

# Anatomical factors associated with gender recognizability: A study on intraoral standardized photographs

## Abstract

**Aim:** The aim of this research was to evaluate the possibility of identifying the sex of 1 subject through visual assessment of a frontal photograph of dentition, and to investigate if some morphological characteristics are related to sex determination. **Methods:** 5 expert dentists, 5 non-expert dentists and 5 laypeople were made to watch 100 intraoral photographs for 5 seconds each and to establish their sex. The responses of the participants and the baseline characteristics of photographed dentitions were analyzed.

**Results:** The proportion of right answers was  $56.0\% \pm 8.2\%$  in the group of expert dentists,  $65.0\% \pm 6.0\%$  in the group of non-expert dentists and  $58.6\% \pm 4.5\%$  in the group of non-expert people. The round shape of maxillary central incisors was related to the female gender ( $P = .006$ ). The male condition was correlated with poor oral hygiene for 4 observers. Female sex perception was correlated with round morphology of upper central incisors for 3 observers.

**Conclusion:** No difference in the ability to determine the sex was registered among groups, suggesting that sex perception is not strongly influenced by the characteristics of dentition.

## KEYWORDS

dental esthetics, odontometry, sex determination, sexual dimorphism, visual perception

## 1 | INTRODUCTION

Many studies have explored the possibility of evaluating sexual dimorphism in teeth, in order to understand if a correlation exists between teeth characteristics and sex.<sup>1-9</sup> In 1955, Frush and Fisher proposed the “dentogenic theory”, stating that the right form of teeth for a dental prosthesis should be chosen taking in account the patient’s gender, personality and age. According to the authors, femininity was characterized by roundness and smoothness of teeth shape, while masculinity was related to boldness and hardness; therefore, oval and cubic teeth shape were recommended respectively for females and males.<sup>1</sup>

The presence of sexual dimorphism in tooth morphology was then extensively investigated in literature, and used mainly in forensic dentistry as an additional method for sex determination. Tooth-crown mesio-distal and bucco-lingual dimensions are significantly different between males and females; mandibular canines show the greatest dimensional difference, followed by premolars, being larger in males than in females. Sterrett et al. recorded that the mean width and height of central incisors, lateral incisors and canine teeth were significantly greater in males than in females (Caucasian population); moreover, the authors found a positive correlation between gender and width/length ratios of anterior teeth.<sup>2</sup> Sexual dimorphism has been well explained by Moss and Moss-Salentijn, who postulated that males show larger size of tooth crown in comparison with females because males have a longer period of amelogenesis for both primary and secondary dentition.<sup>10</sup> According to Acharya and Mainali, sexual dimorphism in dental measurements could be due to the Y chromosome producing slower male maturation.<sup>11</sup> In 2011, Khangura et al. revealed that all permanent maxillary incisors and canines exhibited larger mean values of mesio-distal dimension in males compared with females but only canines were found to be statistically significant for sexual dimorphism.<sup>4</sup> Also, labiolingual dimension and crown height of canine showed highly consistent results for sexual dimorphism and hence it can be used as an adjunct along with other procedures for gender characterization.<sup>5,6</sup> Several studies have investigated canine dimorphism: according to this research, mandibular canine width and intercanine distance were greater in males and allowed correct sex determination in 74%-88% of cases.<sup>7,8</sup> Garn et al.<sup>12</sup> posited that sexual dimorphism was greater in the mandibular

canine than in the maxillary canine, contrary to the results obtained in 2 studies on a Japanese population.<sup>13,14</sup> Lateral incisors seem to be smaller than the central incisors in females. Therefore, Aitchison suggested the introduction of the incisor index, a ratio between maxillary lateral incisor and central incisor maximum mesio-distal diameter, and found it to be higher in males than in females.<sup>9</sup>

Even though these characteristics may be used as additional information for sex determination, to our knowledge no study has evaluated the capability of individuals to perceive sexual differences through visual assessment by evaluating the correlation between the response and some parameters retrievable from teeth photographs.

The aim of the present paper was to evaluate through a questionnaire the possibility of identifying the sex of 1 subject through observation of a frontal photograph of dentition, and to investigate if some morphological characteristics are related to sex discrimination. The hypothesis was to assume that it is possible to discriminate the gender of 1 individual by observing a picture of his/her teeth.

## 2 | MATERIALS AND METHODS

The present study was conducted following the principles of the 1964 Declaration of Helsinki and its later amendments or comparable ethical standards. Due to the characteristics of the study protocol, no approval by an institutional review board/ethical committee was required because all photographs used were anonymized.

