SYSTEMATIC REVIEW

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Socioeconomic status and dental service utilization among children and adolescents: systematic reviews and meta analysis

Nadeera Senavirathna[1*], Enamul Kabir[2,3], Ayele Mamo Abebe[1] and Rasheda Khanam[1,3]

Abstract

Background Dental health and care among children and adolescents are a major neglected area of public health, leading to both physical and mental health consequences in the long term. Several demographics, economic, and social factors influence dental service utilization, with Socio-Economic Status (SES) being a significant determinant. SES plays an important role in the utilization of dental services for children and adolescents. This systematic review and meta-analysis aim to explore the association between SES and dental service utilization in this population.

Methods Using the PRISMA (Preferred Reporting Items for Systematic Reviews and Meta-Analyses) guidelines, we searched PubMed, Web of Science, and Scopus for relevant articles published between January 2000 and September 2024. We selected global studies that examined the association between SES and dental service utilization among children and adolescents. Different subgroup analysis based on socioeconomic indicators (household income, parental educational level and/ or occupational level, household assets, SES index, and annual household consumption expenditure), economic classification of the country (high, upper-middle, or lower-middle), nature of the dental insurance system and type of outcome measure. Pooled Odd Ratio (OR) and 95% confidence intervals (CIs) were calculated for the outcome using a random-effects model. Furthermore, meta-regression and sensitivity analysis were conducted to identify the sources for heterogeneity.

Results A total of 48 studies met the inclusion criteria for this review. The meta-analysis revealed that children and adolescents from higher SES were about twice as likely to utilize dental services (OR = 2.10, 95% CI: 1.32–2.89) compared to those from lower SES backgrounds. The subgroup analysis indicated that various factors influenced the association between SES and dental service utilization among children and adolescents. These included specific SES indicators—household income (OR = 1.65, 95% CI: 1.37–1.94), parental occupation and/or education level (OR = 3.30, 95% CI: 1.12–5.47), and household assets (OR = 1.47, 95% CI: 1.15–1.78)—as well as the economic classification of the country, with higher-income countries (OR = 2.57, 95% CI: 1.24–3.90) and upper-middle-income countries (OR = 1.52, 95% CI: 1.26–1.78) showing stronger associations. The type of dental insurance system also influenced the outcomes, with significant associations found in countries with universal coverage (OR = 1.73, 95% CI: 1.19–2.26), means-tested systems (OR = 1.70, 95% CI: 1.40–2.00), and mixed public-private systems (OR = 1.47, 95% CI: 1.09–1.85). Additionally,

*Correspondence:
Nadeera Senavirathna
nironadee20207@gmail.com
Full list of author information is available at the end of the article

the type of outcome measure also played a role, with recent dental service use (OR = 2.21, 95% CI: 1.18–3.23) and preventive dental service use (OR = 2.01, 95% CI: 1.19–2.84) demonstrating significant effects.

Conclusion The findings provide evidence that children and adolescents with low SES are associated with lower utilization of dental services. Interventions focused on these groups targeting specific barriers to care are needed to improve equitable dental service utilization.

Keywords Children, Adolescents, SES, Dental service, Meta-analysis

Introduction

Dental health is a crucial indicator of overall health and well-being. Poor dental health negatively impacts daily life and quality of life due to pain, discomfort, tooth loss, impaired oral functioning, and in severe cases, death (e.g., from oral cancer) [1]. While billions of people suffer from the burden of dental diseases, it is crucial among the children and adolescents. Children's dental health issues are recognized as one of the significant health issues in the world, affecting at least 621 million children and adolescents ([1]– [2]). Compared to other common diseases, dental diseases (especially caries) exhibit the highest severity among children aged 8–9 years [3–5].

These childhood dental diseases may negatively affect future quality of life in their adulthood. That is, failing to treat childhood dental diseases might hinder mental and physical growth in their adulthood. In 2021, World Health Organization passed a resolution for promotional initiatives in children dental health at the family and school levels that are integrated with the primary healthcare system [6, 7]. This underscores the significance of addressing children and adolescent dental health from a public health perspective. Also, dental health care remains one of the most commonly unmet healthcare needs globally [8].

One way of effectively addressing this growing issue is to provide universal and accessible primary care, with regular and preventive utilization of dental services having the potential to improve children and adolescent dental health outcomes [9–12]. Dental services including regular, and preventive are available under healthcare systems in many countries, but the utilization to these services is limited depending on large number of socio-economic and demographic factors. Studies highlighted that access to dental services is determined by the geographical location of the patients and services, convenience and ability to organize services to accommodate the individual, adaptability to the service provided, reciprocal acceptability of professionals and end users, health system type and local context ([13]– [14]). Also, some studies have shown that low SES, low monthly household income and low educational level are associated with less use of dental services [15–18].

However, dental diseases are most prevalent conditions globally, linked with many behavioural factors. Unlike most of other Non-Communicable Diseases, dental diseases can be reduced through timely preventable measures. This made a growing focus on prevention or early detection and management. Although several epidemiological studies have evaluated the associations, casual inferences between SES and dental service utilization, but to date, no systematic review and meta-analysis efforts have been made to quantify the association of SES on dental service utilization among children and adolescents.

Assessing the degree to which SES associates dental service utilization among children and adolescents, enables to have a better understanding of the influential factors that determine utilization leading for.

better policy interventions and strategies. A systematic review and meta-analysis that synthesizes existing evidence can provide a clearer picture of the disparities in dental service use related to socio-economic factors. This can, in turn, guide targeted strategies to reduce barriers to dental service, improve access, and promote equity in dental health services.

Therefore, the aim of this study is to critically review the scientific literature and quantify the association between SES and dental service utilization among children and adolescents. This research will contribute to a better understanding of how socio-economic factors influence dental health behaviours, ultimately supporting efforts to enhance oral health outcomes in younger populations.

Material and methods

As shown in Fig. 1, the methodology for this review of the literature was informed by the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA). The protocol for this review was registered at the international database of prospectively registered systematic reviews, PROSPERO (CRD 42024616044).

Search strategies

Electronic databases of PubMed, Scopus, and Web of Sciences were searched for relevant studies published from 01/01/2000 to 30/09/2024. Search terms including subject headings and free-text words were developed in MEDLINE and then adapted for other databases. The

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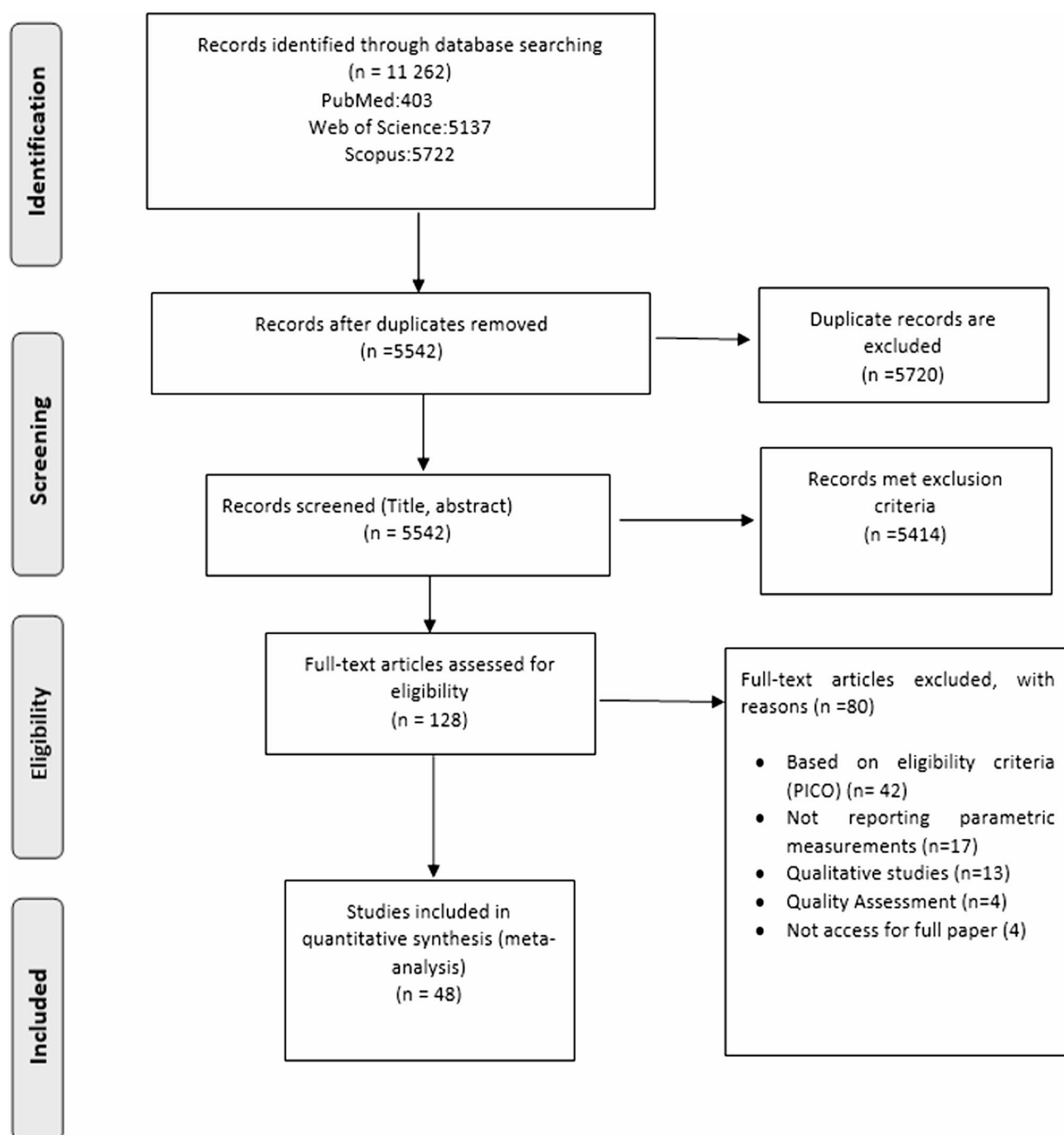
Fig. 1 Flowchart of the search process according to PRISMA guidelines in this systematic review and meta-analysis

following search strategies were used to search title/abstract in the three electronic databases.

