

Intentional Dental Modifications in the African Population

Candy Kgabi *, Scheila Manica  and Hemlata Pandey 

School of Dentistry, University of Dundee, Dundee DD1 4HN, UK; hpandey001@dundee.ac.uk (H.P.)

* Correspondence: candykgabi@gmail.com

Abstract: (1) This research paper aims to conduct a comprehensive review of the existing scientific literature on intentional dental modifications within the African population. By synthesizing and analysing studies, this paper aims to shed light on the prevalence, cultural significance, and forensic implications of intentional dental modifications. (2) A scoping review was conducted according to PRISMA for Scoping Reviews and a search performed in June 2023 on the three electronic databases Scopus, PubMed, and Web of Science. (3) The search resulted in 30 studies and showed that intentional dental modifications, also referred to as nontherapeutic dental modifications, are prevalent across the African population for reasons linked to traditional medicine, ethnic affiliation, and individualism, with the highest-reported modification being infant oral mutilation at 53%, followed by tooth filing at 10%, and others such as lip plates, diastema piercings, dental avulsion, dental tattooing, crowns, and oral piercings. (4) The quality and quantity of the available literature on intentional dental modifications in the African population is limited due to bias in reporting, as most studies are those of individuals with severe health complications. The data gathered from this study could further aid in the analysis and identification of nontherapeutic dental modifications, be used in profiling, and assist in the estimation of population affiliation.

Keywords: forensic dentistry; dental modifications; tooth jewellery; gingiva tattoo; oral piercings; Africa



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1. Introduction

The practice of permanently altering one's body is known as body modification and has been around since ancient times. It may include tattooing, scarification, branding, and dental modifications [1]. In the previous literature, dental modification has been referred to as dental art or mutilation. These modifications are also known as nontherapeutic modifications or intentional dental modifications and are particularly helpful for interpreting human cultures and, therefore, have garnered attention from archaeologists and anthropologists [2]. Scott and Turner have classified dental modifications into (1) dietary, (2) occupational, (3) incidental, and (4) intentional [3]. In this study, the authors investigated the intentional dental modifications that are carried out across the African population.

The dental modifications on African populations are undertaken as part of rites of passage, for social status, as ethnic affiliation markers, fashion trends, and “traditional medicine” [4–6]. In the case of traditional medicine, they are carried out under the belief that they offer therapeutic or preventive properties against various illnesses. These modifications include, but are not limited to, gum tattooing and the extraction of tooth buds in infants, commonly referred to as infant oral mutilation (IOM). IOM is common in the East African region and has led to severe complications, such as odontomas, pulp necrosis, HIV/AIDS, and fatality [4,7–9]. Gum tattooing involves needling in pigments from lantern soot and the plant Jimsonweed (*Datura stramonium*), leaving the gingiva a dark bluish colour [10].

The scientific literature on intentional dental modifications performed on soft tissues in the African population is limited as they are non-invasive. Non-invasive modifications

include, but are not limited to, tooth crowns, dental grills, tooth jewellery, oral piercings, and oral tattoos. Oral piercings and tattoos are reportedly performed to look unique in the West, in contrast to cultural reasons in Africa. Turton reports that lip plates are now used as a form of tourism by Mursi and Surma women, as tourists come to take photographs with them [11]. Researchers have mentioned that oral jewellery is unique and suggest charting these modifications for ease of human identification [12]. Due to the increase in migration to developed countries, healthcare providers and forensic specialists should be aware of these customs and traditions [13]. Intentional dental modification in Africa offers a compelling area of study, as it shows the potential for using dental traits as tools in human identification for possible repatriation.

Dental modifications, whether for therapeutic or non-therapeutic purposes, are an important component in aiding the estimation of identity via dental means and play a crucial role in forensic dentistry [14,15]. This research contributes to our knowledge of intentional dental modification in Africa. Throughout this paper, the term “dental modifications” will refer to intentional dental modifications.

The aim of this study is to investigate the several types of dental modifications across African populations to assist with the identification of dental remains in comparative dental analysis or dental profiling.

