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Original Article

Burden and Determinants of Oral Exostoses in a Mississippi Population: A Retrospective Study

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Abstract

This research aimed to determine the prevalence of exostosis among individuals in Mississippi. A review of the patient database at the UMMC School of Dentistry was conducted from January 2018 to May 2021. Subjects presenting with exostosis were identified and enrolled through evaluation of intraoral photographs, full-mouth series (FMS), panoramic radiographs, and cone-beam computerized tomography (CBCT) scans. Individuals lacking either maxillary or mandibular exostosis were not considered for inclusion. Additionally, demographic information—namely age, sex, and racial background categorized as Caucasian, African-American, or Asian—was collected for each subject. All exostosis-related data were subsequently analyzed and organized by age, sex, and racial background. To obtain a more granular statistical picture, multiple logistic regression analysis was applied. The presence of maxillary and mandibular tori was investigated in a sample of 1242 patients. Of these, 303 individuals in the Mississippi cohort received a diagnosis of maxillary and/or mandibular tori, yielding an overall prevalence of 24.4%. The condition was more commonly encountered among females (57.4%) than among males (42.6%). When stratified by race, the highest frequency was documented in Caucasians (71.3%), with African-Americans accounting for 23.8% and Asians comprising 5%. A notably high prevalence of exostosis was observed in the Mississippi population. The data generated from this work can heighten clinical awareness of these bony protrusions, thereby strengthening diagnostic accuracy. This knowledge may prove especially valuable for oral surgeons, periodontists, and prosthodontists engaged in pre-prosthetic surgical planning and denture construction.

Keywords: Exostosis, Tori, Hyperostosis, Mandible, Maxilla, Oral findings

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Introduction

Tori, also referred to as exostosis, represent non-pathologic, generally symptom-free, benign overgrowths arising from the cortical bone layer [1-3]. Their nomenclature depends upon their specific positioning within the jaw bones [2, 4]. The type most frequently encountered, developing on the palatal bone along the midline of the maxilla, is termed torus palatinus [2, 5]. The variant that appears on the lingual side of the mandibular premolar and canine region, typically affecting both sides, is designated torus mandibularis [2, 5, 6]. Beyond these two dominant presentations, tori may also emerge on the vestibular, buccal, or palatal surfaces of the jaws [7]. Classification of these bony outgrowths takes into account their size (palpable, visible, or large) and contour (flat, nodular, spindle-shaped, or lobular) [1, 8].

The mechanisms underlying oral tori, including torus palatinus, are not yet fully elucidated; however, several hypotheses propose that autosomal dominant inheritance and genetic determinants play a substantial role in their genesis. Although associations have been drawn between torus palatinus and chromosomal disorders as well as Mendelian syndromes, the prevailing view, grounded largely in observational findings, is that its inheritance follows an autosomal dominant pattern [9]. At the same time, it has been linked to parafunctional habits such as tooth clenching and bruxism, as well as to tooth loss, which may result in excessive occlusal loading or an uneven distribution of masticatory forces [10]. Investigators have also explored the contributory role of environmental factors, such as vitamin deficiencies or diets rich in calcium, in the etiology [1, 3]. Even though the precise etiology remains unclear, published studies indicate that the incidence of oral tori can vary with factors such as ethnicity, sex, and age [11-14].

Oral tori are not classified as pathological entities [4]. They represent benign, slowly expanding osseous formations built mostly of compact bone. Under the microscope, they consist of dense cortical bone that is ordinarily well delineated from the surrounding tissue. Occasional inclusions of trabecular bone may be seen, yet the structure is principally cortical in nature and usually demonstrates scant vascularity or inflammatory change [1- 3, 15]. In selected scenarios, these tori may serve a useful function; for example, documented cases exist of similar growths being harvested surgically for regenerative purposes, serving as an autogenous bone graft donor site [4, 14]. In other situations, however, this anatomical feature creates obstacles for both the individual and the treating practitioner [14]. It is well recognized that such osseous prominences can obstruct a patient's ability to perform adequate oral hygiene and that repeated chewing-related trauma over a torus can predispose the overlying soft tissue to ulceration [1, 16]. Moreover, they can pose technical challenges for oral surgeons and prosthodontists during surgical procedures and prosthetic rehabilitation [14, 17]. To illustrate, wound healing after gingivectomy near a mandibular torus may deviate from the expected course, leading to restricted flap mobility and complicating dentoalveolar surgical interventions [1, 14]. When such complications arise, the operative removal of the oral tori may be indicated [18]. It is therefore imperative that general dental practitioners, oral and maxillofacial surgeons, periodontists, and prosthodontists maintain a high index of suspicion for these anatomic variants and account for them meticulously during treatment formulation.

