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KNOWLEDGE, ATTITUDES AND ADOPTION OF AMALGAM PHASEDOWN AMONGST DENTISTS IN NAIROBI COUNTY: A CROSS-SECTIONAL STUDY

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ABSTRACT

Background: Dental amalgam has long been used as a durable restorative material; however, global efforts to phase it down have intensified due to concerns regarding mercury exposure and its environmental and health effects. This study aimed to assess the knowledge, attitudes, and adoption of amalgam phasedown among practicing dentists in Nairobi County, Kenya.

Methods: This descriptive cross-sectional study was conducted among 83 practicing dentists in Nairobi County. Participants were recruited using a non-probability sampling approach. Data was collected using a self-administered questionnaire assessing knowledge, attitudes, and practices related to amalgam phasedown. Data were analyzed using Microsoft Excel and SPSS. Descriptive statistics were presented as frequencies and percentages, and associations between variables were tested using the Chi-square test, with statistical significance set at $p < 0.05$.

Results: All 83 (100%) participants were aware of amalgam phasedown. Ministry of Health circulars 44 (53.0%) were the most common source of information, closely followed by Kenya Dental Association communications 38 (45.8%). Regarding attitudes, 37 (44.6%) participants opposed the complete phase-out of amalgam, 30 (36.1%) supported it, and 16 (19.3%) were neutral. In terms of adoption, 45 (54.2%) participants reported rarely using amalgam, 21 (25.3%) used it occasionally, and 17 (20.5%) no longer used it in practice. A statistically significant association was found between reduced amalgam use and continuous training on posterior composite placement ($\chi^2 = 9.351$, $p = 0.009$).

Conclusion: Dentists in Nairobi County demonstrated good knowledge and a generally positive orientation toward amalgam phasedown, with a substantial shift toward reduced use of amalgam. However, financial constraints and concerns regarding alternative materials remain key barriers to the phasedown. Strengthening continuous professional training and improving affordability of

alternative restorative materials through government sponsored initiatives are recommended strategies to support an effective and equitable transition away from dental amalgam.

INTRODUCTION

The use of dental amalgam dates back as early as 659 AD, with the earliest documented use during the Tang Dynasty, where it was reportedly composed of tin and silver, as described in medical texts written by Su Kung.^{1, 2} Dental amalgam has been widely used globally for many years due to its durability, which is attributed to its superior mechanical properties compared to tooth-colored restorative materials.³ It has a compressive strength of approximately 380–540 MPa after final set, enabling its use in restoring posterior teeth with a high survival rate, and when properly placed under ideal conditions, it may last more than a decade.⁴ Additionally, amalgam is more affordable than tooth-colored restorative materials such as dental resin composites (DRCs) and glass ionomer cements (GICs), and is less technique-sensitive, making it easier to manipulate compared to alternatives like resin composites.^{5, 6} Consequently, it has remained the most commonly used restorative material for posterior teeth in many public dental facilities in this setting.

Despite its long history and excellent clinical performance, dental amalgam is currently being phased down globally due to potential health risks associated with mercury and environmental concerns. Exposure to mercury has been linked to adverse outcomes including impaired fetal neurological development, reduced fertility, brain and nerve damage, and cardiovascular disease.^{7, 8} The phasedown gained momentum following the Minamata Convention on Mercury (2013),

an international treaty aimed at protecting human health and the environment from mercury and mercury compounds.⁹ The Convention prohibited the establishment of new mercury mines, called for the phase-out of existing ones, and introduced measures to control emissions and mercury-containing products. In response, the World Dental Federation (FDI) has advocated for reduced amalgam use by promoting preventive oral health strategies and encouraging research into safe amalgam waste management practices.¹⁰ Although dental mercury emissions are relatively small compared to other sources, Tibau and Grube¹¹ identified dental amalgam as a significant but often overlooked contributor to global mercury pollution, arising from illegal diversion of dental mercury into artisanal and small-scale gold mining, crematoria emissions, and the use of sewage sludge in agriculture. These processes contribute to contamination of air, water, and food, ultimately affecting human health.¹²

