

# Relationship between permanent upper anterior teeth and anthropometric facial measures in different populations: a narrative review

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**Aim:** The main purpose of this study was to conduct a narrative review investigating the possible relationship between permanent maxillary anterior teeth and anthropometric facial parameters in different populations.

**Methods:** Searches were performed in the PubMed, BVS (*Biblioteca Virtual em Saúde*) and SciELO databases to identify relevant scientific articles using the following search terms: “maxillary anterior teeth”, “facial measurements” and “anthropometry”, in such a way that 218 publications were found. After application of inclusion and exclusion criteria, 13 publications remained for full-text reading. **Results:** All studies involved male and female samples and it was notorious that male measurements were unanimously higher than those obtained in the opposite sex. The age of the analyzed participants ranged from 17 to 60 years; however, a mean age of 18 to 25 years was the most investigated in literature. In addition, facial measurements including the bizygomatic width, interpupillary distance, intercanthal distance, interalar width and intercommissural width have been proposed to help determine the correct size of anterior teeth. **Conclusion:** It was concluded that despite the limited number of studies, some factors that influence dental and facial dimensions, such as sex and age, can be identified. However, there is no standardization of the facial or dental parameters used in the studies, a fact that makes it difficult to establish a universal ratio for clinical dental practice.

**Keywords:** Anthropometry. Esthetics, dental. Dental prosthesis. Dentition, permanent.

## Introduction

Anthropometry is the science that specifically studies the dimensions and proportions of different parts of the human body, including weight, height and body segment measures, which can be used to establish differences among populations<sup>1</sup>. Anthropometry is an effective non-invasive method that is currently used as a diagnostic tool and for monitoring medical treatments<sup>2</sup>.

Historically, many philosophers, artists and architects have analyzed the proportions of the human body. During the Renaissance period, by placing the human figure inside circles and squares, Leonardo da Vinci (1452-1519) studied human dimensions and thus contributed to the concept of anthropometry. Analyzing da Vinci's studies, Boyd (1980) noted facial proportions and measures that he later used for facial harmonization<sup>3</sup>.

In dentistry, anthropometric studies investigating the permanent maxillary anterior teeth and their relationship with facial parameters are essential to achieve satisfactory esthetic and functional results<sup>4</sup>. Furthermore, the factors that most influence a harmonious anterior dentition are the size, shape and arrangement of the maxillary anterior teeth, particularly the maxillary central incisors in an anterior view<sup>4</sup>.

Different anatomical landmarks have been proposed to help determine the correct size of anterior teeth, including the bizygomatic width, interpupillary distance, intercanthal distance, interalar width, and intercommissural width<sup>5</sup>. Regarding the subjective esthetic pattern, different assessment indicators exist for different individuals<sup>6</sup>. On the other hand, the extraoral soft tissue configuration depends on genetic, ethnic, malocclusion and environmental factors and varies according to age and sex<sup>7</sup>.