- PubMed search strategy:

(("socioeconomic factors"[MeSH Terms] OR "socioeconomic factors"[Text Word]) OR ("social class"[MeSH Terms] OR SES[All Fields]) OR ("income"[MeSH Terms] OR income[Text Word]) OR inequality[All Fields]) AND (("dental health services"[MeSH Terms] OR "dental health services"[Text Word]) OR ("dental service"[MeSH Terms] OR "dental service"[Text Word])) AND (("child"[MeSH Terms] OR children[Text Word]) OR ("adolescent"[MeSH Terms] OR adolescents[Text Word]) OR ("paediatrics"[MeSH Terms]) OR (early[All Fields] AND childhood [All Fields]) OR school-age[All Fields]). Combinations of search terms were used,

including "Boolean" operators (And/Or) and MeSH (Medical Subject Heading) terms.

- Scopus search strategy:

(TITLE-ABS-KEY ("socioeconomic factors" OR "socio-economic status" OR "social class" OR SES OR income OR inequality)) AND (TITLE-ABS-KEY ("dental health services" OR "dental service")) AND (TITLE-ABS-KEY (child OR children OR adolescent OR teenagers OR paediatrics OR "early childhood" OR "school-age")).

- Web of science search strategy:

TS= ("socioeconomic factors" OR "socioeconomic status" OR "social class" OR SES OR income OR inequality) AND TS= ("dental health services" OR "dental service") AND TS= (child OR children OR adolescent OR teenagers OR paediatrics OR "early childhood" OR "school-age").

Study selection and selection criteria

This study included cross-sectional and longitudinal studies in examining association of SES on children and adolescent dental service utilization. Also, this review included only peer review journal articles to ensure the scientific rigor and methodological quality. Grey literature sources including government reports, dissertations and preprints were excluded to maintain peer review standard throughout the analysis. EndNote 21 is used for managing the selected studies and CADIMA for removal of duplicates. However, the selection of studies was based

on some specified inclusion and exclusion criteria outlined in Table 1.

Data extraction

Initially the related papers were selected from the electronic databases. Next, duplicated titles and abstracts of selected papers were identified and removed from the study database using the options "find and delete duplication" in software. Then, two reviewers (NNS and AMA) selected manuscripts based on titles and abstracts for further review using the full texts. The full text articles were selected based on the predetermined inclusion and exclusion criteria. We developed a data extraction form, and all studies were evaluated within this document. This extracted data on study characteristics including country of study, year of publication, study design, population characteristics, type of socioeconomic indicators and crude/adjusted estimates and quality assessment were recorded.

In our study, the primary analysis focused on comparing higher and lower SES groups to highlight the most significant disparities in dental service utilization. This approach simplifies the analysis and clearly identifies areas where interventions are most needed. However, while the middle SES group is not included in the pooled estimate, to fully understand the social gradient and capture any potential nonlinear relationships middle SES group is also included in our analysis. This provides a more comprehensive view of the social gradient changes on dental service utilization across the entire spectrum while informing more effective and equitable interventions.

Table 1 Inclusion and exclusion criteria

Category	Inclusion Criteria	Exclusion Criteria
Publication Date	Published in between 01/01/2000 to 30/09/2024 without restrictions for language	Published before 01/01/2000 or after 30/09/2024
Study Design	Studies reporting association analyses using one or more of following socioeconomic variables (family income, parental education level, parental occupational level, household assets, annual household consumption expenditures and SES index)	Studies not reporting association analyses using one or more of following socioeconomic variables (family income, parental education level, parental occupational level, household assets, annual household consumption expenditures and SES index)
Population	Studies investigating only children and adolescents	Studies that included particularly vulnerable or special subpopulations (socioeconomic displacement due to conflicts, strong cultural influences, and ecological influences); Children with specific conditions (e.g. Allergies, cancer, diabetes etc.); have a mental health issue; and have impairments (e.g., visual, audio, and motor)
Analysis Type	Studies reporting crude or adjusted analysis	Qualitative studies, descriptive studies
Study Quality	Published in peer-reviewed journals	Conference proceedings, book chapters, grey literature
Representation of population	Studies based on whole population data or samples representative of whole populations	Studies not representative of whole population
Outcome Measures	Studies that use reliable or validated measures for SES or related outcomes of dental service use	Studies that do not use reliable or validated measures for SES or related outcomes of dental service use and with significant missing data

The methodology for this literature was informed by Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) guidelines. The PECO question (P = Population; E = Exposure; C =Comparison; O = Outcome) was defined in this study as follows: P - Children and Adolescents, E - SES, C - Different SES groups, and O - Dental service utilization

Quality assessment

This study used the Newcastle Ottawa Scale (NOS) modified for observational studies to perform the quality assessment. This assessment included several criteria under mainly three criteria to measure the quality of the study [19]. Participants selection, groups comparability, and investigation of exposure or outcome are the three groups used to evaluate the selected studies. Study quality was rated on a scale from 1 (very poor) to 9 (high) [19]. Studies with scores less than 5 were considered as having low methodological quality, scores of 5 to 7 were considered as moderate quality, and those above 7 were considered as high quality [19–21]. The items included in these three groups are (i) representativeness of the sample (Was the group representative for the target population), (ii) whether national sampling was performed, (iii) whether the sample size and method were appropriate, (iv) whether sampling bias was present (Were non-responders reported on? Was nonresponse < 30% or otherwise justified), (v) whether the exposure was ascertained (Were reports based on interviews, questionnaires, or not described at all), (vi) whether researchers controlled for confounders, (vii) whether the outcome assessment was robust (blinded external assessment, or via records or self-reports, or none reported assessment method), and (vii) whether statistical reporting was complete ([20]– [21]).

In addition, this study used GRADE (Grading of Recommendations Assessment, Development, and Evaluation) approach in evaluating the certainty of evidence across outcomes included in the meta-analysis. Criteria including imprecision, inconsistency, indirectness, risk of bias and publication bias were assessed under this approach. The reliability of the evidence is upgraded or downgraded depending on the study characteristics and categorized it as "high", "moderate", "low", or "very low" quality. The detailed GRADE ratings are presented in Supplementary Table 2.

Data synthesis and statistical analysis

The meta-analysis was conducted to estimate the pooled effect size and 95% Confidence Intervals (95% CI) on the association of SES on dental service utilization among children and adolescents. Unless when adjusted estimates were reported, unadjusted odds ratios (OR) were calculated from the available data. Also, when different levels of adjustment were used for analysis, the model adjusted for the highest number of confounders was used.

SES is used to refer to a family's access to economic and social resources. SES can be estimated using different measures including household income status (in income quintiles), parental education level, or parental occupational level, household assets, annual household consumption expenditures and SES index – determined by various government bodies, each using country-specific methodologies ([22]– [23]). The household assets are determined based on housing types, ownership of a car in the home, health insurance (including medical and dental), availability of household goods and household construction materials.

Heterogeneity among the studies was assessed using I^2 statistics. The I^2 statistics is used for the measurement of heterogeneity in meta-analysis. This describes the percentage of variation across studies rather than sampling error. Random effect model with DerSimonian-Laird method was used for estimation of pooled effect size in meta-analysis. The heterogeneity of the analysis revealed a high level of significant heterogeneity (94.80%) across the included studies, with a p-value < 0.001. Given the substantial variation in effect sizes across studies, a subgroup analysis was conducted to better explain the sources of heterogeneity. This analysis was stratified based on different SES measures employed in the studies, including household annual income, parental education level and/or parental occupation, household assets, SES index, and annual household consumption expenditure. Additionally, a socioeconomic gradient analysis was performed to examine dental service utilization among children and adolescents based on household income status. Due to limited use other SES measures in studies, only mostly frequently using SES measures (household income status) was selected for this analysis and showed a strong significant association with dental service utilization.

Subgroup analysis was further extended to examine potential sources of heterogeneity based on study characteristics, such as the country of study (classified into upper income, upper middle income, and lower middle-income categories based on World Bank Economic Classification, type of dental insurance system and the type of outcome measurement used (e.g. visit to the dentist in the past 12 months, lifetime dental visits, and visits for

Table 2 Meta analysis to the association between SES and dental service utilization to the socioeconomic gradient for level household income status

Socioeconomic indicator	OR (95% CI)	Inconsistency index (I²)	*P* value
Household Income *(N=28)*			
Low (Reference Category)	1		
Middle	1.31 (1.12–1.51)	0.00%	< 0.01
High	1.65 (1.37–1.94)	0.00%	< 0.01

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preventive care). This enabled to identify factors contributing to the observed heterogeneity in the estimates of dental service utilization across studies.