2. Materials and Methods

In this scoping review, the PCC model (population, concept, context) was employed in accordance with the recommendations of the Joanna Briggs Institute and it helped us to develop the following review questions [16]:

1. What is known from the existing literature about intentional dental modifications in populations across Africa?
2. Which is the most modified dental tissue in the African population?

Population: humans with the use of any type of modification orally (teeth, lips, tongue), with no restriction on age.

Concept: the type of modification, including, but not limited to, tooth extraction, dental jewellery, tooth filing, and dental mutilation.

Context: we considered all modifications in any setting restricted to Africans.

2.1. Eligibility Criteria

Inclusion criteria: research articles, review articles, and case reports that were published in English, studies specifically focused across African population, studies reporting on non-therapeutic dental modifications such as tooth filing, tooth chipping, dental tattoo, tooth extraction, and tooth jewellery.

Exclusion criteria: dental modifications that were performed for therapeutic purposes, papers outside the African population.

2.2. Search

To identify the relevant scientific literature on dental modifications in the African population, a comprehensive search strategy, using the appropriate keywords for this review, oral piercing, lip modification, gum modification, dental modification, and Africa, was performed in the bibliographic databases Scopus, PubMed, and Web of Science in June 2023. The keywords were combined with BOOLEAN operators for each database, as shown in Table 1. In addition, the reference list of relevant papers was also checked.

Table 1. The search article strategy and highlighted keywords for a study on dental modifications across African populations. The asterisks (*) serve as wildcard characters used to represent various forms and extensions of a keyword.

Step	Keywords Employed
1	Tooth OR Teeth OR Dentin OR Dental OR Dentist * OR Lip OR Labial OR Tongue OR Oral OR Dentition OR Mouth
2	Modification * OR Alteration * OR Mutilation OR Anthropologic *
3	Ornamental OR Cosmetic OR Fashion OR Aesthetic or Esthetic OR Art OR Filing OR Evulsion OR Ablation OR Jewel * OR Inlay * OR Mutilation or Ritual OR Tradition * OR Culture *
4	Africa *
5	1 AND 2 AND 3 AND 4 AND 5

2.3. Data Extraction and Synthesis

The final search results were exported to Endnote 20, duplicates were removed, and the remaining results were finally exported to the Rayyan web application [17], where screening was conducted manually against the inclusion criteria, looking at the titles and abstracts. Articles that were eligible for screening were retrieved and reviewed. The selection process was recorded using a PRISMA flow diagram (see Figure 1).

