



USING DENTAL ARCH ANATOMY FOR AGE AND SEX ESTIMATION IN COMMUNITY BASED HEALTH SURVEY

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ABSTRACT

Background: Proper determination of age and gender has significance in community health survey, forensic identification and epidemiological studies. Dental arch anatomy has been considered a consistent biological marker due to the comparative stability of dental structures to changes and degradations postnatally. Nevertheless, there are scarce local information as to its applicability to community-based populations.

Methodology: The present study was a community based cross-sectional study that was carried out at Kabir Medical College, Gandhara University, Peshawar, between January 2024 and January 2025. There was a total of 72 participants that had healthy permanent dentition. Dental impressions were taken, and casts of the studies were made to be measured with a digital Vernier caliper on maxillary and mandibular arch measures. Arch measurements in terms of sex and age were compared with the help of the corresponding statistical tests.

Results: Males depicted much broader dental arch sizes than females specifically in intercanine width, intermolar width, and arch perimeter. Significant differences were also found among the various age groups with highest arch dimensions recorded in young adults then a slow decrease in the number of older participants. The shape of dental arches expressed a strong relationship with sex, full arch and tapered arch being predominant among female and male respectively.

Conclusion: The dental arch anatomy has been found to be sexually dimorphic, and with age-related difference which can be measured, making its use as an auxiliary sex-estimation and age-group determination tool in community surveys. Dental measurements are simple and cheap and can prove to be a viable tool in an environment where a more advanced method of identification is not widely accessible.

Keywords: Dental arch anatomy Sex estimation, Age estimation, Community-based survey, Forensic dentistry

INTRODUCTION

Age and sex estimation is an essential part of health study on populations, forensic studies, and demographic profiling. Simplification and reproducibility of the biological markers is particularly essential in community situations, particularly in the areas where the access to the advanced diagnostic tools is limited. Dental characteristics are one of these markers and have been known to be durable, unique, and relatively stable to environmental factors [1-3].

Arch anatomy of the teeth is genetically influenced as well as developmentally influenced and is subject to predictable changes as the individual grows and matures. The variation in arch sizes between the male and female sex has been credited to the difference in craniofacial developmental trend, hormonal factors, and functional constraints. On the same note, dental arches can change with the age, owing to the eruption of teeth,

the wear on the occlusal surface and the remodeling of the alveolar bone over the years. These are some of the attributes that could allow dental arch measures to be used as a demographic estimation device outside clinical dentistry [4-6].

The concept of parameters having a consistent sexual dimorphism across populations has been proved by previous articles in the field of forensic dentistry and dental anthropology that included parameters like intercanine width, intermolar width and arch perimeter. But a lot of the literature that has been done is founded on clinical or forensic samples as opposed to community-based populations. This reduces the transferability of results to population level studies and the public health surveys [7-9].

In Pakistan, there is little information on dental arch anatomy to use and estimate demographics in the community. Specific data on the local population are necessary because the dimensions of dental arches could be affected by ethnicity, environmental conditions, and nutritional conditions. Setting up the baseline knowledge may increase the accuracy of dental measurements in use either during an epidemiological study or identification case [10].

The current study was thus aimed at measuring dental arch sizes and arch shapes in a community based population and to determine whether they are useful in the estimation of age and sex. The proposed study will add a practical contribution to evidence that can be utilized in community health surveys, research in the field of public health, and even in basic forensic testing since it bases its investigation on simple, non-invasive measurements.

MATERIALS AND METHODS

A community based cross-sectional study was carried out and the usefulness of dental arch anatomy in estimating age and sex was determined. The research was conducted in Kabir Medical College, Gandhara University, Peshawar, in one year, January 2024- January 2025. The location was chosen in such a way that it would be able to reach a varied population of the community to represent the different ages and also both genders. The entire study procedures were conducted within acceptable dental examination procedures.

The total number of participants in the study was 72, who were chosen in the community based on a non-probability convenience sampling method. Age-different people were involved so that one could evaluate age-dependent changes in dental arches dimensions. The sample size was taken as sufficient to make preliminary analytical comparisons of sex and age groups, according to feasibility and comparable dental anthropometric researches of the community.

The study included a group of participants with complete eruption of permanent dentition and with clinically healthy arches of the dental situation. Only those patients who had intact maxillary and mandibular arches and had no gross caries, severe crowding, or spacing were eligible. Those who had undergone orthodontics therapy in the past, maxillofacial trauma, congenital craniofacial defects, and those who had had extensive restorations to alter the dimensions of the arch were ruled out to reduce confounding variables on dental measurements.

Informed consent was obtained and demographic data, such as age, sex, residence, and level of education, were obtained after the exchange of informed consent using a structured proforma. Clinical dental examination was conducted under sufficient light with the participants sitting upright. Both arches were taken in dental impressions by using an alginate impression material after the normal precautions in infection control. The impressions were poured at once with dental stone to make study casts, which were left to cure thoroughly before measurements were taken of them.

