

# Impact of Secondhand Smoke from Conventional Cigarettes, IQOS, and E-Cigarettes on Children's Oral Health: A Cross-Sectional Study

F. S. Ludovichetti<sup>1</sup>, A. G. Signoriello<sup>2</sup>, A. Gracco<sup>3</sup>, R. Lo Giudice<sup>4</sup>, P. Lucchi<sup>5</sup>, E. Stellini<sup>6</sup>, S. Mazzoleni<sup>7</sup>

<sup>1</sup>Adjunct Professor, DDS, MSc, PhD, Department of Neurosciences – Dentistry Section, Università degli Studi di Padova, Padova, Italy.

<sup>2</sup>Resident, DDS, Department of Neurosciences – Dentistry Section, Università degli Studi di Padova, Padova, Italy.

<sup>3</sup>Associate Professor, DDS, Department of Neurosciences – Dentistry Section, Università degli Studi di Padova, Padova, Italy.

<sup>4</sup>Adjunct Professor, DDS, Department of Biomedical and Dental Sciences and Morphological and Functional Imaging, University of Messina, Messina, Italy

<sup>5</sup>Adjunct Professor, DDS, Department of Neurosciences – Dentistry Section, Università degli Studi di Padova, Padova, Italy.

<sup>6</sup>Full Professor, DDS, Department of Neurosciences – Dentistry Section, Università degli Studi di Padova, Padova, Italy.

<sup>7</sup>Associate Professor, DDS, Department of Neurosciences – Dentistry Section, Università degli Studi di Padova, Padova, Italy.

DOI 10.23804/ejpd.2025.2386

email: francesco.ludovichetti@unipd.it

## Abstract

**Aim** Secondhand smoke (SHS) is a major public health concern, especially for children, who are particularly vulnerable to its harmful effects. Although alternative smoking devices like IQOS and e-cigarettes are marketed as harm reduction tools, their impact on paediatric oral health remains underexplored. This study evaluates the effects of SHS from conventional cigarettes, IQOS, and e-cigarettes on cotinine levels in gingival crevicular fluid and the risk of dental caries in children.

**Materials and Methods** A cross-sectional study was conducted involving 160 children aged 3 to 14 years, categorised into four groups based on exposure: SHS from conventional cigarettes, SHA (secondhand aerosol) from IQOS, e-cigarettes, and a no-smoking control group. Each group included 40 participants, ensuring an equal distribution across exposure conditions. Children in the SHS/SHA groups were exclusively exposed to emissions from a single product type (cigarettes, IQOS, or e-cigarettes) to isolate product-specific effects. Cotinine levels were measured using liquid chromatography-tandem mass spectrometry (LC-MS/MS), and dental caries were assessed via the Decayed-Missing-Filled Teeth (DMFT) index. Parental smoking habits, oral health behaviours, and environmental factors were recorded through a questionnaire. Statistical analyses included one-way ANOVA, Kruskal-Wallis tests, and Spearman's correlation.

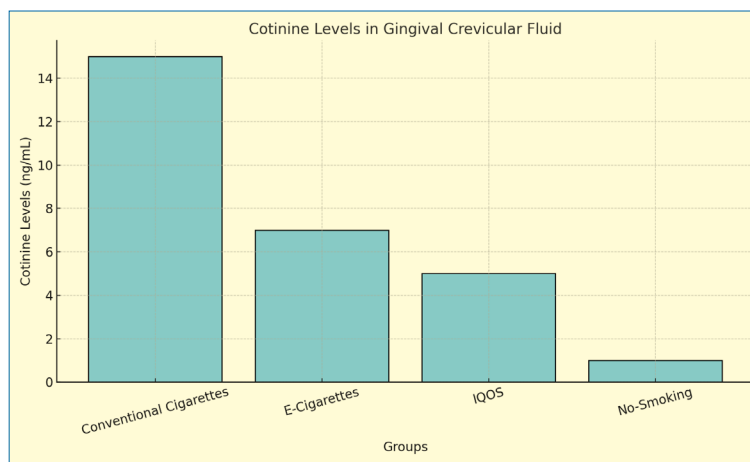
**Results** The highest cotinine levels were found in children exposed to conventional cigarette SHS ( $15.0 \pm 5.0$  ng/mL), followed by e-cigarettes ( $7.0 \pm 2.5$  ng/mL), IQOS ( $5.0 \pm 2.0$  ng/mL), and the no-smoking group ( $1.0 \pm 0.5$  ng/mL) ( $p < 0.05$ ). DMFT scores followed a similar trend, with the highest scores in the conventional cigarette group ( $4.0 \pm 1.5$ ), followed by e-cigarettes ( $3.5 \pm 1.3$ ), IQOS ( $3.0 \pm 1.2$ ), and the no-smoking group ( $1.0 \pm 0.8$ ) ( $p < 0.05$ ). Parental questionnaires revealed frequent smoking or vaping in enclosed spaces and suboptimal oral hygiene practices among children exposed to SHS. A strong positive correlation between cotinine levels and DMFT scores was observed ( $p = 0.72$ ,  $p < 0.001$ ).