A survey conducted in Kenya revealed that dentists were aware of the Minamata Convention on Mercury; however, concerns were raised that the adoption of the policy could negatively affect the quality of dental training and provision of oral healthcare due to increased costs. The study also highlighted that the phasedown would pose challenges in addressing the burden of dental caries, particularly in low- and middle-income countries.^{13, 14} Furthermore, the phasedown is expected to exacerbate oral health inequalities between affluent individuals and those with limited financial resources, with a more

pronounced impact in low- and middle-income countries due to limited government funding and inadequate insurance coverage for oral health services compared to general healthcare.¹⁴ In light of existing policies on mercury phase-out, the phasedown of dental amalgam is inevitable; however, several challenges are anticipated in implementing this transition in low- and middle-income countries such as Kenya. There is limited published data on the attitudes and adoption of amalgam phasedown among Kenyan dentists, who are key stakeholders in ensuring the success of this initiative. Therefore, the objective of this study was to assess the knowledge, attitudes, and adoption of amalgam phasedown among practicing dentists in Kenya.

METHODS

Study design and setting

This was a descriptive cross-sectional study conducted among practicing dentists in Nairobi County, Kenya.

Study population and sampling

The study targeted dentists engaged in clinical practice within Nairobi County. Inclusion criteria were dentists actively involved in clinical practice who provided informed consent to participate in the study, while those not engaged in clinical care were excluded. Purposive sampling approach was used whereby all dentists involved in clinical practice within Nairobi were eligible to participate, this was chosen due to the small size of the study population.

Sample size determination

The sample size was determined using Fischer's formula for finite populations¹⁵, assuming a prevalence of 50%, a 95% confidence level, and a margin of error of 10%. Based on the estimated number of practicing

dentists in Kenya. Of the 120 dentists approached, 83 responded and were included in the study, giving a response rate of 69.2%.

Data collection

Data was collected using a structured, self-administered questionnaire distributed both electronically (via email) and in hard copy format. The questionnaire assessed participants' knowledge, attitudes, and practices regarding amalgam phasedown. Knowledge was evaluated using close-ended and Yes/No questions focusing on awareness of the Minamata Convention, its adoption year (2013), Kenya's signatory status, and awareness of amalgam separators and implementing bodies. Attitudes were assessed using Likert scale and dichotomous questions addressing perceptions toward amalgam phasedown and alternative restorative materials. Adoption was assessed based on reported frequency of amalgam use and use of alternative materials. The questionnaire was pre-tested on a group of 10 participants drawn from the study population to assess for clarity and ease of use, feedback gained was used to improve the questionnaire.

Data analysis

Collected data was coded and analyzed using Microsoft Excel and IBM SPSS Statistics (version 2022). Descriptive statistics, including frequencies and percentages, were computed. Associations were assessed using Chi-square and Fisher's exact tests, with $p < 0.05$ considered statistically significant. Questionnaires with incomplete responses were excluded from the analysis; no imputation was performed.

Potential sources of bias and mitigation

Several potential sources of bias were identified and addressed. Selection bias may have arisen from the use of purposive sampling, as dentists who were more engaged with professional networks or policy

communications may have been more likely to participate, potentially over representing those with greater awareness of amalgam phasedown. This was mitigated by distributing the questionnaire through multiple channels, including both electronic and hard copy formats, to reach a broader range of practitioners. Response bias was a further concern, as participants may have provided socially desirable answers regarding their attitudes and adoption practices; this was minimized by ensuring the questionnaire was anonymous and self-administered. Information bias was also considered, given that knowledge and practice data were based on self-report rather than direct observation; however, self-administered questionnaires are a standard and widely accepted method in cross-sectional studies of this nature. The cross-sectional design inherently limits causal

inference, and this is acknowledged as a limitation of the study.

