Clinical, Cosmetic and Investigational Dentistry

Dovepress
Taylor & Francis Group

Open Access Full Text Article

ORIGINAL RESEARCH

Maxillary Anterior Teeth Dimensions: A Biometric Analysis in a Kuwaiti Population

Ahmad Alsahli[1], Mohammad Qali[2], Jagan Kumar Baskaradoss[3], Dana AlOuda[4], Mubarak Alsaeed[5]

[1]Department of General Dental Practice, College of Dentistry, Kuwait University, Jabriya, Kuwait; [2]Department of Surgical Sciences, College of Dentistry, Kuwait University, Jabriya, Kuwait; [3]Department of Developmental and Preventive Sciences, College of Dentistry, Kuwait University, Jabriya, Kuwait; [4]Ministry of Health, Sulaibikhat, Kuwait; [5]Aline Dental Center, Jahra, Kuwait

Correspondence: Ahmad Alsahli, Department of General Dental Practice, College of Dentistry, Health Sciences Center, Kuwait University, P.O. Box 24923, Safat, 13110, Kuwait, Tel +965-24633469, Email ahmad.alsahli@ku.edu.kw

Purpose: Maxillary anterior tooth dimensions are critical in esthetic and restorative dentistry, yet data remain limited for some populations. Existing reference values may not apply universally, and sex-related differences are underreported. This study examined the clinical crown width (w), length (l), and width/length ratio (w/l) of maxillary central incisors, lateral incisors, and canines in a Kuwaiti adult population, and evaluated the sex-related differences.

Patients and Methods: Maxillary 3D resin models were obtained from 126 healthy adults. Mesiodistal width (w) and clinical crown length (l) were measured with a digital caliper (0.01 mm). The w/l ratio was calculated, and reproducibility was tested on 24 models. Sex differences were assessed with independent sample *t*-tests.

Results: Of the participants, 84 (66.6%) were female and 42 (33.4%) were male, with a mean age of 29.8 years. Mean (± SD, range) crown widths were 8.83 ± 0.65 (7.5–9.8) mm, 6.83 ± 0.52 (6.0–7.8) mm, and 7.76 ± 0.58 (6.8–8.7) mm for central, lateral, and canine teeth, respectively. Corresponding lengths were 9.83 ± 0.72 (8.2–11.2) mm, 8.00 ± 0.60 (7.0–9.2) mm, and 9.14 ± 0.68 (8.0–10.4) mm. The corresponding w/l ratios were 91% (centrals), 86% (laterals), and 86% (canines). Statistically significant sex differences were observed in crown length ($p < 0.001$) and w/l ratio ($p < 0.001$) for all three tooth types, with males exhibiting longer crowns and females showing higher w/l ratios.

Conclusion: Width/length ratios were higher in females across all maxillary anterior teeth, whereas crown length of all anterior teeth and canine width were greater in males, showing the greatest sexual dimorphism. Ethnicity and sex significantly influence maxillary anterior tooth dimensions, highlighting the need for population- and sex-specific reference values to guide esthetic and restorative treatment.

Keywords: width-to-length ratio, tooth dimensions, maxillary anterior teeth, esthetic dentistry

Introduction

Smile esthetics play a significant role in patients' self-perception, confidence, and satisfaction with dental treatment. Successful treatment of anterior teeth depends on factors such as shade, shape, texture, and size.[1,2]

From a clinical perspective, understanding the ideal dimensions, proportions, and ratios of the maxillary anterior teeth allows dentists to deliver predictable and esthetically pleasing outcomes.[3–5] The biometric study of teeth has been extensively discussed in the literature, with a focus on tooth dimensions and establishing guidelines for determining ideal proportions.

Historically, estimating appropriate maxillary anterior tooth dimensions, particularly for edentulous patients, utilized anthropometric measurements of the face.[6] Traditional methods include relating the width of the central incisor to the bizygomatic width (often using a 1:16 ratio),[7–9] the interpupillary distance,[10] or the interalar width.[11] However, many of these theories proved unreliable; studies often failed to find consistent, statistically significant correlations between these

Received: 3 August 2025
Accepted: 11 November 2025
Published: 19 November 2025

facial measurements and actual tooth size.[9,12,13] Early studies using extracted teeth or skulls were further limited by frequently lacking records of age, gender, and race.[14]

As reliance on facial landmarks proved unreliable, researchers began exploring proportional relationships within the dentition itself. One of the earliest and most influential of these was the "golden mean", proposed for selecting denture teeth. It suggests that the distal tooth's dimension equals the mesial tooth's dimension divided by 1.618.[15] Applied to dentistry, this concept suggests that the visible width of a lateral incisor should be approximately 62% of the width of the adjacent central incisor, and similarly, the canine should be 62% the width of the lateral incisor when viewed from the front. This concept later evolved into the "golden proportion" theory, which suggests that when viewed from the front, the width of each anterior tooth— moving distally from the central incisor to the first premolar— follows a consistent proportional decrease.[16] The goal was to establish a predictable template for selecting and positioning anterior denture teeth, ensuring harmonious esthetics that conform to classical ideals of facial harmony and beauty.

