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SYSTEMATIC REVIEW

Caries status in 12-year-old children, geographical location and socioeconomic conditions across European countries: A systematic review and meta-analysis

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Abstract

Background: Understanding of socioeconomic context might enable more efficient evidence-based preventive strategies in oral health.

Aim: The study assessed the caries-related socioeconomic macro-factors in 12-year-olds across European countries.

Design: This systematic review involved epidemiological surveys on the caries status of 12-year-olds from 2011 to 2022. DMFT was analyzed in relation to gross national income (GNI), United Nations Statistical Division geographical categorization of European countries (M49), unemployment rate, Human Development

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Index (HDI), and per capita expenditure on dental health care. A meta-analysis was performed for countries reporting data on DMFT, stratified by GNI, and geographical location of European countries, using a random-effects model.

Results: The study involved 493 360 children from 36 countries in the geographic region of Europe. The analysis confirmed a strong negative correlation between income and caries experience ($p < .01$). Children living in higher-income countries showed 90% lower odds of poor oral health than in middle-income countries. Children living in West Europe showed 90% lower odds of poor oral health than children living in East Europe.

Conclusion: The strong effect of macro-level socioeconomic contexts on children's oral health suggests favoring upstream preventive oral health strategies in countries with economic growth difficulties, Eastern and Southern parts of Europe.

KEYWORDS

caries epidemiology, children, Europe, healthcare systems, socioeconomic indicators

1 | INTRODUCTION

Dental caries as noncommunicable disease (NCD) shares with other NCDs' modifiable risk factors such as high sugar intake and poor health behavior; its prevalence is strongly influenced by socioeconomic contexts.[1] These determinants strongly influence stark oral health inequalities between and within countries, creating resource unavailability, patient vulnerability and poor accessibility to health care in underprivileged social groups.[2] According to the conceptual theoretical framework proposed by the World Health Organization (WHO) Commission on social determinants of health, the macro-level context influencing health outcomes involves several items as follows: (1) governance, (2) macroeconomic policies, (3) social policies, (4) public policies, (5) cultural and societal values, and (6) epidemiological circumstances.[3]

Social determinants at the micro-level (individual interaction) and meso-level (community interaction) have been identified as strong risk factors contributing to poor oral health.[4] Until now, strategies affecting micro-level modifiable factors were not sufficient to improve oral health and reduce inequities unless accompanied by upstream policies influencing macro-level factors. Evidence of macro-level or country-level social determinants on oral health in paediatric populations is still scarce.[5–8] Understanding these determinants and their mechanisms of correlation might support the application of efficient and effective upstream oral health policies and prevention strategies.[9] A better understanding of the socioeconomic context of oral health might allow to support population-based preventive strategies and address unmet oral healthcare needs with adequately targeted interventions tailored according to the population needs and the characteristics of the local healthcare system.

Recent evidence reported the higher overall prevalence of oral disease in South European countries such as Croatia (60.6%) and Slovenia (58.6%), comparing with northern European countries (≈44%).[10] Although caries prevalence trends declined in developed European countries, during the last couple of decades, stark inequalities are observed putting at-risk population in less developed countries in southern and eastern parts of Europe, and also socially and economically deprived population groups in

Why this paper is important for paediatric dentists

- This systematic review and meta-analysis of studies from European countries show caries experience ranging from 0.30 in Denmark to 6.88 in North Macedonia.
- Caries experience was statistically associated with socioeconomic indicators such as type of geographical location, GNI, and employment rate, with a suggestion of responsible structural or methodological components.
- Of 44 European countries, caries data in 12-year-old children were retrieved for 36 countries and this might be a bias influencing the result of this review.

developed countries. Moreover, persons who are socially and economically disadvantaged have poor oral health accessibility and outcomes, since they tend to seeking urgent, not preventive dental treatment, which contributes to the already existed inequalities.

Previous categorization of healthcare systems according to models, such as Bismarck, Beveridge, Semashko, and Mediterranean, could not be applicable nowadays since each country's healthcare system and it is financing significantly vary according to local circumstances in order to apply a unique approach that ensures health services and financial protection in a local setting. Healthcare system categorization is very difficult, and there are still efforts to categorize, and assess similarities, differences, and performance assessment internationally. Moreover, this debate is still ongoing in scientific areas of health services, health economy, political sciences, epidemiology, and sociological realms. When analyzing dental care in European children, paediatric population usually has a broader coverage and more benefits than adults, but there is a variety regarding co-payments, and the services covered.[11] More research and understanding are needed in the area of international comparison of healthcare delivery, access, and coverage, in order to design targeted and efficient interventions to improve health and reduce unmet needs and oral health inequalities.

This study was planned to assess and evaluate the fluctuation of the caries prevalence in 12-year-olds in the European region and to assess the influence of socioeconomic contexts of each country, that is, gross national income (GNI), United Nations Statistical Division geographical categorization of European countries, unemployment rate, Human Development Index (HDI), and per capita expenditure on dental health care on the prevalence of caries in 12-year-olds.

2 | MATERIALS AND METHODS

2.1 | Study design and search strategy and data source

The present survey was designed as a systematic review. The search involved the PubMed, Scopus, Embase, and Google Scholar databases. The search was performed in June 2023 using keywords "dental," "caries," "permanent teeth," "12-years-old," and "Europe." The reporting of this review followed the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) guideline (the PRISMA checklist is reported in the supplementary file, Table S1). The review protocol was registered (ID: 349408) in the International Prospective Register of Systematic Reviews (PROSPERO) system (https://eur03.safelinks.protection.outlook.com/?url=https%3A%2F%2Fwww.crd.york.ac.uk%2Fprospero%2Fdisplay_record.php%3FRecordID%3D349408&data=05%7C01%7Cguglielmo.campus%40unibe.ch%7Cde6f54c55ca44ce553f508dbdb6e24f7%7Cd400387a212f43eaac7f77aa12d7977e%7C1%7C0%7C638345038345429484%7CUnknown%7CTWFpbGZsb3d8eyJWIjoiMC4wLjAwMDAiLCJQIjoiV2luMzIiLCJBTiI6Ik1haWwiLCJXVCI6Mn0%3D%7C3000%7C%7C%7C&sdata=iroGwzmCU5VifWBD84uKY7ARrLbeSDnka%2F%2Bh5zNxIr8%3D&reserved=0).

Finally, data collected from scientific reports after searching the scientific databases and retrieving publications were from 36 countries of the European region (Table 1).

2.2 | Eligibility criteria

The inclusion criteria concerned observational epidemiological studies, cross-sectional surveys, and dataset public health documents (national statistical oral health registers) dated within the period from 2011 to 2022 involving subjects aged 12 years old (Figure 1). Missing data were supplemented by contacting the corresponding authors. Moreover, the data were supplemented with the data obtained from master and/or doctoral theses and public health documents written in native national languages by contacting the corresponding authors. Publications from countries within the geographic region of Europe according to the United Nations Statistical Division were involved in this survey.[12]

The age of 12 represents an age group indicator in international epidemiological comparisons; as in most countries, these children are the oldest group attending primary schools having a full permanent dentition. Therefore, this age group is convenient for sampling and preventive public health intervention through school systems.

The exclusion criteria involved papers that were not possible to retrieve, surveys that involved sample subjects with special care needs, from regions outside of geographical region of Europe, before 2011, unfit age groups, and if results did not present caries experience as DMFT or when it was not possible to calculate D_3MFT. Data below D_3MFT scores were not used for the purposes of this survey.

2.3 | Outcome Variables

All data of the participants were extracted by two authors (AV and KAS) from the literature search and, if needed, standardized for comparative purposes. The data sources used for obtaining information on oral health outcomes

TABLE 1 Description of the different countries included, by socioeconomic indicators and healthcare systems. Countries are listed in alphabetical order.