A random- effect meta regression model was used to investigate the impact of independent variables on observed heterogeneity in our meta-analysis. Economic level of country, study population, publication year, sample size, type of Odd Ratio reported (crude vs. adjusted Odd Ratio), and type of socioeconomic indicator used were used as independent variables in the model. The dependent variable was dental service utilization. This study used funnel plot and Egger's test to test publication bias. A sensitivity analysis was performed, with the p-value, less than 5% used to test the robustness of results. Stata version 16.1 was used in all analyses.

Results

Search outcomes
As shown in Fig. 1, the initial search led to retrieve total of 11,262 papers and 5720 duplicate papers were removed from the database. After screening the titles and abstracts, 128 papers were selected for the full text assessment. Finally, 48 papers were selected for the quantitative synthesis.

Study characteristics
The narrative synthesis of the 48 papers included in our meta-analysis is illustrated in supplementary Table 1 (in the annex). Of the 48 included papers, 46 papers are cross sectional, and 2 papers are longitudinal studies. These studies are conducted in 21 high income countries, 19 upper middle-income countries and 8 low middle income countries and the countries were classified based on World Bank economic classification. From overall studies, 28 of studies focused on children, 8 of studies focused on adolescents and 12 studies focused on both children and adolescents. The studies included participants aged between 0 and 22 years.

Different indicators are used to measure SES, with household income status ($n = 28$) being the most used indicator, followed by parental educational level and/or parental occupation ($n = 8$), household assets ($n = 4$), household annual consumption expenditure ($n = 3$), and SES indices determined by various government bodies using country-specific methodologies ($n = 7$).

Most of studies were in high quality of assessment ($n = 44$) and few studies were in moderate quality of assessment ($n = 4$). Three types of outcome measurements were used across the studies: recent dental service use ($n = 31$) within the last 24 months, dental service use throughout the lifetime ($n = 13$) and preventive dental service use ($n = 5$).

Meta analysis
The pooled estimate from the global meta-analysis of 48 studies examining the association between SES and dental service utilization among children and adolescents is shown in Fig. 2. The Odds Ratio (OR) for dental service use was calculated using a random effects model with the DerSimonian-Laird method, considering the standard errors (SE) of the studies. The results indicate that children and adolescents from higher SES backgrounds are 2.10 times more likely to utilize dental services compared to those from lower SES backgrounds (OR = 2.10, 95% CI: 1.32–2.89, $p < 0.001$). This suggests a significant positive association between higher SES and increased dental service utilization in this population. Given the substantial variation in effect sizes with high level of significant heterogeneity (94.80%) across studies, subgroup analysis was conducted to better explain the sources of heterogeneity.

Subgroup analysis
The subgroup analysis in this meta-analysis involves in investigating whether the effects observed in the overall analysis were consistent across different subgroups based on SES indicators, the country context of the study, and the type of dental health utilization.

Association between household income status and dental service utilization among children and adolescents
Twenty-eight cross sectional studies evaluated the relationship between household income status (as a measure of SES) and dental service utilization among children and adolescents. As depicted in Fig. 3, the pooled estimates revealed that children and adolescents from higher household income backgrounds had 1.65 times higher odds of utilizing dental service compared to those from lower household income backgrounds (OR = 1.65, 95% CI: 1.37–1.94, $p < 0.001$). This indicates a 65% higher likelihood of dental service utilization among the higher household income group.

Moreover, pooled estimates illustrated in Fig. 4 revealed that children and adolescents from middle household income backgrounds had 1.31 times higher odds of utilizing dental service compared to those from lower household income backgrounds (OR = 1.31, 95% CI: 1.12–1.51, $p < 0.001$). This indicates a 31% higher likelihood of dental service utilization among the middle household income group. The I^2 statistics at both analyses were 0% indicating the absence of heterogeneity across studies.

Meta analysis of association between parental educational level and/or parental occupation and dental service utilization among children and adolescents
Eight cross-sectional studies evaluated the relationship between parental educational level and/or parental occupation (as measures of SES) and dental service utilization
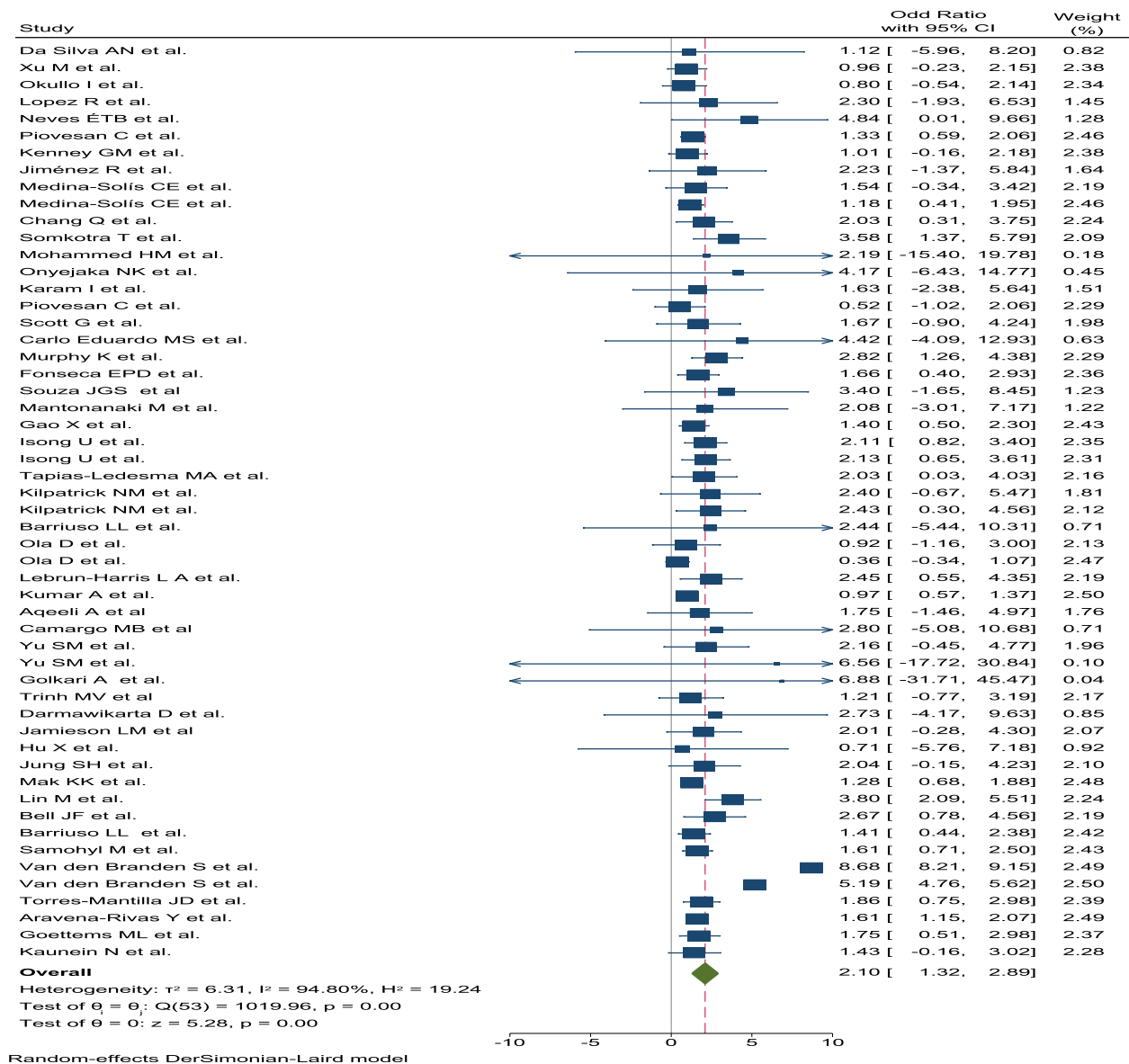
Study		Odd Ratio with 95% CI	Weight (%)
Da Silva AN et al.		1.12 [−5.96, 8.20]	0.82
Xu M et al.		0.96 [−0.23, 2.15]	2.38
Okullo I et al.		0.80 [−0.54, 2.14]	2.34
Lopez R et al.		2.30 [−1.93, 6.53]	1.45
Neves ÉTB et al.		4.84 [0.01, 9.66]	1.28
Piovesan C et al.		1.33 [0.59, 2.06]	2.46
Kenney GM et al.		1.01 [−0.16, 2.18]	2.38
Jiménez R et al.		2.23 [−1.37, 5.84]	1.64
Medina-Solís CE et al.		1.54 [−0.34, 3.42]	2.19
Medina-Solís CE et al.		1.18 [0.41, 1.95]	2.46
Chang Q et al.		2.03 [0.31, 3.75]	2.24
Somkotra T et al.		3.58 [1.37, 5.79]	2.09
Mohammed HM et al.		2.19 [−15.40, 19.78]	0.18
Onyejaka NK et al.		4.17 [−6.43, 14.77]	0.45
Karam I et al.		1.63 [−2.38, 5.64]	1.51
Piovesan C et al.		0.52 [−1.02, 2.06]	2.29
Scott G et al.		1.67 [−0.90, 4.24]	1.98
Carlo Eduardo MS et al.		4.42 [−4.09, 12.93]	0.63
Murphy K et al.		2.82 [1.26, 4.38]	2.29
Fonseca EPD et al.		1.66 [0.40, 2.93]	2.36
Souza JGS et al		3.40 [−1.65, 8.45]	1.23
Mantonanaki M et al.		2.08 [−3.01, 7.17]	1.22
Gao X et al.		1.40 [0.50, 2.30]	2.43
Isong U et al.		2.11 [0.82, 3.40]	2.35
Isong U et al.		2.13 [0.65, 3.61]	2.31
Tapias-Ledesma MA et al.		2.03 [0.03, 4.03]	2.16
Kilpatrick NM et al.		2.40 [−0.67, 5.47]	1.81
Kilpatrick NM et al.		2.43 [0.30, 4.56]	2.12
Barriuso LL et al.		2.44 [−5.44, 10.31]	0.71
Ola D et al.		0.92 [−1.16, 3.00]	2.13
Ola D et al.		0.36 [−0.34, 1.07]	2.47
Lebrun-Harris L A et al.		2.45 [0.55, 4.35]	2.19
Kumar A et al.		0.97 [0.57, 1.37]	2.50
Aqeeli A et al		1.75 [−1.46, 4.97]	1.76
Camargo MB et al		2.80 [−5.08, 10.68]	0.71
Yu SM et al.		2.16 [−0.45, 4.77]	1.96
Yu SM et al.		6.56 [−17.72, 30.84]	0.10
Golkari A et al.		6.88 [−31.71, 45.47]	0.04
Trinh MV et al		1.21 [−0.77, 3.19]	2.17
Darmawikarta D et al.		2.73 [−4.17, 9.63]	0.85
Jamieson LM et al		2.01 [−0.28, 4.30]	2.07
Hu X et al.		0.71 [−5.76, 7.18]	0.92
Jung SH et al.		2.04 [−0.15, 4.23]	2.10
Mak KK et al.		1.28 [0.68, 1.88]	2.48
Lin M et al.		3.80 [2.09, 5.51]	2.24
Bell JF et al.		2.67 [0.78, 4.56]	2.19
Barriuso LL et al.		1.41 [0.44, 2.38]	2.42
Samohyl M et al.		1.61 [0.71, 2.50]	2.43
Van den Branden S et al.		8.68 [8.21, 9.15]	2.49
Van den Branden S et al.		5.19 [4.76, 5.62]	2.50
Torres-Mantilla JD et al.		1.86 [0.75, 2.98]	2.39
Aravena-Rivas Y et al.		1.61 [1.15, 2.07]	2.49
Goettems ML et al.		1.75 [0.51, 2.98]	2.37
Kaunein N et al.		1.43 [−0.16, 3.02]	2.28
Overall		2.10 [1.32, 2.89]	
Heterogeneity: τ^2 = 6.31, I^2 = 94.80%, H^2 = 19.24			
Test of $\theta_i = \theta_j$: Q(53) = 1019.96, p = 0.00			
Test of θ = 0: z = 5.28, p = 0.00			