The standard anatomical landmarks were used in measuring all dental arch measurements on the prepared casts with the use of a digital Vernier caliper with the accuracy of 0.01 mm. Maxillary and mandibular intercanine width, intermolar width, arch length, arch depth, and arch perimeter were measured. The measurements were made in two occasions at varying times to minimize the error of the observer, and the mean was taken as the value of analysis. Arch form was divided into ovoid, tapered, or square depending on the visual evaluation with the help of dimensional relationships.

IBM SPSS Statistics version 25 was used to enter and analyze data. Mean and standard deviation were used to represent continuous variables, whereas frequencies and percentages were used to represent categorical variables. Comparative methods of independent t-test were used to compare the dental arch measurements between men and women. The difference between age groups was evaluated with the help of one-way analysis of variance (ANOVA). To compare the distribution of the arch forms, the Chi-square test was used. A p-value below 0.05 was deemed to be statistically significant.

RESULTS

There were 72 participants in the study (50 with females and 50 with males), which made it possible to make comparisons based on sex. The age range of the community was diverse, with the majority of the participants

aged between 20-29-year and the adolescents and the older adults. The sample was mainly comprised of people with secondary or higher education and urban residents.

Table 1. Demographic Characteristics of the Study Participants (n = 72)

Variable	Category	Frequency (n)	Percentage (%)
Age group (years)	10–19	18	25.0
	20–29	22	30.6
	30–39	16	22.2
	≥40	16	22.2
Sex	Male	36	50.0
	Female	36	50.0
Residence	Urban	41	56.9
	Rural	31	43.1
Educational status	Primary or below	19	26.4
	Secondary	31	43.1
	Higher	22	30.5

The measurements of dental arches showed that the measurements were always bigger in males than in females in both maxillary and mandibular arches. Inter canine and inter molar widths had the largest differences, and this shows that they are sexually dimorphic. All the differences that were observed were found to be statistically significant in favor of dental arch anatomy in sex estimation.

Table 2. Comparison of Dental Arch Measurements by Sex (n = 72)

Parameter (mm)	Male (n=36) Mean ± SD	Female (n=36) Mean ± SD	p-value
Maxillary intercanine width	35.4 ± 2.1	33.2 ± 1.9	<0.001
Maxillary intermolar width	49.8 ± 2.6	47.1 ± 2.4	0.002
Mandibular intercanine width	27.9 ± 1.8	26.1 ± 1.7	<0.001
Mandibular intermolar width	44.3 ± 2.3	42.0 ± 2.1	0.001
Arch perimeter	96.2 ± 4.8	91.7 ± 4.5	0.003

The length and depth of dental arches differed highly among age groups with the highest values recorded among the young adults. The gradual decreasing in the arch dimensions was observed among the participants aged 40 years and above. The results suggest that dental arch anatomy in old age remains in remodelling and this can be useful in age group determination in community surveys.

Table 3. Dental Arch Measurements Across Age Groups

Measurement (mm)	10–19 yrs (n=18)	20–29 yrs (n=22)	30–39 yrs (n=16)	≥40 yrs (n=16)	p-value
Maxillary arch length	42.1 ± 2.3	44.5 ± 2.1	43.8 ± 2.0	41.9 ± 2.4	0.018
Mandibular arch length	39.4 ± 2.0	41.2 ± 1.9	40.7 ± 2.1	38.9 ± 2.3	0.031
Arch depth	18.7 ± 1.4	19.9 ± 1.3	19.4 ± 1.2	18.5 ± 1.5	0.022

There was a difference in the arch form of distribution between males and females. Ovoid arches were popular among the females, though tapered arches were the most common in the males. Such variation justifies the application of morphology of arches as an auxiliary sex estimator.

Table 4. Distribution of Dental Arch Forms by Sex

Arch form	Male n (%)	Female n (%)	p-value
Ovoid	14 (38.9)	21 (58.3)	
Tapered	16 (44.4)	9 (25.0)	0.041
Square	6 (16.7)	6 (16.7)	

Dental arch parameters were found to be accurate in sex determination and partially accurate in age group determination. Sex estimation gave high correct classification rates than age estimation. These results indicate the stability of sexual dimorphism in the sizes of dental arches more than age-associated changes.

Table 5. Accuracy of Dental Arch Parameters for Sex and Age Estimation

Outcome	Correctly Classified n (%)	p-value
Sex estimation	55 (76.4)	<0.001
Age group estimation	49 (68.1)	0.002