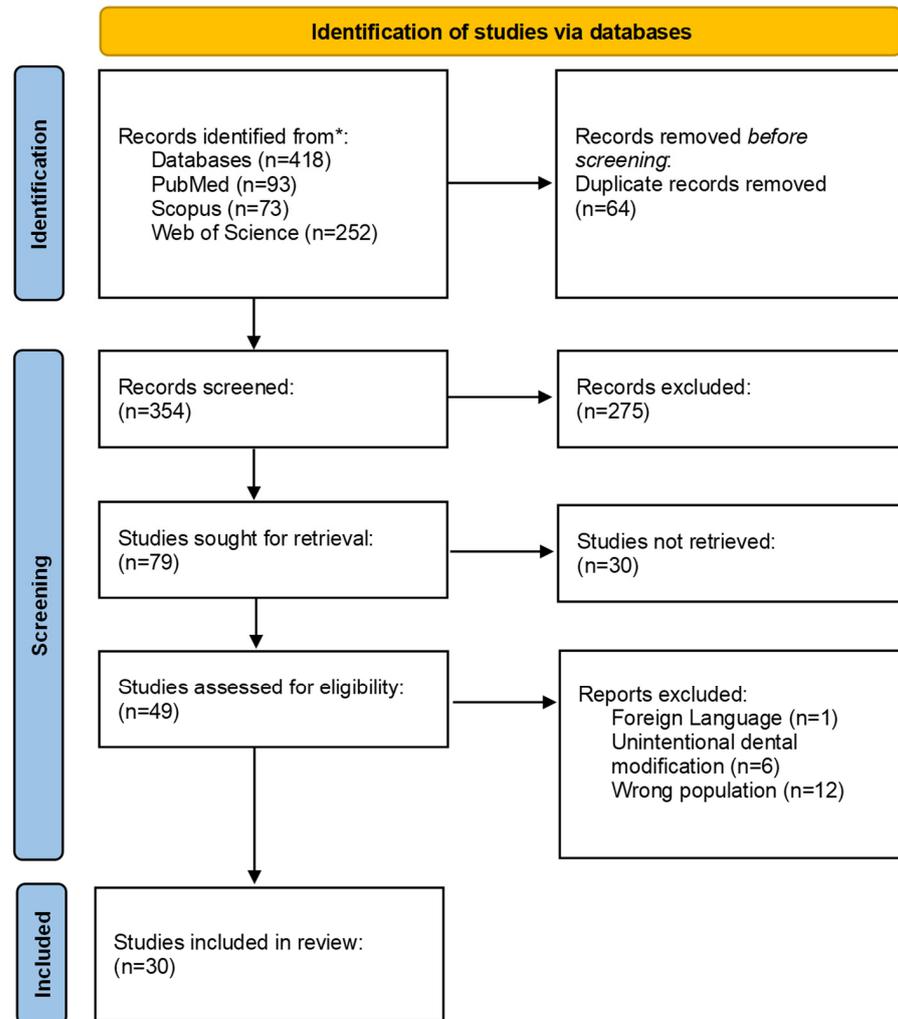


Figure 1. Prisma flow diagram showing selection of included studies [18], where * is the databases [18].

The charting of the data from the included papers was appropriate as a method for scoping reviews. The results were categorised into six categories; (a) author, (b) year of

publication, (c) region of population, (d) soft or hard tissue, (e) type of modification, and (f) purpose of modification; and quantitatively analysed through graphs and tables using Microsoft Excel for Microsoft 365 MSO Version 2312(2023) to show the outcome patterns and relationships. The purposes of modifications will be further examined, categorized into four groups, and elaborated in Table 2.

Table 2. Explanations of the characteristics of the purposes of dental modifications by Kgabi.

Purpose of Dental Modification	Description
Traditional medicine (TM)	Dental modifications performed by traditional healers within the community, believed to treat illness.
Individuality (I)	Dental modifications pursued for cosmetic purposes, aimed at enhancing or altering appearance according to an individual's preference as a form of self-expression.
Ethnic affiliation marker (EAM)	Dental modifications undertaken as a population affiliation, associated with a particular group or tribe to signify cultural or ethnic affiliation.

3. Results

The initial search across three electronic databases led to 418 results. There were 354 articles that remained after the removal of duplicates. These 354 papers were screened, and 275 articles were excluded as they were within the exclusion criteria, resulting in 79 articles before retrieval. The remaining studies were sought for retrieval, and 30 did not have the full text available online. The remaining 49 were screened, looking at the abstracts, and a further 19 were excluded. A total of 30 articles were included in the scoping review (as seen in Figure 1).

The 30 eligible studies were categorized into different types. Archaeological studies involved the excavation of human remains and were conducted in the following countries: Botswana (n = 1), Gabon (n = 1), and Mali (n = 1).

Observational studies (n = 13) utilized questionnaires and examinations for their research and were conducted in the following countries: Ethiopia (n = 4), Kenya (n = 2), South Africa (n = 2), Sudan (n = 1), Tanzania (n = 1), and Uganda (n = 3).

Literature reviews (n = 7): a total of seven articles were literature reviews.

Case reports (n = 7) demonstrated complications of intentional dental modifications from the following countries: Sudan (n = 1), Nigeria (n = 1), Ethiopia (n = 3), Chad (n = 1), and Somalia (n = 1).

Based on the oral tissue modification categorization, hard tissue (n = 28) and soft tissue (n = 6) are observed in this study.

The purpose of modification was examined in 34 instances (n = 34). The most frequent was traditional medicine (n = 19), followed by ethnic affiliation markers (n = 13), and individualism (n = 2). This analysis highlights the diverse motivations behind intentional dental modifications in the reviewed literature.

The overall results according to the categories are shown in Table 3.

Table 3. Summary of evidence according to the characteristics of the study. Abbreviations: A is avulsion, DP is diastema piercing, GT is gingiva tattooing, TF is tooth filing, TBE is tooth bud extraction, TC is tooth crown, OP is oral piercing, LP is lip piercing, and LPI is lip plate.

