

# Determination of Bolton Norms for Indian Population Sample

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## ABSTRACT

**Introduction:** Tooth size discrepancy varies between different ethnic groups and races. Bolton's tooth size norms were originally determined in Caucasian population.

**Objective:** To determine tooth size ratios for maxillary and mandibular dentition in Telangana population of Indian sample and to compare the ratios with standard Bolton norms.

**Materials & Method:** The study sample comprised of 300 subjects (150 males and 150 females) aged between 14-25 years having Angle's Class 1 molar relationship. Study models of all subjects were prepared and mesiodistal dimensions were measured to determine mean Bolton's anterior ratio, overall ratio, overjet and overbite.

**Result:** Evidence of sexual dimorphism was observed with Indian male subjects having greater mean values than the females. The determined mean for anterior tooth ratio was  $80.88 \pm 3.03\%$ , overall tooth ratio  $93.99 \pm 3.11\%$ , overjet  $2.92 \pm 0.62\text{mm}$  and overbite  $2.96 \pm 0.63\text{mm}$ . Statistically significant differences were found between Indian samples and Bolton Caucasian standards.

**Conclusion:** The study provides evidence that tooth sizes are population specific. Mean values specific to particular population groups should be derived in order to make treatment planning more accurate and predictable.

**Key words:** Bolton's analysis, Bolton's ratio, study model analysis, tooth size discrepancy

## INTRODUCTION

The hardest tissues in the human body comprise of teeth, which help in mastication, phonation and also provide a vital esthetic component to the face on visualization.<sup>1</sup> As literature reveals, whenever teeth are properly arranged in maxillary and mandibular arches with muscular forces acting in harmony, it is observed that the occlusion is healthy, stable and esthetically attractive. The size of the teeth plays a very important role in overall treatment planning. Mismatched tooth sizes prevent the clinician from achieving balanced and functional occlusion. Understanding the interplay between arch length and tooth material is the key to overall treatment success. Tooth size, arch form and its dimensions, spacing and tooth size - arch length discrepancies should be accurately determined as a part of routine orthodontic treatment planning. According to Proffit, although natural teeth have a good ratio in most individuals, part of the population (5%) has some degree of disproportion in tooth size.<sup>2</sup>

Disproportion in the mesiodistal dimensions of teeth of opposing dental arches can be defined as tooth size discrepancy. Generally, "contact methods" like Vernier

scales with calipers or millimeter rulers are used to measure mesiodistal tooth dimensions.<sup>3,4</sup> Some "noncontact methods" less frequently used included television images,<sup>5</sup> dental cast prints<sup>6</sup> and occlusal surface laser holograms.<sup>7,8</sup> Stereophotogrammetry<sup>9</sup> and Optocom<sup>10</sup> are advances in computer technology available today for three dimensional cast visualization. Black<sup>11</sup> was one of the first investigators to study tooth size, and measured the mesiodistal tooth dimensions on a large scale. Bolton<sup>12</sup> in 1958 postulated on tooth size disharmony which remains one of the most accepted studies till date.

Studies for specific populations to determine tooth ratios have been conducted in the past. Lundstrom<sup>13</sup> in 1964 found significant differences amongst populations for tooth size ratios which in turn could affect incisor inclinations, interincisal angle, overbite and overjet. Differences in tooth size ratios for Caucasoid, Mongoloid and Negroid populations were evaluated in another study by Lavelle<sup>14</sup> who determined that overall and anterior ratios were greater in Negroids as compared to Caucasoids with the Mongoloids showing intermediate readings.

Crosby and Alexander<sup>15</sup> found no differences in incidence rates among different groups but observed that subjects

within each group showed tooth size discrepancies greater than 2 standard deviations from the Bolton mean. Lew and Keng<sup>16</sup> found no differences in tooth size ratios for the anterior teeth which closely matched the original Bolton standards in Chinese population.

Hashim *et al*<sup>17</sup> concluded that the Sudanese population closely matched the Caucasian figures. However, they mentioned that the population of Sudan comprised of several racial groups with differing features making conclusions difficult. Analysis of Bolton tooth size ratios among Qatari population by Hashim *et al*<sup>18</sup> showed similarities in overall Bolton ratio, while significant differences were observed in anterior ratio.

Hashim and Murshid<sup>19</sup> investigated tooth size ratios in Saudi population with varying malocclusions. No differences in anterior and overall ratio were evident when compared to Bolton standards. The study provided evidence that malocclusions in general do not affect tooth size ratios.

Variations in labiolingual crown thickness and the possible changes in Bolton analysis were investigated by Rudolph *et al*.<sup>20</sup> They determined a formula which considered labiolingual thickness in predicting anterior tooth size discrepancies. Individuals with thin incisors showed stronger correlation with intermaxillary ratios as compared to thick teeth.

Nie and Lin<sup>21</sup> studied Chinese population to compare intermaxillary tooth size discrepancies amongst different malocclusion groups for both sexes. There was a significant difference in tooth size ratios where Class III groups had higher mean values than Class I and Class II.

An analysis of two databases PubMed and Cochrane Review revealed only one study till date in the Indian context evaluating Bolton ratios in North Indian population with varying malocclusions. The results showed that Class II subjects had a tendency for greater mesiodistal widths in the mandibular anterior region as compared to maxillary anterior region.

Evidence in literature about varying tooth sizes in populations and the need to formulate population

specific Bolton norms formed the primary reason for the study. The objectives of the study is to determine tooth size discrepancy of clinical significance in a representative sample of Indian population sample of Telangana State and to formulate Bolton norms which could be used in population specific treatment planning. The values determined through the study would also be compared with standard Bolton norms.