Random-effects DerSimonian-Laird model

Fig. 2 Forest plot from meta-analysis showing the combined odd ratios for dental service utilization among higher SES compared to lower SES across all included studies (*n* = 48)

among children and adolescents. The estimates of the Fig. 5 showed that children and adolescents whose parents have higher occupational and/or educational levels are 3.3 times more likely to utilize dental services compared to their peers with parents who have lower occupational and/or educational levels (OR = 3.30, 95% CI: 1.12–5.47, *p* < 0.001).

Also as observed in Fig. 6, further revealed that children and adolescents with middle parental occupation and/or educational level had an insignificant association with utilizing dental services compared to those with lower parental occupation and/or educational level (OR = 3.04, 95% CI: 0.79–5.29, *p* > 0.001).

Increasing of OR from lowest to middle to higher SES groups illustrated a clear gradient effect in Table 2. This explains that from low to middle SES: there is an increase in dental service utilization among children and adolescents, showing a positive gradient as SES improves. And from low to high SES also there is an increase in dental service utilization, indicating a stronger positive gradient. This effect shows improvement of dental service utilization progressively with higher SES levels. Also, I^2 statistic remains 0% emphasizing the absence of heterogeneity among results across studies.

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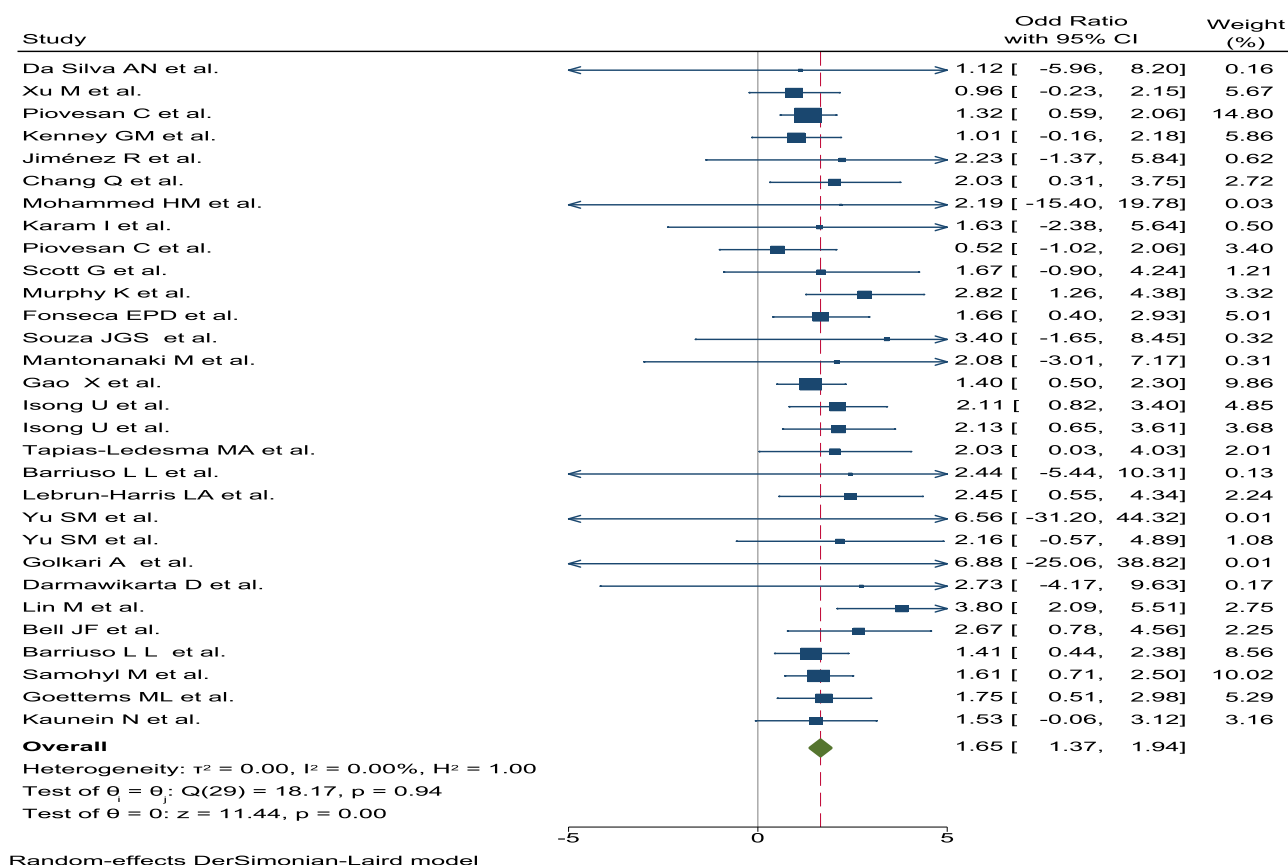
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Fig. 3 Forest plot from meta-analysis showing the combined odd ratios for dental service utilization among higher vs. lower income household income groups, with income as the SES indicator

Meta analysis of association between household assets and dental service utilization among children and adolescents

Four cross sectional studies evaluated the relationship between household assets (as a measure of SES) and dental service utilization among children and adolescents. Figure 7 conveyed that children and adolescents from households with higher asset were 1.47 times more likely to use dental services compared to those from less affluent households (OR = 1.47, 95% CI: 1.15–1.78, $p < 0.001$). This suggests that children and adolescents in higher asset households were 47% more likely to access dental care than their peers in lower asset households. The I^2 statistics was 0%, signifying that there was no observable heterogeneity across the studies.

Meta analysis of association between SES index and dental service utilization among children and adolescents

Seven cross-sectional studies evaluated the relationship between the SES index (as a measure of SES) and dental service utilization among children and adolescents. Pooled estimates in Fig. 8 indicated that there was no statistically significant association between SES index and dental service utilization in this population.

Meta analysis of association between annual household consumption expenditure and dental service utilization among children and adolescents

Three cross sectional studies evaluated the relationship between annual household consumption eexpenditure (as a measure of SES) and dental service utilization among children and adolescents. As presented in Fig. 9, the estimates indicated that there is no statistically significant link between annual household consumption expenditure and the utilization of dental services among children and adolescents.