Country	Income category[a]	United Nations Statistical Division geographical categorization of European countries (M49)	Unemployment[b]	Human Development Index[c]
Austria[13]	Very high	Western Europe	Medium	Very high
Albania[28]	Middle	Southern Europe	High	High
Belarus[29]	Middle	Eastern Europe	High	Very high
Belgium[13]	Very high	Western Europe	Medium	Very high
Bosnia and Herzegovina[30]	Middle	Southern Europe	High	High
Bulgaria[31]	Middle	Eastern Europe	Medium	Very high
Croatia[32]	Middle	Southern Europe	Medium	Very high
Cyprus[33]	Very high	Southern Europe	Medium	Very high
Denmark[13]	Very high	Northern Europe	Medium	Very high
Estonia[13]	High	Northern Europe	Medium	Very high
Finland[13]	Very high	Northern Europe	Medium	Very high
France[13]	Very high	Western Europe	High	Very high
Georgia[34]	Middle	Eastern Europe	High	Very high
Germany[35–37]	Very high	Western Europe	Low	Very high
Greece[38,39]	High	Southern Europe	High	Very high
Greenland[40]	Very high	Northern Europe	Low	Very high
Hungary[41]	Middle	Eastern Europe	Low	High
Italy[42]	Very high	Southern Europe	Medium	Very high
Kosovo[43]	Middle	Southern Europe	High	High
Latvia[44,45]	High	Northern Europe	Medium	Very high
Lithuania[46]	High	Northern Europe	Medium	Very high
Moldova[47]	Middle	Eastern Europe	Low	High
North Macedonia[48,49]	Middle	Southern Europe	High	High
Norway[50,51]	Very high	Northern Europe	Low	Very high
Poland[52–54]	High	Eastern Europe	Low	Very high
Portugal[55]	High	Southern Europe	Medium	Very high
Romania[23,26,27]	Middle	Eastern Europe	Medium	Very high
Russian Federeation[56–59]	Middle	Eastern Europe	Low	Very high
Serbia[60]	Middle	Southern Europe	Low	Very high
Slovakia[61,62]	High	Eastern Europe	Medium	Very high
Slovenia[63]	Very high	Southern Europe	Medium	Very high
Spain[64–66]	Very high	Southern Europe	High	Very high
Sweden[24,25]	Very high	Northern Europe	Medium	Very high
Switzerland[21,67]	Very high	Western Europe	Low	Very high
United Kingdom[68–71]	Very high	Northern Europe	Low	Very high
Ukraine[72]	Middle	Eastern Europe	Medium	High

[a]Low-middle and low-income countries with a GNI of $15 000 or less; the upper middle-income countries with a GNI between $15 001 and $25 000; high-income countries with a GNI of more than $25 000.

[b]Low: countries with low unemployment rate of ≤5%; medium: countries with medium unemployment rate of more than 5% but ≤10%; high: countries with high unemployment rate of >10%.

[c]High human development with HDI between 0.700 and 0.799; very high human development with a HDI of 0.800 or greater.

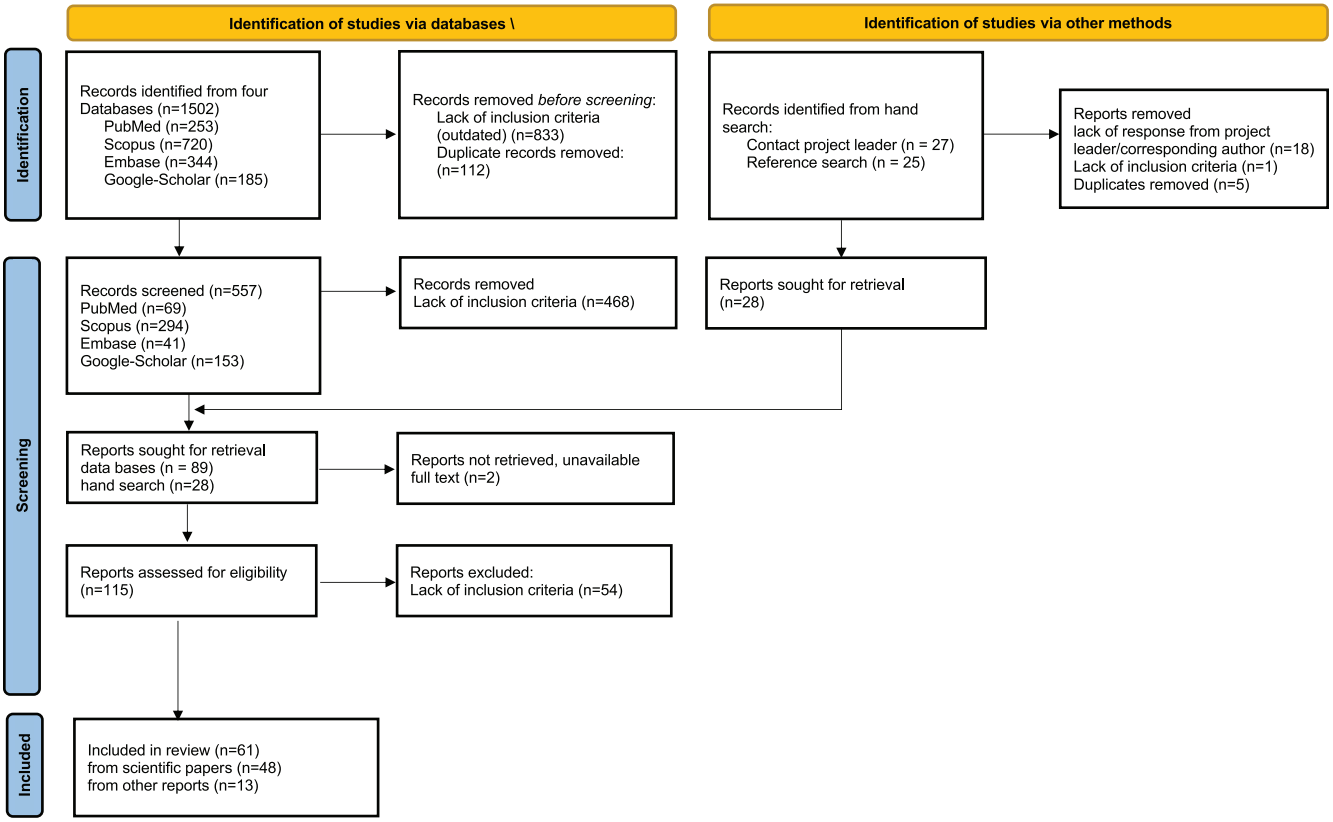

FIGURE 1 Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) flowchart of the review process.

included scientific databases (PubMed, Scopus, Embase, and Google Scholar) and hand search using references and the Malmo University Database.[13] The first database was designed in Excel Microsoft Office®. The DMFT was categorized as low experience with a DMFT ≤1, as medium-high experience with a DMFT >1 but ≤2, as high experience with a DMFT >2 but ≤3, and as very high experience with a DMFT >3 by the authors, partially following the WHO handbook. After completion of data extraction, one author (KAS) randomly selected 10% of the papers and checked each data entry fields (especially data used for the metanalyses) to assess whether data extraction was carried out correctly.

2.4 | Independent variables

The following socioeconomic indicators were added: GNI, United Nations Statistical Division geographical categorization of European countries (M49), unemployment rate, HDI, and per capita expenditure on dental health care.

The data on GNI were obtained via the World Bank Open Data sets, and there were no low-income countries in the sample of this study (according to the World Bank, GNI is $1135 or less).[14] Also, only three countries involved in the present survey could be categorized as lower middle income (according to the World Bank, GNI is between $1136 and $4465). More than half of all countries ($n=18$) that were included in this survey could be categorized as high income (according to the World Bank, GNI is more than $13 846) ranging from Romania (GNI=$14 160) to Switzerland (GNI=$87 720). With this in mind and the distribution of GNI across European countries, the authors decided to modify World Bank categorization and apply it to the present survey using the following three income categories according to GNI: (1) middle income with a GNI of $15 000 or less; (2) high income with a GNI between $15 001 and $25 000; and (3) very high income with a GNI of more than $25 000 (Table 1). The mean number of decayed, missing, and filled teeth and the DMFT indices of the countries were then stratified according to the GNI category.

