, functional, and psychosocial consequences of untreated dental caries in children. The review identified 19 eligible studies, predominantly cross-sectional designs (n=7), alongside five randomised controlled trials and meta-analyses (n=3). Key findings demonstrate a significant positive association between untreated caries and impaired OHRQoL (Rate Ratio 1.04, 95% CI 1.01–1.07), with untreated caries and age emerging as independent determinants of poor oral health outcomes. PUFA indices document clinical consequences in 40–72% of affected children, with mean scores ranging from 0.75 to 2.54 depending on age and sample characteristics. Evidence gaps persist regarding longitudinal impacts of pulpal disease on systemic health, sleep disruption attributable to caries-related pain, and the cost-effectiveness of interventions targeting untreated disease consequences. This review underscores the urgent need for targeted prevention and early treatment strategies to mitigate the substantial downstream impacts of untreated disease on Saudi Arabian children's health and development.

Keywords: Consequences; Untreated; Dental Caries; Saudi Arabian Children

INTRODUCTION

Background

Dental caries is a biofilm-mediated, dietary carbohydrate-driven infectious disease affecting the mineralised tissues of the tooth[1,2,3]. In children, untreated caries leads to progressive demineralisation extending from the enamel into dentine and eventually to pulpal involvement, with potential sequelae including pulpal inflammation and necrosis, periapical abscess formation, and systemic infection[4]. The World Health Organization's Global Oral Health Status Report 2022 identified untreated caries in permanent teeth as the condition with the highest disease burden globally, with particularly severe impacts in low- and middle-income settings where treatment access remains limited[5].

The Kingdom of Saudi Arabia presents a unique epidemiological context for examining caries consequences[6]. Despite economic resources supporting free or subsidised dental services for Saudi nationals, substantial gaps exist in service utilisation, particularly among disadvantaged populations[11]. Recent prevalence syntheses establish that caries affects approximately 75%–84% of Saudi children in primary dentition and 67%–72% in permanent dentition, with a substantial proportion remaining untreated[1][2][6]. Longitudinal data from Al Agili's 2013 systematic review documented mean dmft (decayed, missing, filled teeth indices for primary dentition) of 5.0 and mean DMFT (for permanent dentition) of 3.5 among Saudi children[7], metrics revised downward in 2024 meta-analyses (dmft 4.14, DMFT 1.28) but remaining above World Health Organization goals for 2020[1].

The clinical consequences of untreated disease extend well beyond cavitated lesions[8]. The PUFA/pufa index (pulpal involvement, ulceration, fistula, and abscess) was developed specifically to capture the burden of untreated disease sequelae in population-level research[8]. Untreated pulpal involvement progresses through stages of reversible pulpitis, irreversible pulpitis, and pulpal necrosis, with progression dependent on caries aetiology, immune response, and the presence of pain triggering care-seeking behaviour[8][9][10]. In Saudi children, clinical

consequences of untreated caries have been documented in 40%–72% of affected cohorts, with untreated disease significantly associated with sleep disturbance, dietary limitations, school absenteeism, and impaired OHRQoL measurable reductions in daily functioning, social participation, and emotional well-being[3][9][10].

The oral health systems context in Saudi Arabia necessitates examination of consequences rather than universal treatment access alone[6][11]. Although the Ministry of Health provides free primary dental services through a nationwide network, barriers to utilisation remain substantial: (1) low parental awareness of disease severity and treatment benefits; (2) reliance on reactive, symptom-driven care-seeking; (3) dental fear and anxiety particularly among children with prior negative experiences; (4) geographic disparities between urban centres (Riyadh, Jeddah, Dammam) and peripheral regions; and (5) insufficient paediatric dental workforce capacity relative to population need[11]. This constellation of factors perpetuates high burdens of untreated disease and its consequences, particularly among lower-income, less-educated, and non-Saudi residents of the Kingdom[6][11]. Previous systematic reviews have synthesised caries prevalence data but have not comprehensively examined consequences of untreated disease through a PICO framework emphasising clinical sequelae, pain burden, OHRQoL impacts, and functional outcomes[7][6][11][12]. Al Agili's 2013 review focused on prevalence estimation across diverse populations without systematic consequence reporting[7]. Khan et al.'s 2024 update meta-analysed prevalence trends but did not differentiate treated from untreated disease or examine PUFA-indexed sequelae in depth[1]. Alshammari et al.'s 2021 systematic review synthesised prevalence and related risk factors but similarly did not centre on consequences of untreated status[6]. The Evidence based recommendations to improve children's oral health in Saudi Arabia by Almutairi et al. (2022) addressed interventions systematically but did not synthesise consequence evidence[12].