Ethical considerations

Ethical approval was obtained from the Kenyatta National Hospital–University of Nairobi Ethics and Research Committee (KNH-ERC/UA/31). Informed consent was obtained from all participants and confidentiality maintained.

RESULTS

Demographic characteristics

A total of 83 dentists participated. Their ages ranged from 25 – 63 years with a mean age of 35 (SD ± 9.3). Most participants 38 (45.8%) worked in both the private and public sectors, 28 (33.7%) in public only, and 17 (20.5%) in private clinics only. Masters graduates accounted for the largest group 46 (55.4%) among the participants. (Table 1)

Table 1

Demographic characteristics, Education or qualification, level of specialty and Place of work of the participating Dentists

Characteristics	Description	N (%)
Age	<25 years	12 (14.5%)
	26 – 35 years	37 (44.5%)
	36 – 45 years	22 (26.5%)
	46 – 55 years	10 (12%)
	>56 years	2 (2.5%)
Sex	Female	46 (54.9%)
	Male	37 (45.1%)
Education or qualification	Undergraduate	26 (31.4%)
	Masters Graduates	46 (55.4%)
	Postgraduate Diploma	9 (10.8%)
	PhD	2 (2.4%)
Place of Work	Private sector	17 (20.5%)
	Public sector	28 (33.7%)
	Both private and public sector	38 (45.8%)
Type of Specialty	Prosthodontics	9 (10.84%)
	Periodontics	13 (15.66%)
	Paedodontics	12 (14.46%)
	Orthodontics	5 (6.02%)

	OMFS (Oral and Maxillofacial Surgery)	5 (6.02%)
	Public health	2 (2.41%)
	Restorative and Esthetics	3 (3.61%)
	Endodontic	1 (1.20%)
	General dentists	33 (39.72%)

Knowledge on dental amalgam phasedown

All 83 (100%) participants were aware of the amalgam phasedown. Ministry of Health

circulars were the most common source of information reported by 44 (53%) (Table 2).

Table 2

Knowledge regarding amalgam phasedown; source of information

Source of Data	Frequency	Percentage (%)
Internet	31	37.3
Kenya Dental Association circulars	38	45.8
Dental Journals	28	28
Ministry of Health circulars	44	53
Social media	3	3.6
Print Media and Broadcast	5	6
Biomaterial Classes	10	12.8
Government of Kenya seminars	1	1.2
International Forums	1	1.2
Workshop at KIE now KICD	1	1.2

A good number of participants, 56 (67.5%) were familiar with the Minamata Convention, with 39 (47%) of the dentists reporting accurately that it was adopted in 2013. With regards to the body in charge of amalgam phasedown, 35 (42.7%) reported accurately that the Ministry of Health was the body in charge. The Majority 78 (94%) knew about dental amalgam separators, but only 29 (35%)

of them had seen one. Less than half, 39 (47%) reported that an amalgam separator had been installed at their place of work.

Attitude towards amalgam phasedown

A total of 37 (44.6%) of the dentists, were against the phase out of amalgam, 16 (19.3%) remained neutral, and 30 (36.1%) advocated for the discontinuation of amalgam (Fig. 1).

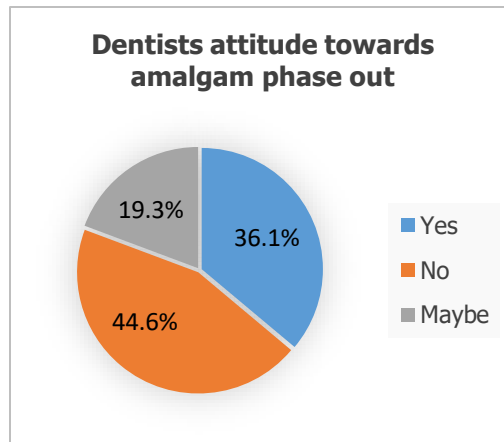


Figure 1: Dentists attitude towards amalgam phase out

The major advantages of using the amalgam-free restorations, as per the responses, were due to better esthetics, a great range of

applications, better bonding to enamel, and better micro-conservative restorations (Fig. 2).