The countries were grouped according to the United Nations Statistical Division geographical categorization of European countries as follows: Eastern Europe, Northern Europe, Southern Europe and Western Europe (presented in Table 1).[12]

Data on the unemployment rate were obtained via World Bank Open Data and having in mind mean value and ranges of unemployment rate in the region of Europe the authors decided to categorize unemployment rate into following categories: countries with low unemployment rate of ≤5%; countries with medium unemployment rate of more than 5% but ≤10%; and countries with high unemployment rate of >10%.[15]

Although HDI involves four categories (low, medium, high, and very high), all subjects in this study comprised only two HDI categories: high human development with HDI between 0.700 and 0.799, and very high human development with a HDI of 0.800 or higher. These data were obtained via online available resources.[16]

Data on country per capita expenditure on dental health care (USD) were obtained through Organization for Economic Co-operation and Development (OECD) e-library.[17]

Quality assessment was performed using the customized quality assessment tool developed by The National Heart, Lung and Blood Institute for Observational Cohort and Cross-sectional studies, case–control studies, and controlled intervention studies (https://www.nhlbi.nih.gov/health-topics/study-quality-assessment-tools). The quality of the papers was recorded according to the following scores: 11–14: good quality, 7–10: fair quality, and 0–6: poor quality.

2.5 | Statistical methods

One-way analysis of variance was run to evaluate whether the difference in caries experience stratified by geographical categorization, and socioeconomic indicators was statistically significant. Furthermore, the distribution of DMFT indices was compared with the previously described GNI classes. Fisher's exact test Yates Continuity Correction was performed to verify whether there is a statistically significant association between DMFT categories and the GNI.

Moreover, an ordinal logistic regression analysis of DMFT categories according to socioeconomic indicators and geographical country location was performed.

Lastly, a meta-analysis was performed for countries that reported data on the sample size, mean, and standard deviation of the DMFT. If standard deviation was not reported within the publication, in order to be able to pool the effect in the meta-analysis model it was either calculated from the available data or imputed, and additional sensitivity analysis was performed in that case.[18] The standard deviation was converted to the standard error for the purpose of the meta-analysis. If multiple reports were retrieved from a country, for the purposes of meta-analysis the different reports were weighted, if the data were similar. If a single-center/local/regional study and a nationwide study were retrieved from the same country, only the nationwide study was included. If there were only single-center/local/regional studies available, the recent one was included in the analysis. The meta-analysis of the mean DMFT was stratified by GNI and geographical location of the country, using a random-effects model with 95% confidence interval. Heterogeneity between studies was reported using the I^2 statistic and a 95% prediction interval. To investigate heterogeneity, meta-regression was performed for year of publication. Sensitivity analysis was performed to test the robustness of the results by running the meta-analysis only with data obtained from national surveys and data in which the standard deviation was reported in the included studies. The meta-analyses were performed using *meta* command in StataSE18®.

3 | RESULTS

Total data included 493 360 children from samples of 61 scientific and public health reports in the 36 countries of the European region, ranging from 22 subjects in Belgium to 89 442 subjects in a study sample in United Kingdom.

Of 1502 records identified via four database search, 27 authors were contacted, and finally, 61 reports were analyzed (Figure 1).

The majority of the studies ($n = 32$, 56.15%) were classified as being of fair quality. Seventeen studies (33.33%) and two studies were ranked as being of poor and good quality, respectively (Appendix S1). Lack of sample size justification or power analysis (Question 5 in the quality assessment methods) affected the quality outcome of the papers. The data extraction agreement among examiners was high (93.5%). The quality assessments table is reported in Appendix (Table S2).

The DMFT index showed a statistically significant association ($p < .01$) with the countries' GNI (Table 2). The results revealed a highly statistically significant lower experience of decayed, missing, and/or filled teeth in higher-income countries. A strong statistically significant association between income category and DMFT categories was noted: the lower the income, the higher the caries experience is (Table 2).

Statistically significant differences in DT ($p < .01$) were observed according to the geographical location of the country (Table 3). Overall, the countries of West Europe presented the lowest experience of caries, followed by the countries in North Europe ($p < .01$). The East and South European countries clearly showed the highest experience of caries as shown in Table 3. The same features are observed when comparing the unemployment rate and DMFT ($p < .05$), as well as HDI with DMFT ($p < .01$; Table 3).

A further analysis, using the ordinal logistic regression analysis, assessed the level of impact of socioeconomic determinants on caries experience in different countries. The results confirmed statistically significant differences between caries experience in countries categorized according to GNI of the country, with children living in higher-income countries having 90% lower odds of poor oral health than children living in middle-income countries ($p < .01$; Table 4). Although the strongest association was observed

TABLE 2 DMFT index across European countries stratified by gross national income (GNI) categories[a].

(A) Mean, standard deviation, and range				
Income category (GNI)	**Decayed teeth, mean ± SD (range)**	**Missing teeth, mean ± SD (range)**	**Filled teeth, mean ± SD (range)**	**DMFT, mean ± SD (range)**
Middle income	1.67 ± 0.55 (0.56–2.59)	—	1.00 (1.00–1.00)	3.17 ± 1.05 (1.82–6.88)
High income	1.21 ± 0.84 (0.33–2.10)	0.05 ± 0.04 (0.00–0.09)	1.09 ± 0.80 (0.52–2.00)	2.49 ± 0.99 (1.18–4.45)
Very high income	0.42 ± 0.73 (0.00–3.18)	0.13 ± 0.03 (0.00–0.05)	0.43 ± 0.23 (0.20–0.70)	0.85 ± 0.36 (0.30–2.03)
One-way ANOVA	$F = 10.84$ $p < .01$	$F = 1.29$ $p = .35$	$F = 2.23$ $p = .18$	$F = 53.23$ $p < .01$
(B) DMFT categorization (low experience with a DMFT ≤1, as medium-high experience with a DMFT >1 but ≤2, as high experience with a DMFT >2 but ≤3, and as very high experience with a DMFT >3)				
Income category (GNI)	**Low experience, *n* (%)**	**Medium-high experience, *n* (%)**	**High experience, *n* (%)**	**Very high experience, *n* (%)**
Middle income	—	1 (5.00)	8 (40.00)	11 (55.00)
High income	—	5 (45.50)	3 (27.30)	3 (27.30)
Very high income	22 (81.50)	3 (11.10)	1 (3.70)	1 (3.70)

Note: Fisher's exact test with Yates continuity correction, $p < .01$. Number of countries and percentage. Statistically significant differences in bold.

[a]Middle-income countries: USD ≤15 000; high-income countries: USD 15001/$25 000; very high-income countries: USD >25 000.

TABLE 3 DMFT index across European countries stratified by healthcare systems (A), unemployment rate (B) and Human Development Index (HDI) (C).

	Decayed teeth, mean ± SD (range)	**Missing teeth, mean ± SD (range)**	**Filled teeth, mean ± SD (range)**	**DMFT, mean ± SD (range)**
(a) M49 country categorization				
East Europe	1.86 ± 0.41 (1.54–2.59)	0.09 ± — (0.09–0.09)	0.52 ± — (0.52–0.52)	2.87 ± 0.53 (1.77–3.53)
South Europe	0.92 ± 0.66 (0.10–2.16)	0.03 ± 0.04 (0.00–0.06)	0.87 ± 0.18 (0.74–1.00)	2.31 ± 1.64 (0.65–6.88)
North Europe	0.99 ± 1.32 (0.00–3.18)	0.00 ± 0.00 (0.00–0.00)	0.80 ± 1.04 (0.20–2.00)	1.30 ± 1.14 (0.30–4.45)
West Europe	0.21 ± 0.16 (0.10–0.60)	0.02 ± 0.03 (0.00–0.05)	0.54 ± 0.18 (0.30–0.70)	0.80 ± 0.27 (0.44–1.36)
One-way ANOVA	$F = 5.62$ $\mathbf{p < .01}$	$F = 2.69$ $p = .18$	$F = 0.19$ $p = .90$	$F = 9.62$ $\mathbf{p < .01}$
(b) Unemployment rate				
Low unemployment rate	0.83 ± 1.11 (0.00–3.18)	0.05 ± 0.04 (0.00–0.09)	0.42 ± 0.21 (0.20–0.67)	1.23 ± 0.89 (0.40–3.20)
Medium unemployment rate	0.87 ± 0.95 (0.00–2.59)	0.01 ± 0.03 (0.00–0.06)	0.83 ± 0.69 (0.20–2.00)	2.08 ± 1.23 (0.30–4.45)
High unemployment rate	1.07 ± 0.68 (0.10–2.16)	—	1.00 ± — (1.00–1.00)	2.38 ± 1.60 (0.65–6.88)
One-way ANOVA	$F = 0.24$ $p = .79$	$F = 0.89$ $p = .46$	$F = 0.82$ $p = .48$	$F = 3.30$ $\mathbf{p < .05}$
(c) Human Development Index				
High	1.62 ± 0.59 (0.56–2.16)	—	1.00 ± — (1.00–1.00)	3.41 ± −1.61 (1.82–6.88)
Very high	0.78 ± 0.88 (0.10–3.18)	0.03 ± 0.04 (0.00–0.09)	0.65 ± 0.55 (0.2–2.00)	1.73 ± 1.13 (0.30–4.45)
One-way ANOVA	$F = 4.98$ $\mathbf{p < .05}$	$F = 0.51$ $p = .50$	$F = 0.37$ $p = .56$	$F = 13.51$ $\mathbf{p < .01}$

Note: Statistically significant differences in bold.