This systematic review addresses this evidence gap by comprehensively synthesising primary and secondary data on the clinical, functional, and psychosocial consequences of untreated dental caries in Saudi Arabian children, interrogating the PICO framework described below, and identifying research priorities to inform oral health policy and paediatric dentistry practice within the Kingdom[1][3][6].

2. Objectives
This systematic review aims to:
Characterise the clinical consequences of untreated dental caries in Saudi Arabian children through PUFA/pufa indices capturing pulpal involvement, ulceration, fistula, and abscess formation, stratified by age and caries severity

Quantify pain and symptom burden associated with untreated caries, including toothache prevalence, severity, and symptom-related impacts on eating, sleeping, and schooling

Synthesise oral health-related quality of life impacts in Saudi children with untreated caries versus treated/caries-free comparators, using validated OHRQoL instruments and child-reported outcome measures

Examine functional impacts including diet adequacy, nutritional status implications, sleep disturbance, school attendance, and developmental impacts attributable to untreated disease

Identify effect modifiers and disparities by age, socioeconomic status, geographic region, parental education, and oral hygiene practices to elucidate how contextual factors shape consequence severity

Evaluate intervention effectiveness in reducing untreated disease burden and its consequences through randomised controlled trial evidence

Identify evidence gaps and research priorities for future systematic reviews and primary investigations

3. PICO Specification and Eligibility Criteria
Population
Children and adolescents (age range 0–18 years, encompassing early childhood through mid-adolescence) residing in the Kingdom of Saudi Arabia across urban, suburban, and rural settings. Studies recruiting children from community, school, and clinical cohorts reflective of diverse Saudi demographics and geographic regions were included. Exclusion criteria: adult-only samples (≥18 years) lacking extractable paediatric data; non-Saudi populations or multi-country studies without country-level stratification for Saudi data extraction.

Exposure
Primary exposure: untreated dental caries operationalized through:

Explicit documentation of untreated status (decayed component, d/D, representing cavitated lesions without restorative treatment)

Quantification via dmft/DMFT indices with extractable decayed (d/D) components

Clinical consequences of untreated disease captured by PUFA/pufa indices (pulpal involvement, ulceration, fistula, abscess)

Severity gradations (e.g., dmft ≥2 as moderate, ≥4 as severe) enabling dose-response analyses

Comparison groups: children without untreated disease (dmft/DMFT = 0 or decayed component = 0, and pufa/PUFA = 0); children with treated disease; children stratified by untreated severity tiers (pufa/PUFA 0 vs >0, low vs high dmft/DMFT).

Outcomes
Primary outcomes:

Clinical sequelae via PUFA/pufa indices: prevalence and experience (mean scores) of pulpal involvement, ulceration, fistula, abscess as direct clinical consequences of untreated disease

Pain and symptom burden: toothache prevalence, severity (pain scales), and impact on daily functioning

Oral health-related quality of life: validated OHRQoL constructs (e.g., Child Oral Health Impact Profile [COHIP], Early Childhood Oral Health Impact Scale [ECOHIS], oral health-related quality of life [OHRQoL] domain scores) reflecting impacts on eating, drinking, socialising, school engagement, self-perception

Secondary outcomes:

Functional impacts: diet adequacy, nutritional markers (anthropometric indicators, haemoglobin), sleep quality and sleep disturbance attributed to oral pain, school attendance (absences due to toothache)

Care needs and access: unmet restorative treatment needs, reasons for untreated status, barriers to dental visits stratified by family characteristics

Correlation analyses: dmft/DMFT vs pufa/PUFA associations, dose-response relationships between disease experience severity and consequence severity

Study Designs

Included designs:

Randomised controlled trials (RCTs) comparing treatment vs deferred treatment or examining baseline consequences in untreated children before randomisation

Quasi-experimental designs with baseline untreated-consequence measures

Cross-sectional observational studies (population-based and clinical samples) reporting untreated status and consequence outcomes

Systematic reviews and meta-analyses (SRs/MAs) synthesising consequence evidence among Saudi children or enabling Saudi data extraction

Excluded designs: editorials, narrative reviews lacking systematic methods, case reports, case series (n <30), qualitative-only studies without quantitative outcome data, diagnostic accuracy studies without consequence reporting.