### 2.1 | Questionnaire

The participants in the study were asked to watch once on a monitor (24-inch, liquid crystal display) a video containing 100 anonymized intraoral photographs of people, with the images switching from 1 to the following automatically after 5 seconds. Images were chosen to be included in the study if they showed at least 20 teeth (from 2nd premolar to 2nd premolar for both arches) without prosthetic reconstructions, such as crowns, veneers or bridges. The pictures were of people aged more than 18 years, who agreed for their photographs to be used anonymously for scientific studies. The photographs were digitally cut in order not to show perioral tissues (lips).

The questionnaire was administered to 5 expert dentists (with >10 years of experience), 5 non-expert dentists (with <3 years of experience) and to 5 non-expert people with no experience in the field of dentistry. They were asked to say if the picture belonged, in their opinion, to a male or a female. The response was required within 5 seconds, while watching the video.

### 2.2 | Outcomes

The primary outcome was the number of correct answers for each participant to the study.

The secondary outcomes were: (a) the total number of right responses for each picture; (b) the correlation between the characteristic of cases portrayed and the gender of the subjects; (c) the correlation between the characteristic of cases portrayed of the pictures and the response of each participant; and (d) the in-group and between-group agreement between participants who filled the questionnaire and the number of right answers.

Baseline characteristics were classified by 2 authors (AA, MM) and any disagreement in classification was resolved by discussion or consulting a third investigator (BZ). 19 dental, gingival and occlusal parameters were considered: (a) color of the oral mucosa (0 = pink; 1 = red, 2 = intense red); (b) pigmentation of the mucosa (0 = absent, 1 = present); (c) mucogingival line (0 = not evident, 1 = evident); (d) teeth color on the VITA scale (Vita Classical A1-D4<sup>®</sup>; VITA Zahnfabrik, Bad Säckingen, Germany) (0 = A1, 1 = A2, 2 = A3, 3 = A4); (e) alterations in the teeth color (0 = absent, 1 = present); (f) level of oral hygiene (0 = good oral hygiene, <20% Full-Mouth Plaque Score; 1 = poor oral hygiene); (g) alignment (0 = aligned, 1 = disalignment of only 1 tooth, 2 = disalignment of >1 tooth); (h) bite (0 = normal bite, 1 = open bite, 2 = deep bite, 3 = edge to edge); (i) presence of 1 cross-bite (0 = not present, 1 = present); (j) morphology of upper central incisors (0 = square, 1 = round, 2 = triangular); (k) width/ height ratio of maxillary central incisor (mean

of left and right values); (l) dimensional ratio of lateral and central incisors width (mean of left and right values); (m) presence of diastema between teeth (0 = absent, 1 = present); (n) morphology of canines (0 = triangular, 1 = not triangular); (o) abrasions (0 = absent, 1 = present); (p) occlusal vertical dimension (0 = normal, 1 = reduced); (q) visibility of molar teeth (0 = not visible, 1 = visible); (r) presence of gingival recessions (0 = not present, 1 = single recession, 2 = multiple recessions in anterior region, 3 = multiple recessions in posterior region, 4 = multiple recessions both in anterior and posterior regions); and (s) presence of visible interdental papillae (0 = not present; 1 = present).

### 2.3 | Statistical methods

Descriptive statistics were provided by means and standard deviations for continuous variables and by frequencies for categorical variables. Shapiro-Wilk served to test normality of distributions.

The correlation between characteristics of the cases represented and results of the questionnaires was evaluated by using a linear regression model and logistic regression model depending on the characteristics of the dependent variable. The in-group and between-group agreement were calculated by means of Cohen's kappa (1-1).

The level of significance was set at  $P = .05$ . 3 | RESULTS

The questionnaire was administered to a total of 15 people (7 women and 8 men) with a mean age of  $52.2 \pm 19.3$  years for the expert dentist group,  $26.6 \pm 2.2$  years for the non-expert dentist group and  $39.6 \pm 21.1$  years for the non-expert group. The number of right answers in the group of expert dentists was  $56.0 \pm 8.2$ , it was  $65.0 \pm 6.0$  in the group of non-expert dentists and  $58.6 \pm 4.5$  in the group of non-expert people. The distribution of the number of right answers for each picture is shown in Figure 1 and it is normally distributed. Figures 2 and 3 show 2 of the pictures that were evaluated by the examiners.

Among all considered parameters, the round shape of maxillary central incisors was related to the female gender ( $P = .006$ ).

As for the perception of people who responded to the questionnaire, without taking into consideration their correctness, some parameters showed a correlation with the perceived sex. The male condition was correlated with poor oral hygiene for 4 observers; it was correlated with darker teeth color, loss of interdental papilla, higher width/height ratio for maxillary incisors and with aligned teeth with exception of 1 misaligned tooth for 3 other observers. Female sex perception was correlated with round morphology of upper central incisors for 3 observers. A summary of the results of the regression analysis is shown in Figure 4.

The concordance between those who responded to the questionnaire was generally poor ( $<0.4$ ) or null, as reported in detail in Table 1.