Table 3 presents the results of the extended subgroup analysis based on different study characteristics. The studies were categorized according to the World Bank's classification of countries by income level (i.e. high income, upper-middle income, lower-middle income). The results highlight a significant association between SES and dental service utilization in higher income countries (OR: 2.57; 95% CI:1.24–3.90) and upper middle-income countries (OR:1.52; 95% CI:1.26–1.78). However, no significant association was found between SES and dental service utilization among children and adolescents in lower-middle-income countries.
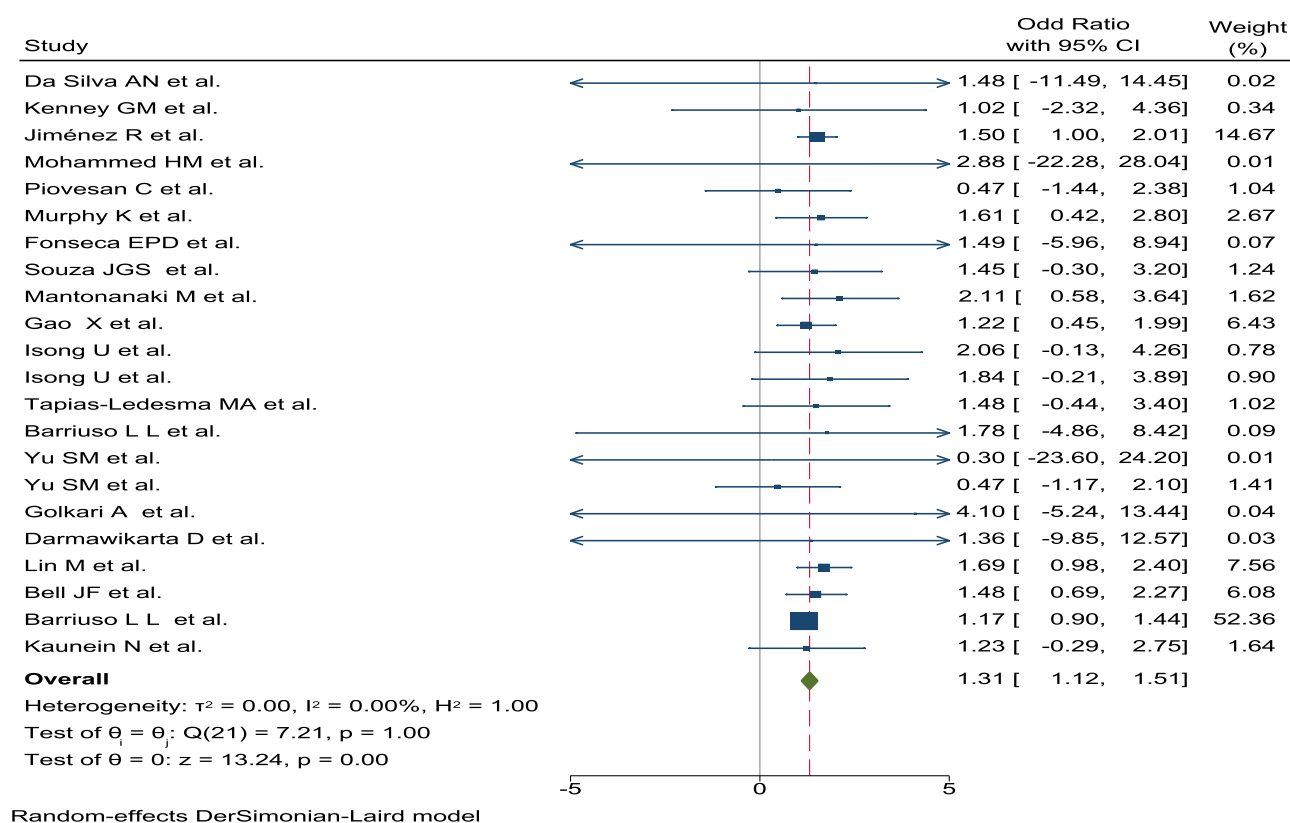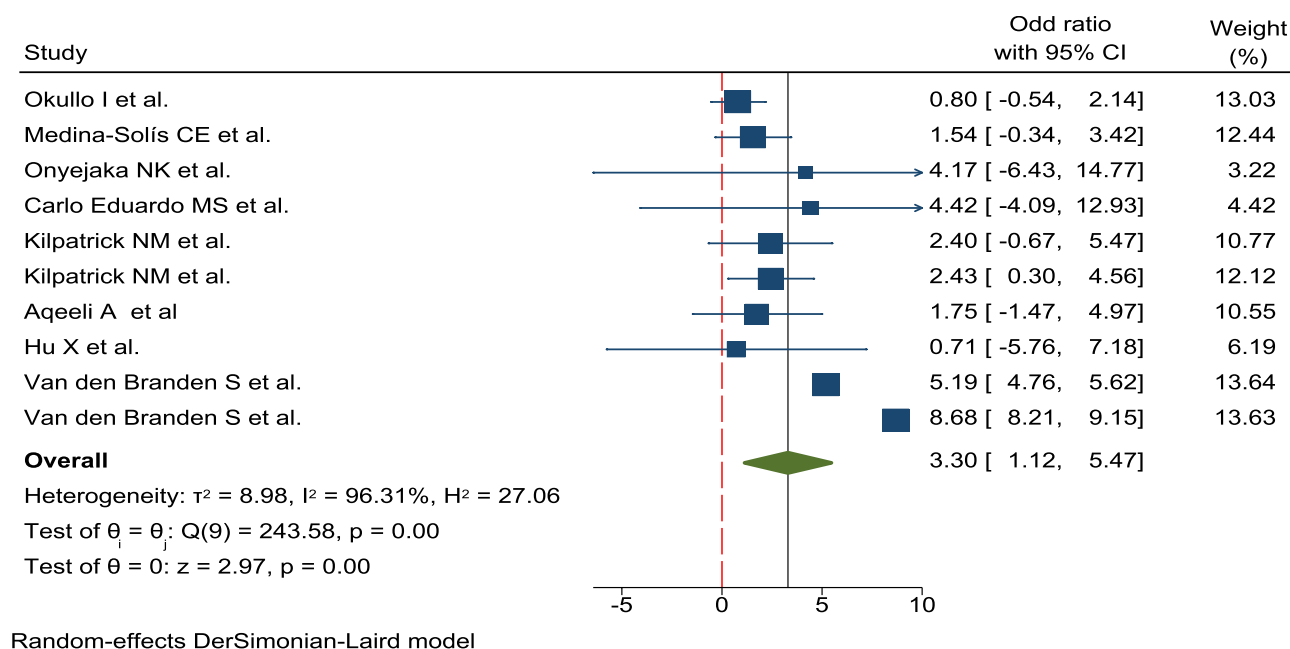
Study	Odd Ratio with 95% CI	Weight (%)
Da Silva AN et al.	1.48 [-11.49, 14.45]	0.02
Kenney GM et al.	1.02 [-2.32, 4.36]	0.34
Jiménez R et al.	1.50 [1.00, 2.01]	14.67
Mohammed HM et al.	2.88 [-22.28, 28.04]	0.01
Piovesan C et al.	0.47 [-1.44, 2.38]	1.04
Murphy K et al.	1.61 [0.42, 2.80]	2.67
Fonseca EPD et al.	1.49 [-5.96, 8.94]	0.07
Souza JGS et al.	1.45 [-0.30, 3.20]	1.24
Mantonanaki M et al.	2.11 [0.58, 3.64]	1.62
Gao X et al.	1.22 [0.45, 1.99]	6.43
Isong U et al.	2.06 [-0.13, 4.26]	0.78
Isong U et al.	1.84 [-0.21, 3.89]	0.90
Tapias-Ledesma MA et al.	1.48 [-0.44, 3.40]	1.02
Barriuso L L et al.	1.78 [-4.86, 8.42]	0.09
Yu SM et al.	0.30 [-23.60, 24.20]	0.01
Yu SM et al.	0.47 [-1.17, 2.10]	1.41
Golkari A et al.	4.10 [-5.24, 13.44]	0.04
Darmawikarta D et al.	1.36 [-9.85, 12.57]	0.03
Lin M et al.	1.69 [0.98, 2.40]	7.56
Bell JF et al.	1.48 [0.69, 2.27]	6.08
Barriuso L L et al.	1.17 [0.90, 1.44]	52.36
Kaunein N et al.	1.23 [-0.29, 2.75]	1.64
Overall	1.31 [1.12, 1.51]	

Heterogeneity: $\tau^2 = 0.00$, $I^2 = 0.00\%$, $H^2 = 1.00$
Test of $\theta_i = \theta_j$: Q(21) = 7.21, p = 1.00
Test of $\theta = 0$: z = 13.24, p = 0.00

Random-effects DerSimonian-Laird model

Fig. 4 Forest plot showing pooled odd ratios for dental service utilization among middle vs. lower-income household income groups, using income as the SES indicator

Study	Odd ratio with 95% CI	Weight (%)
Okullo I et al.	0.80 [-0.54, 2.14]	13.03
Medina-Solís CE et al.	1.54 [-0.34, 3.42]	12.44
Onyejaka NK et al.	4.17 [-6.43, 14.77]	3.22
Carlo Eduardo MS et al.	4.42 [-4.09, 12.93]	4.42
Kilpatrick NM et al.	2.40 [-0.67, 5.47]	10.77
Kilpatrick NM et al.	2.43 [0.30, 4.56]	12.12
Aqeeli A et al	1.75 [-1.47, 4.97]	10.55
Hu X et al.	0.71 [-5.76, 7.18]	6.19
Van den Branden S et al.	5.19 [4.76, 5.62]	13.64
Van den Branden S et al.	8.68 [8.21, 9.15]	13.63
Overall	3.30 [1.12, 5.47]	

Heterogeneity: $\tau^2 = 8.98$, $I^2 = 96.31\%$, $H^2 = 27.06$
Test of $\theta_i = \theta_j$: Q(9) = 243.58, p = 0.00
Test of $\theta = 0$: z = 2.97, p = 0.00