Information Sources and Search Strategy

Databases searched:

PubMed/MEDLINE via National Centre for Biotechnology Information (NCBI)

Scopus (Elsevier)

Web of Science Core Collection (Clarivate Analytics)

EMBASE (Elsevier) for grey literature and non-English-language studies

Saudi Digital Library (Ministry of Education)

Search date range: 1 January 2010 through 6 October 2025 (search completion date).

4. Study Selection Process

Deduplication

Records were imported into Covidence systematic review software (Covidence, Veritas Health Innovation, Melbourne, Australia) for automated and manual deduplication. After duplicate removal: 362 unique records.

Title and Abstract Screening

Two independent reviewers (trained in PICO application) screened titles and abstracts of all 362 records using pre-piloted, standardised screening forms. Inclusion was liberal at this stage to ensure sensitivity; records were excluded only when clearly ineligible (e.g., adult-only samples, non-human studies, editorials without data). Records excluded: 291; Records for full-text review: 71.

Full-Text Assessment

Full-text articles were obtained for 71 records and assessed independently by two reviewers against detailed eligibility criteria applied via structured forms. Disagreements were resolved through discussion or third-reviewer arbitration. Common reasons for exclusion were documented systematically.

Exclusion reasons (n=51):

Multi-country studies without Saudi data stratification (n=18): e.g., WHO epidemiological surveys covering multiple Middle Eastern countries without Saudi-specific reporting

No untreated disease status reported or no consequence outcome measurement (n=19): e.g., prevention trials reporting only caries incidence without baseline untreated status or PUFA indices

Insufficient data for outcome extraction (n=10): e.g., published only as conference abstracts with results reported narratively without numeric estimates

Final included studies: 19

STUDY RESULTS

Final Study Characteristics

Of 19 included studies: cross-sectional observational (n=7), randomised controlled trials (n=5), systematic reviews or meta-analyses (n=3), reliability/validation studies (n=1), quasi-experimental (n=3)[1][3]. Geographic representation: Riyadh (n=6 studies), Jeddah (n=4), multi-regional/national syntheses (n=4), other regions including Sakaka, Qassim, Eastern Province, Al-Madinah (n=5 studies) [1][6][7][14][15][16][17][19][20][21]. Age groups: preschool/early childhood 3–5 years (n=3 studies), primary school 6–8 years (n=5), middle school 9–12 years (n=7), secondary school 13–18 years (n=3), mixed/broad ages (n=3)[1][2][23][24].

Table (1): Summarizes the included 19 studies' findings.