However, the clinical relevance of the golden proportion remains controversial, as studies have shown it is rarely observed in natural smiles.[17] Only a small percentage of individuals demonstrate this ratio between anterior teeth.[18] Moreover, adherence to the golden proportion does not necessarily correlate with smile attractiveness, indicating that natural esthetics are highly individualized and cannot be fully defined by fixed mathematical ratios.[19]

To address these limitations, the "repeated ratio" concept was introduced, proposing the Recurring Esthetic Dental (RED) proportion of 62%, 70%, or 80% based on tooth length.[3] The core principle of the RED proportion is that the ratio between the perceived widths of two adjacent anterior teeth should remain constant as one moves distally (from the central incisor to the lateral incisor, and from the lateral incisor to the canine).[3] However, these proportions have also shown inconsistent applicability across diverse populations.[20,21]

This inconsistency in applicability of universal mathematical and anthropometric rules underscores the importance of biometric analysis of anterior teeth, particularly in cases involving tooth wear, periodontal disease, or developmental defects. While the literature describes normative tooth dimensions, emerging evidence suggests that these norms may not be universally applicable,[22] and that gender and ethnicity influence dental dimensions.[8,23,24]

Sexual dimorphism is a consistent finding across different populations, with males exhibiting significantly larger width and length measurements for maxillary anterior teeth compared to females.[14,25,26] In some populations, only specific maxillary anterior teeth exhibited greater w/l ratios in males than in females,[8,26] while in others, all anterior teeth varied by sex.[25]

Furthermore, using dimensional guidelines developed for one racial group (eg, Caucasian subjects, where many early studies originated[23,24]) and applying them to other populations is logically flawed.[8,27] Studies have documented variations in tooth dimensions across ethnic groups.[8,25,26,28]

The width/length (w/l) ratio of maxillary anterior teeth, often used as a stable reference,[29] has shown significant variation depending on the population and measurement methods. For example, studies have reported a central incisor w/l ratio of 85%,[25,26] while others found higher[8] or lower ratios.[27,30] In Turkish populations the w/l ratio was 89%, whereas in Asian populations it was 72%,[8,27] Asians exhibited lower ratios relative to Caucasians.[23] These findings suggest that ethnicity affects tooth dimensions and ratios, making data derived primarily from Caucasian populations less applicable to other groups.

With the increasing integration of digital technologies into esthetic and restorative dentistry—such as digital smile design[31,32] and AI-driven tooth morphology generation[33] —the accuracy of these systems depends heavily on reliable biometric input. Precise measurements of width, length, and width-to-length (w/l) ratios of maxillary anterior teeth in Kuwaiti adults is essential for establishing population-specific reference data to calibrate digital workflows.[34] Such data enable digital treatment planning and esthetic evaluation tools to accurately represent the morphologic diversity of the local population.

Therefore, reliable clinical and esthetic decision-making in prosthodontic and restorative treatment requires normative data that reflect the unique ethnic and gender distributions within the population. Accordingly, this study aims to evaluate the clinical crown dimensions—specifically width, length, and width-to-length (w/l) ratio—of the maxillary anterior teeth in the Kuwaiti population. Additionally, it tests the null hypothesis that no differences exist between males and females in these tooth dimensions.

Materials and Methods

Ethics Statement

Ethical approval for this study was obtained from the Health Sciences Center Ethical Committee at Kuwait University (VDR/EC-2025-44) and the Ministry of Health Ethical Committee (2023/2325) and conducted in accordance with the Helsinki Declaration of 1975, as revised in 2000. Written Informed consent was obtained from participants prior to data collection.

Sample Size Calculation

The power analysis was performed using G*-power (ver. 3.1.9.7; Heinrich-Heine-Universität Düsseldorf, Düsseldorf, Germany). The effect size was determined to be 0.32, based on the mean differences in the length (in mm) of the central incisors between different ethnic groups from a previous study.[23] We calculated the sample size based on a power calculation of 0.8 with a confidence level of 95%. The "statistical test" was set to "*t*-test". "Type of power analysis" was "A priori". The output parameters showed the total sample size required was 124.

Inclusion and Exclusion Criteria

Inclusion criteria were Kuwaiti patients 18 years and above, with no missing anterior teeth, no severe crowding, no caries, no restorations, no excessive wear, and no history of orthodontic or prosthodontic treatment. Exclusion criteria included individuals younger than 18 years, teeth with developmental defects, severe wear, chipping, diastema, periodontal disease, or a history of orthodontic treatment.

Data Collection

This study focuses on measurements of actual tooth dimensions (mesiodistal width, crown length, and width-to-length ratios), whereas other studies have examined additional esthetic parameters, including arch symmetry, apparent width, and golden proportion. These metrics were selected to establish basic reference values in a defined population and minimize the subjectivity associated with more broad esthetic evaluations. Additional studies may examine the correlation between these metrics and perceived esthetic criteria.

Data were collected at two fully independent private dental clinics and at the university dental clinic, following standardized recruitment procedures and inclusion/exclusion criteria. Patient demographics were collected using standardized questionnaires. Intraoral scans were obtained using either iTero (Align Technology) or Trios 3 (3Shape) scanners, exported as stereolithography (STL) files with the manufacturers' standard software, and 3D-printed using a D3 printer (D3 series, Rapidshape, Rapidobject) with a light-curing resin (P pro Master Model Dark Beige, Straumann) to ensure workflow uniformity. Scanning protocols were standardized across all sites, and all patient information was securely stored.