**Conclusion** SHS exposure from all sources negatively impacts children's oral health, with conventional cigarettes posing the greatest risk. While IQOS and e-cigarettes reduce SHS exposure compared to conventional cigarettes, they still result in measurable nicotine absorption and increased caries risk. Public health strategies and clinical interventions should prioritise creating smoke-free environments and raising awareness about the risks of SHS/SHA from all nicotine-containing products on paediatric health.

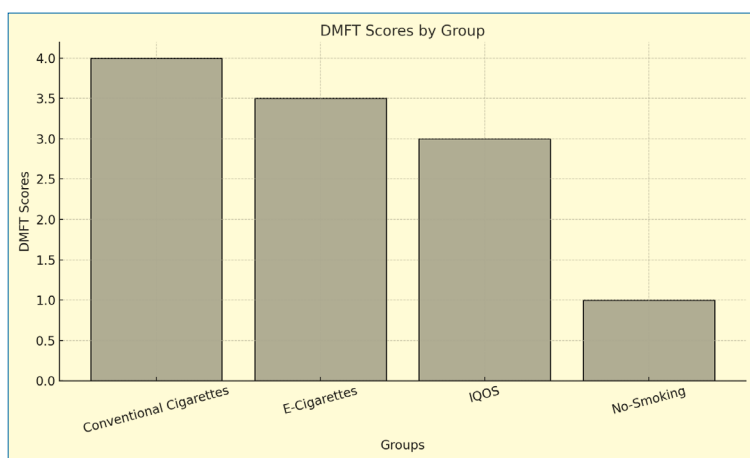
**KEYWORDS** passive smoking, cotinine, paediatric oral health, electronic cigarettes.

## Introduction

Secondhand smoke (SHS) is a pervasive global health issue that disproportionately affects children. According to the World Health Organization (WHO), over 40% of children worldwide are exposed to SHS in their homes, resulting in significant health consequences [WHO, 2019]. SHS contains more than 7,000 chemicals, including at least 70 known carcinogens, and its toxic profile includes nicotine, carbon monoxide, heavy metals, and formaldehyde [U.S. Department of Health and Human Services, 2014]. These substances can impair immune function, disrupt normal physiological development, and increase the risk of numerous conditions, including respiratory infections, asthma, and otitis media [Öberg et al., 2014]. Among the myriad health concerns associated with SHS, its impact on oral health is increasingly recognized. Dental caries, the most prevalent chronic disease in children, affects nearly 50% of those aged 6 to 11 years globally [Petersen et al., 2005]. The relationship between SHS and dental caries is multifaceted, involving mechanisms such as reduced salivary flow, impaired enamel mineralization, and increased colonisation by cariogenic bacteria like *Streptococcus mutans* [D'oria et al., 2024]. A study by Avsar et al. demonstrated that children exposed to SHS had a significantly higher risk of caries, with a dose-response relationship between the number of household smokers and caries incidence [Avsar et al., 2013]. Recently, alternative tobacco products, such as IQOS and e-cigarettes, have emerged, marketed as potentially less harmful than conventional cigarettes. IQOS (I Quit Ordinary Smoking), a heated tobacco product, operates by heating tobacco to temperatures below combustion, thereby reducing the release of toxic substances. Studies suggest that IQOS emits approximately 90% fewer harmful chemicals than conventional cigarettes [Mahlich et al., 2024]. Similarly, e-cigarettes generate an aerosol by heating a liquid containing nicotine, flavorings, and other chemicals. Despite their harm-reduction claims, both products have been shown to produce aerosols containing nicotine and toxicants, raising concerns about their safety, particularly in non-smoking individuals exposed



**FIG 1.** Cotinine Levels in Gingival Crevicular Fluid. Mean cotinine levels (ng/mL) in children exposed to SHS from conventional cigarettes, IQOS, and e-cigarettes, compared to a non-exposed group.



**FIG 2.** DMFT Scores by Group. Mean DMFT index scores across exposure groups, showing a higher prevalence of caries in children exposed to SHS/SHA.