The central objective of the present study was to quantify the prevalence of tori in a Mississippi-based population, thereby furnishing dental healthcare providers in the state with timely and reliable epidemiologic data. Global statistics on the prevalence of maxillary and mandibular tori exhibit marked variation. A secondary purpose of this investigation was to augment the existing body of evidence by drawing on a Mississippi demographic to yield more reliable prevalence figures for this geographic region.

Materials and Methods

The research protocol was approved by the Institutional Review Board of The University of Mississippi Medical Center (IRB file number: 2021V0588). Every step of the study was carried out in compliance with the Helsinki Declaration.

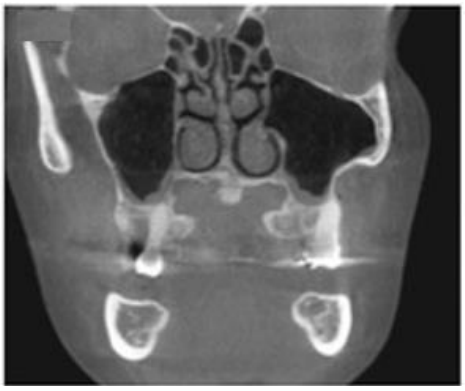
The patient records of the University of Mississippi Medical Center School of Dentistry (UMMC SOD) served as the basis for this retrospective analysis. A comprehensive review was undertaken of intraoral photographs, full-mouth series (FMS), panoramic radiographs, and cone-beam computerized tomography (CBCT) scans obtained from the clinic's repository of individuals managed at UMMC SOD from January 2018 through May 2021. Individuals aged 18 years or older who demonstrated evidence of oral tori were enrolled in the study **(Figures 1 and 2)**. A designated EPIC code was also applied to identify patients with tori within the database. Intraoral photographs routinely display bony excrescences along the palatal or mandibular contours as well as circumscribed nodular or sessile elevations. Panoramic radiographs depict oral tori as radiopaque, sharply bordered masses located in the maxillary or mandibular arches. Identification of these masses via CBCT imaging yields additional granularity, pinpointing the exact site, dimensions, and configuration of the tori, thereby facilitating distinction from alternative osseous pathologies or exostoses. Radiographically, tori consist of dense cortical bone, usually lacking notable trabecular contribution, and present as non-expanding, static formations. Subjects whose imaging results, across the various modalities, conformed to these characteristics were eligible for inclusion in the evaluation. Recorded parameters comprised the age, sex, and racial origin (Caucasian, African-American, or Asian) of the participants. The anatomical location was likewise assessed, noting whether the relevant structure was confined to the maxilla alone, the mandible alone, or involved both jaws. All protected health identifiers were stripped before data consolidation.

a)

b)

Figure 1. Intraoral ph otos of patients with tori. (a) Intraoral photograph of a patient with maxillary tori. (b) Intraoral photograph of a patient with mandibular tori.

a)



b)

c)

Figure 2. CBCT cross-section images of patients. (a) CBCT sagittal section image of a patient with maxillary tori. (b) CBCT coronal section image of a patient with maxillary tori. (c) CBCT axial section image of a patient with mandibular tori.

Statistical processing was conducted using IBM SPSS V 23 (IBM SPSS Statistics for Windows, Version 23.0, Armonk, 2015, NY: USA). The analytical approach involved multiple log istic regression, and the cutoff for statistical significance was established at $P < 0.05$.

Results and Discussion

A sample of 1242 patients was screened for maxillary and mandibular exostosis. Overall, 303 individuals in the Mississippi population were identified with max illary and/or mandibular tori, yielding a prevalence of 24.4%. The age distribution among affected patients spanned from 18 to 93 years. The average age was 56 ± 16.2. The condition was more prevalent in females (n = 174, 57.4%) than in males (n = 129, 42.6%). Stratification by race revealed a higher frequency among Caucasians (n = 216, 71.3%) than among African-Americans (n = 72, 23.8%) and Asians (n = 15, 5%). The subset with oral tori strictly in the maxilla comprised 30 patients (9.9%), those with tori restricted to the mandible totaled 195 (64.4%), and those with tori in both jaws totaled 78 (25.7%).