Although STL files can be analyzed digitally, physical 3D-printed resin models were used for measurement to align with traditional and clinically validated protocols that use calipers for physical dimensions. This approach allowed for consistent tactile access to interproximal contact points and enhanced calibration between examiners. Additionally, given the use of different intraoral scanners across sites, standardized 3D printing ensured uniform measurement conditions.

All primary measurements were recorded within one week of resin model printing by a single examiner (D.A., general dentist). The maximum mesiodistal width (perpendicular to the long axis of the tooth) and the maximum apical–incisal crown length (parallel to the long axis of the tooth) were measured for the central incisors, lateral incisors, and canines (Figure 1). A digital caliper (Max-Cal™, Fred V. Fowler Company) with 0.01 mm precision was used for measurements. Calibration and resetting to zero were performed before each measurement. In addition, demographic data were obtained, including age and sex.

Statistical Analysis

Descriptive statistical analysis was conducted using statistics software (SPSS Statistics v22.0, IBM Corp). To assess interexaminer reliability, the intraclass correlation coefficient (ICC) was assessed using 24 randomly selected casts. In

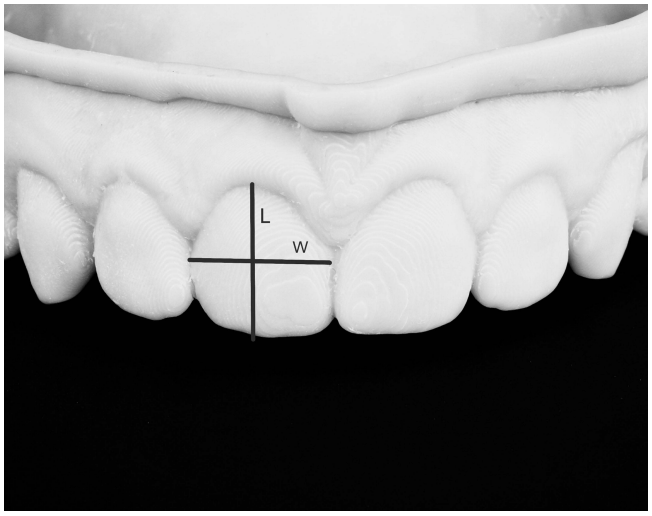

Figure 1 The widest mesiodistal dimension (W) was measured perpendicular to the long axis of the tooth, while the longest apical–incisal length (L) was measured parallel to the long axis. These reference points were used to calculate the width/length (W/L) ratio for biometric analysis.

these 24 casts, measurements (lengths and widths) were repeated by a second examiner (A.S. general dentist). Both examiners were trained in the measurement protocol using pilot models prior to the study, and calibration was performed to ensure consistency. The Shapiro–Wilk test was used to assess the normality of outcome variables, including length, width, and w/l ratios. All data were normally distributed. Independent sample t-tests were used to compare sex differences in tooth group width, length, and w/l ratios. All tests were two-sided, with an alpha level of 0.05 considered statistically significant.

Results

Of the 126 patients, 84 (66.6%) were women. In total, 92 patients (73.0%) attended a private dental clinic and 16 (12.7%) attended xxxxxx University. Table 1 presents the ICC results for interexaminer reliability for the length and width measurements for all 6 anterior teeth. In all instances, the ICC was >0.8, (indicating good reliability), except for the maxillary right canine and maxillary left lateral incisors, with ICC = 0.6 (indicating moderate reliability). These values imply substantial amount of agreement between raters, suggesting that the measurements are reasonably consistent.

Table 1 Interexaminer Reliability Between Two Examiners for 24 Randomly Selected Patients

Teeth	Intraclass Correlation Coefficient	95% Confidence Interval	
		Lower	Upper
Maxillary right canine: width	0.631	0.147	0.84
Maxillary right canine: length	0.99	0.978	0.996
Maxillary right lateral incisor: width	0.875	0.71	0.946
Maxillary right lateral incisor: length	0.972	0.934	0.988
Maxillary right central incisor: width	0.936	0.853	0.972
Maxillary right central incisor: length	0.99	0.978	0.996
Maxillary left central incisor: width	0.97	0.93	0.987
Maxillary left central incisor: length	0.99	0.978	0.996
Maxillary left lateral incisor: width	0.64	0.168	0.844
Maxillary left lateral incisor: width	0.976	0.944	0.99
Maxillary left canine: width	0.879	0.721	0.948
Maxillary left canine: length	0.992	0.983	0.997

Table 2 Mean, Standard Deviation (SD), Range, Maximum, and Minimum Values for the Widths, Lengths, and Width/Length (w/l) Ratios of the Three Tooth Groups in the Maxillary Dentition