to secondhand emissions [Goniewicz et al., 2014; [Abdul-Karim et al., 2011]. The oral health implications of SHS/SHA from these alternative products remain underexplored. While research on conventional cigarettes indicates a clear association between SHS exposure and increased caries risk, evidence regarding IQOS and e-cigarettes is limited. Bitzer et al. [2020] reported that while IQOS and e-cigarettes reduce exposure to certain toxicants compared to conventional cigarettes, they are not risk-free. Schober et al. found that e-cigarette emissions contain fine particulate matter and volatile organic compounds capable of causing oxidative stress and inflammation [2019]. Additionally, Ludovichetti et al. highlighted that public awareness of the risks associated with SHS/SHA from alternative tobacco products is limited, suggesting a need for further investigation [2024]. Children's vulnerability to SHS/SHA exposure is compounded by behavioral and environmental factors. A significant proportion of SHS exposure occurs in enclosed spaces such as homes and cars, where toxicants can accumulate to high levels. Moreover, parental smoking behaviours often correlate with suboptimal oral health practices in children, including irregular tooth brushing and frequent consumption of sugary snacks [Severino et al., 2021]. A study by Becerra et al. emphasised that such behaviours, combined with SHS exposure, exacerbate the risk of dental caries in children, particularly in low- and middle-income households where access to preventive dental care is limited [2022]. To address these gaps in knowledge, this study aims to evaluate the effects of SHS/SHA from conventional cigarettes, IQOS, and e-cigarettes on children's oral health. Specifically, we investigate cotinine levels in gingival crevicular fluid as a biomarker of SHS exposure and their association with dental caries, measured by the Decayed-Missing-Filled Teeth (DMFT) index. Furthermore, we examine parental

smoking behaviours, oral health practices, and environmental factors to provide a comprehensive understanding of SHS's impact.

## Materials and Methods

### Study Design and Setting

This cross-sectional study was conducted between January 2023 and June 2024. The study adhered to the guidelines outlined by the Declaration of Helsinki, and informed consent was obtained from the parents or legal guardians of all participants.

### Participants

A total of 160 children aged 3 to 14 years undergoing routine dental visit in 3 different dental private practices were enrolled in the study. Participants were divided into four groups based on parental smoking habits and household exposure:

- Conventional cigarette group (n = 40): Children exposed to SHS from at least one parent who smoked conventional cigarettes daily for more than one year.
- IQOS group (n = 40): Children exposed to SHS/SHA from at least one parent who exclusively used IQOS for at least one year.
- E-cigarette group (n = 40): Children exposed to SHS/SHA from at least one parent who exclusively used e-cigarettes for at least one year.
- No-smoking group (n = 40): Children living in households where no one smoked any form of tobacco or used vaping devices.

Smoking behaviours were classified based on validated definitions from the Global Adult Tobacco Survey [Global Adult Tobacco Survey

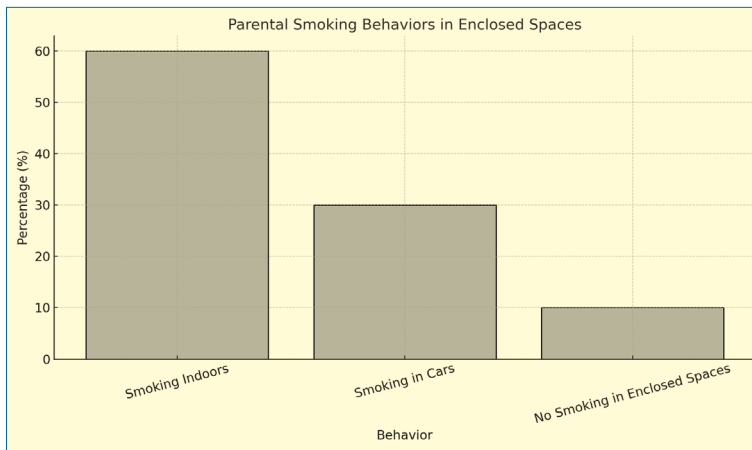


FIG 3. Parental Smoking Behaviours in Enclosed Spaces. Percentage of parents reporting smoking or vaping indoors or in cars, highlighting common exposure settings.

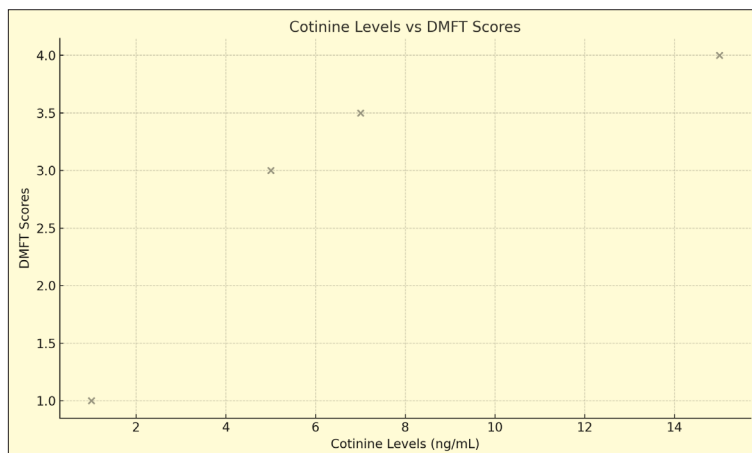


FIG 4. Correlation Between Cotinine Levels and DMFT Scores. Scatter plot showing the positive correlation between cotinine levels and DMFT scores, indicating greater caries risk with increased nicotine exposure.