Author	Country	Oral Tissue (S = Soft, H = Hard)	Type of Oral Modification	Region of Modification in the Mouth	Purpose of Modification
Agbor et al. [19]	Cameroon	H	TF	Upper anterior teeth	EAM
Amailuk et al. [4]	Sudan	H	TBE	Deciduous lower canines	TM
Arigbede et al. [5]	Nigeria	H	DP	Upper anterior teeth	TM

Table 3. Cont.

Author	Country	Oral Tissue (S = Soft, H = Hard)	Type of Oral Modification	Region of Modification in the Mouth	Purpose of Modification
Aseffa et al. [20]	Ethiopia	H	DP	Upper anterior teeth	TM
Brooks and Reynolds [21]	Ethiopia	S	GT	Anterior gingiva	TM
Davidovich et al. [8]	Ethiopia	H	TBE	Deciduous lower canines	TM
Dinur et al. [22]	Ethiopia	H	TBE	Deciduous lower canines	TM
Diouf et al. [23]	Senegal	H	TC	Anterior teeth	I
		S	GT	Anterior gingiva	EAM
Ebrahim and Naidoo [24]	RSA	S	OP	Lips and tongue	I
Elgamri et al. [25]	Sudan	H	TBE	Deciduous lower canines	TM
Fabian and Mumghamba [6]	Tanzania	H	TF	Upper anterior teeth	EAM
		S	LP	Upper lip	
Finucane et al. [26]	Mali	H	TF	Upper anterior teeth	EAM
Friedling et al. [27]	RSA	H	A	Anterior teeth	EAM
Garve et al. [28]	East Africa	H	TBE	Deciduous lower canines	TM
Garve et al. [29]	Ethiopia	S	LPI	Lower lip	EAM
Gebrekirstos et al. [30]	Ethiopia	H	TBE	Deciduous lower canines	TM
Girgis et al. [31]	Not stated	H	TBE	Deciduous lower canines	TM
L. J. Hoenig [32]	Congo	S	LPI	Upper and lower lips	EAM
Husain et al. [33]	Uganda	H	TBE	Deciduous lower canines	TM
Kemoli et al. [34]	Kenya	H	TBE	Deciduous lower canines	TM
Khonsari et al. [35]	Chad	H	TBE	Deciduous lower canines	TM
Mekete et al. [36]	Ethiopia	H	TBE	Deciduous lower canines	TM
Mosothwane [37]	Botswana	H	TF	Upper central incisors	EAM
Musinguzi et al. [38]	Uganda	H	TBE	Deciduous lower canines	TM
Mutai et al. [39]	Kenya	H	TBE	Deciduous lower canines	TM
Noman et al. [40]	Somalia	H	TBE	Deciduous lower canines	TM
Noy et al. [41]	Ethiopia	H	TBE	Deciduous lower canines	TM
		H	TF	Upper anterior incisors	EAM
		H	TBE	Deciduous lower canines	TM
J. J. Pindborg [42]	Uganda	H	A	Lower central incisors	EAM
		H	TBE	Deciduous lower canines	TM
		H	TF	Upper anterior incisors	EAM
Villootte et al. [43]	Gabon	H	A	Upper central incisors	EAM
Wandera and Kasumba [44]	Uganda	H	TBE	Deciduous lower canines	TM

Tooth bud extraction is the most common type of modification at (n = 17), followed by tooth filing (n = 5), avulsion (n = 3), diastema piercing (n = 2), gingiva tattooing (n = 2), lip plates (n = 2), lip piercing (n = 1), oral piercing (n = 1), and tooth crowns (n = 1), as seen in Figure 2.