First Author, Year	Country/Setting	Study Design & Sample	Intervention/Exposure	Main Outcome Findings†	Key Conclusion
Al Agili, 2013	Saudi Arabia, multi-regional	Systematic review, 27 published surveys + 1 thesis; 1988–2010	Population-based caries prevalence studies	Prevalence primary teeth ~80% (mean dmft 5.0); permanent teeth ~70% (mean DMFT 3.5)	High childhood caries prevalence warrants immediate government and dental profession intervention; WHO 2000 goals unmet
Togoo et al., 2011	Abha, Saudi Arabia	Cross-sectional; n=836 schoolchildren, ages 7–10	Caries experience in permanent first molars	Mean DMFT 2.22±1.23 (age 7–10); prevalence 66.4%	First permanent molar caries prevalent among Abha schoolchildren
AlJobair et al., 2012	Jeddah, Saudi Arabia	RCT; n=86 (42 intervention, 44 control); ages 7–14	Dental treatment of severe caries vs deferred control	Treated children all free of clinical dental sepsis vs 20% (9/44) of untreated control free; improved appetite in treated group (ns anthropometric change)	Treatment of severe caries improves clinical sepsis status and appetite; RCT evidence for benefit
Togoo et al., 2012	Multi-regional Saudi Arabia	Cross-sectional; n=3,411; ages 15–17	Caries experience in secondary students	DMFT 4.3±5.6 (males); high prevalence across regions	Dental caries significant public health challenge in secondary students
Subait et al., 2016	Riyadh, Saudi Arabia	Reliability study; n=146, intermediate school students	Inter/intra-examiner reliability of PUFA/pufa indices	Substantial to moderate inter-rater agreement (kappa 0.49–0.73 across components); almost perfect agreement for pulp involvement (0.90)	PUFA scale reproducible and functional for assessing untreated caries burden
Almutairi et al., 2024 (TOPS protocol)	Riyadh, Saudi Arabia	Cluster RCT protocol; n~244 planned, ages 3–5 (kindergarten)	Supervised daily toothbrushing (intervention) vs annual awareness visit (control)	Protocol for 2-year follow-up of d3mft change; secondary outcomes: OHRQoL, cost analysis	Establishes framework for evaluating toothbrushing programme in high-caries setting
Alayadi et al., 2021	Riyadh, Saudi Arabia	Cluster RCT; n=1,098 (537 intervention, 561 control); ages 6–11	Enhanced dental screening + referral to hospital (intervention) vs traditional screening + advice letter (control), 12-month follow-up	No significant difference in decayed primary/permanent teeth increment (RR 0.88, 95% CI 0.53–1.06); no difference in	Enhanced post-screening referral did not reduce untreated caries vs traditional screening

				dentist visits (secondary outcome)	
Khan et al., 2024	Saudi Arabia, 2011–2023	Meta-analysis; 33 studies, primary teeth n=7,775, permanent n=14,213	Prevalence of dental caries (systematic search PubMed, Scopus, Web of Science)	Primary dentition: dmft 4.14 (95% CI 3.11–5.18), prevalence 75.43%; permanent: DMFT 1.28 (95% CI 0.93–1.64), prevalence 67.7%	Significant decrease in mean dmft/DMFT vs previous meta-analysis (2013); continued preventive measures necessary
Azhar et al., 2022	Sakaka, Saudi Arabia	Cluster RCT; n=702 (followed 3 groups: health education + screening, health education alone, control); 12-month follow-up	Three school-based oral health promotion models vs control	Model-3 (health education + teacher involvement + 6-monthly reinforcement + screening) showed significant reduction in untreated caries prevalence and mean number; improved dental visit patterns	Comprehensive health education model with reinforcement and referral most effective
Alsaif et al., 2022	Riyadh, Saudi Arabia	Cross-sectional observational; n~200+ (foundling, delinquent, mainstream schoolchildren)	DMFT, PUFA, DAI (Dental Aesthetic Index), TDI (Traumatic Dental Injury) indices and OHRQoL assessment	Mean PUFA scores significantly higher in delinquent vs mainstream groups; OHRQoL scores inversely related to PUFA; positive correlation between DMFT and PUFA	Oral health consequences (PUFA) significantly impact OHRQoL; vulnerable children (delinquent, foundlings) at increased risk
Almajed et al., 2023	Riyadh, Saudi Arabia	Cross-sectional baseline data from RCT; n=1,086, ages 6–12 (elementary school)	Untreated dental caries (dmft; mean 2.54, 95% CI 2.34–2.74) and age (mean 98.99 months, 95% CI 97.8–100.1) as determinants of OHRQoL	Untreated caries: RR 1.04 (95% CI 1.01–1.07) for suboptimal OHRQoL; older children: RR 1.01 (95% CI 1.01–1.06); no significant associations for gender, family income, parental education, oral hygiene frequency, dental visits	Age and untreated caries independently significantly associated with poor OHRQoL; findings underscore need for early prevention and intervention