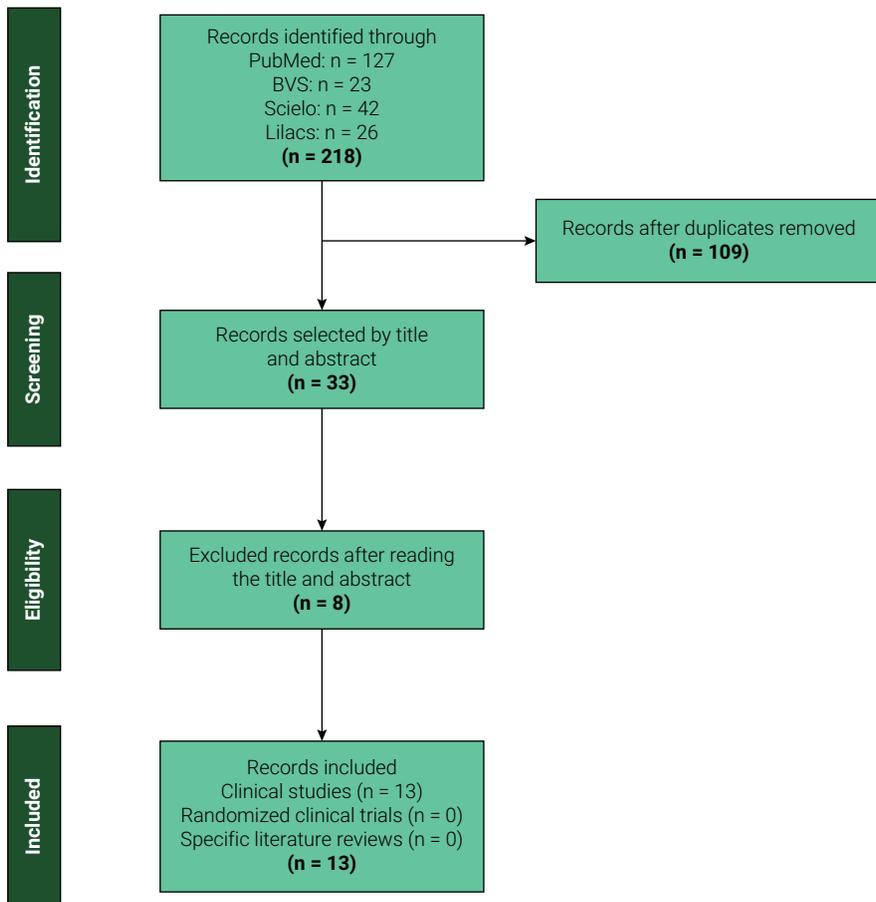
Despite notable and ongoing advances in the field of dentistry, there is a lack of widely reliable methods for the determination of maxillary anterior tooth morphology, with the recommendation that dentists also use their clinical experience and critical sense to achieve good esthetic results in the fabrication of dentures or complex restorations. Given the divergent findings in the literature regarding the possible relationships between permanent maxillary anterior teeth and anthropometric facial measurements, the aim of the present study was to conduct a review on these findings in different populations, seeking to assess the possible factors that influence differences in facial and dental measurements.

## Methods

Searches were performed in the PubMed, BVS (*Biblioteca Virtual em Saúde*) and Scielo databases to identify relevant scientific articles using the following search terms: "maxillary anterior teeth", "facial measurements" and "anthropometry". Studies on human teeth were considered eligible.

As illustrated in Figure 1, initial screening using the cited keywords retrieved 218 articles and 21 of them met all inclusion criteria. Article type (clinical studies, randomized clinical trials and literature reviews), language (English, Portuguese or

Spanish) and time span (period from 2004 to 2019) were used for reading title and abstracts. There were 9 clinical studies, 0 randomized clinical trials, and 5 literature reviews specific to the area. Case reports, letters to the editor, technical descriptions and publications in other languages or those not available on the internet or did not report outcomes of interest (sensitivity, specificity and concordance) were excluded, totaling 197 removed articles.



**Figure 1.** Flowchart and step-by-step sampling process.

## Results and Discussion

Predicting the morphological parameters of maxillary anterior teeth is extremely important for edentulous patients, including patients with tooth agenesis and trauma victims, since this proportion is used for the fabrication of fixed or removable dentures and restorative treatments. Within this context, dentures are aimed at restoring the patient's morphological and functional characteristics. Thus, this narrative review uses previous analyses of predetermined measurements on plaster casts, digital photographs and those obtained directly from subjects of different

ethnicities to relate facial measurements, for example, with the size of artificial teeth in completely edentulous patients<sup>8</sup>.

According to analyzed publications, different methods are used to measure facial and dental dimensions as shown in Table 1. However, such variety measurement forms can cause errors due to the imprecision of reference points and failures in techniques execution. In addition, as measurements can also be performed on plaster models or photographs, biases, small arc adjustments, and the position in which the photograph was taken can interfere with these measurements<sup>4,8</sup>.

