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ORIGINAL RESEARCH

ASSESSING THE RELIABILITY OF MORPHOMETRIC ANALYSIS OF PRIMARY MOLAR IN DETERMINING SEX DIMORPHISM

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ABSTRACT

Background: Odontometric measurements of human dentition serve as a reliable tool in forensic odontology that aids in personal identification. The morphometry of permanent human teeth is well established in literature, however only few studies have been performed on primary teeth.

Aim: To evaluate the reliability of morphometric analysis of the deciduous second molar for sex dimorphism among Indian children from Gulbarga city.

Material and methods: The current study was performed on 258 sets of maxillary and mandibular diagnostic dental casts obtained from Indian children residing in Gulbarga city. With a digital Vernier calliper the measurements recorded are Mesiodistal width (MD), Cervico occlusal height(CO), Buccolingual/Buccopalatal width(BL/BP) and Intermolar width (IMW) of all the four primary second molars.

Results: The mean linear dimension of primary second molar with respect to MD, CO, BL/BP, and maxillary intermolar width was higher in males as compared to that of females. A significant difference in MD width between genders was observed in the primary maxillary molars 55 and 65 ($p<0.05$). The BL/BP width of maxillary and mandibular molar showed a significant difference between the genders for 55,65,75 and 85 ($p<0.05$). No statistical significant correlation between primary maxillary and mandibular molars was noted for the parameter CO and intermolar width between the genders ($p>0.05$).

Conclusion: In conclusion, sexual dimorphism is noted in the primary dentition similar to that found in permanent dentition. Our results displayed that the boys had higher linear dimensions of the second primary molars as compared to the girls.

Keywords: Odontometrics, primary molar, sexual dimorphism, intermolar width, forensic odontology, morphometric analysis

INTRODUCTION

Human teeth are unique structures which offer many physiological functions. Human dentition is often regarded as a durable and unique identifier, comparable to fingerprints, making it a crucial element in forensic odontology for personal identification[1]. Nonetheless, in situations such as mass disasters or accidents where identifying victims is challenging, teeth being the hardest and most resilient part of the human body often remain intact even after events like high-impact explosions. This durability makes them valuable tools in personal identification [2].

Personal identification is an essential basic step corresponding to several procedures that are mainly aimed at individualizing or identifying a person or object [3]. Age estimation and gender determination are the foremost tasks in personal identification. Despite several methods available for gender determination, it is well established that the morphometric tooth size measurements is a reliable and commonly used odontometric investigations for sex determination in human teeth [4,5].

Several studies have been published reflecting the role of odontometrics in gender determination in permanent teeth [6-9]. There is inadequate research on the morphometry of primary teeth and its role in forensics. The present study aims to focus on this lacunae. There is lack of normative data on the intermolar width, mesio-distal, bucco-lingual and cervico-occlusal dimensions of the primary molars. These data are valuable in understanding the reliability of SD analysis. The purpose of this study is to determine the morphometric analysis and sex dimorphism of primary second molars among Indian children of Gulbarga city.

MATERIALS AND METHODS

Study design, study setting and duration:

The present study was conducted on 258 sets of maxillary and mandibular diagnostic dental casts obtained from Indian children of Gulbarga city. Institutional Ethics Committee approval from the Institutional Ethics Committee of Maharaj Vinayak Global University, located in Jaipur, Rajasthan, India was obtained before the study commenced (MVGU/PHD/2021/754). Voluntary consent was obtained from all the participants, before collecting the data.

Estimation of Sample size:

The following formula was applied to determine the sample size

$$n = \frac{(\sigma 1^2 + \sigma 2^2)/(z1\text{-}\alpha/2 + z1\text{-}\beta)^2}{\Delta^2}$$

For 95% confidence interval and 90% power, the sample size estimated was 258. Thereby, the total sample size of 258 sets of maxillary and mandibular diagnostic dental cast were included.

Study Sample and population:

This study employed a purposive sampling technique to select 258 sets of maxillary and mandibular diagnostic dental casts from a specific population of Indian children with primary teeth.