TABLE 4 Ordinal logistic regression analysis of the DMFT categorization by socioeconomic indicators and geographic location.

Variable	**Odds ratio (SE)**	***p*-Value**	**95% confidence interval**
DMFT categorization			
GNI	0.10 (0.07)	**.00**	0.03–0.37
Unemployment rate	0.99 (0.41)	.98	0.44–2.23
Human Development Index	1.82 (1.71)	.50	0.32–10.47
Geographical location	0.57 (0.25)	.20	0.24–1.35

Note: Number of observations = 58; LR $\chi^2_{(4)} = 53.99$; log likelihood = −50.29; $p < .01$. Statistically significant associations in bold.

between countries' income category and caries experience, multinomial ordinal logistic regression analysis revealed that children living in Western European countries have 95% lower odds of oral disease than children living in the East or South of Europe (Table S3).

The results confirmed clear differences in caries experience in Eastern European countries compared with Western European countries, when categorized according to both GNI (Figure 2) and geographical location (Figure 3). The overall mean DMFT by GNI category was 0.85 (GNI >25 000), 2.49 (GNI 15001–25 000), and 3.17 (GNI ≤$15 000), respectively. The overall DMFT according to the country geographical location was 0.80, 1.30, 2.31, and 2.87 for West Europe, North Europe, South European, and East Europe, respectively. Only 17% ($n = 3$) of the East European countries had a mean DMFT that was lower than the overall pooled mean DMFT of 2.10, whereas all the countries in the West Europe had a mean DMFT lower than the overall pooled mean DMFT. The extracted data were used to generate Figure 4 with 95% confidence intervals and test of significance within the mean DMFT of the subgroups of countries that were categorized according to per capita expenditure on dental health care—all countries with per capita expenditure on dental health above 100USD had lower mean DMFT than the overall pooled mean DMFT = 2.10. Meta-regression results show that the year of publication and geographical location of the country explain 32% of in-between study heterogeneity. Heterogeneity was high, reported at 100% with the I^2 statistic and a 95% prediction interval of 0.29–4.49 (Table S4). Sensitivity analysis results show that the overall pooled DMFT mean remained unchanged.

4 | DISCUSSION

The results of the present survey showed that 12-year-old children living in economically disadvantaged European countries, and in particular in Eastern European countries present worse oral health conditions than children living in high-income countries in northern part of Europe.

Although all countries included in this review are part of the European region, the dental health care of paediatric population revealed differences, mainly related to access, coverage, and benefits. Despite being broader compared with adults, the analysis of dental health care in children in Europe showed a variety regarding co-payments, and the services covered, that diverge between different European states.[11] Current debate in the dental public health scientific literature highlights the importance of social determinants of health on children's oral health. The provision of treatment-focused modern dental care showed poor outcomes in meeting the populational needs, bearing in mind that the global numbers of untreated oral disease escalated by 1 billion during the last three decades.[19] As caries exceeds any other NCD in prevalence, there is a need for radical change in prevention strategies, moving toward upstream public health solutions and addressing the underlying risk factors shared with other NCDs.[20] Therefore, a better understanding and comparison of the different oral healthcare systems could provide more and clear information on their efficiency in the respective countries as well as why and how different factors influence oral health. Recent data gathered by the European Observatory on Health Systems and Polices confirmed that in most European countries, dental health care for children is almost fully covered, and children are mostly protected from the co-payments; there are, however, so many differences and similarities in terms of funding, treatment coverage, age group considered, that the comparison according to the type of healthcare system is hardly possible.[11]

DMFT at 12 years of age is recognized as the leading indicator of the oral health in children and adolescents. The results of the present study confirmed that DMFT of children aged 12 years is statistically significantly higher in low/medium income countries, in countries in East and South Europe, and in countries with higher unemployment rates, up to DMFT value of 6.88.

Bearing in mind that oral health is considered an integral part of overall health and an important element of quality of life and well-being, inequalities in oral health cannot be disregarded. Differences between countries are recognized by researchers, health professionals, politicians, and even lay people. Oral health inequalities are, however, completely avoidable, considering that oral diseases are mostly preventable and can be reduced and stopped with carefully planned preventive, prophylactic, and minimally invasive interventions. The same goes for immigrants or underprivileged children living in low socioeconomic circumstances. A preventive program carried out from 1964 to 2009 succeeded in reducing caries experience by 83% in the canton of Zurich, Switzerland.[21] But as far as EU Members States were concerned, DMFT decreased at least twofold, up to sevenfold, when data from the mid-70s were compared with the latest DMFT available at the beginning of the 21st century.[22] Children living in Eastern Europe showed higher DMFT than those living in Western Europe, when data were available, but data unavailability presents an issue. The significant regional differences observed within the European continent were also confirmed by the poor availability of DMFT data in 12-year-old children in developing countries, confirming the poor monitoring, evaluation, and performance of healthcare systems, especially in the Balkan region compared with high-income EU countries.[22]