	Mean (SD) (mm)	Maximum (mm)	Minimum (mm)	Range (mm)
Central width	8.83 (0.50)	9.93	7.65	2.29
Central length	9.83 (1.02)	12.31	7.20	5.12
Central w/l ratio	0.91 (0.09)	1.22	0.68	0.54
Lateral width	6.83 (0.53)	8.29	5.31	2.98
Lateral length	8.00 (0.96)	10.93	5.21	5.72
Lateral w/l ratio	0.86 (0.10)	1.22	0.62	0.60
Canine width	7.76 (0.43)	9.21	6.86	2.35
Canine length	9.14 (1.07)	12.18	6.60	5.59
Canine w/l ratio	0.86 (0.09)	1.11	0.70	0.41

Table 3 Mean and Standard Deviation (SD) Values for the Widths, Lengths, and Width/Length Ratios of the Three Tooth Groups in the Maxillary Dentition According to Sex

Teeth	Mean Width (SD) (mm)	*P* value	Mean Length (SD) (mm)	*P* value	Width/Length Ratio	*P* value
Central incisors						
Male Female	8.94 (0.53) 8.77 (0.47)	0.08	10.36 (1.00) 9.57 (0.94)	<0.001	0.87 (0.08) 0.92 (0.09)	<0.001
Lateral incisors						
Male Female	6.90 (0.55) 6.79 (0.52)	0.30	8.52 (0.86) 7.74 (0.91)	<0.001	0.82 (0.08) 0.89 (0.10)	<0.001
Canines						
Male Female	8.00 (0.43) 7.63 (0.37)	<0.001	9.88 (1.07) 8.78 (0.86)	<0.001	0.82 (0.08) 0.88 (0.09)	<0.001

The mean, standard deviation (SD), and range for the width, length, and w/l ratio of each tooth type are listed in Table 2. The mean width was 8.83, 6.83, and 7.76 mm for the central incisors, lateral incisors, and canines, respectively. The mean length was 9.83, 8.00, and 9.14 mm for the central incisors, lateral incisors, and canines, respectively. The mean w/l ratio was 91% for the central incisors, 86% for the lateral incisors, and 86% for the canines.

Table 3 presents the mean and SD values for width, length, and w/l ratio according to gender. Central incisors in males had the largest mean width (8.94 mm), and lateral incisors in women had the smallest mean width (6.79 mm). When comparing the mean width between genders, male canines had significantly greater coronal width (8.00 mm; $P < 0.001$) than female canines (7.63 mm). Central incisors in males had the largest mean length (10.36 mm), followed by male canines (9.88 mm) and female central incisors (9.57 mm). Lateral incisors of females had the smallest mean length among all three types of teeth (7.74 mm). The mean lengths of central incisors, lateral incisors, and canines were significantly larger in males than females ($P < 0.001$). The w/l ratio ranged from 0.82 (for lateral incisors and canines in males) to 0.92 (central incisors in women). The w/l ratio was significantly higher ($P < 0.001$) in women than in men for central and lateral incisors and canines.

Discussion

The aim of this study was to examine the clinical crown width (w), length (l), and width-to-length ratio (w/l) of maxillary central incisors, lateral incisors, and canines in a sample of adults from Kuwait, and to assess potential sex-related differences. The null hypothesis was that no significant differences would be observed between males and females in

these tooth dimensions. This hypothesis was partly rejected based on our findings. Specifically, crown length and w/l ratio showed statistically significant sex differences for all three tooth types ($P < 0.001$). In each case, males had longer crown lengths, while females exhibited higher w/l ratios. However, crown width showed a significant difference between sexes only for canines ($P < 0.001$); no statistically significant differences were observed for the width of central incisors ($P = 0.08$) or lateral incisors ($P = 0.30$). These results suggest that while tooth length and proportion consistently vary between sexes, differences in crown width are more tooth-specific.

The results of this study show that the mean clinical crown length of all maxillary anterior teeth is significantly greater in males than in females. The order of mean length was central incisor > canine > lateral incisor (Table 2). However, although canine width in males was significantly greater than that in females, no significant sex differences were observed in the width of central or lateral incisors. These findings suggest that sex influences the length of all maxillary anterior teeth but affects width only for the canines. In terms of the w/l ratio, females exhibited significantly higher ratios compared with males for all maxillary anterior teeth (Table 3), likely due to the increased crown length in males. The mean w/l ratio of the study population was 91% for central incisors and 86% for both the lateral incisors and canines (Table 2). Interexaminer reliability was high (ICC ≥ 0.8) for all teeth, except for the maxillary right canine and left lateral incisor.[35]

Dental measurements in this study were conducted on resin-printed models based on STL files obtained by digital scanning, in contrast to previous studies that relied on stone models.[25,26,30] Digital scans are highly accurate, and small deviations can be measured using both iTero and Trios 3 scanners.[36] Resin models further minimize measurement errors associated with scratches and wear on stone casts due to repeated handling. The accuracy of resin-printed models for dimensional measurements has also been validated in prior research.[37,38]

Similar to other studies, the present population exhibited a consistent ranking of maxillary anterior tooth dimensions (central incisors > canines > lateral incisors).[8,26,28] The mean widths were also comparable to previous findings: 8.32–8.71 mm for central incisors, 6.32–6.99 mm for lateral incisors, and 7.40–7.91 mm for canines.[25–27] However, the mean central incisor length in this study was shorter than those reported in other studies,[25–27] but was similar to values observed in neighboring regions, such as Turkey and Saudi Arabia.[8,28]

While comparable patterns were observed with Turkish and Saudi populations, interpreting biometric data across regions requires caution. Geographic proximity does not guarantee morphological equivalence, as demographic and genetic differences may lead to measurable variations in dental morphology.[39,40] Both prior studies were conducted exclusively on dental students or residents—a narrow, relatively homogeneous group with ideal dental conditions—whereas the current study included adults from the general Kuwaiti population, offering data that better reflect real clinical variability. These factors underscore the need for localized biometric data and emphasize the importance of establishing population-specific reference norms for restorative and esthetic planning in Kuwait.