**Table 1.** Sociodemographic characteristics

Author/Year	Title	Ethnicity/ race	Age (years)	Measurement method	Male-female ratio
Al Wazzan <sup>20</sup>	The relationship between intercanthal dimension and the widths of maxillary anterior teeth	Saudi Arabia	19-55	human measures	443 (203 males and 240 females)
Al Wazzan <sup>22</sup>	The visible portion of anterior teeth at rest	Saudi Arabia	20-60	human measures	473 (213 males and 260 females)
Hasanreisoglu et al. <sup>4</sup>	An analysis of maxillary anterior teeth: facial and dental proportions	Turkey	Mean: 22	digital photography and casts	100 (50 males and 50 females)
Gomes et.al. <sup>23</sup>	Correlation between facial measurements and the mesiodistal width of the maxillary anterior teeth	Brazilian	17-33	digital photography and casts	81 (37 men and 44 women)
Isa et al. <sup>8</sup>	Regression methods to investigate the relationship between facial measurements and widths of the maxillary anterior teeth	Chinese and Maley	18-36	digital photography	60 (22 male and 38 female)
Ellakwa et al. <sup>10</sup>	Quantifying the selection of maxillary anterior teeth using intraoral and extraoral anatomical landmarks	Australian	> 18	digital photography and casts	98 (55 males and 43 females)
Kini and Angadi <sup>12</sup>	Biometric ratio in estimating widths of maxillary anterior teeth derived after correlation anthropometric measurements with dental measurements	India (Asia)	18-23	digital photography and casts	70 (24 males and 46 females)
Ahmed et al. <sup>17</sup>	Facial measurements and maxillary anterior teeth mesio-distal dimensions, is there a relationship?	Iraqi Arab	---	digital photography and casts	71 (34 males and 37 females)
Rawat et al. <sup>11</sup>	Evaluation of relation between bizygomatic width and mesiodistal dimension of maxillary central in Indian population: an in vivo study	Indian	> 18	human measures	200 (100 males and 100 females)
L-Kaisy; Garib <sup>14</sup>	Selecting maxillary anterior tooth width by measuring certain facial dimensions in the Kurdish population	Kurdish	21-32	digital photography and casts	65 (38 males and 27 females)

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Hasan et al. <sup>13</sup>	Relation of maxillary central incisors width to some facial measurements	---	18-25	human measures and casts	160 (80 males and 80 females)
Misch <sup>24</sup>	Guidelines for maxillary incisal edge position – a pilot study: the key is the canine	Caucasian	30-59	human measures	104 (59 males and 45 females)
Raghavendra et al. <sup>19</sup>	Prediction of facial profile based on morphometri measurements and profile characteristics of permanent maxillary central incisor teeth	Indian	18-23	human measures and casts	100 (50 males and 50 females)

With respect to facial measurements, the intercanthal distance that is defined as the distance between the inner corner of the right eye and the inner corner of the left eye was compared by some authors to dental measurements<sup>9</sup>. Using a photograph and plaster cast, Gomes et al.<sup>6</sup> found a mean intercanthal distance of 34.39 mm, with a mean of 33.76 mm in women and of 34.78 mm in men. Similar findings have been reported by Ellakwa et al.<sup>10</sup> and Rawat et al.<sup>11</sup> (Table 2). However, the results reported by other authors<sup>11-13</sup> showed significant variations, with lower values than those obtained in the other studies, a fact that can be explained by the measurement method used and by the variability among subjects of different ethnicities. According to L-Kaisy and Garib<sup>14</sup>, the intercanthal distance is considered a reliable anatomical dimension that can be used for the selection of anterior teeth since application of the golden ratio  $[(\text{intercanthal distance}) \times 0.618] / 2$  provides the width of the central incisors. These authors were thus able to estimate the width of the central incisors in Kurdish men; however, this estimation does not apply to Kurdish women in whom the calculated value was smaller than the actual measurement. Therefore, this ratio cannot be applied universally according to the surveyed literature.