Selection criteria:

Inclusion Criteria: The study included healthy children with a full set of primary teeth, no developmental anomalies in tooth shape and no dental crowding. Only children who expressed willingness to participate were included.

Exclusion Criteria: Children were excluded if they exhibited normal or abnormal tooth attrition due to physiological or pathological reasons, or if any primary maxillary or mandibular teeth were missing. Those with dental misalignment issues including malocclusion, crowding, rotation, malaligned teeth or a history of restorative treatments, orthodontic procedures, dental trauma were also excluded. Additionally, children with syndromes, a history of radiotherapy or chemotherapy, cleft lip and/or palate or partially erupted teeth were not considered. Children unwilling to participate were likewise excluded from the study.

Sample Collection:

Maxillary and mandibular arch impressions were taken using alginate material. Later, the impressions were disinfected with a 0.5% sodium hypochlorite solution. Once disinfected, the impressions were poured with dental stone.

Study procedure:

Single examiner with same digital vernier caliper performed the measurements

It was calibrated to an accuracy of ±0.02 mm.

Study Outcomes:

The key parameters measured in the 258 cast includes:

1. **Mesiodistal Width (MD):** Was taken as the maximum expanse between the proximal aspects of the crown.
2. **Cervico-occlusal (CO):** Distance from the tip of the crown to the cementoenamel junction was measured.
3. **Buccolingual width/ Buccopalatal width (LL/BP):** It is the measurement from the buccal side which faces the cheek to the lingual or palatal side.
4. **Inter molar width:** Was determined by measuring the straight-line distance between the central fossae of the deciduous second molars on both sides.
5. **Sexual dimorphism (SD):** SD was calculated using the formula given by Garn and Lewis. [10]
   SD=Xm-1×100/Xf
   Where Xm = mean intermolar width of males and Xf = mean intermolar width of females

Statistical analysis

The data were organized and analyzed statistically using SPSS version 21, employing the unpaired t-test.

Results with a p-value less than 0.05 were regarded as statistically significant.

RESULTS

Table 1 presents the descriptive statistics, including the mean and standard deviation, for various second primary molars in both genders. The mean linear dimension of second primary molars with respect to MD, CO, BL/BP, and maxillary intermolar width was higher in males than in females (Table 1).

Table 1. The linear dimension of primary second molars based on sex

Parameters	Gender	N	Mean	SD	SE
MD 55	Male	25	8.98	0.70	0.14
	Female	23	8.35	1.16	0.24
MD 65	Male	25	8.85	0.64	0.13
	Female	23	8.41	0.81	0.17
MD 75	Male	25	9.59	0.73	0.15
	Female	23	9.31	1.06	0.22
MD 85	Male	25	9.46	0.72	0.14
	Female	23	9.30	0.90	0.19
CO 55	Male	25	4.44	0.64	0.13
	Female	23	4.34	0.45	0.09
CO 65	Male	25	4.67	1.03	0.21
	Female	23	4.21	0.53	0.11
CO 75	Male	25	4.30	0.51	0.10
	Female	23	4.43	0.49	0.10
CO 85	Male	25	4.60	0.61	0.12
	Female	23	4.57	0.38	0.08
BL/BP 55	Male	25	9.25	0.52	0.10
	Female	23	8.18	0.89	0.18
BL/BP 65	Male	25	9.22	0.63	0.13
	Female	23	8.17	0.98	0.20
BL/BP 75	Male	25	8.38	0.57	0.11
	Female	23	7.76	0.98	0.20
BL/BP 85	Male	25	8.22	0.56	0.11
	Female	23	7.66	0.89	0.18
MaxillaIMW	Male	25	44.07	3.50	0.70
	Female	23	42.60	3.22	0.67
MandibleIMW	Male	25	36.81	3.56	0.71
	Female	23	37.14	2.32	0.48

A statistically significant difference between genders in primary maxillary molars 55 and 65 were noted ($p<0.05$), whereas no statistical significance was noted for MD width in 75 and 85 ($p>0.05$). (Table 2 and graph 1).