From the 300 tori-diagnosed patients, 216 were Caucasian. Within this group, 126 (58.3%, n = 126) were female, and 90 (41.7%) were male. Tori were located exclusively in the maxilla in 18 individuals (8.3%), exclusively in the mandible in 138 (63.9%), or in both jaws in 60 (27.8%). Caucasian patients had a mean age of 54.8 ± 15.2 years. The African-American contingent numbered 72. Of these, 39 (n = 39, 54.2%) were female, and 33 (45.8%) were male. Tori were limited to the maxilla in 12 cases (16.7%), to the mandible in 45 cases (62.5%), and affected both jaws in 15 cases (20.8%). The mean age of African-American patients was 48.2 ± 16.9 years. The Asian subgroup included 15 patients. Here, 9 (n = 9, 60%) were female, and 6 (40%) were male. None of the Asian patients had tori solely in the maxilla; 12 (80%) displayed them only in the mandible, and 3 (20%) had them in both jaws. The mean age for Asian patients was 51.4 ± 23.5 years **(Table 1).**

Table 1. Distribution of patients according to ethnicity.

Variable	Category	Caucasian	African-American	Asian
Sex distribution	Female	n = 126 (58.3%)	n = 39 (54.2%)	n = 9 (60%)
	Male	n = 90 (41.7%)	n = 33 (45.8%)	n = 6 (40%)
Anatomical location	Maxilla only	n = 18 (8.3%)	n = 12 (16.7%)	n = 0 (0%)
	Mandible only	n = 138 (63.9%)	n = 45 (62.5%)	n = 12 (80%)
	Both jaws	n = 60 (27.8%)	n = 15 (20.8%)	n = 3 (20%)
Age statistics	Median (range)	56 (18–93)	52 (20–75)	51 (24–90)
	Mean ± SD	54.8 ± 15.2	48.2 ± 16.9	51.4 ± 23.5

Tori presenting exclusively in the maxilla were documented in 30 patients, among whom 27 (90%) were female, and 3 (10%) were male. Of those with maxillary-only tori, 18 individuals (60%) were Caucasian and 12 (40%) were African-American. The mean age of patients with tori confined to the maxilla was 51.9 ± 12.4 years. Cases with tori occurring only in the mandible reached 195, split between 99 (50.8%) females and 96 (49.2%) males. Regarding ethnicity, 138 patients (70.8%) were Caucasian, 45 (23.1%) were African-American, and 12 (6.1%) were Asian. The mean age for this group was 54.1 ± 16.6. Tori were detected in both jaws among 78 patients, of whom 48 (61.5%) were female and 30 (38.5%) were male. Among those with tori in both arches, 60 (77%) were Caucasian, 15 (19.2%) African-American, and 3 (3.8%) Asian. The mean age of patients with tori in both jaws was 51.1 ± 16.9 years **(Table 2).**

Table 2. Distribution of patients according to the localization of oral tori.

Parameter	Category	Only maxillary	Only mandibulary	Both jaws
Gender	Female	n = 27 (90%)	n = 99 (50.8%)	n = 48 (61.5%)
	Male	n = 3 (10%)	n = 96 (49.2%)	n = 30 (38.5%)
Ethnicity	Caucasian	n = 18 (60%)	n = 138 (70.8%)	n = 60 (77%)
	African-American	n = 12 (40%)	n = 45 (23.1%)	n = 15 (19.2%)
	Asian	n = 0 (0%)	n = 12 (6.1%)	n = 3 (3.8%)
Age	Median (range)	50 (29–67)	58 (20–93)	51.5 (18–87)
	Mean ± SD	51.9 ± 12.4	54.1 ± 16.6	51.1 ± 16.9

According to the multiple logistic regression, the odds of mandibular tori were unrelated to patient age ($P = 0.59$) or Asian ancestry ($P = 0.99$), but were significantly associated with patient sex ($P < 0.001$) and Black ancestry ($P = 0.04$). The strongest predictive formula for mandibular exostosis was:

$$\text{logit}(P) = \log(P/(1 - P)) = 4.091 - 2.113 \times \text{female} - 0.989 \times \text{black} \quad (1)$$

Where P represents the probability of tori presence, and female and black serve as dichotomous observational variables (0 = false or 1 = true). The predictive capacity of this model reached 90%.

The multiple logistic regression further demonstrated that the odds of maxillary tori were not associated with patient age ($P = 0.08$), Asian ancestry ($P = 0.18$), or Black ancestry ($P = 0.98$), but were significantly associated with patient sex ($P < 0.001$). The strongest predictive formula for maxillary exostosis was:

$$\text{logit}(P) = \log(P/(1 - P)) = -1.068 + 0.79 \times \text{female} \quad (2)$$

Where P represents the probability of tori presence, and female is a dichotomous observational variable (0 = false, 1 = true). The predictive capacity of this model reached 64%.