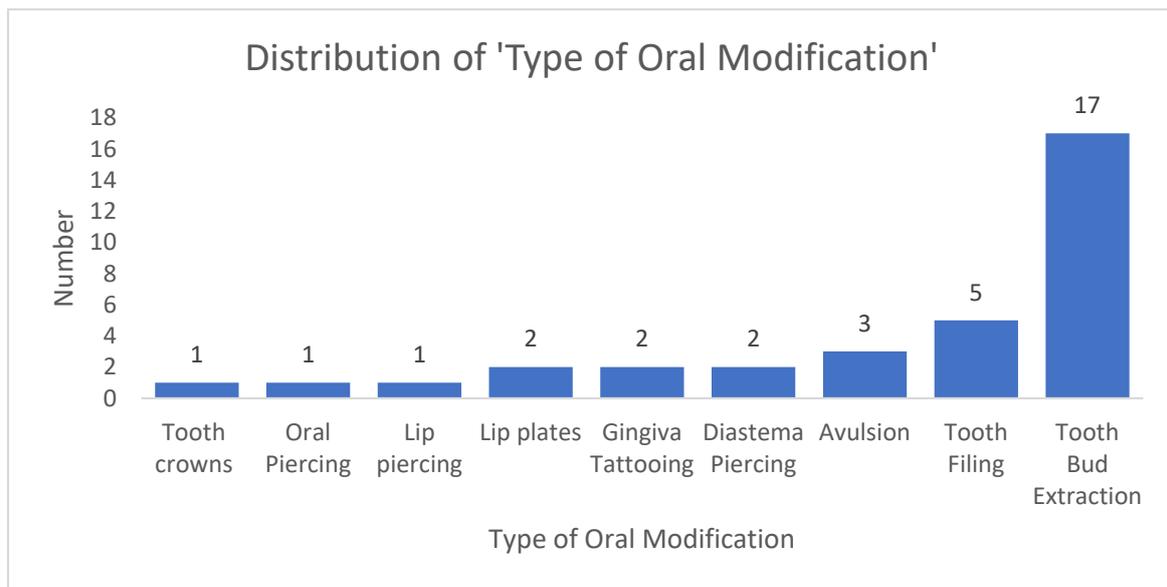


Figure 2. Chart illustrating the types of oral modifications.

The most common region of modification is the deciduous lower canines (n = 17), followed by the upper anterior teeth (n = 4), upper central incisors (n = 2) and one count each for the rest of the regions, as seen below in Table 4.

Table 4. Distribution by region of modification.

Region in the Mouth	Number
Deciduous lower canines	17
Upper anterior teeth	4
Upper central incisors	2
Anterior teeth	2
Anterior gingiva	2
Upper central incisors	2
Lower central incisors	1
Lips and tongue	1
Upper and lower lips	1
Upper lip	1
Lower lip	1
Grand total	34

4. Discussion

Forensic dentistry’s identification process utilizes antemortem dental charts and post mortem examinations. The study examined 30 papers spanning from 1969 to 2020, outlining intentional dental modifications among the African population, highlighting the acknowledgment of this practice in academia. It is evident that the research focusing specifically on soft tissue modifications remains limited.

To address the initial research question, the existing literature provides insight into the reasons behind these modifications. This enables a comprehensive understanding and appreciation of the practices associated with modifications.

With respect to the second research question, it was found that most of the modifications were performed on hard tissues as opposed to soft tissues. The prevalence of modifications on hard tissues may indicate that certain cultural practices in Africa place greater emphasis on altering the appearance of the teeth. Furthermore, it might imply that individuals seek changes to their smile, driven by cultural beliefs, fashion, or self-

expression. This distribution also suggests that there may be a continuity of traditional practices within certain communities.

4.1. Hard Tissue Modifications

Hard tissue modifications accounted for 82.3% of the dental modifications, with the prevalence attributed to the invasive nature of the techniques employed.