**Table 2.** Facial measurements of the analyzed studies.

Author/ year	Inter canthal distance	Interpupillary distance	Intercommissural distance	Interalar width	Inter-zygomatic distance
Al Wazzan <sup>20</sup>	A= 31.92mm M= 32.94mm F= 31.91mm	---	---	---	---
Al Wazzan, 2004 <sup>22</sup>	---	---	---	---	---
Hasanreisoglu et al. <sup>4</sup>	---	---	---	---	---
Gomes et al. <sup>23</sup>	A= 34.39mm M= 34.78mm F= 33.76mm	A= 69.09mm M= 69.97mm F= 66.68mm	A= 56.58mm M= 59.09mm F= 54.83mm	A= 41.22mm M= 43.19mm F= 38.79mm	---
Isa et al. <sup>8</sup>	---	---	---	---	A= 7.94mm
Ellakwa et al. <sup>10</sup>	A= 60.68mm M= 62.01mm F= 58.91mm	A= 50.61mm M= 51.11mm F= 49.95mm	A= 38.27mm M= 39.82mm F= 36.28mm	---	---
Kini and Angadi <sup>12</sup>	A: 30.55mm	A: 61.97mm	A: 47.72mm	---	---

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Ahmed et al. <sup>17</sup>	M= 34.34mm F= 33.25mm	---	M= 57.52mm F= 56.47mm	---	M= 135.4mm F= 133.58mm
Rawat et al. <sup>11</sup>	---	---	---	---	M= 19,76mm F= 118,43mm
L-Kaisy and Garib <sup>14</sup>	---	---	---	---	A= 7.4 mm M= 7.54 mm F= 7.25 mm
Hasan et al. <sup>13</sup>	M= 31.44mm F= 30.99mm	---	---	---	M= 111.94mm F= 109.05mm
Misch <sup>24</sup>	---	---	---	---	---
Raghavendra et al. <sup>19</sup>	---	---	---	---	---

Legends: A: Arithmetic average; M: Male; F: Female.

Another important facial parameter was the interpupillary distance, which is equivalent to the distance from the center of the right pupil to the center of the left pupil<sup>9</sup>. Therefore, the interpupillary distance and the mesiodistal width of the incisors remain constant throughout life and the relationship only changes according to race and sex<sup>14</sup>. Wide numerical variation was observed in this parameter. Gomes et al.<sup>6</sup> obtained a mean interpupillary distance of 69.09 mm, while Ellakwa et al.<sup>10</sup> and Kini and Angadi<sup>12</sup> reported mean values of 61.97 and 60.68 mm, respectively. In addition to the interpupillary distance, the intercommissural distance also differed among studies, as shown in Table 2. Gomes et al.<sup>6</sup> found a mean intercommissural distance of 56.58 mm, whereas lower values were reported by other authors<sup>10,12</sup>. Thus, the intercanthal and interpupillary distances can be chosen since they are essential parameters for human facial esthetics. In addition, these distances are easily evaluated because of their high interexaminer reliability and the dimensions of the adult eye are established early and maintained throughout adult life, with the interpupillary distance being defined at 4 years of age and the intercanthal distance at 11 years<sup>10</sup>.

The interalar width corresponds to the medial canthal line<sup>15</sup>. It has been shown to be compatible with the straight distance between canine tips and varies according to sex and ethnic group<sup>14</sup>. This parameter was less frequently reported in the selected publications. In the study by Gomes et al.<sup>6</sup>, the mean interalar width was 41.22 mm, while Ellakwa et al.<sup>10</sup> found a mean width of 38.27 mm (Table 2). Divergences exist regarding the intercanine measurement since some authors use the distal surface instead of the canine tip as a reference. However, according to Hasanreisoglu et al.<sup>4</sup>, the interalar width is commonly used to estimate the position of the maxillary canines.