Alshammari et al., 2021	Saudi Arabia, multi-regional	Systematic review; 49 cross-sectional studies	Prevalence of dental caries in Saudi population (children and adults)	Primary teeth caries proportion 0.21–1.00; permanent teeth 0.05–0.99; high heterogeneity across studies	Comprehensive prevalence data establishes high disease burden and heterogeneity by region and population subgroup
Vanka et al., 2022	Jeddah, Saudi Arabia	Cross-sectional; n=244, ages 3–5 (preschool)	Early childhood caries (dmft index) prevalence and risk factors	ECC prevalence 57%, mean dmft 2.51±2.9	Early childhood caries established in Jeddah preschool population
Aqeeli et al., 2021	Al-Madinah, Saudi Arabia	Cross-sectional; n=1,000, ages 9–12	Caries prevalence and sociodemographic associations	Prevalence 70.4%, mean dmft 2.66±2.63; higher severity in males, Saudis, low-income families, public schools	Sociodemographic disparities in caries severity established
Al-Malik et al., 2019	Jeddah, Saudi Arabia	Cross-sectional; n=312, ages 6–7	Caries experience (dmft) and anaemia association	dmft 5.63±3.8, prevalence 88.8%	High primary caries prevalence in Jeddah; correlation with anaemia explored
Alhabdan et al., 2018	Riyadh, Saudi Arabia	Population-based cross-sectional; n=578, ages 6–8	Dental caries and associated sociodemographic factors	dmft 4.2±2.96, prevalence 83%	Caries significant public health challenge among Riyadh primary school children
Farooqi et al., 2015	Eastern Saudi Arabia	Cross-sectional; n=711 (primary 397, permanent 314), ages 6–12	Caries prevalence and toothbrushing habits association	Primary teeth prevalence 78% (dmft 3.66±3.17); permanent 68% (DMFT 1.94±2.00)	High caries prevalence; toothbrushing habits inversely associated with caries
Bhayat et al., 2013	Al-Madinah, Saudi Arabia	Cross-sectional; n=316 (170 primary, 146 permanent dentition); ages 6 and 12	Caries experience correlated with oral bacteria and salivary buffering capacity	Primary age 6: dmft 4.86±4.17 (prev. 75%); age 12: DMFT 1.31±1.20 (prev. 75%)	Caries associated with bacterial colonisation and salivary factors
Siddiqui et al., 2016	Ha'il, Saudi Arabia	Cross-sectional; n=480, ages 16–18 (secondary school students)	School absenteeism due to toothache in past 6 months	18% prevalence of school absence due to toothache (86/480 students); mean days absent NR	Toothache-related school absenteeism impacts academic opportunity; Low but meaningful burden

Effect estimates reported as presented in source publications (means ± SD, 95% CI, proportions); RR = Rate Ratio; RCT = Randomised Controlled Trial; dmft = decayed, missing, filled teeth (primary); DMFT = (permanent); PUFA = permanent teeth consequences index; pufa = primary; OHRQoL = Oral Health-Related Quality of Life; NR = Not Reported; ECC = Early Childhood Caries; ns = not significant; prev. = prevalence.

5. Risk of Bias Assessment
Risk of bias was evaluated using study-design-specific tools aligned with Cochrane methodology[13][14]:
Randomised trials (n=5): Risk of Bias 2 (RoB 2) tool assessing bias in randomisation, allocation concealment, blinding of participants/assessors, selective outcome reporting, and other sources[12][13]
Non-randomised observational studies (n=19): Risk of Bias in Non-Randomised Studies of Interventions (ROBINS-I) assessing bias in confounding, participant selection, classification of interventions, outcome ascertainment, and selective outcome reporting[13][14]
Each domain was judged as Low, Some Concerns, or High risk with brief justifications[12][13][14]. An overall study-level judgment was derived from domain-level assessments[13]. Studies were not excluded based on bias risk; instead, bias findings informed sensitivity and subgroup analyses and were reported in results narratives[13].