Random-effects DerSimonian-Laird model

Fig. 5 Forest plot showing pooled odd ratios for dental service use among children with higher vs. lower parental occupation and/or education as SES indicators
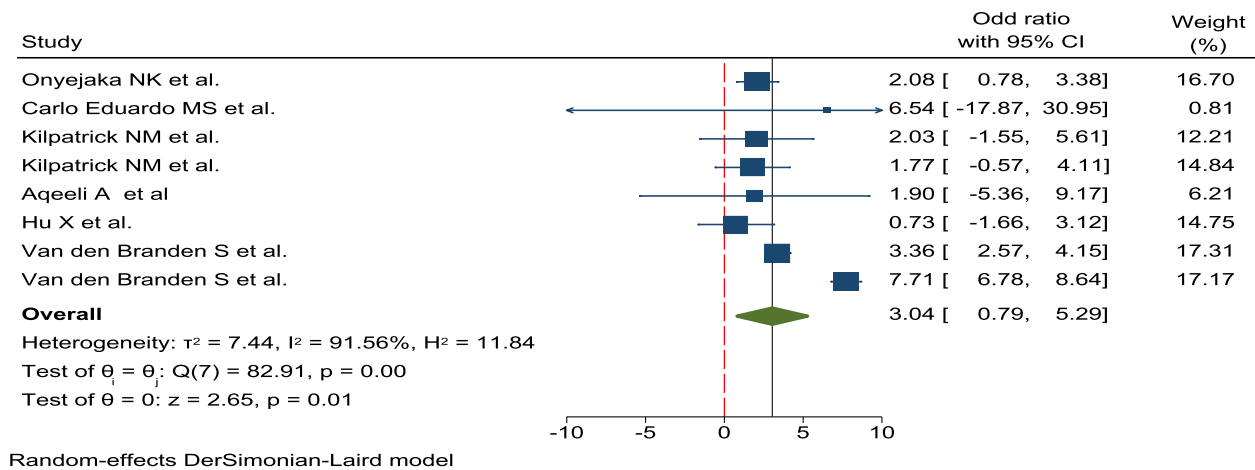
Fig. 6 Forest plot showing pooled odd ratios for dental service use among children with middle vs. lower parental occupation and/or education, as SES indicator
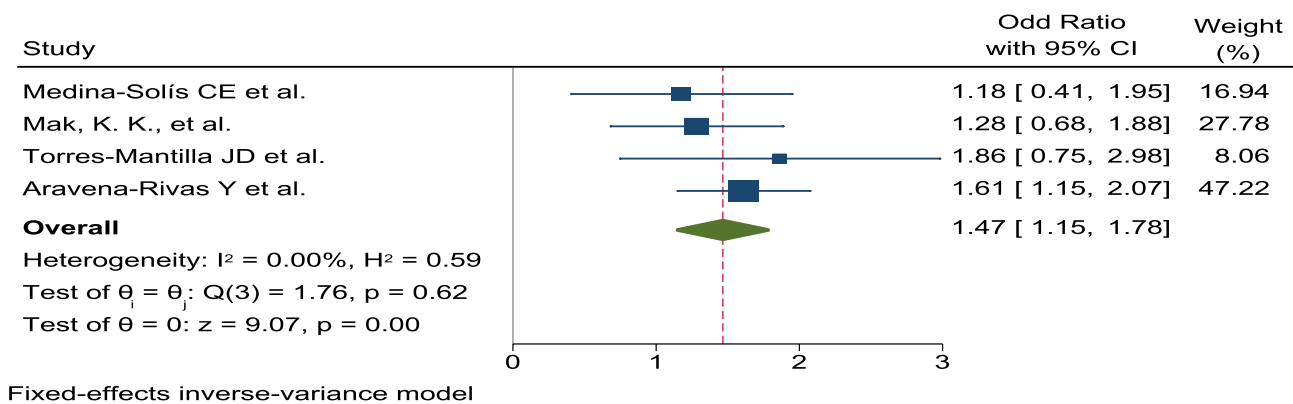

Fig. 7 Forest plot from meta-analysis showing pooled odd ratios for dental service use among children with higher vs. lower household assets, used as the SES indicator
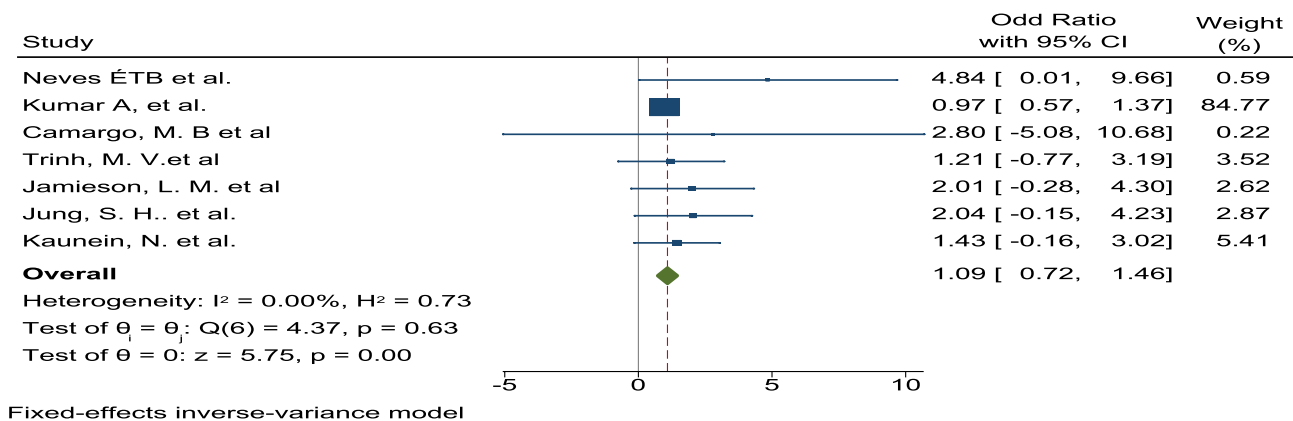

Fig. 8 Forest plot showing the combined odd ratios for dental service utilization among children with higher vs. lower SES index, used as the SES indicator

In addition, studies were grouped according to type of dental insurance system in that respective country (i.e. universal dental health insurance, mean tested public dental health insurance, mixed dental health insurance system provided by both public and private sectors, predominantly by private dental health insurance). The results highlight a significant association between SES and dental service utilization in countries with universal dental health insurance (OR: 1.73; 95% CI:1.19–2.26), mean tested public dental health insurance (OR:1.70; 95% CI:1.40–2.00) and mixed dental health insurance system provided by both public and private sectors (OR:1.47;
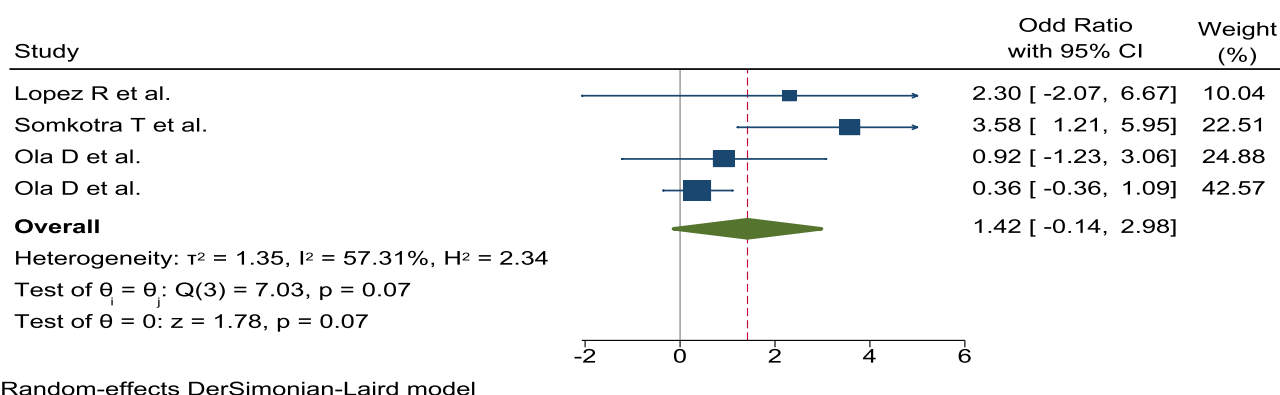
Fig. 9 Forest plot showing pooled odd ratios for dental service utilization among children with higher vs. lower annual household consumption expenditure, used as the indicator of SES

Table 3 Meta - Analysis according to the different subgroup characteristics

	Number of Studies	Random effect [a]OR 95% [b]CI	[c]I²	P-Value
All Studies	48			
Based on economic classification of the country of study				
High income countries	25	2.57 (1.24- 3.90)	0.00%	0.000
Upper middle income	20	1.52 (1.26-1.78)	0.00%	0.000
Lower middle income	9	0.85 (0.52-1.18)	0.00%	0.900
Type of dental insurance system				
Universal dental health insurance	16	1.73 (1.19 - 2.26)	0.00%	0.000
Mean tested public dental health insurance	17	1.70 (1.40 - 2.00)	0.00%	0.000
Mixed dental health insurance	14	1.47 (1.09 - 1.85)	0.00%	0.000
Predominantly private dental health insurance	7	0.83 (0.50 - 1.16)	0.00%	0.720
Based on type of outcome measure used to estimate dental service utilization				
Dental service use (12 months before)	36	2.21 (1.18-3.23)	0.00%	0.000
Dental service use (Lifetime)	13	0.99 (0.56-1.42)	0.00%	0.620
Preventive dental service use	5	2.01 (1.19-2.84)	48.64%	0.000

[a]OR, Odd Ratio of the association between SES and dental service utilization of children and adolescents

[b]CI – Confidence Interval

[c]I² Statistics

[d]The total number of studies is more than 51 because of inclusion of more than one indicator per study

95% CI:1.09−1.85). However, no significant association was found between SES and dental service utilization among children and adolescents in countries with predominantly private dental health insurance system.