From this study, 56.7% of the papers are on infant oral mutilation (IOM), which would explain why the most reported area in the oral cavity of dental modification comprises the “deciduous lower canines”. The prevalence of IOM has led to severe complications such as odontomas, root dilaceration, pulp necrosis, HIV/AIDS, and fatality [4,45]. IOM, commonly known as “Ebiinyo” is believed to have been started in the 1930s in Africa by colonial dentists and then adopted by traditional healers, in an effort to “heal” infants that had fever and vomiting as the protruding tooth buds were considered to cause infants to be sick [31]. IOM is performed with either a hot knife, blade, or fingernail, with no sterilization involved [8,25,31]. A study performed in Uganda reports that infants that had IOM performed had a higher mortality rate due to sepsis and bacteraemia [33]. A study conducted in Israel showed that 57.7% of Ethiopian children aged between 3.5 and 6.8 years had their canines missing. This suggests that even after emigrating, the practice of IOM continues. On the contrary, a study performed in Sudan showed a decrease in the prevalence of IOM, alluding to the awareness of IOM oral health education [25,36,38]. Gebrekirstos et al. concur with the decline in IOM in Ethiopia as healthcare is now easily accessible [30]. However, in 2018, the prevalence was high, at 61%, in Kenya in the Maasai population [34], indicating that the community still holds strongly to their belief and suggesting that communities in rural areas do not have access to healthcare facilities. The studies demonstrate that IOM originates from East Africa and is most concentrated in the East African population, posing the question of whether specialists can use the absence of canines in the estimation of ancestry.

Avulsion is when a tooth is completely removed from its socket, which is commonly referred to as ablation. This practice is prevalent in South Africa, and reasons for this modification include peer pressure, fashion, and gang initiation [27]. Dental avulsion has been observed from precolonial times in Gabon, from an exhumation showing missing central and lateral incisors; the author points to ablation as there were no signs of pathological diseases, making this a strong ethnic marker [43].

Tooth filing is the next most commonly reported modification type, at 13%. It is synonymously known as tooth “chipping” or “knocking”. Tooth chipping is performed as more of an ethnic affiliation than a beauty enhancer. In Southern Africa, tribes in the Namib desert, the !Kung and Chokwe, are known to file their teeth into a pointy shape to look like lions [46]. In 2016, an excavation was carried out in Botswana, and the human remains were identified as being from the Chokwe tribe due to the inverted V modification performed on the central incisors [37]. This is imperative in showing that intentional dental modifications can be used in human identification and profiling. The findings illustrate that tooth filing is widespread across Africa, which would make it hard to estimate ancestry if looking solely at this type of modification.

A diastema is embraced in some parts of Africa, and people intentionally increase the diastema, as it is regarded as a sign of beauty [47]. Only two papers reported on diastema piercing, which is the act of enlarging the space between the central incisors performed by non-dental professionals. Traditionally, this process is performed by an elder woman, with a handheld axe, or a metal file, but recently, social media has seen a rise in cases where nail technicians use handheld drills to make the diastema wider. This intentional modification involves using a sharp filing instrument with no anaesthesia and, if performed incorrectly, can result in the necrosis of pulp and the need for endodontic treatment [5]. In Sudan, diastema piercing is also performed as an ethnic affiliation marker, with the belief that participants will resemble their ancestors [20]. This is a strong indicator of cultural integrity.

Considering that these modifications are performed by non-clinical practitioners, it would be advisable for clinicians to document artificially made diastemas if observed.

A tooth crown is a type of cap that is placed over a tooth and may be placed after a root canal or a filling; however, in the case of intentional dental modification, it is placed over a healthy tooth, and usually a gold crown is preferred. A tooth crown represents beauty, elegance, and wealth, and can be worn by both men and women [23]. Recently, in South Africa, there has been a rise in dental modification of gold teeth or “grillz” [48]. The evolution from having one single gold tooth to having multiple teeth is evident in this regard, driven by fashion and media.

4.2. Soft Tissue Modifications

According to the study’s findings, soft tissues account for 17.7% of dental modifications; one can hypothesise that, despite the prevalence and popularity of soft tissue modifications, there will be fewer case reports as they heal quickly, are less painful, and have few-to-no consequences.

Gingiva tattooing is a common practice in Ethiopia, performed on the anterior gingiva and sometimes on the lips and surroundings of the mouth [21]. Brooks and Reynolds report a case of gingiva tattooing, which was performed to alleviate dental pain in the upper jaw but was unsuccessful in this regard [21]. Diouf et al. report that the Fulani tribe in Mali associate gum tattooing with courage, elegance, and nobility when choosing a wife [23]. Gingival tattooing is a tradition that is carried out currently, and more research should be conducted on the long-term effects of this practice. In addition, the results of this study show that gingiva tattoos may be found in both the Eastern and Western parts of Africa, which raises the question of whether they are common throughout the continent or are exclusive to these two areas.