No significant correlation between primary maxillary and mandibular molars was noted for the parameter "Cervico Occlusal" between the genders ($p>0.05$). (Table 3 and graph 2).

The BL/BP width of maxillary and mandibular molar showed a significant difference between the genders for 55,65,75, and 85 ($p<0.05$) (Table 4 and graph 3). No statistically significant difference in intermolar width between genders was observed in either arch ($p > 0.05$) (Table 5 and graph 4).

Table 2. MD width of deciduous second molar

Measurements	t-value	p-value	Mean diff	Std. Err	95% ci	
					Lower	Upper
MD 55	2.2960	0.0260*	0.6282	0.27	0.08	1.18
MD 65	2.0970	0.0420*	0.4393	0.21	0.02	0.86
MD 75	1.0710	0.2900	0.2793	0.26	-0.25	0.80
MD 85	0.6870	0.4960	0.1604	0.23	-0.31	0.63

*$p<0.05$

Graph 1. MD width of deciduous second molar

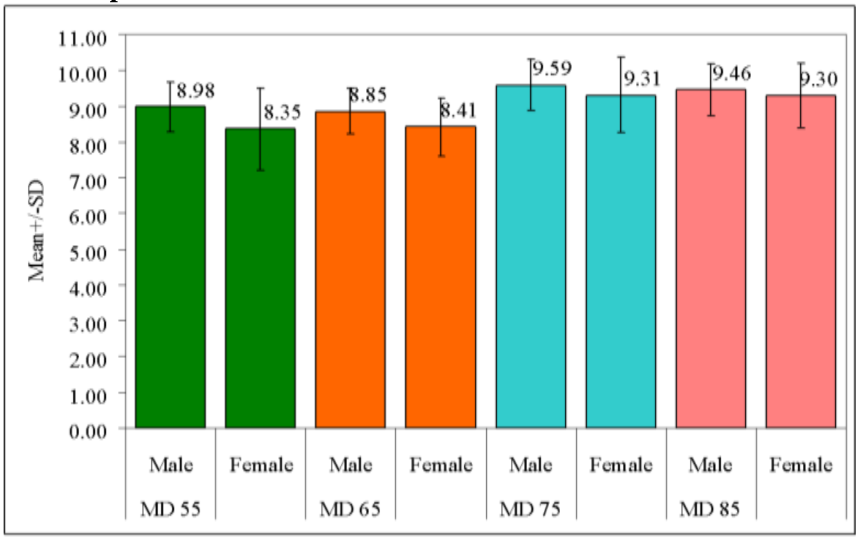


Table 3. CO measurements of deciduous second molar

Measurements	t-value	p-value	Mean diff	Std. Err	95% ci	
					Lower	Upper
CO 55	0.6550	0.5160	0.1049	0.16	-0.22	0.43
CO 65	1.8950	0.0640	0.4550	0.24	-0.03	0.94
CO 75	-0.9260	0.3590	-0.1348	0.15	-0.43	0.16
CO 85	0.2360	0.8150	0.0348	0.15	-0.26	0.33