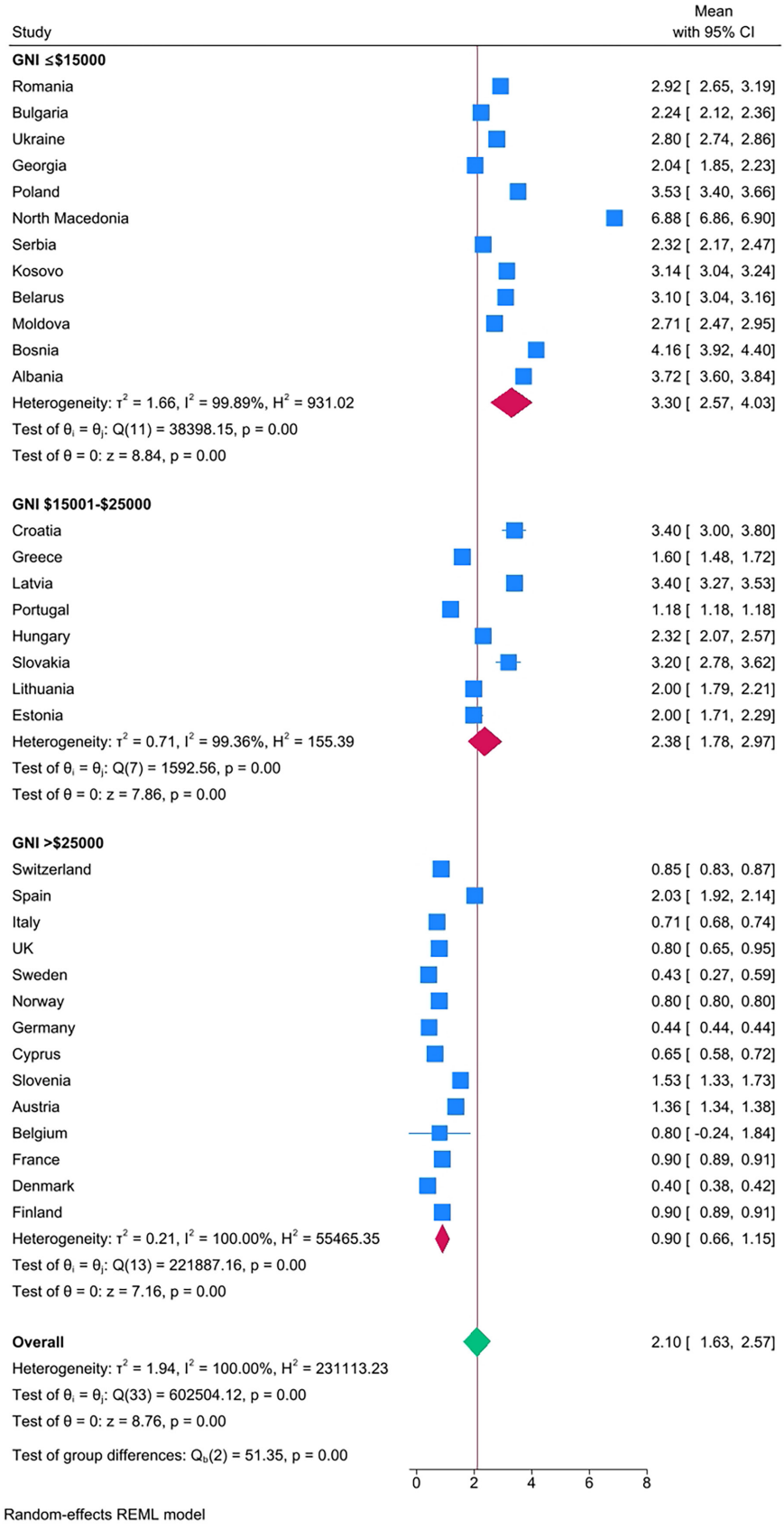

FIGURE 2 Forest plot of the pooled caries experience (DMFT) by gross national income (GNI) stratified by country and ordered by prevalence. Box size represents the sample size.

The *p*-value approaching 1, as presented in the figures, also explains $I^2 = 0$, suggesting high heterogeneity among all the included studies with regard to survey design and methodology. Similar methods for describing the oral health status of samples from different countries allow for comparing data and correctly interpreting of the results.

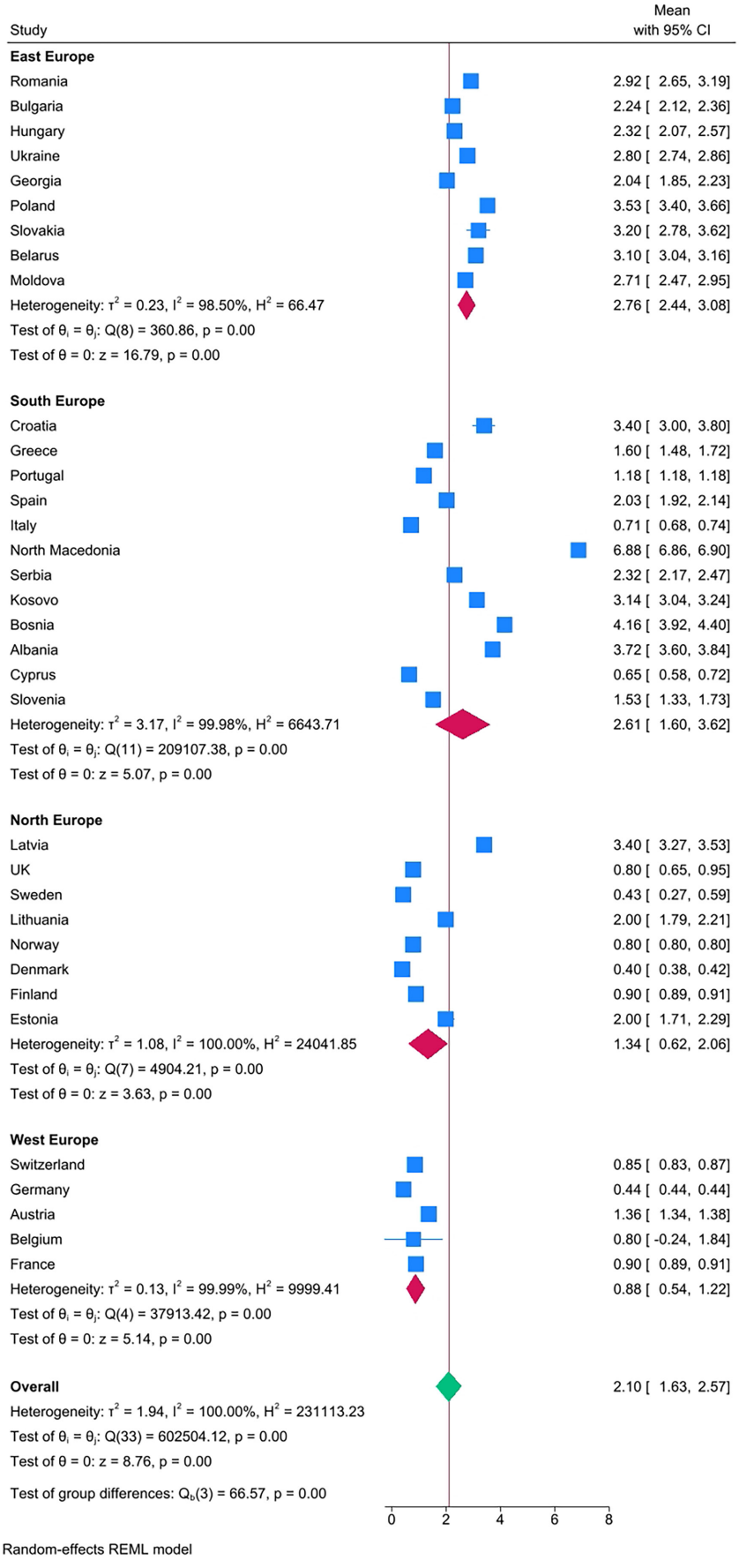

FIGURE 3 Forest plot of the pooled caries experience (DMFT) by geographical location stratified by country and ordered by prevalence. Box size represents the sample size.