Differences in crown lengths compared to other studies[27,30] may be due to the use of extracted teeth for measurements, rather than diagnostic casts, highlighting the distinction between clinical and anatomical crown lengths.[25,30] In the present study, males exhibited significantly longer crown lengths than females for all maxillary anterior teeth, consistent with findings from other populations.[14,25,26] However, while the mean canine width in males was significantly greater than in females, no significant sex differences were observed in the widths of central or lateral incisors. This contrast with other studies where all maxillary anterior teeth were wider in males than in females.[14,25,26] In a Turkish population, the mean width and length of central incisors and canines were greater in men, but the lateral incisors exhibited similar dimensions across sexes.[8] These differences in tooth dimensions between males and females are likely attributable to ethnic variations.

Various dental ratios have been proposed in the literature, but the w/l ratio is considered the most stable and reliable reference, especially in cases of worn dentition[23,30] or altered passive eruption.[26] In the present study, the w/l ratio of all maxillary anterior teeth was significantly greater in females than in males (Table 3). This finding contrasts with other studies suggesting that dental ratios are not influenced by sex.[14] Among females, the central incisors exhibited the highest w/l ratio (92%), followed by the lateral incisors (89%) and canines (88%). In males, the w/l ratio was 87% for the central incisors and 82% for both the lateral incisors and canines. This difference is likely attributable to the significantly longer central incisors observed in males (Table 2).

These findings contrast with those from a study conducted in the Caucasian population, where females exhibited a higher w/l ratio only for the canines, with no significant differences observed for the central and lateral incisors.[26] Similarly, in the Turkish population, only the canines showed significantly higher w/l ratios in females.[8] Despite these differences, the canines remain the most sexually dimorphic teeth, as reported in the literature.[26] In contrast, Our results indicate that the w/l ratio is influenced by sex across all maxillary anterior teeth within the studied sample of the Kuwaiti population.

In the present study, the mean w/l ratios ranged from 82% to 92%, compared with 76%–86% in a previous study.[26] Our findings align with those from Turkish and Saudi studies, where w/l ratios ranged from 82.1%–91.2%.[26,28] However, these values exceed those reported in Caucasian and European populations.[25,26]

Thus, the sample in this study appears to share similarities with Turkish and Saudi populations, exhibiting a more square-like tooth shape with shorter heights and greater widths than other groups.[8] Archeological studies have revealed a similar genetic origin between the Turkish and Arab populations, which helps explain the close resemblance of our results to those from Turkey.[41] This supports the conclusion that the w/l ratio of maxillary anterior teeth is influenced by ethnicity.

Although the present study focused on a single ethnic group, comparison with prior studies confirms that w/l ratios are ethnically dependent.[23] However, it is important to note that some research has reported no significant effect of sex on height-to-width ratios in the maxillary anterior teeth of White and Black populations.[14]

Previous research has suggested that an optimal esthetic width-to-height ratio is 75%–80%.[29,42,43] For the maxillary teeth, studies reported w/l ratios of 81% in Caucasians[26] and approximately 75% in Europeans.[30] Dentists tend to prefer tooth proportions with w/l ratios of 75%–78%,[44,45] while dental students and patients favor around 75%.[42] Certain diagnostic tools for restorative and surgical treatment planning are also designed around a w/l ratio of 78%.[46]

However, the findings from our study and others[8,26] indicate that the central incisor w/l ratio often exceeds these values. For example, one study with a larger sample size reported a central incisor w/l ratio of 85%,[25] aligning with patient preferences for ratios of around 82% for an esthetically pleasing smile.[47] These findings suggest that the acceptable range for w/l ratios may be broader than previously reported.

Recruitment was conducted at three sites — two private clinics and the Kuwait University Dental Center — using a convenience sampling technique to select participants from regular patients attending these clinics. While this approach enhances sample accessibility, it may limit the generalizability of the findings, as the study population may not fully represent the diversity of the wider Kuwaiti population. In addition, the female-to-male imbalance in the sample does not reflect the actual sex distribution in the Kuwaiti population and the broad age range of participants may have introduced variability due to age-related changes such as tooth wear.

Although standardized protocols were applied, the use of two different intraoral scanners (iTero and Trios 3) could have introduced subtle measurement variability between devices. The reliance on resin-printed models for caliper-based measurements, rather than direct analysis of STL files, may also have introduced dimensional deviations, even though resin models have been validated for accuracy in prior studies.