Collaborative Group, 2011]. Parents completed a detailed questionnaire to confirm eligibility for group allocation.

**Data Collection**

*Cotinine Levels in Gingival Crevicular Fluid:*

Cotinine levels were used as a biomarker for SHS exposure. Samples of gingival crevicular fluid were collected using absorbent paper strips, which were inserted into the gingival sulcus for 30 seconds. The strips were then stored at -80°C until analysis. Cotinine concentrations were quantified using liquid chromatography-tandem mass spectrometry (LC-MS/MS), a highly sensitive and specific method [Benowitz, 1996; Hukkanen and Jacob, 2005].

*Dental Caries Assessment:*

Dental caries were assessed using the Decayed-Missing-Filled Teeth (DMFT) index, following the guidelines of the World Health Organization's Oral Health Surveys: Basic Methods, 5th Edition [WHO, 2013]. Examinations were conducted by two calibrated pediatric dentists to ensure inter-rater reliability (kappa coefficient = 0.92).

*Parental Questionnaire:*

Parents completed a structured questionnaire to collect information on smoking habits, frequency of SHS exposure, oral health behaviours (e.g., toothbrushing frequency, sugary snack consumption), and environmental factors (e.g., ventilation practices). The questionnaire was adapted from validated tools used in previous studies [Campo et al., 2021; Misailidi et al., 2014] (Appendix A).

**Statistical Analysis**

Statistical analyses were performed using SPSS (version 26.0, IBM Corp.). Continuous variables were expressed as means and

standard deviations (SDs), while categorical variables were expressed as frequencies and percentages.

*Comparison Between Groups:*

Cotinine levels and DMFT scores were compared among the four groups using one-way ANOVA for normally distributed data and Kruskal-Wallis tests for non-parametric data. Post-hoc analyses were conducted using Tukey's HSD test or Dunn's test with Bonferroni correction as appropriate.

*Correlation Analysis:*

The relationship between cotinine levels and DMFT scores was assessed using Spearman's rank correlation coefficient.

*Multivariate Regression:*

Multivariate linear regression was performed to identify predictors of DMFT scores, including cotinine levels, oral health behaviours, and environmental factors. Statistical significance was set at  $p < 0.05$ .

**Sample Size Calculation**

The sample size was calculated based on an expected difference in mean cotinine levels between the groups of 5 ng/mL, with a standard deviation of 7 ng/mL. Using a significance level of 0.05 and a power of 0.80, a minimum of 35 participants per group was required. To account for potential dropouts, the sample size was increased to 40 participants per group.

**Results**

**Cotinine Levels in Gingival Crevicular Fluid**

The analysis of cotinine levels revealed significant differences among the four groups. The conventional cigarette group exhibited

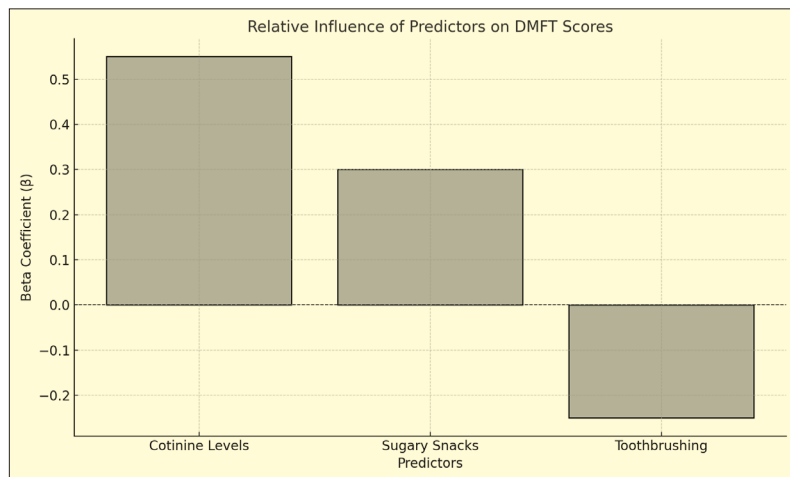


FIG 5. Relative Influence of Predictors on DMFT Scores. Multivariate analysis of factors influencing DMFT scores, with cotinine levels as a key predictor.