This retrospective analysis evaluated the frequency of oral tori in a Mississippi population, focusing on associations with ethnic background, age, and biological sex. The data we gathered demonstrate that exostoses affecting both the upper and lower jaws occur more frequently in women, and a substantially elevated frequency was observed among Caucasian individuals in this cohort. The knowledge gained from these patterns contributes meaningfully to our understanding of how demographic characteristics shape the distribution of this anatomical variation, highlighting trends that may inform future clinical practice and population-level research. From a practical clinical standpoint, the relevance of these observations stems from the fact that tori are straightforward to detect on routine radiographic examination, and their comparatively high prevalence in Mississippi may necessitate greater attentiveness on the part of dental clinicians, particularly when formulating prosthetic treatment strategies. If these bony protuberances are indeed encountered more frequently in this geographic area than in other groups, such a finding could inform standard care protocols and call for more individualized approaches to treating patients who present with these osseous outgrowths.

The published literature includes comparable studies that have measured the prevalence of oral tori across various population groups [5, 7, 10, 12, 19-28]. A survey of prior work indicates that the rate at which bony nodules appear varies considerably across populations. Even though abundant research affirms that cohorts originating from Jordan [10], Japan [19,20], Turkey [12], Taiwan [21], Morocco [22], Romania [23], Nigeria [24], Malaysia [25], Thailand [5,7], Norway [27], and Ghana [28] exhibit oral tori, comparatively few studies have been directed at inhabitants of the United States. Among the limited U.S.-based reports, Austin *et al*. [29] communicated that palatal tori were present in 19.5% of African-American individuals in the country. Separately, Woo [30] reported prevalence figures of 37% among African Americans, 45% among White Americans, and 47% among Mongolians in the United States. By contrast, the research presented here did not restrict its focus to the palate alone; rather, it encompassed all oral tori throughout the cavity, revealing that 24.4% of people in Mississippi harbor these formations. In a further investigation set in the USA, Sonnier *et al*. [14] examined a collection of 328 contemporary American skulls to log instances of mandibular tori, palatal tori, and palatal tubers [14]. The authors reported that, among 254 crania classified as Caucasian, mandibular tori were identified in 63 cases (24.8%) and palatal tori in 58 cases (22.8%) [14]. Within that same study, 25 of the 74 skulls of African-American origin exhibited mandibular tori (33.8%), whereas palatal tori were present in only 9 specimens (12.2%) [14]. Given that the origins of oral tori involve an interplay of hereditary and environmental determinants, a heightened prevalence within specific populations and ancestral groups is an expected phenomenon [11-14]. To the best of our knowledge, the research at hand is the only published investigation on this subject to focus exclusively on the Mississippi populace. As such, it stands to enrich the existing evidence base and sharpen practitioners' diagnostic awareness of this anatomical entity.

Our data clearly show that the percentage of individuals with oral tori varies markedly by ethnicity. These observations point toward ancestral origin as a meaningful contributor to the formation of these structures. Along similar lines, El Sergani *et al*. [18] evaluated the frequency of the torus palatinus across a combined sample of 1102 individuals, comprising 625 of European descent, 377 of West African descent, and 100 of East Asian descent. Although the exact population examined in the present study was not identical, Sergani *et al*. [18] reported a higher prevalence of torus palatinus among women of East Asian ancestry. Such an outcome bolsters the view that both ancestral heritage and biological sex may influence prevalence figures. Sergani *et al*. [18] further observed in their dataset that torus palatinus was more frequent in females, a result that aligns with the findings we report here. Consistent with these patterns, multiple analyses across groups of European, African, and Asian lineages have indicated that maxillary palatal tori are more common among women. In the course of a Norwegian investigation, Haugen [31] surveyed for palatal tori and found them in 11.2% of female participants versus 6.7% of male participants, confirming a female predominance. Data from other sources reveal that this anatomical feature is similarly common among women who identify as Black American [18, 29], Thai [5], and Ghanaian [28]—that is, reports have yielded similar conclusions. While torus palatinus was not the direct, isolated subject of scrutiny within the present work, one may nonetheless assert that maxillary tori prevalence corresponds to these earlier reports, insofar as a female predominance was likewise detected.