These factors should be taken into account when interpreting and generalizing the findings. Despite these limitations, the study provides valuable population-specific biometric data that can serve as a robust baseline for clinical and esthetic treatment planning in Kuwait.

Classical anthropometric and ratio-based theories, including the Golden Proportion and Recurrent Esthetic Dental (RED) proportion, remain subjects of debate. However, these concepts have been adapted into practical, data-driven applications in contemporary digital dentistry. The biometric norms established in this study provide population-specific reference data for Kuwaiti adults, making them highly relevant for current digital workflows. These measurements facilitate the calibration of digital smile design and virtual patient simulation software, thereby enhancing accuracy and cultural relevance.[34,48] As a result, clinicians gain reference values that support precise esthetic assessment and informed tooth selection. This reduces the need for laboratory adjustments or modifications to restorations in order to achieve harmonious tooth proportions across sexes and ethnic groups.[49]

In a broader context, these findings contribute to the regional mapping of Middle Eastern dentofacial characteristics. They also enable meaningful comparisons with neighboring populations, such as Saudi and Turkish groups, and reflect Kuwait's unique ethnic composition and genetic diversity—shaped by Arabian and Persian ancestry.

To implement these biometric norms in clinical practice, clinicians should familiarize themselves with the reference data and incorporate it into digital tools by adjusting software settings in digital smile design applications to reflect population-specific values. Applying these norms during patient consultations enables validation of esthetic plans and facilitates discussions regarding culturally and individually tailored outcomes. Ultimately, relying on locally derived biometric data, rather than generalized datasets, allows clinicians to achieve esthetic results that are both precise and culturally appropriate within restorative workflows.

Future research should explore the esthetic impact of different w/l ratios across ethnicities, using tools such as mockups or digitally edited photographs. Such studies would enable clinicians to establish esthetic preference for the optimal dimensions in maxillary anterior teeth and achieve the best esthetic outcomes for diverse populations. Additionally, the adoption of digital scanning technology can facilitate larger sample sizes, yielding more reliable and representative data on maxillary tooth dimensions for various populations. This would enhance the ability to generalize findings to entire populations.

Conclusion

This study demonstrated significant sexual dimorphism in the dimensions of maxillary anterior teeth among Kuwaiti adults. Males exhibited longer crown lengths for all anterior teeth, while females exhibited higher width-to-length (w/l) ratios. Only the width of the canine teeth differed significantly by sex. The mean w/l ratios were 91% for central incisors and 86% for both lateral incisors and canines. These ratios are higher than those reported for Caucasian and European populations but are similar to values observed in Turkish and Saudi populations. These results indicate that both ethnicity and sex are important determinants of tooth dimensions in this population.

These biometric norms offer population-specific reference values to guide esthetic restorative and prosthetic treatment planning. Integrating these data into digital smile design systems and artificial intelligence-based esthetic analysis workflows can improve the accuracy of digital tooth libraries and enable customization for Kuwaiti and Gulf populations. Using local biometric data as the foundation for esthetic decisions allows clinicians to achieve restorations that are precise, harmonious, and culturally relevant.

Data Sharing Statement

The datasets used and/or analyzed during this study are available from the corresponding author upon reasonable request.

Acknowledgments

We would like to thank the Department of Dental Administration, Research and Survey Division at the Ministry of Health, for their assistance. We are particularly grateful to Dr. Fajer Alsallal for her support in conducting the survey.

Author Contributions

All authors made a significant contribution to the work reported, whether that is in the conception, study design, execution, acquisition of data, analysis and interpretation, or in all these areas. All authors took part in drafting, revising or critically reviewing the article; gave final approval of the version to be published; have agreed on the journal to which the article has been submitted; and agree to be accountable for all aspects of the work.

Funding

This research did not receive any specific grant from funding agencies in the public, commercial, or not-for-profit sectors.