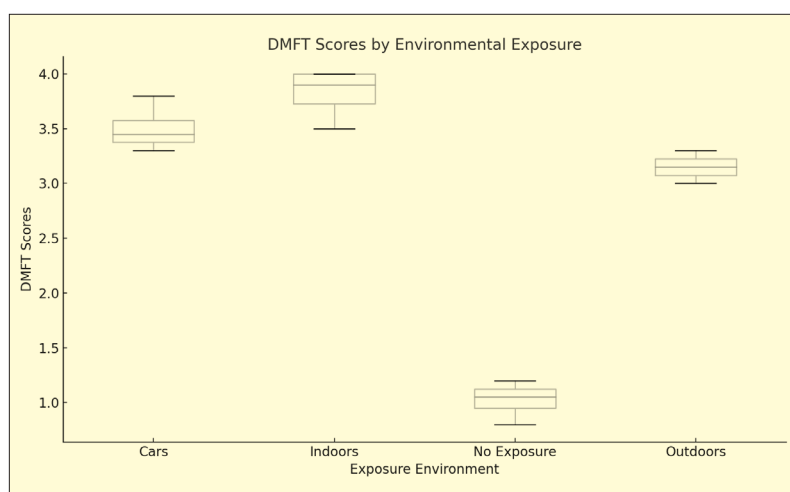


FIG 6. DMFT Scores by Environmental Exposure. DMFT scores by household smoking habits and ventilation, illustrating environmental influences on caries risk.

the highest mean cotinine levels ( $15.0 \pm 5.0$  ng/mL), followed by the e-cigarette group ( $7.0 \pm 2.5$  ng/mL) and the IQOS group ( $5.0 \pm 2.0$  ng/mL). The no-smoking group demonstrated the lowest levels ( $1.0 \pm 0.5$  ng/mL). One-way ANOVA showed statistically significant differences between groups ( $p < 0.05$ ). Post-hoc comparisons indicated that all smoking groups had significantly higher cotinine levels than the no-smoking group, and the conventional cigarette group differed significantly from both IQOS and e-cigarette groups. (Fig.1)

**DMFT Scores**

Dental caries, as measured by the DMFT index, followed a similar trend. The conventional cigarette group had the highest mean DMFT score ( $4.0 \pm 1.5$ ), followed by the e-cigarette group ( $3.5 \pm 1.3$ ) and the IQOS group ( $3.0 \pm 1.2$ ). The no-smoking group had the lowest DMFT score ( $1.0 \pm 0.8$ ). The Kruskal-Wallis test confirmed significant differences in DMFT scores among groups ( $p < 0.05$ ). Post-hoc analyses showed that all smoking groups had significantly higher DMFT scores than the no-smoking group. Among smoking groups, the conventional cigarette group had the highest scores, significantly differing from the IQOS group (Fig.2).

**Parental Questionnaire Findings**

The parental questionnaire provided additional insights:

*Smoking Behaviours:*

Among smoking parents, 50% smoked conventional cigarettes, 25% used IQOS, and 25% used e-cigarettes.

80% of smoking parents reported smoking or vaping in enclosed

environments, with 60% smoking indoors and 30% in cars(Fig.3).

*Oral Health Behaviours:*

Only 40% of children brushed their teeth at least twice daily.

70% of children consumed sugary snacks frequently.

Preventive dental visits were reported by only 30% of parents.

*Environmental Factors:*

40% of households had additional smokers.

Ventilation systems or air purifiers were used in only 20% of households.

**Correlation Between Cotinine Levels and DMFT Scores**

Spearman’s rank correlation analysis revealed a strong positive correlation between cotinine levels and DMFT scores ( $\rho = 0.72$ ,  $p < 0.001$ ). This indicates that higher SHS exposure, as reflected by cotinine levels, is associated with an increased risk of dental caries (Fig.4).

**Multivariate Regression Analysis**

Multivariate linear regression identified cotinine levels ( $\beta = 0.55$ ,  $p < 0.001$ ), frequency of sugary snack consumption ( $\beta = 0.30$ ,  $p = 0.01$ ), and frequency of toothbrushing ( $\beta = -0.25$ ,  $p = 0.03$ ) as significant predictors of DMFT scores. The overall model explained 62% of the variance in DMFT scores (adjusted  $R^2 = 0.62$ )(Fig.5).

**Discussion**

The results of this study provide a comprehensive analysis of the impact of secondhand smoke and aerosol (SHS and SHA) exposure