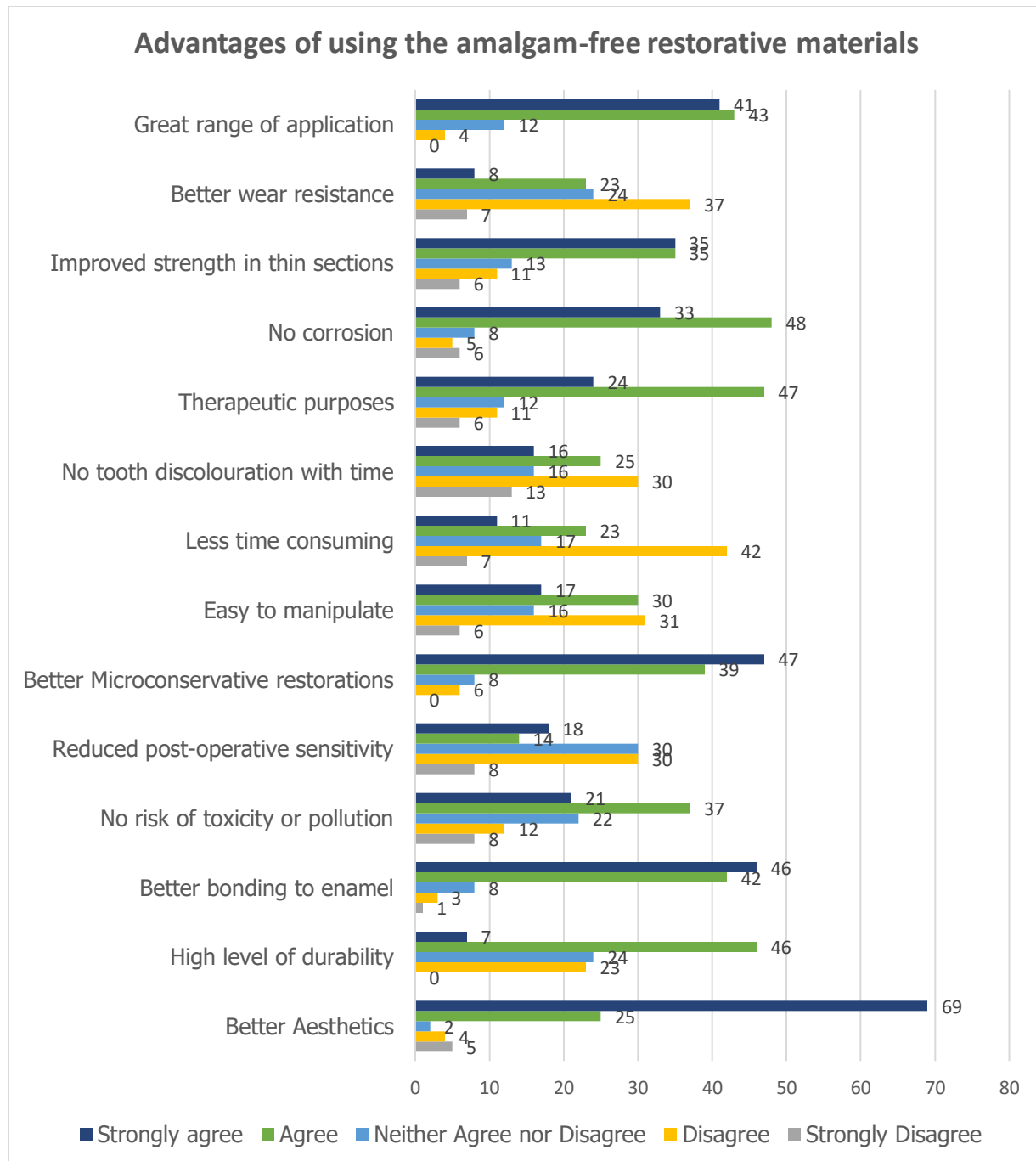


Figure 2: Advantages of using the amalgam-free restorative materials

The major disadvantages of using amalgam-free restorative materials, as per the responses,