Disclosure

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

References

1. Ahmad I. Anterior dental aesthetics: dental perspective. *Br Dent J*. 2005;199(3):135–141. doi:10.1038/sj.bdj.4812569
2. Spear FM, Kokich VG, Mathews DP. Interdisciplinary management of anterior dental esthetics. *J Am Dent Assoc*. 2006;137(2):160–169. doi:10.14219/jada.archive.2006.0140
3. Ward DH. Proportional smile design using the recurring esthetic dental (RED) proportion. *Dent Clin North Am*. 2001;45(1):143–154. doi:10.1016/S0011-8532(22)00473-6
4. Pires LC, Leandrin TP, Aroni MAT, et al. Digital Smile Design and mock-up technique in esthetic crown lengthening: 2-year follow-up of six cases. *Int J Esthet Dent*. 2022;17(1):58–75.
5. Carrera TMI, Freire AEN, de Oliveira GJPL, et al. Digital planning and guided dual technique in esthetic crown lengthening: a randomized controlled clinical trial. *Clin Oral Investig*. 2023;27(4):1589–1603. doi:10.1007/s00784-022-04780-8
6. Young HA. Selecting the anterior tooth mold. *J Prosthet Dent*. 1954;4(6):748–760. doi:10.1016/0022-3913(54)90041-4
7. Abdullah MA. Inner canthal distance and geometric progression as a predictor of maxillary central incisor width. *J Prosthet Dent*. 2002;88(1):16–20. doi:10.1067/mpr.2002.126095
8. Hasanreisoglu U, Berksun S, Aras K, Arslan I. An analysis of maxillary anterior teeth: facial and dental proportions. *J Prosthet Dent*. 2005;94(6):530–538. doi:10.1016/j.prosdent.2005.10.007
9. Scandrett FR, Kerber PE, Umrigar ZR. A clinical evaluation of techniques to determine the combined width of the maxillary anterior teeth and the maxillary central incisor. *J Prosthet Dent*. 1982;48(1):15–22. doi:10.1016/0022-3913(82)90041-5
10. Cesario VA, Latta GH. Relationship between the mesiodistal width of the maxillary central incisor and interpupillary distance. *J Prosthet Dent*. 1984;52(5):641–643. doi:10.1016/0022-3913(84)90133-1
11. Hoffman W, Bomberg TJ, Hatch RA. Interalar width as a guide in denture tooth selection. *J Prosthet Dent*. 1986;55(2):219–221. doi:10.1016/0022-3913(86)90348-3
12. Latta GH, Weaver JR, Conkin JE. The relationship between the width of the mouth, interalar width, bizygomatic width, and interpupillary distance in edentulous patients. *J Prosthet Dent*. 1991;65(2):250–254. doi:10.1016/0022-3913(91)90170-2
13. Kern BE. Anthropometric parameters of tooth selection. *J Prosthet Dent*. 1967;17(5):431–437. doi:10.1016/0022-3913(67)90140-0
14. Gillen RJ, Schwartz RS, Hilton TJ, Evans DB. An analysis of selected normative tooth proportions. *Int J Prosthodont*. 1994;7(5):410–417.
15. Lombardi RE. The principles of visual perception and their clinical application to denture esthetics. *J Prosthet Dent*. 1973;29(4):358–382. doi:10.1016/s0022-3913(73)80013-7
16. Levin EI. Dental esthetics and the golden proportion. *J Prosthet Dent*. 1978;40(3):244–252. doi:10.1016/0022-3913(78)90028-8
17. Londono J, Ghasemi S, Lawand G, Dashti M. Evaluation of the golden proportion in the natural dentition: a systematic review and meta-analysis. *J Prosthet Dent*. 2023;129(5):696–702. doi:10.1016/j.prosdent.2021.07.020
18. Preston JD. The golden proportion revisited. *J Esthet Dent*. 1993;5(6):247–251. doi:10.1111/j.1708-8240.1993.tb00788.x
19. Mahshid M, Khoshvaghti A, Varshosaz M, Vallaei N. Evaluation of "golden proportion" in individuals with an esthetic smile. *J Esthet Restor Dent*. 2004;16(3):185–192. discussion 193. doi:10.1111/j.1708-8240.2004.tb00032.x
20. Melo M, Ata-Ali F, Huertas J, et al. Revisiting the maxillary teeth in 384 subjects reveals A deviation from the classical aesthetic dimensions. *Sci Rep*. 2019;9(1):730. doi:10.1038/s41598-018-36770-w
21. Cinelli F, Piva F, Bertini F, Russo DS, Giachetti L. Maxillary anterior teeth dimensions and relative width proportions: a narrative literature review. *Dent J*. 2023;12(1):3. doi:10.3390/dj12010003
22. Chu SJ. Range and mean distribution frequency of individual tooth width of the maxillary anterior dentition. *Pract Proced Aesthet Dent*. 2007;19(4):209–215.
23. Tsukiyama T, Marcushamer E, Griffin TJ, Arguello E, Magne P, Gallucci GO. Comparison of the anatomic crown width/length ratios of unworn and worn maxillary teeth in Asian and white subjects. *J Prosthet Dent*. 2012;107(1):11–16. doi:10.1016/S0022-3913(12)60009-2
24. Wang Y, Song Y, Zhong Q, Xu C. Evaluation of influence factors on the width, length, and width to length ratio of the maxillary central incisor: a systematic review and meta-analysis. *J Esthet Restor Dent*. 2021;33(2):351–363. doi:10.1111/jerd.12606
25. Orozco-Varo A, Arroyo-Cruz G, Martínez-de-Fuentes R, Jiménez-Castellanos E. Biometric analysis of the clinical crown and the width/length ratio in the maxillary anterior region. *J Prosthet Dent*. 2015;113(6):565–70.e2. doi:10.1016/j.prosdent.2014.11.006
26. Sterrett JD, Oliver T, Robinson F, Fortson W, Knaak B, Russell CM. Width/length ratios of normal clinical crowns of the maxillary anterior dentition in man. *J Clin Periodontol*. 1999;26(3):153–157. doi:10.1034/j.1600-051x.1999.260304.x
27. Marcuschamer E, Tsukiyama T, Griffin TJ, Arguello E, Gallucci GO, Magne P. Anatomical crown width/length ratios of worn and unworn maxillary teeth in Asian subjects. *Int J Periodontics Restorative Dent*. 2011;31(5):495–503.
28. Alqahtani AS, Habib SR, Ali M, Alshahrani AS, Alotaibi NM, Alahaidib FA. Maxillary anterior teeth dimension and relative width proportion in a Saudi subpopulation. *J Taibah Univ Med Sci*. 2021;16(2):209–216. doi:10.1016/j.jtumed.2020.12.009
29. Chiche G, Pinault A. *Esthetics of Anterior Fixed Prosthodontics/Gerard Chiche*. Alain Pinault; 1994.
30. Magne P, Gallucci GO, Belser UC. Anatomic crown width/length ratios of unworn and worn maxillary teeth in white subjects. *J Prosthet Dent*. 2003;89(5):453–461. doi:10.1016/S0022-3913(03)00125-2
31. Yue Z, Luo Z, Hou J, Zhang H. Application of 3D digital smile design based on virtual articulation analysis in esthetic dentistry: a technique. *J Prosthet Dent*. 2025;133(1):24–30. doi:10.1016/j.prosdent.2023.11.014
32. Baaj RE, Alangari TA. Artificial intelligence applications in smile design dentistry: a scoping review. *J Prosthodont*. 2025;34(4):341–349. doi:10.1111/jopr.14000
33. Saleh O, Spies BC, Brandenburg LS, et al. Feasibility of using two generative AI models for teeth reconstruction. *J Dent*. 2024;151:105410. doi:10.1016/j.jdent.2024.105410
34. Çakmak G, Cho JH, Choi J, Yoon HI, Yilmaz B, Schimmel M. Can deep learning-designed anterior tooth-borne crown fulfill morphologic, aesthetic, and functional criteria in clinical practice? *J Dent*. 2024;150:105368. doi:10.1016/j.jdent.2024.105368
35. Fleiss J. *The Design and Analysis of Clinical Experiments*. John Wiley & Sons; 2011:149–185.
36. Lee KC, Park SJ. Digital intraoral scanners and alginate impressions in reproducing full dental arches: a comparative 3D assessment. *Appl Sci*. 2020;10(21):7637. doi:10.3390/app10217637