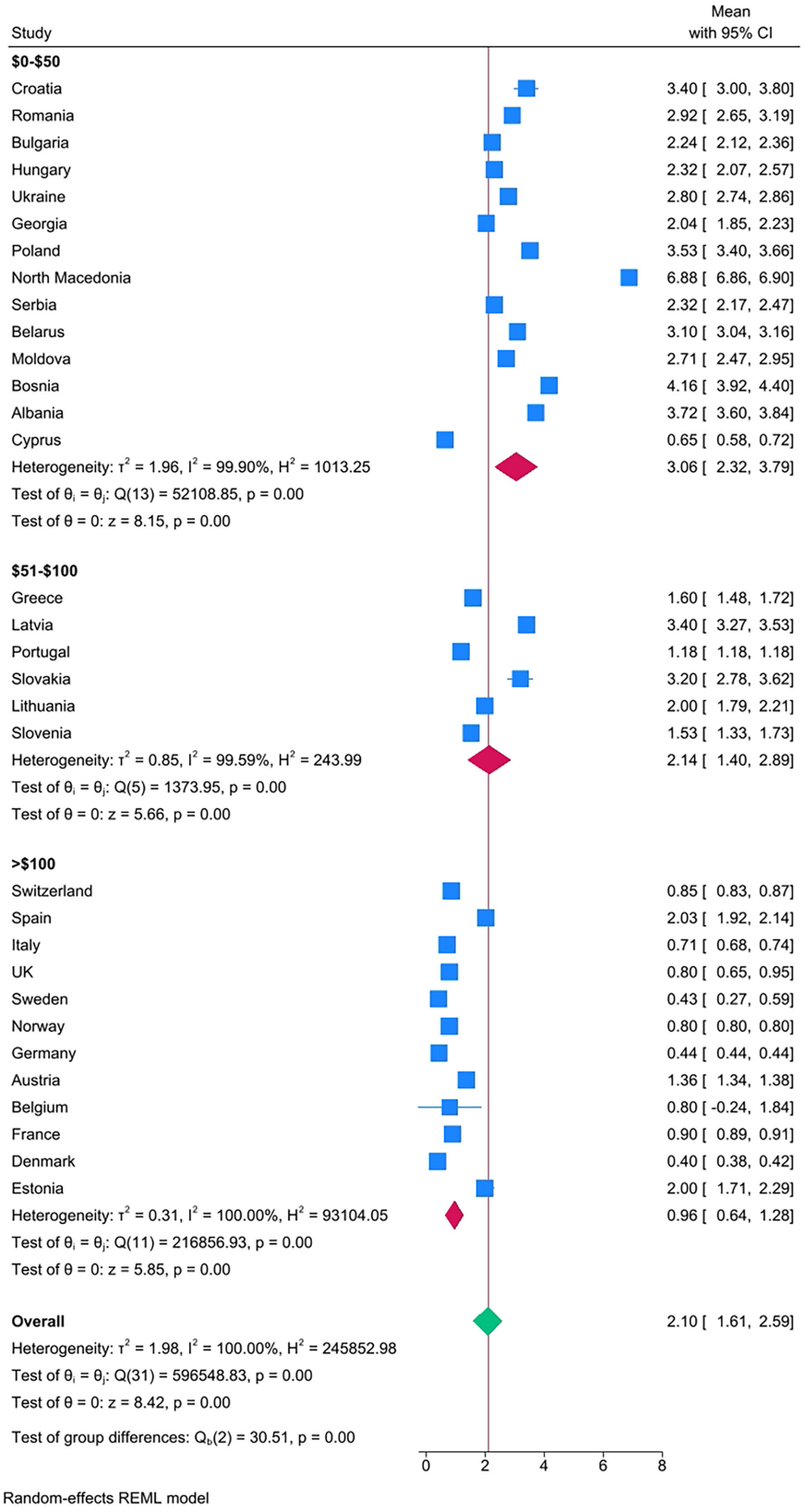

FIGURE 4 Forest plot of the pooled caries experience (DMFT) by per capita expenditure on dental health care stratified by country and ordered by prevalence. Box size represents the sample size.

Nonetheless, taking into account the limitations of the present survey, the results should be interpreted carefully. Firstly, the survey covered a 10-year period in which several countries' data (e.g., England, Wales and Northern Ireland, Greece, and Switzerland) were collected in 2012 or 2013—new health policies and political decisions may have been introduced in these years that could have changed the epidemiological situation in the

respective countries. In addition, the COVID-19 pandemic in 2020 has limited access to oral health care and stopped population oral health preventive programs worldwide, leading to a deterioration of oral health, especially in vulnerable social groups. Secondly, although most national caries data available for Europe include DMFT of 12-year-olds, it is very hard to compare these results having in mind differences in sampling methods and sample sizes. Studies assessing the caries experience in Belgium ($n=22$),[13] Romania ($n=99$)[23] and Sweden ($n=87$)[24] had rather smaller sample sizes (less than 100 subjects). This analysis, however, involved other studies from these countries having larger sample size.[25–27] Moreover, it should be stressed that the sample size must always be considered in relation to the population size, country regions/districts, and social strata involved. The experience of the caries disease described in the surveys involving regional or local sampling should be carefully interpreted on a national level. The sensitivity analysis performed between regional and national data gathered for the purposes of this survey showed that the overall pooled DMFT mean remained unchanged. Moreover, considering that all studies evaluated involved cross-sectional surveys, it is not possible to obtain precise information on cause and effect. Also, the present study did not include data on sugar consumption and the dental workforce in countries, which might be considered a limitation. Data describing caries, however, experience in the canton of Zurich over a 45-year period did not observe any changes in sugar consumption in Switzerland from 1950 to 2009 although DMFT at the age of 12 years was reduced by 83%, indicating the effectiveness of school-supervised toothbrushing programs.[20] Lastly, social indicators for England, Wales, and Northern Ireland (GNI, unemployment rate, HDI) were used for the whole United Kingdom, although Scotland was not included in the assessment of caries experience in the present survey due to a lack of data for the last 10 years.

Although the authors obtained data on per capita expenditure on dental health care,[17] these could not fit well in the regression model due to multicollinearity that was higher than $r=.85$, therefore influencing p-value and statistical significance. This could be explained by the influence of each country's economic determinants on these data, affecting dental labor costs, used materials, technologies, and their costs.[11] Nonetheless, as shown in Figure 4, the results confirmed strong and clear differences in caries experience in countries with different per capita expenditures on dental health care confirming lower DMFT values than pooled mean DMFT = 2.10 in countries with expenditures higher than 100USD. Further efforts and research should be carried out to explore in detail the influence of these variables on oral healthcare provision and internationally compare the results.

The present findings suggest a strong influence of the GNI, geographical location, unemployment rate, and state welfare on oral health. The literature search and meta-analysis performed in the present survey confirmed a strong connection between oral disease and socioeconomic and political contexts. A better understanding of the concept of caries as a chronic NCD allows for novel approaches and preventive strategies that may prove to be more effective and cost-efficient. Further research should emphasize a large-scale sample involving larger observation periods and countries on all continents. Information on the unavailability of data, indicating poor monitoring and evaluation of preventive strategies, when they exist, would also be relevant.

This survey highlights the need to strengthen preventive strategies in European countries in transition with difficulties in financing oral health systems. Bearing in mind the strong effect of macro-level, socioeconomic, political contexts on children's oral health, these findings strongly suggested the use of upstream approaches in the creation of preventive strategies for oral health. Inequalities in oral health are unfair and completely avoidable with policies that allow the allocation of appropriate resources in European countries.

AUTHOR CONTRIBUTIONS

GC, KAS, and TGW conceived the ideas; KAS, AV, FC, RSR, RJ, AM, JFCR, MM, CM, AA, and MGC collected the data; GC, PC, AA, and RBB analyzed the data; AV, GC, MD, and MEO led the writing; AV, GC, MGC, MD, and MEO revised the paper and gave final approval of the manuscript.

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CONFLICT OF INTEREST STATEMENT

None.

DATA AVAILABILITY STATEMENT

The data that support the findings of this study are available from the corresponding author upon reasonable request.

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SUPPORTING INFORMATION

Additional supporting information can be found online in the Supporting Information section at the end of this article.

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SUPPLEMENTARY MATERIAL

"Caries status in 12-year-old children, health care systems and socio-economic conditions across European Countries. A systematic review and meta-analysis."

Content

Appendix Table 1. Prisma check list **Page 2**

Appendix Table 2. Quality assessment of the included papers **Page 4**

Appendix Table 3 Multinomial ordinal logistic regression analysis of the DMFT categorization by socio-economic indicators and geographic location **Page 6**