Graph 2. CO measurements of deciduous second molar

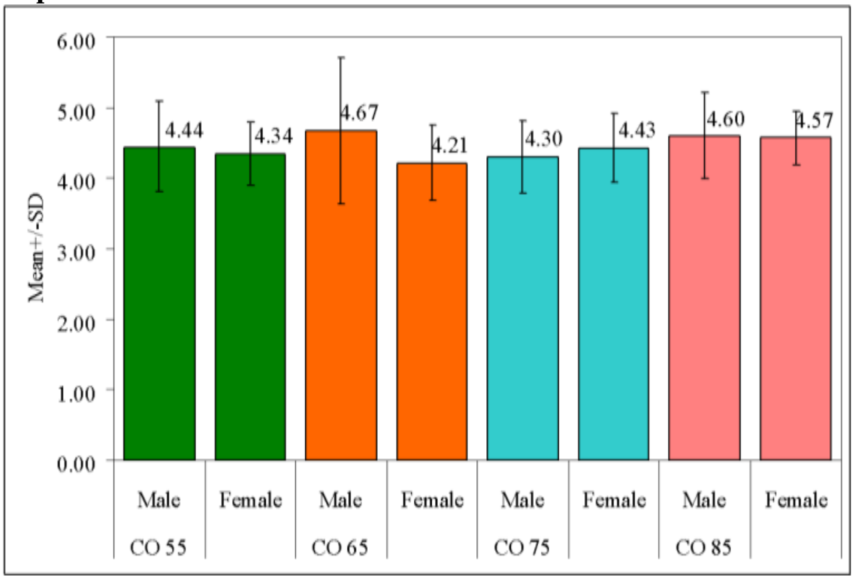


Table 4. BL/BP measurements of deciduous second molar

Measurements	t-value	p-value	Mean diff	Std. Error Difference	95% ci	
					Lower	Upper
BL/BP 55	5.1380	0.0001*	1.0694	0.21	0.65	1.49
BL/BP 65	4.4600	0.0001*	1.0501	0.24	0.58	1.52
BL/BP 75	2.6790	0.0100*	0.6151	0.23	0.15	1.08
BL/BP 85	2.6520	0.0110*	0.5631	0.21	0.14	0.99

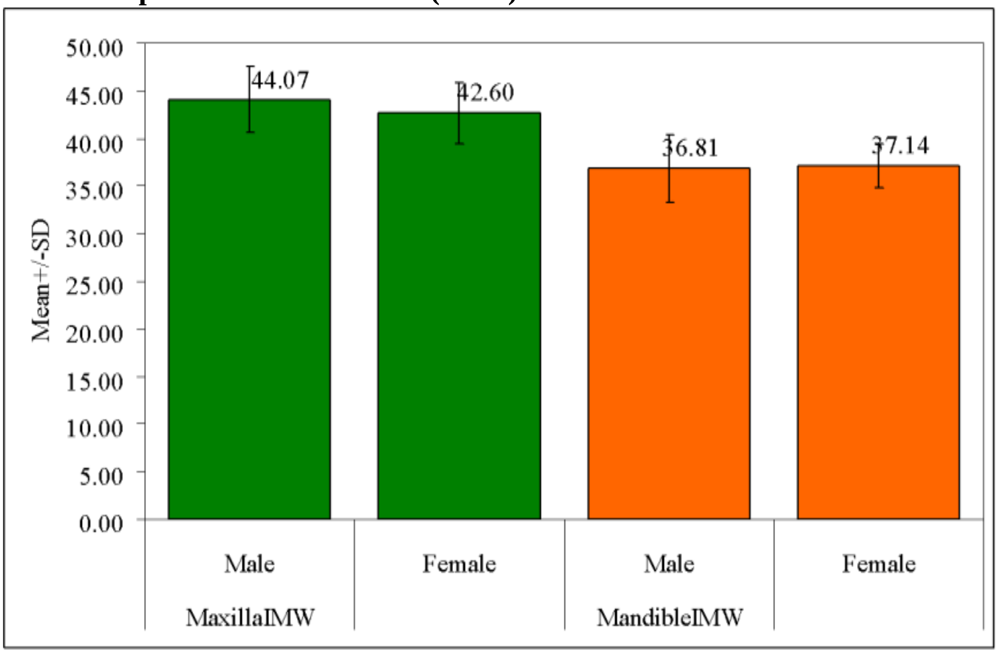
*p<0.05

Graph 3. BL/BP measurements of deciduous second molar

Table 5. Inter-molar width (IMW) in both arches

	t-value	p-value	Mean Difference	Std. Err	95% ci	
					Lower	Upper
Maxillary IMW	1.5070	0.1390	1.4677	0.97	-0.49	3.43
Mandibular IMW	-0.3780	0.7070	-0.3311	0.88	-2.10	1.43

Graph 4. Intermolar width (IMW) in both arches



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DISCUSSION

Sexual dimorphism (SD) is the difference found between genders with respect to size, stature and appearance.[1]1 In forensic investigations, determining sex is crucial for narrowing down the pool of potential identities, thereby aiding the process of individual identification.