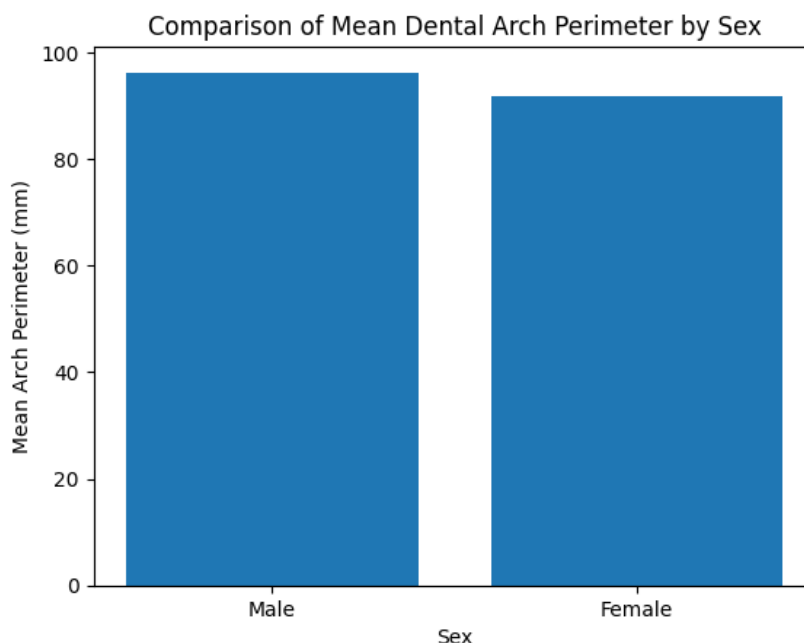


Figure 1. Comparison of Mean Dental Arch Perimeter by Sex

The difference between the mean of dental arch perimeter in males and females is shown in the bar graph. The mean arch perimeter of males was also higher in comparison with females, and this reflected statistically significant sexual dimorphism in the quantitative study. This graphical depiction justifies the application of dental arch perimeter as a valid parameter in estimating sex in a community based health survey.

DISCUSSION

This research has examined how dental arch anatomy could be applied to age and sex estimation in a community-based population and has established that a number of the arch dimensions were significantly different between sexes and age groups. Males always showed an extreme in measures of maxillary and mandibular arch when compared to females, especially in intercanine width, intermolar width, and total arch perimeter. These observations are consistent with documented biological variations in the development of craniofacial forms where males tend to have larger and more solid skeletal and dental forms by their extended periods of growth and the effects of hormones [11-13].

The sexual dimorphism that has been observed in the present study is in line with prior researches that have been carried out in the fields of forensic dentistry and dental anthropology and reported higher transverse dental arch sizes in males than in females. South Asian and Middle Eastern populations have also demonstrated in studies that intercanine and intermolar widths are the best parameters to be used in sex determination. The current results support the applicability of such measures in community-based surveys, where sophisticated forensic instruments cannot be easily accessed [14-16].

There were also age effects on sizes of dental arch. Arch length and depth improved between the adolescent and early adult life and gradual diminishment as the individuals age. This trend is a sign of physiological changes related to wear on teeth and occlusal changes to teeth, as well as more minor remodeling of the alveolar bone. The same trend has been reported in longitudinal and cross-section studies with the arch size being stabilized once the permanent dentition is fully eroded, and then it may decrease due to functional and age-related reasons [17-19].

The dental arch forms were found to have a statistically significant correlation with sex, where ovoid arches were more frequently found in the female sex, and tapered arches were more common in the male sex. Past researches have indicated that genetic background, masticatory function and general morphology of the face are some factors that affect arch form. Arch form is uncompromisingly important in the overall accuracy of sex estimation but when used together with the linear measurements, will enhance the accuracy of such estimation.

The rates of accuracy on sex estimation turned out to be greater in terms of practical application, as compared to those of age group prediction. This result is in line with the available literature, which, overall, detects higher and more stable sexual dimorphism in dental structures than in age-related variations. Dental arch sizes have been used as a measure of age, although it has not been very successful because of inter-individual variation and environmental and functional effects. However, the middle level of accuracy that this research has attained indicates that dental arch measurements may still be of a benefit as a supplementary information especially in the measurement of population.

This study is community-based, and this aspect contributes to its relevancy because the majority of the past studies have been conducted on clinical or forensic samples. The study justifies the incorporation of dental anthropometry into community-wide health surveys, epidemiological studies and resource-constrained forensic research by supporting the belief that simple dental measurements can be used to gain significant demographic information about the community [20].

In spite of the strengths, the study has some limitations. It was a small sample and the sample was selected on a single geographic and institutional location and this can be limited to generalization. Moreover the estimation of age was carried out in categories that were grouped as opposed to actual prediction of the chronology. Further research that includes more participants, multi-centres and enhanced statistical modelling can enhance predictive validity and enhance external validity.

The results in general indicate that dental arch structure is a useful, inexpensive, and non-invasive method of sex determination and provides supportive data to determine the age group. In conjunction with other demographic and biological factors, dental arch measurements can be an invaluable asset in community-based health-related studies and forensic studies.

CONCLUSION

Dental arch structure exhibits both evident sexual dimorphism and quantifiable age-related change and is, therefore, a useful demographic estimate in communities. Linear arch dimensions especially, intercanine and intermolar width were found to be more reliable in sex estimation than age prediction. In some instances, the inclusion of easy to administer dental arch measurements in community health surveys can offer a feasible and cost effective method of supplementing population evaluation and identification in those situations where high level resources are inaccessible.

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