Appendix Table 4. Output of the meta-regression analysis **Page 7**

Appendix Table 1. Prisma check list

Section and Topic	Item #	Checklist item	Location where item is reported
TITLE			
Title	1	Identify the report as a systematic review.	1
ABSTRACT			
Abstract	2	See the PRISMA 2020 for Abstracts checklist.	2
INTRODUCTION			
Rationale	3	Describe the rationale for the review in the context of existing knowledge.	3
Objectives	4	Provide an explicit statement of the objective(s) or question(s) the review addresses.	3
METHODS			
Eligibility criteria	5	Specify the inclusion and exclusion criteria for the review and how studies were grouped for the syntheses.	4,5
Information sources	6	Specify all databases, registers, websites, organisations, reference lists and other sources searched or consulted to identify studies. Specify the date when each source was last searched or consulted.	4
Search strategy	7	Present the full search strategies for all databases, registers and websites, including any filters and limits used.	4
Selection process	8	Specify the methods used to decide whether a study met the inclusion criteria of the review, including how many reviewers screened each record and each report retrieved, whether they worked independently, and if applicable, details of automation tools used in the process.	4,5
Data collection process	9	Specify the methods used to collect data from reports, including how many reviewers collected data from each report, whether they worked independently, any processes for obtaining or confirming data from study investigators, and if applicable, details of automation tools used in the process.	5
Data items	10a	List and define all outcomes for which data were sought. Specify whether all results that were compatible with each outcome domain in each study were sought (e.g. for all measures, time points, analyses), and if not, the methods used to decide which results to collect.	5
	10b	List and define all other variables for which data were sought (e.g. participant and intervention characteristics, funding sources). Describe any assumptions made about any missing or unclear information.	6
Study risk of bias assessment	11	Specify the methods used to assess risk of bias in the included studies, including details of the tool(s) used, how many reviewers assessed each study and whether they worked independently, and if applicable, details of automation tools used in the process.	5
Effect measures	12	Specify for each outcome the effect measure(s) (e.g. risk ratio, mean difference) used in the synthesis or presentation of results.	5,6
Synthesis methods	13a	Describe the processes used to decide which studies were eligible for each synthesis (e.g. tabulating the study intervention characteristics and comparing against the planned groups for each synthesis (item #5)).	5
	13b	Describe any methods required to prepare the data for presentation or synthesis, such as handling of missing summary statistics, or data conversions.	5
	13c	Describe any methods used to tabulate or visually display results of individual studies and syntheses.	5
	13d	Describe any methods used to synthesize results and provide a rationale for the choice(s). If meta-analysis was performed, describe the model(s), method(s) to identify the presence and extent of statistical heterogeneity, and software package(s) used.	5
	13e	Describe any methods used to explore possible causes of heterogeneity among study results (e.g. subgroup analysis, meta-regression).	5
	13f	Describe any sensitivity analyses conducted to assess robustness of the synthesized results.	5,6
Reporting bias assessment	14	Describe any methods used to assess risk of bias due to missing results in a synthesis (arising from reporting biases).	5,6
Certainty assessment	15	Describe any methods used to assess certainty (or confidence) in the body of evidence for an outcome.	5,6
RESULTS			
Study selection	16a	Describe the results of the search and selection process, from the number of records identified in the search to the number of studies included in the review, ideally using a flow diagram.	7
	16b	Cite studies that might appear to meet the inclusion criteria, but which were excluded, and explain why they were excluded.	7
Study characteristics	17	Cite each included study and present its characteristics.	7
Risk of bias in studies	18	Present assessments of risk of bias for each included study.	8
Results of individual studies	19	For all outcomes, present, for each study: (a) summary statistics for each group (where appropriate) and (b) an effect estimate and its precision (e.g. confidence/credible interval), ideally using structured tables or plots.	8
Results of syntheses	20a	For each synthesis, briefly summarise the characteristics and risk of bias among contributing studies.	8,9
	20b	Present results of all statistical syntheses conducted. If meta-analysis was done, present for each the summary estimate and its precision (e.g. confidence/credible interval) and measures of statistical heterogeneity. If comparing groups, describe the direction of the effect.	8,9
	20c	Present results of all investigations of possible causes of heterogeneity among study results.	8
	20d	Present results of all sensitivity analyses conducted to assess the robustness of the synthesized results.	8

Section and Topic	Item #	Checklist item	Location where item is reported
Reporting biases	21	Present assessments of risk of bias due to missing results (arising from reporting biases) for each synthesis assessed.	8,9
Certainty of evidence	22	Present assessments of certainty (or confidence) in the body of evidence for each outcome assessed.	8,9
DISCUSSION			
Discussion	23a	Provide a general interpretation of the results in the context of other evidence.	10
	23b	Discuss any limitations of the evidence included in the review.	11
	23c	Discuss any limitations of the review processes used.	11
	23d	Discuss implications of the results for practice, policy, and future research.	11,12
OTHER INFORMATION			
Registration and protocol	24a	Provide registration information for the review, including register name and registration number, or state that the review was not registered.	3
	24b	Indicate where the review protocol can be accessed, or state that a protocol was not prepared.	3
	24c	Describe and explain any amendments to information provided at registration or in the protocol.	3
Support	25	Describe sources of financial or non-financial support for the review, and the role of the funders or sponsors in the review.	13
Competing interests	26	Declare any competing interests of review authors.	13
Availability of data, code and other materials	27	Report which of the following are publicly available and where they can be found: template data collection forms; data extracted from included studies; data used for all analyses; analytic code; any other materials used in the review.	

Appendix Table 2. Quality assessment of the included papers except national surveys not published (tool developed by The National Heart, Lung and Blood Institute for Observational Cohort and Cross-sectional studies, Case-Control studies and Controlled-Intervention studies (https://www.nhlbi.nih.gov/health-topics/study-quality-assessment-tools).

Study ID	Title	Source	Country	Quality Assessment
Hysi et al., 2014	Caries experience and treatment needs among Albanian 12-year-olds.	Community Dent Health. 2014;31(3):141-144.	Albania	Fair
Leous, 2016	The feasibility of descriptive epidemiology in assessments of dental caries disease in children in Russia and Belarus.	Stomatologiya. 2016;95(4):21.	Belarus	Poor
Markovic et al., 2013	Oral Health in Bosnia and Herzegovina Schoolchildren - Findings of First National Survey	Austin J Dent. 2014;1(2):1010	Bosnia	Poor
Zukanović, 2013	Caries risk assessment models in caries prediction.	Acta Med Acad. 2013;42(2):198-208. doi:10.5644/ama2006-124.87	Bosnia	Poor
Onov & Beltcheva, 2020	Caries Prevalence in 12-year-old Children from Plovdiv - a Multifactorial Regression Analysis.	Folia Med (Plovdiv). 2020;62(1):159-164. doi:10.3897/folmed.62.e47894	Bulgaria	Poor
Lešić et al, 2019	Caries prevalence among schoolchildren in urban and rural Croatia.	Cent Eur J Public Health. 2019;27(3):256-262. doi:10.21101/cejph.a5314	Croatia	Poor
Panagidis & Schulte, 2012	Caries prevalence in 12-year-old Cypriot children.	Community Dent Health. 2012;29(4):297-301.	Cyprus	Fair
Sgan-Cohen et al., 2014	Dental caries among children in Georgia by age, gender, residence location and ethnic group.	Community Dent Health. 2014;31(3):163-166.	Georgia	Fair
Pieper et al., 2013	K, Lange J, Jablonski-Momeni A, Schulte AG. Caries prevalence in 12-year-old children from Germany: results of the 2009 national survey.	Community Dent Health. 2013;30(3):138-142.	Germany	Fair
Jordan et al., 2014	The Fifth German Oral Health Study (Fünfte Deutsche Mundgesundheitsstudie, DMS V) - rationale, design, and methods.	BMC Oral Health. 2014;14:161.	Germany	Fair
Splieth et al., 2019	40-Year Longitudinal Caries Development in German Adolescents in the Light of New Caries Measures.	Caries Res. 2019;53(6):609-616.	Germany	Good
Oulis et al., 2012	Caries prevalence of 5, 12 and 15-year-old Greek children: a national pathfinder survey.	Community Dent Health. 2012;29(1):29-32.	Greece	Fair
Diamanti et al., 2021	Oral hygiene and periodontal condition of 12- and 15-year-old Greek adolescents. Socio-behavioural risk indicators, self- rated oral health and changes in 10 years.	Eur J Paediatr Dent. 2021;22(2):98-106.	Greece	Fair
Ekstrand et al., 2020	The impact of a national caries strategy in Greenland 10 years after implementation. A failure or a success?	Int J Circumpolar Health. 2020;79(1):1804260.	Greenland	Fair
Szöke et al., 2008	Changing Levels of Dental Caries over 30 Years among Children in a Country of Central and Eastern Europe - The Case of Hungary.	Oral Health Prev Dent. 18(1):177-183	Hungary	Fair
Campus et al., 2020	Caries severity and socioeconomic inequalities in a nationwide setting: data from the Italian National pathfinder in 12-years children.	Sci Rep. 2020;10(1):15622.	Italy	Fair
Ferizi et al., 2020	Oral Health Status Among 12-Year-Old Schoolchildren in Kosovo.	Pesqui Bras Odontopediatria Clin Integr. 2020;20.	Kosovo	Fair
Maldupa et al, 2021	Caries Prevalence and Severity for 12-Year-Old Children in Latvia.	Int Dent J. 2021;71(3):214-223.	Latvia	Fair
Gudkina et al., 2016	Factors influencing the caries experience of 6 and 12 year old children in Riga, Latvia.	Stomatologija. 2016;18(1):14-20.	Latvia	Poor
Narbutaitė et al., 2016	Variation in fluorosis and caries experience among Lithuanian 12 year olds exposed to more than 1 ppm F in tap water.	J Investig Clin Dent. 2016;7(2):187-192.	Lithuania	Fair
Bilder et al., 2018	The pathfinder study among schoolchildren in the Republic of Moldova: dental caries experience.	Int Dent J. 2018;68(5):344-347.	Moldova	Fair
Nonkulovski et al., 2022	Dental caries experience of 12 year old children from Resen municipality. 35.	Journal of Dental Problems and Solutions. Published online January 19, 2022:001-005.	North Macedonia	Poor
Sarakinova et al., 2013	National strategy for prevention of oral diseases in children from 0 to 14 years old age in the Republic of Macedonia for the period 2008-2018.	Pril (Makedon Akad Nauk Umet Odd Med Nauki). 2013;34(2):129-134.	North Macedonia	Poor
Sulo et al, 2022	Regional variations in caries experience, predictors, and follow-up among children and adolescents in Western Norway.	Acta Odontol Scand. 2022;80(4):289-294.	Norway	Fair
Statistics Norway, 2021.	Dental Health Care 2015-2021. Available from:	https://www.ssb.no/en/statbank/table/11985/.	Norway	Fair
Olczak-Kowalczyk, 2016	Dental caries level and sugar consumption in 12-year-old children from Poland. Advances in Clinical and Experimental.	Medicine. 2016;25(3):545-550.	Poland	Poor
Gaszynska et al., 2014	Thirty years of evolution of oral health behaviours and dental caries in urban and rural areas in Poland. Annals of Agricultural and Environmental.	Medicine. 2014;21(3):557-561.	Poland	Poor