In forensics for the purpose of personal identification, DNA evaluation gives accurate results. However, it is time consuming and costly. On the other hand, measuring linear dimensions such as anthropometric or odontometric parameters offers a practical approach for sex determination in large populations, as these methods are straightforward, reliable, affordable, and easy to perform.[12,13,20]

Dental morphometry is considered a dependable method for sex estimation because most teeth complete their development before skeletal maturity, making them especially useful for identifying sex in children. Primary teeth are particularly valuable in this context, as other sexually dimorphic traits are less developed in young individuals. This makes dental measurements a reliable indicator for sex determination in early ages. [15] Also, literature reveals that odontometric features vary based on race, geographical location and ethnicity. These reasons necessitate the present study in Indian children in Gulbarga city.

We found that the mean linear dimension of primary molars teeth with respect to MD, CO, BL/BP and intermolar width was higher in male children than in female children. A similarity was seen in the studiesperformed by Singh and colleagues [16], Morreess et al [17], Anderson [18], Kuswandari and Nishino [19].

Garn [29] noted a correlation where teeth with greater mesiodistal measurements also tend to have increased buccolingual dimensions. This pattern was also evident in the current study. A statistically significant difference in MD width between genders in primary maxillary molars 55 and 65 were noted in our study. In the present research, a greater dimorphism based on gender was observed in buccolingual dimension of all the four primary second molars which is in accordance with the study done by Margetts and Brown [22] and Eswara et al, [21]. Male children exhibited larger primary molar dimensions. In contrast, Barberia et al [23] reported no SD in buccolingual dimension in Spanish children. Yuen et al [24] reported that SD was totally absent in the Chinese population.

In the current investigation, we observed no statistically significant difference was noted between width of intermolar region in maxillary and mandibular arches amongst the genders. This was in compliance with Nagaveni and colleagues[14]. In our study the maxillary IMW in males and females was 44.07 and 42.60 respectively while the mandibular IMW was 36.81 and 37.14 respectively. The study conducted by Nagaveni et al found the IMW to be 35.64 ± 2.69 in males and 34.46 ± 2.01 in females [14].

The findings of the present study contribute to the existing knowledge on SD in primary teeth and emphasize the measurements of the primary second molars as useful indicators for the determination of sex. Ghorbanyjavadpour et al [25] reported similar findings and stated that mandibular primary molars, provide more reliable indicators for sex identification.

The conclusions drawn from this research implies that the linear measurements are greater in boys when compared with that of the girls. Very few researches have been published investigating the gender differences in primary teeth. The present study is the first study to exclusively perform an investigation on all four primary second molars.

Apart from the application in forensic odontology, the data obtained from the present study can provide valuable sources of normative reference standard for the manufacturers of standard sized preformed crowns and bands. Thereby aiding the clinicians to select them and to understand the developing occlusion and malocclusion.

Thus, the present research furnishes a basic documentation of deciduous second molar dimensions in a sample of Indian children from Gulbarga city. However, further studies with larger sample size, with systematically distributed sampling techniques which include measurements for all the teeth are required to test and to generalize these results to the entire population.

CONCLUSION

In conclusion, SD is noted in the primary dentition similar to that found in permanent dentition. Our results displayed that boys had higher linear dimensions of the primary molar than the girls. A significant difference was found between the genders in mesiodistal measurement and buccolingual/buccopalatal dimensions of primary molars. With the observations from the present research, it can be noted that dimensions of the primary teeth can be employed in evaluating the gender of the children. However, further studies are necessary to warrant the present results.

DECLARATIONS

Conflict of interest
The authors declare that they have no conflict of interest.

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