Another dimension to be analyzed is the bizygomatic width, which corresponds to the maximum horizontal distance from the left facial boundary to the right facial boundary<sup>16</sup>. As can be seen in Table 2, the mean male and female bizygomatic width varied widely among the studies that included this facial parameter<sup>11,13,17</sup>. According to Berry's biometric ratio method, a ratio of 1:16 can be applied to describe the relationship between the width of the upper central incisor and the

bizygomatic width; however, the studies included in this review did not confirm this ratio, which has been shown to be based on flawed statistical procedures<sup>10</sup>. However, Hasanreisoglu et al.<sup>4</sup> observed a ratio of 1:16 between the bizygomatic width and central incisor width in Turkish women.

Combining facial and dental measurements, Kini and Angadi<sup>12</sup> found a high correlation between the intercommissural width and the distance between canine tips on the photograph and between canine tips on the plaster cast and interpupillary distance, with biometric ratios of 1:1.35 and 1:1.41, respectively, in the Indian population. Thus, in the absence of pre-extraction records, extraoral anthropometric measurements can help determine the ideal dental measurements for this population. L-Kaisy and Garib<sup>14</sup> demonstrated a significant correlation between the interpupillary width and dental measurements; however, the correlation between the interalar and intercanthal facial measurements was weak, a fact that impairs the use of this correlation, for example, as a basis for the fabrication of dentures.

The present literature review selected publications from different parts of the world, with a predominance of studies conducted on the Asian continent (61.54%,  $n = 8$ ). In this regard, ethnicity is a factor that influences the dimensions analyzed<sup>18</sup>, which may explain the non-uniform results showing significant discrepancies.

All the selected studies involved male and female samples and some of these publications assessed gender differences. Although the mean values of the measurements differed only slightly between genders, with male measurements being unanimously higher than female measurements, Wang et al.<sup>18</sup> concluded that gender influences dental and facial measurements and that dentists should pay attention to this factor when establishing treatment plans for patients undergoing oral rehabilitation.

Another parameter analyzed in the articles was the mesiodistal width of the upper right and left central incisors. Hasan et al.<sup>13</sup>, L-Kaisy and Garib<sup>14</sup> and Ahmed et al.<sup>17</sup> compared this parameter between genders and observed a similar mean value in male subjects, respectively, 8.79, 8.58 and 8.48 mm for the right central incisors and 8.80, 8.66 and 8.55 mm for the left central incisors. The same pattern of similarity was observed in women, respectively, 8.55, 8.57 and 8.30 mm for the right central incisors and 8.64, 8.55 and 8.33 mm for the left central incisors. Thus, the width of the maxillary central incisor was used to assess racial and gender differences, and the dimensions recorded for the anterior teeth were comparable and similar to the mean values reported in the literature<sup>18</sup>.

Ellakwa et al.<sup>10</sup>, Rawat et al.<sup>11</sup>, Raghavendra et al.<sup>19</sup> and Al Wazzan<sup>20</sup> did not distinguish between the maxillary right and left central incisors and only reported the average value of these teeth, which was established as the final mesiodistal width. The authors used this parameter and compared it between genders. In these articles, the widths were 8.51, 8.50, 8.61 and 8.50 mm for males, respectively, and 8.29, 7.9, 8.36 and 8.25 mm for females.

Rawat et al.<sup>11</sup> and L-Kaisy and Garib<sup>14</sup> also included measurements of the mesiodistal width of the left and right lateral incisor in their studies. The male subjects evaluated exhibited, respectively, 6.73 and 6.47 mm for the right lateral incisors and

6.67 and 6.39 mm for the left lateral incisors. Isa et al.<sup>8</sup> reported the following mean results in the population analyzed: 7.09 mm for the right lateral incisors and 7.07 mm for the left later incisors. However, the authors did not perform comparisons between genders.

The age of the analyzed participants ranged from 17 to 60 years; however, a mean age of 18 to 25 years was the most commonly investigated since the permanent dentition is complete in most individuals of this age group and dental friction is minimal<sup>19</sup>.