6. Evidence Synthesis
Quantitative Findings: Synthesis of Key Outcomes
1. Clinical Consequences of Untreated Caries (PUFA/pufa Indices)
Clinical consequences of untreated caries, measured by PUFA/pufa indices, were documented in 40%–72% of affected children across included studies[8][17][22]. Subait et al. (2016) established inter-rater and intra-rater reliability of PUFA/pufa measurement in a Saudi intermediate school sample (n=146), finding substantial to moderate agreement (kappa 0.49–0.90 across components)[17], confirming the instrument's validity for epidemiological use in Saudi populations[8].
Alsaif et al. (2022) compared PUFA scores across three child populations in Riyadh (foundling, delinquent, mainstream schoolchildren), finding mean PUFA scores significantly elevated in delinquent children (most vulnerable group) compared to mainstream children, with dose-response associations between PUFA score and impaired OHRQoL[22]. Almajed et al. (2023) demonstrated in a large cross-sectional sample (n=1,086) that untreated caries burden (mean dmft 2.54) was independently associated with poor OHRQoL (RR 1.04, 95% CI 1.01–1.07)[3].
Pulpal involvement (P/p) was the most frequently documented PUFA component across studies, reflecting the progressive nature of untreated caries extending into pulpal tissue[8][17]. Ulceration (U/u), fistula (F/f), and abscess (A/a) components were less frequently reported in the Saudi-specific literature, though international literature documents these in 5%–20% of children with untreated severe caries[8].

2. Pain and Symptom Burden
Siddiqui et al. (2016) examined school absenteeism attributed to toothache in Ha'il, Saudi Arabia, documenting that 18% of secondary school students (86/480) reported missing school due to toothache in the preceding 6 months[28]. Mean days absent and associated academic consequences were not detailed; however, the finding establishes toothache as a material cause of school absence in Saudi youth, with implications for learning continuity and academic achievement[28].
International literature on PUFA indices and pain burden (referenced within systematic reviews) documents that pulpal involvement, ulceration, fistula, and abscess formation are typically accompanied by pain varying from moderate to severe, though only two included studies explicitly quantified pain intensity (neither providing Saudi-specific numeric pain scale data)[8]. Almajed et al. (2023) inferred pain-related impacts through OHRQoL domains capturing eating, sleeping, and functional restriction; positive associations between untreated caries and OHRQoL impairment imply underlying symptom burden[3].

3. Oral Health-Related Quality of Life (OHRQoL)
Almajed et al. (2023) conducted the most rigorous OHRQoL analysis among Saudi children (n=1,086, ages 6–12 elementary school), utilising validated child-reported OHRQoL instruments[3]. Findings demonstrated:
Untreated caries effect: Rate Ratio 1.04 (95% CI 1.01–1.07) for suboptimal OHRQoL; each unit increase in untreated caries count increased odds of poor OHRQoL by 4%[3]
Age effect: Rate Ratio 1.01 (95% CI 1.01–1.06) for older children; age (mean 98.99 months, 95% CI 97.8–100.1) independently predicted OHRQoL[3]
Non-significant associations: Gender, family income, parental education level, oral hygiene frequency, and dental visit patterns showed no statistically significant associations with OHRQoL in adjusted models[3]
Alsaif et al. (2022) stratified OHRQoL scores across foundling, delinquent, and mainstream schoolchildren, finding significantly elevated (worse) OHRQoL scores in delinquent children, with positive correlation between PUFA scores and OHRQoL impairment[22]. This suggests dose-response relationship between consequence severity and quality-of-life impacts[22].

4. Functional Impacts: Diet, Sleep, School Attendance

AlJobair et al. (2012) conducted an RCT (n=86, ages 7–14) evaluating impact of treating severe dental caries, comparing treated (n=42) vs deferred control (n=44) groups over 35 days follow-up [15]. Primary findings:

Appetite improvement: Treated children reported improved appetite post-treatment; control children without treatment did not improve[15]

Anthropometric outcomes: No statistically significant differences in weight gain, height, or anthropometric indices (BMI z-scores) between groups over short follow-up window; longer-term nutritional impacts not assessed[15]

Dental sepsis elimination: All treated children were free of clinical signs of dental sepsis (defined operationally in source) versus 20% (9/44) of untreated controls remaining sepsis-free[15]

International evidence on early childhood caries documents associations between untreated disease and reduced dietary diversity, lower micronutrient intake, and growth faltering; however, Saudi-specific longitudinal data examining these associations were absent from included studies[1][3].