37. Cuperus AMR, Harms MC, Rangel FA, Bronkhorst EM, Schols JGJH, Breuning KH. Dental models made with an intraoral scanner: a validation study. *Am J Orthod Dentofacial Orthop Dent*. 2012;142(3):308–313. doi:10.1016/j.ajodo.2012.03.031
38. Sousa MVS, Vasconcelos EC, Janson G, Garib D, Pinzan A. Accuracy and reproducibility of 3-dimensional digital model measurements. *Am J Orthod Dentofacial Orthop*. 2012;142(2):269–273. doi:10.1016/j.ajodo.2011.12.028
39. Uysal T, Yagci A, Aldrees AM, Ekizer E. Ethnic differences in dentofacial relationships of Turkish and Saudi young adults with normal occlusions and well-balanced faces. *Saudi Dent J*. 2011;23(4):183–190. doi:10.1016/j.sdentj.2011.08.002
40. Majumder P, Mahanta P, Kalita C, et al. Variability and patterning in permanent tooth dimensions among four ethnic groups from the north-eastern states of India. *BioMed Res Int*. 2022;2022(1):4733611. doi:10.1155/2022/4733611
41. Hodoğlugil U, Mahley RW. Turkish population structure and genetic ancestry reveal relatedness among Eurasian populations. *Ann Hum Genet*. 2012;76(2):128–141. doi:10.1111/j.1469-1809.2011.00701.x
42. Brisman AS. Esthetics: a comparison of dentists' and patients' concepts. *J Am Dent Assoc*. 1980;100(3):345–352. doi:10.14219/jada.archive.1980.0093
43. Magne P, Belser UC. *Bonded Porcelain Restorations in the Anterior Dentition: A Biomimetic Approach*. London: Quintessence Publishing; 2002.
44. Rosenstiel SF, Ward DH, Rashid RG. Dentists' preferences of anterior tooth proportion—a Web-based study. *J Prosthodont Dent*. 2000;9(3):123–136. doi:10.1053/jopr.2000.19987
45. Ward DH. A study of dentists' preferred maxillary anterior tooth width proportions: comparing the recurring esthetic dental proportion to other mathematical and naturally occurring proportions. *J Esthet Restor Dent*. 2007;19(6):324–337. discussion 338. doi:10.1111/j.1708-8240.2007.00114.x
46. Chu SJ, Hochman MN. A biometric approach to aesthetic crown lengthening: part I—Midfacial considerations. *Pract Proced Aesthet Dent*. 2008;20(1):17–24. quiz 26.
47. Cooper GE, Tredwin CJ, Cooper NT, Petrie A, Gill DS. The influence of maxillary central incisor height-to-width ratio on perceived smile aesthetics. *Br Dent J*. 2012;212(12):589–599. doi:10.1038/sj.bdj.2012.522
48. Ding H, Cui Z, Maghami E, et al. Morphology and mechanical performance of dental crown designed by 3D-DCGAN. *Dent Mater*. 2023;39(3):320–332. doi:10.1016/j.dental.2023.02.001
49. Broll A, Goldhacker M, Hahnel S, Rosentritt M. Generative deep learning approaches for the design of dental restorations: a narrative review. *J Dent*. 2024;145:104988. doi:10.1016/j.jdent.2024.104988