The results of Table 1 showed that the mesiodistal dimension of the maxillary anterior teeth was greater in males than in females. The exact reason for this difference is not well understood, although these authors suggested that sex-linked inheritance and sex hormones influence this parameter. Likewise, Wang et al.<sup>18</sup> also suggested greater dimensions of male teeth compared to female teeth since they follow the facial proportions that are also higher in males.

In the studies by Gomes et al.<sup>6</sup> and Kini and Angadi<sup>12</sup>, the mean distance between the tips of the upper canines determined using digital photographs was shorter than the same mean distance obtained with plaster casts. However, Ellakwa et al.<sup>10</sup> reported the lowest mean value of the same parameter among all cited studies, which was measured in plaster casts of 98 Australian participants older than 18 years. According to the authors, although several intra- and extraoral measures can be used to increase the correlation coefficient, they remain insufficient and the implications of these methods in clinical practice require further investigation.

The fact that men have greater dental measurements than women follow the same justification mentioned above. However, the disparity observed when the data in Table 1 are correlated may be explained by the fact that the anatomical characteristics of the incisors vary according to age<sup>18</sup>. Hartmann and Müller<sup>21</sup> and the articles included in the present review did not show a pattern since they involved subjects of different age groups ranging from 18 to 32 years. Measurements may also differ according to the ethnicity of the population. Furthermore, discrepancies may occur at the time of measurement and depending on the parameter used: plaster casts, photographic models, or human subjects<sup>14</sup>.

Furthermore, Isa et al.<sup>8</sup> reported an investigation with similar results, but did not compare men and women. In a sample of 60 subjects, the mean mesiodistal width was 8.54 mm for the right central incisors and of 8.56 mm for the left central incisors. The fact that the measurements were made on photographic models may have caused divergences in the data because of possible calibration errors.

The variability between the collected data can be explained mainly by the age difference, with the studies including subjects ranging in age from 18 to 55 years. With advancing age, teeth are more likely to exhibit rotations, mesiodistal inclinations, midline deviations, abrasion, and gingival retraction<sup>13</sup>. However, the explanations mentioned above should not be ruled out. On the other hand, Ellakwa et al.<sup>10</sup> found no reduction in tooth width with increasing age.

Finally, Hasanreisoglu et al.<sup>4</sup> used a measurement method different from the other articles, in which the data were obtained by measurement on digital photographs and plaster casts. The authors measured the mesiodistal width of the central incisors, obtaining a mean width of 8.6 mm with the plaster cast and of 8.8 mm with photographs, and the mesiodistal width of the right lateral incisor, obtaining a mean width of 6.7 mm with the plaster cast and of 5.80 mm with photographs. The results of this study showed that measurements using different methods cause differences in the values found. When the measurements are analyzed according to the method used, divergences are found due to the curvature of the arch and the angulation of the maxillary anterior teeth in relation to the frontal plane of the photograph.

## Conclusion

Despite the limited number of studies, some factors that influence dental and facial dimensions, such as sex and age, can be identified. However, there is no standardization of the facial or dental parameters used in the studies, a fact that makes it difficult to establish a universal ratio for clinical dental practice. In view of this gap in the literature, further studies correlating these dimensions in populations from different geographic regions are necessary.

## Conflict of interests

The authors have no conflicts of interest to declare.

## Data availability

Datasets related to this article will be available upon request to the corresponding author.

## Authors contribution

**Maria Tereza de Moraes Longhi** contributed to the development, execution of data collection and writing the article;

**Rafaella Ugrin de Oliveira Silva** contributed to the development, execution of data collection and writing the article;

**Sâmara Cafa Silva Almeida** contributed to the development, execution of data collection and writing the article;

**Alessandra Esteves** contributed to the writing and review of the article;

**Wagner Costa Rossi Júnior** contributed to the writing and review of the article;

**Camila Helena Machado da Costa Figueiredo** contributed to the writing and review of the article;

**Ana Luiza Dias Leite de Andrade** designed the study and contributed to the writing and review of the article, as well as approval of its final version.

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