were: technique sensitivity, water sorption, time consumption, and high cost (Fig. 3)

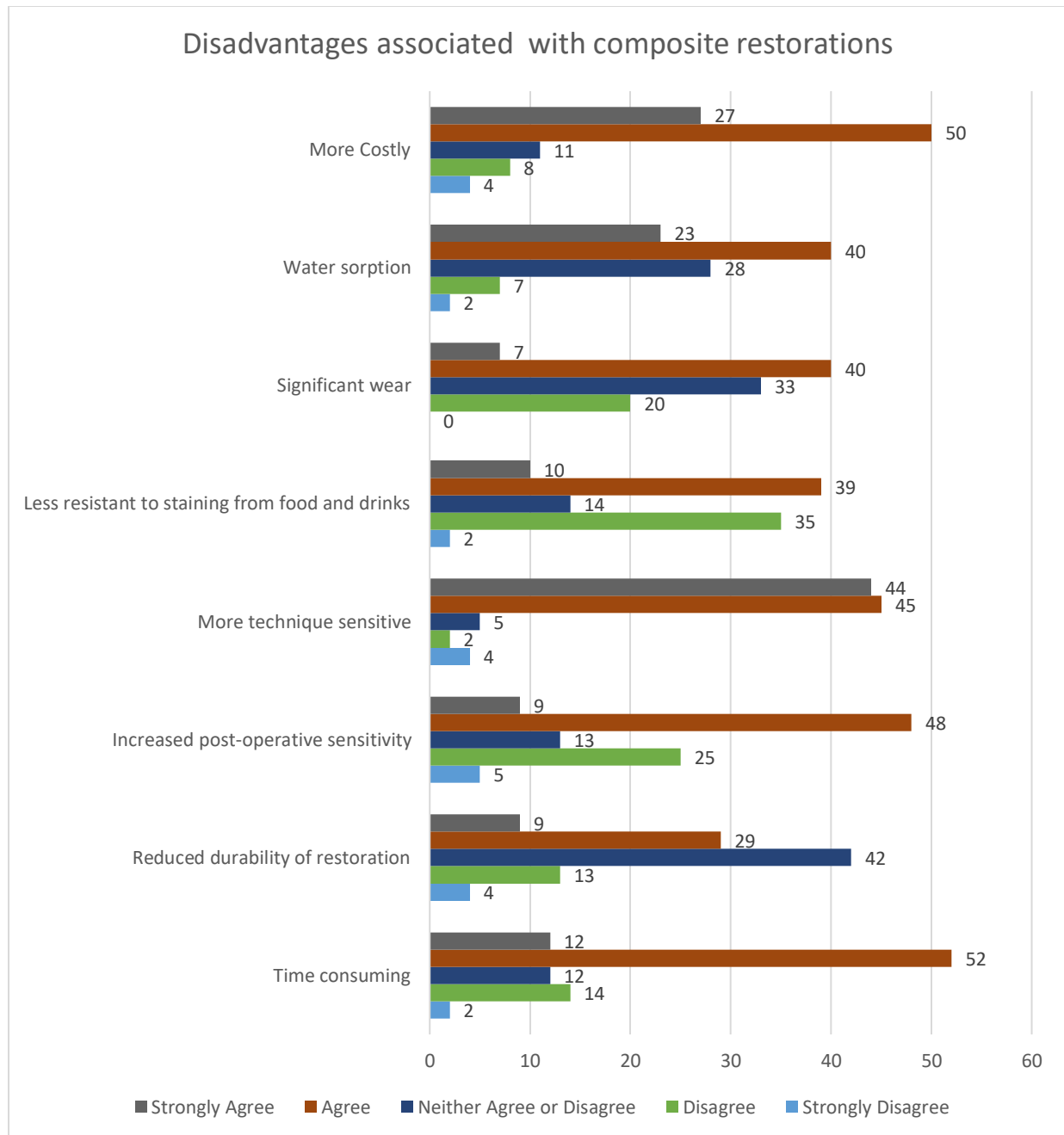


Figure 3: Disadvantages associated with the use of amalgam-free restorative materials

Adoption of amalgam phasedown
 More than half of the participants 45 (54.2%) reported that they rarely used amalgam in

their clinics, 21 (25.3%) used amalgam occasionally, and 17 (20.5%) never used dental amalgam in their procedures (Fig. 4).

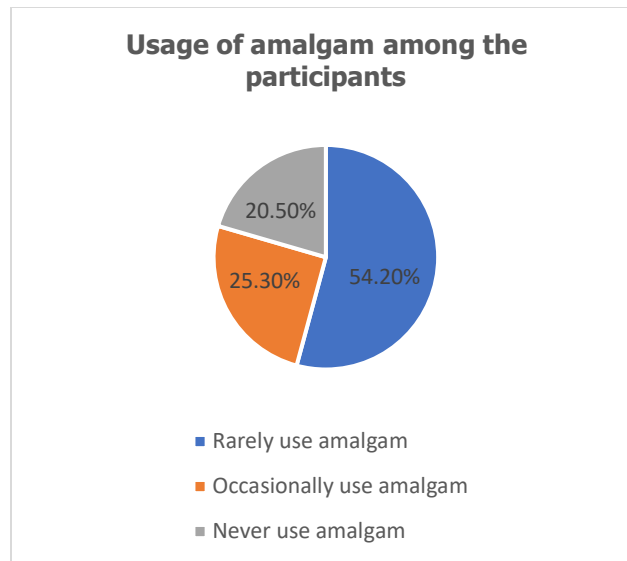


Figure 4: usage of amalgam among the participants

Most of the dentists 76 (92%) reported having been trained in the use of posterior composites in their undergraduate studies, 61 (73.5%) had undergone continuous training after qualifying and 68 (81.9%) reported having undergone training on rubber dam and sectional matrices placement during composite restorations. There was a statistically significant association between the frequency of amalgam usage and continuous training on posterior composite placement ($X^2 = 9.351$, $p = 0.009$), whereby those who received more training on posterior composite reported less usage of amalgam.

DISCUSSION

This study aimed to assess the knowledge, attitudes, and adoption of dental amalgam phasedown among practicing dentists in Nairobi County, Kenya, with the goal of evaluating preparedness for the impending phase-out and identifying potential implementation challenges. The findings demonstrate high levels of awareness and a notable shift toward reduced use of

amalgam; however, attitudinal support for complete phase-out remains mixed, reflecting practical and systemic constraints. All participants were aware of the Minamata Convention, with most demonstrating adequate knowledge of the phasedown and Kenya's status as a signatory. This level of awareness is comparable to findings from developed countries such as Ireland, where similarly high levels of awareness have been reported.¹⁶ The Ministry of Health was identified as the primary source of information, consistent with trends observed in Europe, where implementation has largely been driven by regulatory bodies such as the European Parliament.¹⁷ However, relatively few participants reported acquiring this knowledge through undergraduate training, highlighting an opportunity to strengthen integration of amalgam phasedown concepts within dental curricula.