Oral piercings are cosmetic piercings of the oral cavity with the insertion of decorative art, such as a ring or plate. In 2008, a study was conducted on the prevalence of oral piercings in South Africa and illustrated that oral piercings are a trend common among those aged 16–18 years. However, the modification of lip piercing is not a new one in Africa. It is reported that, in the 1930s, lip plates were prevalent in Congo; the lip was pierced, and gradually stretched out with plates [32]. This is also seen in women in Ethiopia and is used as a measurement of bride price [29]. Garve reports a decrease in the use of lip piercings in the people of Sudan, Ethiopia, and Tanzania because of westernization [29]. On the contrary, Turton reports that lip plates are now used as a form of sociocultural tourism [11]. It is essential to see whether this practice is still performed in the modern day, and to observe the long-term effects of this modification. Superficially, there is reason to think that non-invasive modifications are insignificant; however, in forensic dentistry, they could be exactly what is needed to aid identification.

4.3. Preferred Teeth and Purposes

The distribution of intentional dental modifications revealed that the lower deciduous canines (47%) and upper anterior teeth (23.5%) emphasize the importance of visible areas in and around the mouth. Selfies, which prominently feature anterior teeth and facial expressions, contribute to shaping dental profiles; the combination of selfies and forensic dentistry can be employed to classify identifiable modifications, aiding in the identification of individuals. To optimize forensic investigations, a comprehensive database of dental modifications is required, which would help in establishing connections between individuals and their respective intentional dental modifications and allow easy access to dental profiles to authorities. Other areas of the mouth have lesser frequencies, suggesting their relative insignificance in intentional dental modifications within the studied African population.

Traditional medicine is the most prevalent reason, accounting for 55.9% of cases, reflecting its significance in cultural and spiritual practices. This observation suggests that dental modifications are closely tied to traditional healing and belief systems. Ethnic affiliation

markers represents 38.2% of cases, indicating the role of oral modifications in expressing cultural identities. These modifications may serve as markers of ethnic groups, fostering a sense of belonging. Understanding the cultural significance of these affiliations can offer important anthropological insights. Individualism is less common, at 5.9%, suggesting that personal expression through dental modifications is not as widespread, and possibly implying that self-expression modification is performed through other body modifications.

4.4. Limitations

One limitation of this study is the emphasis on invasive modifications in the literature, resulting in a lack of attention given to intentional modifications involving soft tissues. The exploration of intentional modifications such as tooth jewellery and dental grills that are common in Africa is overlooked. The findings from this study cannot necessarily be generalised to the African population, due to the limited research. Future studies should include larger populations in studies to improve the generalizability.

Another limitation is that language was used as an exclusion criterion. Africa is incredibly diverse, both culturally and linguistically and by limiting the inclusion criteria to English-only publications, there is a risk of excluding valuable research conducted in other languages, such as French. This exclusion has led to a lack of representation of certain regions, cultures, and scientific communities within Africa. Each language has its unique perspectives, findings, and insights, and by focusing solely on English, a considerable portion of the scientific discourse was overlooked. This exclusion has created a language bias, potentially marginalizing the contributions of researchers who publish in other languages. Researchers should remain mindful of the potential biases introduced by language criterion decisions and strive to strike a balance between feasibility and inclusivity to enhance the robustness and relevance of their findings.

Future research should focus on non-invasive dental modifications to bridge the knowledge gap and provide a more comprehensive understanding. Documenting modifications with visual aids, such as photographs and dental charts, is essential for easy comparison. Conducting primary research, like interviews and questionnaires, will offer cultural insights into modifications. Lastly, future studies should address the incidence and long-term effects of non-invasive dental modifications based on the findings.

5. Conclusions

Forensic dentists are responsible for identifying unknown human individuals and dental age assessment and use different methods to reach their conclusion.

According to the results, there is vast knowledge on infant oral mutilation, but little information on other types of intentional dental modifications. The most modified tissue is the hard tissue, which can aid in dental identification. Forensic dentists should consider the absence of teeth or oral modifications as potential indicators of specific populations. The majority of the modifications were observed in Ethiopia, followed by Uganda, suggesting that modifications are more common in East Africa.

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