Rodakowska etal., 2013	Epidemiological analysis of dental caries in 12-year-old children residing in urban and rural settings in the Podlaskie region of north-eastern Poland.	Ann Agric Environ Med. 2013;20(2):325-328.	Poland	Poor
Calado et al., 2017	Caries prevalence and treatment needs in young people in Portugal: the third national study.	Community Dent Health. 2017;34(2):107-111.	Portugal	Fair
Veiga et al.,2015	Prevalence of Dental Caries and Fissure Sealants in a Portuguese Sample of Adolescents.	PLoS One. 2015;10(3):e0121299.	Portugal	Fair
Sava-Rosianu et al., 2021	Caries Prevalence Associated with Oral Health-Related Behaviors among Romanian Schoolchildren. doi:10.3390/ijerph18126515	Int J Environ Res Public Health. 2021;18(12):6515.	Romania	Fair
Jipa et al., 2012	Oral health status of children aged 6-12 years from the Danube Delta Biosphere Reserve.	Oral Health Dent Manag. 2012;11(1):39-45.	Romania	Poor
Ondine Lucaciu et al., 2020	WHO Pathfinder Survey of Dental Caries in 6 and 12-Year Old Transylvanian Children and the Possible Correlation with Their Family Background, Oral-Health Behavior, and the Intake of Sweets.	Int J Environ Res Public Health. 2020;17(11):4180.	Romania	Fair
Leous et al, 2020	Longitudinal study of the primary prevention effect on dental caries.	Stomatologiia (Mosk). 2020;99(2):26-33.	Russia	Poor
Smolyar & Chuhray, 2015	The study of caries incidence in children according to WHO Significant Index of Caries.	Stomatologiya. 2015;94(6):41.	Russia	Poor
Peric et al, 2022	Oral Health in 12- and 15-Year-Old Children in Serbia: A National Pathfinder Study.	Int J Environ Res Public Health. 2022;19(19).	Serbia	Fair
Pilát et al., 2020	Oral health status of 6- and 12-year-old children of Roma origin from Eastern Slovakia: a pilot study. doi:10.21101/cejph.a6225	Cent Eur J Public Health. 2020;28(4):292-296.	Slovakia	Fair
Vrbič et al.,	Epidemiology of Dental Caries and Disease Prevention Among 12-Year-Olds in Slovenia Over Thirty Years (1987-2017).	Oral Health Prev Dent. 18(1):185-196.	Slovenia	Fair
Montero et al., 2016	Oral health-related quality of life in 6- to 12-year-old schoolchildren in Spain.	Int J Paediatr Dent. 2016;26(3):220-230.	Spain	Fair
Obregón-Rodríguez et al., 2019	Prevalence and caries-related risk factors in schoolchildren of 12- and 15-year-old: a cross-sectional study.	BMC Oral Health. 2019;19(1):120.	Spain	Fair
Almerich-Silla et al., 2010	Caries Prevalence in Children from Valencia (Spain) using ICDAS II criteria.	2010. Med Oral Patol Oral Cir Bucal. Published online 2014:e574-e580	Spain	Fair
Bravo et al., 2020	Encuesta de salud oral en España 2020.	Revista Del Ilustre Consejo General De Colegios De Odontólogos Y Estomatólogos De España. 2020;25(4):1-35.	Spain	Poor
Mensah et al., 2021	Swedish quality registry for caries and periodontal diseases (SKaPa): validation of data on dental caries in 6- and 12-year-old children.	BMC Oral Health. 2021;21(1):373.	Sweden	Poor
Kramer et al., 2016	Demographic factors and dental health of Swedish children and adolescents.	Acta Odontol Scand. 2016;74(3):178-185.	Sweden	Fair
Steiner et al., 2010	Changes in dental caries in Zurich school-children over a period of 45 years.	Schweiz Monatsschr Zahnmed. 2010;120(12):1084-1104.	Switzerland	Fair
Waltimo et al., 2015	Caries experience in 7-, 12-, and 15-year-old schoolchildren in the canton of Basel-Landschaft, Switzerland, from 1992 to 2011.	Community Dent Oral Epidemiol. 2015:	UK	Fair
Wang et al., 2021	Dental caries thresholds among adolescents in England, Wales, and Northern Ireland, 2013 at 12, and 15 years: implications for epidemiology and clinical care.	BMC Oral Health. 2021;21(1):137.	UK	Fair
Vernazza et al., 2016	Caries experience, the caries burden and associated factors in children in England, Wales and Northern Ireland 2013.	Br Dent J. 2016;221(6):315-320.	UK	Fair
Baker et al., 2018	Structural Determinants and Children's Oral Health: A Cross-National Study. doi:10.1177/0022034518767401	J Dent Res. 2018;97(10):1129-1136.	UK	Good
Davies et al., 1995	The caries experience of 11 to 12 year-old children in Scotland and Wales and 12 year-olds in England in 2008-2009: reports of coordinated surveys using BASCD methodology.	Community Dent Health. 2012;29(1):8-13.	UK	Fair
Trufanova et al., 2018	Characteristics of epidemiology of dental caries in children from regions with high and optimum fluorine content in drinking water.	Wiad Lek. 2018;71(2 pt 2):335-338.	Ukraine	Poor

Appendix Table 3. Multinomial ordinal logistic regression analysis of the DMFT categorization by socio-economic indicators and geographic location

Number of observations =58 *LR $\chi^2_{(11)} = 64.48$* *Log likelihood= -43.05* *p<0.01*

Variable	Relative Risk Ratio (SE)	P-value	95% Confidence Interval
	DMFT Categorization		
1			
Unemployment rate	0.50 (0.44)	0.43	0.09 -2.80
Geographical location	0.23 (0.24)	0.16	0.29 – 1.84
2			
Unemployment rate	0.37 (0.38)	0.33	0.05 -2.82
Geographical location	0.05 (0.06)	**0.02**	0.00 – 0.62
3			
Unemployment rate	0.37 (0.40)	0.35	0.05 – 2.99
Geographical location	0.09 (0.11)	**0.05**	0.01 -1.05

Appendix Table 4. Meta-regression analysis of the different health systems an publication years of the papers included.

```
  Effect-size label: Mean
        Effect size: DMFTmean
          Std. err.: SE_DMFT

Random-effects meta-regression                  Number of obs  =        34
Method: REML                                    Residual heterogeneity:
                                                             tau2 =   1.319
                                                          I2 (%) =  100.00
                                                             H2 = 41827.22
                                                R-squared (%) =   31.82
                                                Wald chi2(2)   =     17.36
                                                Prob > chi2    =    0.0002
```

_meta_es	Coefficient	Std. err.	z	P>|z|	[95% conf.	interval]
Year	-.1499273	.0690348	-2.17	0.030	-.285233	-.0146217
Geographical~n	-.7536473	.1986943	-3.79	0.000	-1.143081	-.3642136
_cons	305.5903	139.3379	2.19	0.028	32.49296	578.6876

```
Test of residual homogeneity: Q_res = chi2(31) =  2.2e+05Prob > Q_res = 0.0000
```