from conventional cigarettes, IQOS, and e-cigarettes on children's oral health. By combining biomarker analysis, clinical outcomes, and behavioral data, this research underscores the significant risks associated with SHS exposure, even from alternative tobacco products. While conventional cigarettes continue to pose the greatest risk, the measurable impact of IQOS and e-cigarettes highlights the need for a cautious approach to their use in proximity to children. Cotinine levels in gingival crevicular fluid were markedly higher in children exposed to SHS from conventional cigarettes compared to those exposed to IQOS and e-cigarettes. This finding is consistent with prior research, which demonstrates that conventional cigarette smoke contains a high concentration of nicotine and other toxicants, such as polycyclic aromatic hydrocarbons and heavy metals, known to affect systemic and oral health [Schober et al., 2019]. Studies such as those by Avsar et al. have already established a dose-response relationship between SHS/SHA exposure and dental caries in children, emphasizing the severe impact of household smoking on pediatric oral health outcomes [Avsar et al., 2013]. The DMFT scores observed in our study corroborate these findings, with children exposed to conventional cigarette smoke exhibiting significantly higher scores compared to their peers in smoke-free households. IQOS and e-cigarettes, while associated with lower cotinine levels and DMFT scores than conventional cigarettes, are not without risk. Our results align with previous studies by Mahlich et al., who showed that IQOS, despite emitting fewer harmful substances than traditional cigarettes, still exposes users and bystanders to nicotine and other toxicants [Mahlich et al., 2024]. Similarly, research on e-cigarettes by Goniewicz et al. highlights the presence of carcinogenic and toxic substances in e-cigarette aerosols, although at lower concentrations than those found in conventional cigarette smoke [Goniewicz et al., 2014]. These findings suggest that while alternative tobacco products may be less harmful in some respects, their use around children is not without consequences. Recent studies have increasingly highlighted the impact of heated tobacco products (HTPs) and electronic cigarettes (e-cigarettes) not only on users but also on individuals exposed to their emissions. A systematic review by Scala et al. revealed that these products are frequently used alongside conventional cigarettes rather than as full replacements, leading to continuous nicotine exposure among both direct users and bystanders [Scala et al., 2025]. This pattern of use raises concerns about the overall reduction in harm, as sustained nicotine exposure may contribute to long-term health risks even in non-smokers, particularly children. Furthermore, Glantz et al. demonstrated that dual users—those who smoke traditional cigarettes while also using e-cigarettes—are at an even higher risk of developing smoking-related diseases compared to individuals who smoke only conventional cigarettes. E-cigarettes are often marketed as 95% less harmful than conventional cigarettes, the actual reduction in harm is minimal and primarily concerns only specific tobacco-related conditions [Glantz et al., 2024]. This challenges the widely promoted notion that alternative tobacco products significantly reduce harm and instead suggests that their use may, in some cases, exacerbate health risks by prolonging nicotine addiction and increasing exposure to harmful substances. From a tobacco control perspective, the role of these products in smoking cessation remains highly debated. A prospective cohort study conducted by Gallus et al. during the COVID-19 pandemic found that individuals using e-cigarettes or HTPs had a lower probability of quitting smoking than those who did not use these products [Gallus et al., 2024]. This finding aligns with concerns that these devices may not necessarily support cessation but rather maintain nicotine dependence, potentially discouraging smokers from quitting altogether. The need for regulatory measures

addressing the exposure of non-smokers, particularly children, to secondhand emissions from these products has been emphasized in recent literature. Carnicer-Pont et al. highlighted the importance of expanding existing smoke-free and aerosol-free policies to include e-cigarettes and HTPs, given the increasing evidence of their potential risks [Penzes et al., 2024]. Although marketed as less harmful alternatives to traditional cigarettes, these products still contribute to passive nicotine exposure, which has been associated with adverse effects on respiratory and cardiovascular health, as well as increased risks of dental caries in children, as observed in our study. The regulatory landscape, however, remains inconsistent across different countries, with some jurisdictions implementing comprehensive bans on indoor use of these products while others impose minimal restrictions. The findings of the present study reinforce the need for a cautious approach to alternative tobacco products, particularly in environments shared with children. While IQOS and e-cigarettes resulted in lower cotinine levels compared to conventional cigarettes, they were still associated with increased levels of nicotine exposure and a higher prevalence of dental caries among exposed children. The strong positive correlation observed between cotinine levels and DMFT scores reinforces the notion that SHS/SHA exposure, regardless of the source, has a dose-dependent impact on oral health. Nicotine and other toxic substances in SHS/SHA can disrupt enamel formation, alter salivary composition, and increase the colonization of cariogenic bacteria, creating a conducive environment for dental caries [Ludovichetti et al., 2024]. Our study expands on these mechanisms by demonstrating a quantifiable relationship between biomarker levels and clinical outcomes, providing further evidence of the detrimental effects of SHS on pediatric oral health. The behavioral and environmental data collected from the parental questionnaire provide additional context to these findings. A significant proportion of parents reported smoking or vaping in enclosed spaces such as homes and cars, where SHS concentrations can reach hazardous levels. These behaviours are particularly concerning given the findings of Öberg et al., who noted that SHS exposure is most intense in poorly ventilated indoor environments [Öberg et al., 2014]. Furthermore, the prevalence of suboptimal oral health practices among children in smoking households, such as infrequent toothbrushing and frequent consumption of sugary snacks, compounds the risks posed by SHS exposure. Petersen et al. emphasized that these behaviours, when combined with SHS exposure, create a synergistic effect that exacerbates the risk of dental caries [Petersen et al., 2005]. The intermediate results for IQOS and e-cigarettes merit particular attention. These devices are often marketed as harm reduction tools, yet their emissions still contain harmful substances that pose risks to non-users. Our findings suggest that while IQOS and e-cigarettes may reduce the overall toxicant load compared to conventional cigarettes, they are not risk-free, especially for vulnerable populations like children. Shahab et al. demonstrated that IQOS emits fine particulate matter and volatile organic compounds capable of inducing oxidative stress, a pathway implicated in numerous systemic and oral health conditions [Shahab et al., 2017]. Similarly, e-cigarette aerosols, while less harmful than conventional smoke, contain nicotine and other chemicals that can disrupt normal biological processes, as evidenced by studies on respiratory and cardiovascular health [Scala et al., 2025]. These findings have significant public health implications. First, they highlight the importance of creating smoke-free environments to protect children from SHS exposure. While current regulations often focus on conventional cigarettes, our results suggest that policies should be extended to include IQOS and e-cigarettes, given their measurable impact on oral health. The World Health Organization has consistently advocated for