## MATERIALS AND METHOD

The study was designed as an observational ex vivo type to determine Bolton's tooth size ratios for Indian population of Telangana state. A total of 1200 subjects were screened out of which 500 subjects fulfilled the required inclusion criteria. 300 subjects (150 males and 150 females) were randomly selected from this. The inclusion criteria were: subjects of Indian origin, Class I molar and canine relationship bilaterally, permanent teeth from first to first molar in both arches, normal overjet and overbite relation, curve of Spee not exceeding 1.5 mm, no proximal restorations or caries on any teeth.

The parameters evaluated in the study were the overjet, overbite, anterior and overall Bolton tooth ratios. Alginate impressions were made for all subjects and study models were prepared. A digital Vernier caliper with a sensitivity of 0.1mm was used to obtain mesiodistal measurements of the teeth.

The results obtained were subjected to statistical analysis which included t test to compare mean values between males and females and chi square test for determining associations between various variables.

## RESULT

The overjet, overbite, anterior and overall tooth ratios for Telangana Indian population samples are depicted in Table 1. The gender-wise comparison for anterior tooth ratio, overall tooth ratio, overjet and overbite showed that except overall tooth ratio; male norms were greater than in females (Table 2). A comparison of values for Indian sample and Caucasian measurements is given in Table 3.

**Table 1: Norms for overjet, overbite, anterior tooth ratio & posterior tooth ratio**

Parameters	Range	Mean	Std. deviation	Variance
Overjet	2.00	2.92	0.61	0.37
Overbite	2.00	2.96	0.63	0.39
Anterior ratio	28.40	80.88	3.03	9.23
Overall ratio	16.40	93.99	3.11	9.71

**Table 2: Gender comparison for overjet, overbite, anterior tooth ratio & posterior tooth ratio**

Parameters	Male (Mean±SD)	Female (Mean±SD)	Mean difference	t-Value	p-Value
Overjet	2.98±0.65	2.86±0.56	0.123	1.747	0.082
Overbite	3.01±0.65	2.91±0.60	0.096	1.330	0.185
Anterior ratio	81.46±3.15	80.31±2.80	1.155	3.348	0.001*
Overall ratio	93.27±2.38	94.71±3.57	1.432	4.084	0.001*

\*Statistically significant at  $p \leq 0.001$

**Table 3: Comparison of parameters among Indian and Caucasian populations**

Parameters	Indian Mean	Caucasian Mean	Variation	p-Value
Anterior Ratio	80.88±3.03	77.2±1.65	9.23	0.0001*
Overall Ratio	93.99±3.11	91.3±3.11	9.71	0.0001*
Overjet	2.92±0.62	1.92±0.63	0.62	>0.05 (NS)
Overbite	2.96±0.63	2.45±0.81	0.63	>0.05 (NS)

NS: Not significant

## DISCUSSION

Orthodontists should pay special attention to the presence of tooth size discrepancy because about 60% of orthodontic patients present with an anterior Bolton discrepancy.<sup>12</sup> Failure to identify this disparity can invariably create difficulties for finishing cases, especially in regard to the ideal relationship of molars and canines and obtaining ideal overjet and overbite.<sup>13,22</sup>

Crosby and Alexander<sup>15</sup> reported Bolton means for anterior (77.2%) and overall (91.4%) ratios as similar to those of Bolton and Stiffer. Similar results were seen by Mahankudo *et al* in Karnataka population with anterior ratio 77.78% and overall ratio 92.005%.<sup>23</sup> The mean overall ratio in Spanish population was 91.97%,<sup>24</sup> Turkish population was 89.88,<sup>25</sup> Dominican Americans was 91.3%,<sup>26</sup> white Americans was 92.3%<sup>27</sup> and Peruvians was 91.3%.<sup>28</sup> From these studies, it can be concluded that Bolton's overall tooth ratio cannot be applied to all populations.

The results suggest that the overall tooth ratio for Indian population sample is higher than white Americans followed by Spanish, Peruvians and Turkish. These results are similar to Smith *et al*; who showed significant differences in overall and anterior ratios between Whites, Blacks, and Hispanics.<sup>27</sup> Uysal and Sari urged the need for separate anterior and overall tooth ratio means in Turkish population.<sup>25</sup>

According to the present study, Indian males have greater anterior ratio as compared to females in similarity to

Richardson and Malhotra who found that Black North American males had larger teeth than females.<sup>29</sup> Hashim *et al* also concluded that tooth size ratios were slightly greater in males than in females in Qatari population.<sup>18</sup> Bishara *et al* among Iowa, Egypt and Mexico populations reported sexual dimorphism. Further, they mentioned that canines and molars were significantly larger in males.<sup>30</sup>

## CONCLUSION

- Mean values for Telangana population of Indian samples were determined as:
  - Anterior tooth ratio: 80.88 ± 3.03%
  - Overall tooth ratio: 93.99 ± 3.11%
  - Overjet: 2.92 ± 0.62mm
  - Overbite: 2.96 ± 0.63mm
- The comparison between male and female samples suggests sexual dimorphism in tooth measurements. Males were found to have significantly greater mean values than females.
- Collating the mean anterior and overall ratio of Indian population samples with that of Caucasian Bolton's values resulted in statistically significant differences. However, overjet and overbite showed no significant differences.

**OJN**

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