Several complementary investigations reinforce the view that oral tori incidence is not uniform but rather varies across human populations. For example, Kumar Singh *et al*. [4] sought to determine the prevalence of oral tori in a Malaysian context. Their research distinguished among three separate categories of tori: torus palatinus, torus mandibularis, and exostosis [4]. The research team documented that oral tori appeared at a frequency of 33% in the sample under review [4]. Their analysis found that torus palatinus was most often diagnosed in women, whereas torus mandibularis and exostosis showed a male predominance [4]. The finding that the torus palatinus is more characteristic of females converges with other studies cited and the present report [4, 5, 18, 29]. Moreover, the current investigation noted that torus palatinus prevalence was greater among individuals of Malay extraction than among those of Chinese or Indian background [4]. Kumar Singh *et al*. [4] noted that oral tori occurred frequently in their study groups and emphasized that clinicians should remain mindful of these bony landmarks during procedures such as denture design.

Yet another study examined the distribution of buccal and palatal tori in a Thai cohort [7]. Mirroring the methodology of the present work, bony prominences arising in either the maxilla or the mandible were appraised as distinct categories. The authors observed tori, or osseous nodules, in 26.9% of the 960 participants. The rate registered in the Mississippi group stood at 24.4%, a figure that aligns very closely [7]. That investigation revealed a greater predominance of tori located in the lower jaw, with male sex conferring a higher likelihood for tori in both the maxilla and the mandible [7]. It is our view that the contradictory findings scattered throughout the literature on this matter may well be attributable to genuine differences between the populations under study. The Thai study mentioned above further indicated that advancing age raises the probability of presenting with tori [7]. In a similar vein, research conducted in Jordan by Sawair *et al*. (2019) likewise documented an age-dependent escalation in oral tori prevalence, peaking in patients in their fifties [17]. Here, the presence or absence of tori was examined in subjects aged 18-91 years, and a parallel tendency toward greater prevalence at advanced ages was observed. The mean age of individuals who harbored tori stood at 56 ± 16.2. That said, a body of work exists that runs contrary to these findings. For example, Jainkittivong *et al*. [26] concluded from their Thai sample that both mandibular and palatal tori are most frequently observed during the third decade of life. Likewise, a report by Telang *et al*. [25] from Malaysia reported a peak in tori occurrence among individuals aged 20–29 years.

The outcomes of the present investigation align with a substantial body of published work and document the frequency of oral tori within the Mississippi demographic, yet several constraints must be acknowledged. Chief among these is the reliance on retrospective chart-based identification rather than direct clinical examination. Although retrospective designs offer the advantages of greater feasibility, shorter timelines, and the capacity to mine larger archival datasets, they carry an inherent risk that certain dental findings—oral tori among them—that require physical assessment for detection may escape documentation. To illustrate, several authors have stratified oral tori by dimensions, and their data reveal that some tori are smaller and can be identified solely by palpation [1, 8]. Pinpointing oral tori after the fact, guided solely by photographic and radiographic records, poses considerable difficulty. We suspect that diminutive tori may well have gone unrecognized in the present series. A second significant shortcoming concerns the classification scheme, which groups tori merely as maxillary or mandibular. A more nuanced evaluation—one that distinguishes palatal tori, mandibular tori, or buccal/labial-lingual/palatal exostoses, as encountered throughout the literature—would permit a richer interpretation of the data [2, 4]. The binary upper-versus-lower-jaw taxonomy adopted here may have introduced distortions into certain prevalence estimates.

Furthermore, neither genetic assays nor histopathological examinations were undertaken, thereby circumscribing insight into the fundamental mechanisms driving tori development. Additionally, owing to the retrospective nature of this work, we were unable to ascertain the presence of hormonal dysregulation, vitamin D status, autoimmune conditions, or potential metabolic disturbances, all of which could conceivably modulate the formation of oral tori. Notwithstanding these caveats, this study represents, to the best of our knowledge, the inaugural investigation targeting the Mississippi populace and, accordingly, holds considerable value. Future research endeavors of a comparable nature should strive to enroll larger patient cohorts and incorporate direct clinical assessment. Moreover, when comparing individuals of differing racial backgrounds, efforts should be made to recruit roughly equal numbers of participants from each group to make prevalence comparisons along these lines more valid.

Conclusion

A notably high occurrence of oral tori was documented in the Mississippi population. These results underscore the importance of fostering heightened clinical cognizance regarding these osseous protuberances, thereby facilitating superior detection and therapeutic planning. This is particularly significant for oral surgeons, periodontists, and prosthodontists, whose work encompasses pre-prosthetic surgical procedures and the construction of dentures. In addition, this investigation lays the groundwork for subsequent studies aimed at probing the etiological underpinnings of bone formation within the maxillofacial region, which may ultimately advance the understanding of what drives the development of oral tori.

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