comprehensive smoke-free policies, and our findings provide additional evidence to support these recommendations [WHO, 2019]. Second, the role of pediatric dentists and healthcare providers in addressing SHS exposure is critical. Routine screening for SHS exposure using biomarkers like cotinine, combined with targeted counseling on the risks of household smoking or vaping, can help mitigate the oral health risks associated with SHS [Dhar et al., 2004]. Additionally, promoting optimal oral hygiene practices, such as regular toothbrushing with fluoride toothpaste and reducing sugary snack consumption, can help counteract some of the adverse effects of SHS exposure [Farsalinos et al., 2018]. Despite the strengths of this study, including the use of sensitive biomarkers and a comprehensive assessment of oral health outcomes, there are several limitations that warrant consideration. The cross-sectional design limits the ability to establish causality, and the reliance on self-reported data from parents introduces the potential for recall bias. Moreover, the possibility of mixed exposure to SHS and SHA among some children. While groups were classified based on primary exposure, parental smoking data suggest overlaps. Future studies should better differentiate exposure sources and assess whether dual exposure impacts oral health outcomes more severely. Future longitudinal studies with larger and more diverse populations are needed to confirm these findings and explore the long-term effects of SHS exposure on oral health. Furthermore, additional research is needed to elucidate the specific mechanisms by which emissions from IQOS and e-cigarettes affect oral health, as well as to determine whether these products have unique impacts compared to conventional cigarettes.

## Conclusion

In conclusion, this study demonstrates that SHS exposure from all sources negatively impacts children's oral health, with conventional cigarettes posing the greatest risk and IQOS and e-cigarettes showing intermediate effects. These findings underscore the importance of comprehensive public health strategies to reduce SHS exposure, promote smoke-free environments, and enhance awareness of the risks associated with alternative tobacco products. By addressing these challenges through policy, education, and clinical practice, we can better protect vulnerable pediatric populations from the harmful effects of SHS.

## Statements and Declarations

Authors state that they don't have any financial or non-financial interest directly or indirectly related to the present work.

## Authors' contribution

Ludovichetti Francesco Saverio: Design of the work; Data analysis and interpretation; critical revision of the article; final approval of the version to be published. PL and RLG: Drafting the article; critical revision of the article; final approval of the version to be published. AGS: Drafting the article; critical revision of the article; final approval of the version to be published. ES and AG: critical revision of the article; final approval of the version to be published. SM: critical revision of the article; final approval of the version to be published.