Moreover, studies were grouped according to the outcome measure of dental service use. A significant association was found between SES and dental service utilization for both recent dental service utilization (OR: 2.21; 95% CI: 1.18–3.23) and preventive dental service utilization (OR: 2.01; 95% CI: 1.19–2.84). Of the two outcomes, recent dental service utilization demonstrated a particularly strong and significant association with SES.

Meta-regression

This study used the meta- regression to investigate the relationship between study covariates including economic level of country of study, study population

Table 4 Meta-regression for the dental service utilization among children and adolescents and covariates

Variables	β - Coefficient	Standard Error	P-value
Economic level of country	0.4599783	0.2432016	0.064
Study Population	0.2845676	0.3966561	0.477
Sample size	0.000016	0.0000108	0.145
Type of OR reported	0.9466112 **	0.4190739	0.028
Type of Socioeconomic indicator	0.2318712	0.1235795	0.067
Constant	0.7282437	0.8936447	0.419

Number of observations = 54, Adj R-squared = 31.68%, Prob > F = 0.0340, tau2 = 1.461, Model F (7,46) = 2.42

(children or adolescents), sample size, type of SES indicator, type of Odd Ratio reported and the effect sizes.

As shown in Table 4, the meta-regression revealed that moderators including economic level of country, study population (children or adolescents), sample size,

type of SES indicator did not significantly influence to the observed heterogeneity at 0.01 significance level. It further highlighted that type of Odd Ratio reported ($\beta = 0.9466112$, p-value < 0.05) was a significant characteristic influencing the observed heterogeneity. Type of OR reported refers to whether the study reported crude odds ratios or adjusted odds ratios, with adjusted ORs accounting for confounding factors. The adjusted R-squared value of 31.68% indicates that 31.68% of the heterogeneity in the studies can be explained by differences in type of OR reported while 68.32%, remains unexplained, suggesting that other factors not included in the model may contribute to the variability in the results.

Publication bias

We conducted Egger's test and funnel plot to assess the presence of publication bias were shown in Fig. 10. Egger's test is a regression-based method that evaluates funnel plot asymmetry. Specifically, this assesses small study effects or publication bias by examining the relationship between effect sizes and their standard errors. The asymmetry in the funnel plot is tested which indicates the overrepresentation of smaller studies with larger effect sizes in the meta-analysis. Stata software is used with the command: "meta bias, egger". The results of Egger's test indicated an intercept of 0.87 (95% CI: 0.456 to 1.284,

$p > 0.05$). Since the p value is greater than 0.05, suggested the absence of publication bias in the studies analysed.

Sensitivity analysis

This study used the sensitivity analysis is to assess the robustness of the overall findings by examining how changes in individual studies impact the results. The results of the sensitivity analysis indicated in Fig. 11 illustrated that no individual studies were influential on the overall findings. That is, the pooled estimate and confidence intervals remained stable when each study was removed one at a time. Moreover, the reported OR in each study were clustered around the pooled OR, while each OR falling within the lower and upper bounds of the confidence intervals. This justifies that all studies appear to contribute similarly to the overall effect, with no extreme outliers or disproportionate influence on the final pooled result. Based on these findings, all studies were retained in the final analysis, as the results were robust and not significantly influenced by any single study.

Discussion

To the best of our knowledge, this is the first meta-analysis examining the association between SES and dental service utilization among children and adolescents.
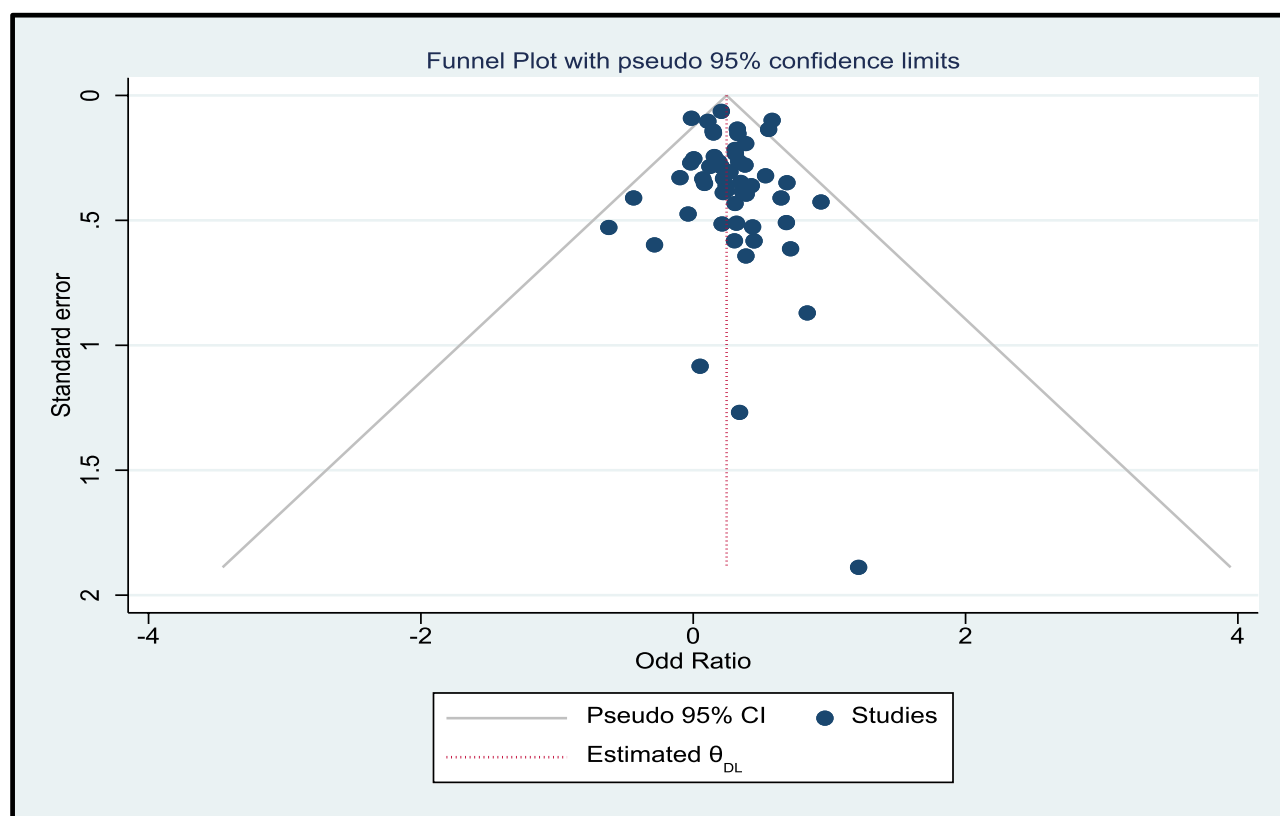

Fig. 10 Funnel Plot with pseudo 95% confidence limits for determining publication bias
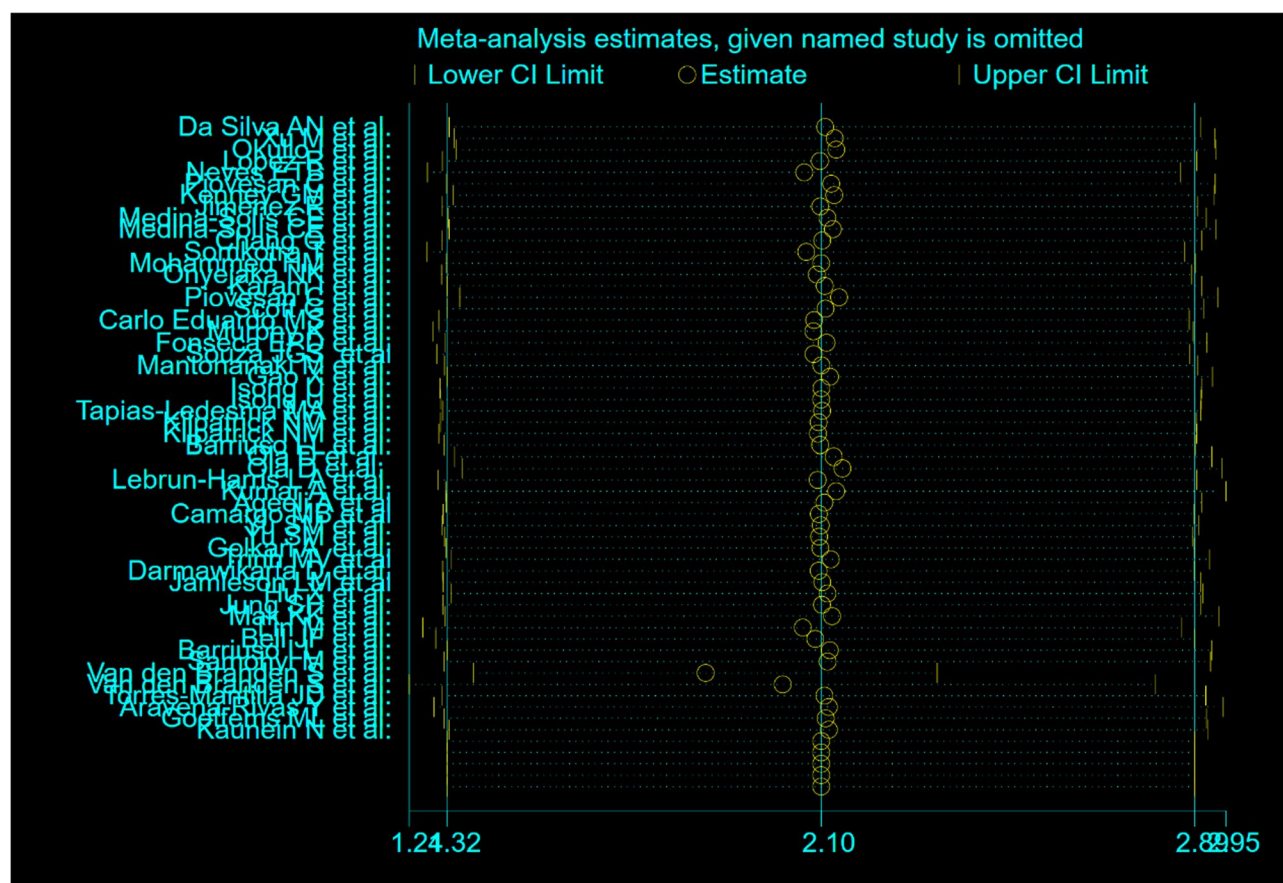
Fig. 11 Sensitivity analysis to check robustness of pooled estimate