### 4 | DISCUSSION

As for the ability of the observers to correctly establish the sex of the person photographed, interestingly, in our study no difference in gender discrimination was recorded between groups. Expert dentists did not show higher capability of giving the right answer as could be expected. In all groups, a high percentage of wrong answers was recorded, showing that it is very difficult to discriminate sex through the observation of intraoral photographs. We can hypothesize that the perception of sex is more strongly related to other factors, such as the morphology of perioral soft tissues. This finding appears to be similar to what was found in 2 papers about gender discrimination that reported the inability for the examiners to discriminate the gender of the subject represented in photographs.<sup>15,16</sup> In 2002, Berksun et al. submitted 60 photographic records of maxillary anterior teeth to a group of 13 expert prosthodontists, asking them to discriminate the gender of the people represented in the photographs. The mean proportion of correct matches ranged 53%-58%, considering the 2 separate observations made by all examiners. The authors concluded that the group of expert prosthodontists was not successful in correctly identifying the gender of the subjects. Moreover, the study, similarly to

what we found, reported fair concordance among all of the examiners.<sup>17</sup> Another study published in 2004 proposed to a group of examiners a questionnaire to identify the gender of the subjects in a total of 204 photographs (1 portrait with closed lips and 1 picture of closed teeth for each subject). The group of examiners was composed of 5 expert dental practitioners and 5 postgraduate students. The proportion of correct responses regarding the identification of the gender of the subject pictured ranged 47%-63% and these values are similar to the results obtained in the present investigation.<sup>16</sup>

With regard to the single parameters analyzed, in the photographs used in the present study, only the morphology of the central incisor had a correlation with the real sex of the subjects. In fact, we found that a round shape of maxillary central incisor was most frequently related to female sex. Interestingly, there was, for 3 examiners, a correlation between the presence of round maxillary central incisors and the female gender perception, whilst for 2 examiners we found a correlation between triangular/trapezoidal maxillary central incisors and the female sex. These assumptions were coherent with what was first stated by Frush and Fisher in 1955 about the shape of maxillary central incisors.<sup>1</sup> However, such consideration about the sexual dimorphism of maxillary incisors found no support in the scientific literature about the evaluation of tooth shape in males and females.<sup>15,16</sup> Several published studies found that larger teeth are most commonly found in males than females,<sup>2,15</sup> but we could not evaluate this aspect because it was not measurable in photographs.

As regards only the perception of morphological characteristics as associated with male or female gender, it is interesting to note that we found no strong relation between our findings and the results of previously published studies which have investigated the impact of dental characteristics on smile esthetics.<sup>18</sup> However, poor oral hygiene, loss of interdental papilla and darker teeth color were associated with male sex, indicating that the social and cultural background plays a fundamental role in perception of sex. Some assumptions found a correspondence in published literature. 1 study by Santos et al., published in 2019, reported the results of a survey on oral hygiene habits in Portugal that found that women generally brush their teeth more frequently than men.<sup>19</sup> Poor oral health was found to be strongly related to male gender also in 12-year-old adolescents.<sup>20</sup> The worse attitude to oral hygiene of males was reported also in other studies that examined populations of different ethnicity.<sup>21,22</sup>

A number of limitations of the present study should be taken in consideration. First, the images used were intraoral photographs and not images of smiles; this kind of image was chosen in order to better evaluate the importance of intraoral tissues and to avoid confounding factors such as the influence of perioral tissues on the gender discrimination process. However, individuals do not commonly experience such vision, and this may influence our investigation of perception, as it is defined as a cognitive process based on earlier experience. Differences in light and color balance in the pictures could also have influenced perception.

Analyzing the protocol in detail, we should consider that the questionnaire used was not previously validated; however, we can assume that the questionnaire used was not different from the 1 adopted in other similar studies.<sup>15-17</sup> Another limitation of our study is that only parameters that could be obtained by the photographs were taken into consideration in the morphological analysis; therefore, some quantitative parameters that were reported to be sex-related, such as canine crown width and length in millimeters, were excluded. The small number of observers and the absence of sample size calculation can be also considered as a limitation of the study. Moreover, each participant could watch and assess the photographs only once, in order to better investigate the general perception of 1 picture, rather than the analysis of specific factors; however, this choice of using a single observation prevented us testing the intraobserver variability.

Taking into consideration the limitations of the present study, we can conclude that:

sex determination through visual assessment of intraoral frontal photographs is very difficult for both laypeople and for expert and non-expert dentists;

the social and cultural background plays a fundamental role in perception of sex;

no strong correlation was recorded between sex perception and dental characteristics which are considered as esthetic

We cannot confirm the initial hypothesis because it seems that gender discrimination by observing intraoral radiographs is not possible with an adequate rate of right answer.

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