## References

- Abdul-Karim ET, Abdul-Razaq ZH. Cord serum cotinine as a biomarker of fetal exposure to environmental tobacco smoke. *Neurosciences (Riyadh)*. 2011;16(2):120–4.
- Avsar A, Topaloglu B, Hazar-Bodrumlu E. Association of passive smoking with dental development in young children. *Eur J Paediatr Dent*. 2013;14(3):215–8.
- Becerra BJ, Arias D, Becerra MB. Sex-specific association between environmental tobacco smoke exposure and asthma severity among adults with current asthma. *Int J Environ Res Public Health*. 2022;19(9):5036.
- Benowitz NL. Cotinine as a biomarker of environmental tobacco smoke exposure. *Epidemiol Rev*. 1996;18(2):188–204.
- Bitzer ZT, Goel R, Trushin N, Muscat J, Richie JP Jr. Free radical production and characterization of heat-not-burn cigarettes in comparison to conventional and electronic cigarettes. *Chem Res Toxicol*. 2020;33(7):1882–7.
- Campo L, Vecera F, Fustinoni S. Validation of a questionnaire to assess smoking habits, attitudes, knowledge, and needs among university students: a pilot study among obstetrics students. *Int J Environ Res Public Health*. 2021;18(22):11873.
- D'oria V, Bettocchi S, De Cosmi V, Paglia M, Colombo S, Scaglioni S, Agostoni C, Beretta M, Braiotta F, Berti C, Paglia L. Risk factors for early childhood caries in Italian preschoolers: a cross-sectional analysis. *Eur J Paediatr Dent*. 2024;25(4):271–6.
- Dhar P. Measuring tobacco smoke exposure: quantifying nicotine/cotinine concentration in biological samples by colorimetry, chromatography and immunoassay methods. *J Pharm Biomed Anal*. 2004;35(1):155–68.
- Farsalinos KE, Yannovits N, Sarri T, Voudris V, Poulas K. Nicotine delivery to the aerosol of a heat-not-burn tobacco product: comparison with a tobacco cigarette and e-cigarettes. *Nicotine Tob Res*. 2018;20(8):1004–9.
- Gallus S, Stival C, McKee M, Carreras G, Gorini G, Odone A, van den Brandt PA, Pacifici R, Lugo A. Impact of electronic cigarette and heated tobacco product on conventional smoking: an Italian prospective cohort study conducted during the COVID-19 pandemic. *Tob Control*. 2024;33(2):267–70.
- Glantz SA, Nguyen N, Oliveira da Silva AL. Population-based disease odds for e-cigarettes and dual use versus cigarettes. *NEJM Evid*. 2024;3(3):EVIDo2300229.
- Global Adult Tobacco Survey Collaborative Group. Tobacco questions for surveys: a subset of key questions from the Global Adult Tobacco Survey (GATS). 2nd ed. Geneva: World Health Organization; 2011.
- Goniewicz ML, Knysak J, Gawron M, Kosmider L, Sobczak A, Kurek J, Prokopowicz A, Jablonska-Czapla M, Rosik-Dulewska C, Havel C, Jacob P 3rd, Benowitz NL. Levels of selected carcinogens and toxicants in vapour from electronic cigarettes. *Tob Control*. 2014;23(2):133–9.
- Hukkanen J, Jacob P 3rd, Benowitz NL. Metabolism and disposition kinetics of nicotine. *Pharmacol Rev*. 2005;57(1):79–115.
- Ludovichetti FS, Zuccon A, Di Fiore A, Zambon G, Bargan A, Stellini E, Mazzoleni S. Perception of the oral health risks of passive smoking from traditional cigarettes, electronic cigarettes, and heated tobacco products: a cross-sectional study. *Tob Induc Dis*. 2024;22.
- Mahlich J, Kamae I. Switching from cigarettes to heated tobacco products in Japan—potential impact on health outcomes and associated health care costs. *Healthcare (Basel)*. 2024;12(19):1937.
- Misailidi M, Tzatzarakis MN, Kavvalakis MP, Koutedakis Y, Tsatsakis AM, Flouris AD. Instruments to assess secondhand smoke exposure in large cohorts of never smokers: the smoke scales. *PLoS One*. 2014;9(1):e85809.
- Öberg M, Jaakkola MS, Woodward A, Peruga A, Prüss-Ustün A. Worldwide burden of disease from exposure to second-hand smoke: a retrospective analysis of data from 192 countries. *Lancet*. 2011;377(9760):139–46.
- Penzes M, Stival C, Gonzalez A, Koprivnikar H, Carreras G, Gorini G, Possenti I, Lugo A, Gallus S, Fernández E. Best practices for expansion of smoke-free and aerosol-free environments in Europe: protocol for the consultation to experts. *Tob Prev Cessat*. 2024;10.
- Petersen PE, Bourgeois D, Ogawa H, Estupinan-Day S, Ndiaye C. The global burden of oral diseases and risks to oral health. *Bull World Health Organ*. 2005;83(9):661–9.
- Scala M, Dallera G, Gorini G, Achille J, Havermans A, Neto C, Odone A, Smits L, Zambon A, Lugo A, Gallus S. Patterns of use of heated tobacco products: a comprehensive systematic review. *J Epidemiol*. 2025 Jan 11. doi: 10.2188/jea.JE20240109.
- Schober W, Fembacher L, Frenzen A, Fromme H. Passive exposure to pollutants from conventional cigarettes and new electronic smoking devices (IQOS, e-cigarette) in passenger cars. *Int J Hyg Environ Health*. 2019;222(3):486–93.
- Severino M, Caruso S, Ferrazzano GF, Pisaneschi A, Fiasca F, Caruso S, De Giorgio S. Prevalence of early childhood caries (ECC) in a paediatric Italian population: an epidemiological study. *Eur J Paediatr Dent*. 2021;22(3):189–98.
- Shahab L, Goniewicz ML, Blount BC, Brown J, McNeill A, Alwis KU, Feng J, Wang L, West R. Nicotine, carcinogen, and toxin exposure in long-term e-cigarette and nicotine replacement therapy users: a cross-sectional study. *Ann Intern Med*. 2017;166(6):390–400.
- U.S. Department of Health and Human Services. The health consequences of smoking—50 years of progress: a report of the Surgeon General. Atlanta: Centers for Disease Control and Prevention; 2014.
- World Health Organization. Oral health surveys: basic methods. 5th ed. Geneva: World Health Organization; 2013.
- World Health Organization. WHO global report on trends in prevalence of tobacco use 2000–2025. 3rd ed. Geneva: World Health Organization; 2019.