The global meta-analysis highlights that children and adolescents from higher SES have higher odds of dental service utilization than their counterparts. The meta-analysis of different subgroups revealed that SES indicator (Income Status, parental educational level and/or parental occupational level and household assets), economic classification of the country (higher income and upper middle-income countries), type of outcome measure (recent dental service use and preventive care) are strongly influenced the association between SES and dental service utilization among children and adolescents.

Our findings align with similar results of previous studies [24–26] suggesting that there is a positive association between dental service utilization of children and adolescents with higher SES. Reinforcing the results, study by Machry RV et al. (2013) highlighted that use of dental services varied according to parental SES while children from low socioeconomic backgrounds used dental services less frequently in Brazil [27]. Similarly study by Nagdev P et al. (2023), highlighted results of their bivariate analysis showing a significant association between SES of parents and children dental service utilization [28].

Theoretical frameworks such as Bourdieu's sociological theory, materialistic theory, Social Capital Theory, Health Capital Model provide valuable insights into the underlying reasons for these SES-related disparities in healthcare. According to Bourdieu's sociological theory, children with parents or guardians with higher levels of economic status and social capital would have better perceptions of use of dental service [29]. In addition, the Health Capital model suggests that individuals consider their health as a form of capital that they can invest in overtime to improve their quality of life and future well-being. Thus, members of higher SES are more likely to invest in their children's dental health by seeking regular checkups and preventive care as they have financial means to do so. But low SES families, on the other hand, may not have the resources to make these investments and may only seek dental service when problems arise [30, 31]. Similarly, materialistic theory states that health inequalities are largely the result of differences in material living conditions, such as income, education, employment, and access to healthcare.

In our analysis household income and parental educational level or/and parental occupation as the most used measure of SES. In addition, SES indicators including

household assets, standardized SES index has been used by some studies. Income is considered as a good proxy for reflecting the SES which is used to estimate the financial capacity of household to spend on healthcare use (including dental service). In addition, this strongly highlights the inequalities in access to material circumstances, resulting in health care use inequalities [32, 33]. Similarly, the education and occupation status of the parents and household assets also reflects the SES of a household. This mostly determines the access to a higher income, comfortable housing conditions, schooling for children and access to quality healthcare facilities (including dental services). This also reflects non-economic social characteristics, such as prestige, access to information, influence over others and coping [34].

However, in line with these theories, our study found that household income, education and occupation status of the parents and household assets as predictors of dental service utilization of children and adolescents. Families with higher income levels have better access to dental services for their children because they can afford to visit dentists regularly and are more likely to prioritize preventive care. This finding is similar to previous research [32–34] which emphasized SES as a multidimensional construct that shapes the use of dental service.

According to the World Bank classification of countries based on Per Capital Gross National Income includes mainly four categories: high, upper middle, upper lower and low-income countries. Our findings suggest that high and upper middle-income countries showed a significant association between SES and dental service utilization among children and adolescents irrespective of SES indicators. In supporting our findings, a study by Petersen et al. (2005) highlighted that countries with better economy possess better healthcare systems with quality resources have shown a pronounced disparities in dental service utilization due to SES as higher-income families had greater access to regular dental services [23]. But findings further suggest an insignificant association between SES and dental service utilization among children and adolescents irrespective of SES indicator in low-income countries. This may be due to limited healthcare resources and poor healthcare system in low-income countries to exhibit insignificant SES-related dental service utilization patterns.

Moreover, World Health Organization (WHO) has reported that lower middle-income countries possess limited dental health infrastructure facilities with fewer dental professionals, fewer public health programs, and less investment in preventive services [35, 36]. Consequently, the role of SES in influencing the dental service of children and adolescents might not be significant due to overall lack of dental service services. On the other hand, another possible reason for not showing a significant association between SES and dental service use in lower middle-income countries might be inclusion of a smaller number of studies for our analysis which possibly reduce the statistical power.

Subgroup analysis further identified a significant association between SES and dental service utilization in countries with universal dental health insurance, means-tested public dental health insurance, and mixed systems provided by both public and private sectors. This may be due to the non-financial barriers that lower SES households have to face even dental care services are offered free of charge, lower-SES households that hinder getting the service. Several studies have shown that in countries like Mexico, despite the provision of universal dental care services for children, disparities in dental service use persist between high and low SES households. This suggests that inequalities in dentalcare utilization cannot be eliminated solely through universal or free insurance coverage. Other influential factors, including inadequate fluoride concentration in water supplies, poor oral hygiene behaviors such as infrequent tooth brushing, limited parental awareness, transport difficulties, geographic disparities in the availability of services, and dental anxiety or fear of treatment [37, 38]. However, no significant association was found between SES and dental service utilization among children and adolescents in countries with predominantly private dental health insurance systems. This finding reflects the restricted affordability of the private dental care services largely to the high SES households. Consequently, children from lower SES might exclude from receiving care under private dental health insurance system, leading for a limited variability in service utilization across SES groups.

Furthermore, we further identified a significant association between SES and recent dental service use and preventive dental service use but no significant association with dental service use (during lifetime). This could be higher SES parents are more likely to visit dentist during past year for regular checkup or preventive care of their children. But lower SES parents, on other hand, might not visit dentist due to their financial constraints, poor dental health knowledge that prevent their children seeking dental service regularly [12, 39–41].

The meta-regression analysis in this study highlighted factors including the economic level of the country, study population (children or adolescents), sample size, and the type of SES indicator used in the studies were not significantly associated with the observed heterogeneity in the pooled odds ratios. This suggest that these are not crucial sources for the observed heterogeneity. However, type of OR reported was identified as a significant moderator influencing the heterogeneity in the effect sizes. This emphasis that studies reporting the adjusted OR had different results compared with crude OR, suggesting that

controlling for confounders has effect on the reported effect size of each study.

Limitations

This study has some limitations that should be acknowledged. Firstly, this study has considered solely the association of SES on dental service utilization of children and adolescents. However, numerous other demographic, geographic and economic factors can also significantly influence dental service utilization outcomes. Future systematic reviews and meta-analyses should encompass a broader range of influential factors to provide a more comprehensive understanding of this issue. Second, most of the included studies were cross-sectional in design, which hinders causal inferences. Future research should aim to include longitudinal studies to better establish causal links between SES and dental service utilization outcomes. Thirdly, different studies have employed different type of study design, including the adjustments made for various confounders. These factors have influenced the findings and contributed to heterogeneity. However, by conducting a meta regression analysis, we were able to better understand the impact of these variables. But future studies should focus on additional potential moderators and conduct sensitivity analyses to better understand the other sources of this unexplained variability. Finally, future studies can add middle income groups in addition to poorest and richest income groups to increase the accuracy and depth of analysis.

Strengths

Besides the few limitations of this study, there are strengths of this study. Firstly, this study used three main electronic databases with no restriction on language and most of the selected studies are of high quality to ensure the validity of our findings. Secondly, this study employed different measurements for multiple dimensions of SES in the subgroup analysis by standardizing the measurements. Finally, this research encompasses a global sample of 625,338 children and adolescents from 25 countries.

Conclusion

In conclusion, our study demonstrated that children and adolescents from higher SES were more likely to utilize dental services than those with lower SES. The subgroup analysis revealed that SES indicators (household income status, parental occupation and/or educational level, household assets), economic classification of the country (higher income, upper-middle) and type of outcome measure (recent dental service use and preventive dental service use) significantly influenced dental service utilization of children and adolescents. Meta-regression analysis found that the type of Odd Ratio reported has significantly influenced the observed heterogeneity.

Identifying the most vulnerable groups is critical for informing public health policies, as this evidence can guide the design of targeted interventions and dental health promotion strategies. By highlighting the socioeconomic disparities in dental service utilization among children and adolescents, this study equips policymakers with actionable insights to address barriers to access and ensure equitable oral healthcare. Implementing policies that prioritize preventive care, subsidized dental services, and community-based education programs can mitigate the risk of poor dental health across all socioeconomic strata. These findings underscore the importance of developing universal strategies adaptable to different countries, enabling policymakers to reduce oral health inequities and promote the overall well-being of children and adolescents, regardless of their socioeconomic background.

Author details

[1]School of Business, University of Southern Queensland, Toowoomba, Australia
[2]School of Mathematics, Physics and Computing, University of Southern Queensland, Toowoomba, Australia
[3]Centre for Health Research, University of Southern Queensland, Toowoomba, Australia

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