Despite high awareness, gaps remain in infrastructure and implementation. While the majority of participants were familiar with dental amalgam separators, access and utilization were limited, with more than half

reporting absence of such devices in their facilities. This finding aligns with studies from developing regions, where inadequate infrastructure for mercury and biomedical waste management remains a significant challenge.¹⁸ Strengthening availability and enforcement of amalgam waste management measures is therefore critical during the transition period, particularly given that a substantial proportion of participants still reported some level of amalgam use.

Attitudes toward amalgam phasedown were divided. A considerable proportion of dentists believed that amalgam remains a useful restorative material, citing concerns regarding alternative materials such as resin composites. Similar concerns have been reported in the United Kingdom, where clinicians expressed limited confidence in composite restorations, particularly in complex posterior cases.¹⁹ Evidence from Saudi Arabia further supports these concerns, indicating higher rates of restorative failure and secondary caries associated with composites compared to amalgam.²⁰ In contrast, studies from Europe suggest that the phase-out of amalgam is often regarded as inevitable, with clinicians demonstrating acceptance despite reservations.²¹ These findings suggest that resistance to phasedown is influenced more by practical clinical challenges than by lack of awareness.

Cost implications emerged as a major barrier to implementation. Discussions from the EADAP meetings in Nairobi highlighted concerns regarding the affordability of alternative materials, with participants expressing the need for government support through subsidies or other financial interventions. International experiences vary, with costs borne largely by patients and providers in Norway,²² while in the

United Kingdom, the transition has been supported through publicly funded healthcare systems such as the NHS.^{19, 21} Without similar policy support, the phasedown of amalgam in low- and middle-income countries risks exacerbating existing oral health inequalities.

Despite these concerns, adoption of amalgam phasedown was generally positive. The majority of participants reported rare or no use of amalgam, indicating a shift in clinical practice toward alternative materials. Nevertheless, the proportion of dentists still frequently using amalgam remains higher compared to countries such as Norway, where usage rates have declined significantly.²³ This suggests that while progress is being made, the transition is not yet complete.

The increased use of dental resin composites among participants reflects a broader shift toward minimally invasive and aesthetic restorative approaches. Bulk-fill composites were the most preferred materials for posterior restorations, likely due to their favorable mechanical properties, including improved wear resistance and strength. Additionally, amalgam-free materials offer advantages such as superior aesthetics, absence of corrosion, and more conservative cavity preparation. The therapeutic benefits of materials such as glass ionomer cements, compomers, and giomers, particularly their fluoride-releasing properties, further support their use in patients at high risk of caries.^{3, 24, 25}

Limitations of the study

One of the limitations of this study was that it was conducted in an urban setting, this limits the generalizability to rural areas, a nationwide study is recommended to provide a broader perspective on the status of amalgam phasedown. Additionally, the

cross-sectional design does not capture temporal changes in the knowledge, attitude and practices among the dentists towards the phasedown.

To enhance the uptake of amalgam phasedown strategies and ensure preparedness for complete phase-out, coordinated efforts are required. The Ministry of Health and relevant stakeholders should prioritize improving the affordability and accessibility of alternative restorative materials, as well as expanding continuous professional training to enhance clinical competence and confidence. Such measures will be essential to ensure that the transition away from dental amalgam is both clinically effective and equitable.

CONCLUSION

Dentists in Nairobi County demonstrated good knowledge of amalgam phasedown and positive orientation toward its implementation, with a substantial proportion reporting reduced or discontinued use of dental amalgam in clinical practice. Despite this progress, notable challenges remain, particularly the high cost of alternative restorative materials and concerns regarding their clinical performance in certain applications.

Policy-driven support and stakeholder engagement through government-driven initiatives is recommended to ensure that the phasedown does not compromise the quality and accessibility of oral healthcare, particularly in resource-limited settings.

Conflict of interest

The authors declare no conflict of interest.

Author's contribution

Study conception and design: Laureen Kiao, Laura Edalia

Data collection: Laureen Kiao

Analysis and interpretation of results: all authors

Manuscript preparation: all authors

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