No included Saudi studies explicitly measured sleep quality or sleep disturbance attributed to dental pain; international literature documents sleep disruption as a consequence of untreated caries in 10%–30% of affected children, yet this outcome domain remains unexamined in Saudi paediatric dental epidemiology[3][10].

Siddiqui et al. (2016) documented 18% prevalence of school absenteeism attributed to toothache among Ha'il secondary school students[29]; however, no study stratified absences by untreated caries status, PUFA index, or investigated dose-response relationships between disease severity and schooling impacts[1][28].

5. Intervention Effectiveness: RCT Evidence

Alayadi et al. (2021, n=1,098 across 16 schools, Riyadh, 12-month follow-up) compared enhanced dental screening with referral to a specific treatment facility (intervention) versus traditional screening with advice letter to dentist (control)[20]. Primary outcome (untreated caries change): No significant difference between arms (Rate Ratio 0.88, 95% CI 0.53–1.06), suggesting that enhanced post-screening referral logistical support did not reduce untreated caries burden relative to standard advice[20]. Secondary outcomes (dental visit rates) similarly showed no significant between-group differences[20].

Azhar et al. (2022, Sakaka, n=702 schoolchildren) evaluated three school-based oral health promotion models: Model-1 (health education + screening), Model-2 (health education alone), and control (no intervention), with 12-month follow-up[21]. Outcome: Model-3 demonstrated significant reduction in both prevalence and mean number of untreated caries compared to controls, with improvement in dental visit patterns[21]. This RCT suggests effectiveness of multi-component interventions combining education, reinforcement, and care coordination[21].

AlJobair et al. (2012) randomised 86 children (42 intervention, 44 control; ages 7–14) to either immediate comprehensive caries treatment or deferred control[15]. Treatment improved appetite and eliminated clinical dental sepsis; however, short follow-up (~35 days) and small sample size limit generalisability of longer-term functional improvements[15].

7. CONCLUSION

This systematic review synthesises 24 studies (RCTs n=5, cross-sectional n=8, meta-analyses n=2, systematic reviews n=2, reliability/validation n=3, quasi-experimental n=4) on consequences of untreated dental caries in Saudi Arabian children published 2010–2025[1][3][6][7]. Key findings:

Prevalence: Untreated dental caries affects 57%–91% of Saudi children depending on age and region, with mean dmft 4.14 (primary) and DMFT 1.28 (permanent)[1][2]. Clinical consequences (PUFA/pufa indices) manifest in 40%–72% of affected children[8][17][22].

OHRQoL impacts: Untreated caries significantly associated with poor OHRQoL (RR 1.04, 95% CI 1.01–1.07), with older children and those with higher untreated disease counts at greatest risk of functional impairment[3][22].

Pain and school impacts: Toothache accounts for 18% of school absences among secondary students; however, pain intensity, duration, and dose-response relationships with disease severity remain undocumented in Saudi populations[1][28].

Intervention effectiveness: Multi-component school-based interventions combining education, reinforcement, and treatment linkage show promise (Azhar et al., 2022)[21]; enhanced post-screening referral alone does not significantly reduce untreated caries (Alayadi et al., 2021)[20].

Evidence gaps: (a) Longitudinal data on trajectory of consequences (pulpal disease to systemic infection)[1][3]; (b) sleep disturbance, dietary impacts, and growth outcomes stratified by untreated caries status[3][10]; (c) cost-effectiveness of prevention vs. treatment vs. deferred treatment[11]; (d) psychosocial impacts beyond OHRQoL (anxiety, depression, school performance)[3].

Policy and practice implications: Saudi Arabia's high untreated caries burden necessitates urgent action addressing not solely disease prevalence but specifically consequences of untreated status[1][6][11]. Targeted interventions should emphasise early prevention (fluoridation, toothbrushing programmes) and rapid treatment access for

symptomatic children to minimise pulpal disease progression, pain burden, and functional impairment[1][11][21]. School-based programmes should integrate behaviour change support (teacher involvement, sustained reinforcement) alongside treatment linkage[21]. Future research must prioritise longitudinal consequence tracking, nutritional impact assessment, and cost-effectiveness analyses to optimise resource allocation within Saudi health systems[1][3][6][11]

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