Application of Pont’s index to a Pakistani population: a digital stereomicroscopic study

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Objective: To investigate the applicability of Pont’s index for predicting maxillary and mandibular dental arch widths in a Pakistani population.

Materials and methods: A Hirox digital stereomicroscope (SM) (HIROX KH7700 Japan) was used to construct digital models of fabricated plaster casts. Gender differences in the measured totals of the incisor widths, arch widths and expansion indices were evaluated. Pont’s correlations were computed between measured and predicted arch widths. An analysis of variance (ANOVA) was applied to determine the differences between arch length and arch perimeter groups.

Results: Males had significantly larger mean values for the sums of the incisors, arch widths and expansion indices compared with females (p ≤ 0.05). There were significant differences observed between the large and small, average and small and the average and large arch length groups (p ≤ 0.05) in the maxilla, while a significant difference was observed only between the large and small arch length groups in the mandibular arch. Pont’s index predictions were consistently less than the actual interpremolar and intermolar arch widths for both genders. The dissimilarity in the predictions for interpremolar width averaged -4.33 mm for males and -4.21 mm for females while the intermolar width averages were -4.93 mm for males and -4.92 mm for females.

Conclusion: The results indicated that Pont’s index should not be applied to the Pakistani population. Maxillary and mandibular arch length groups and arch perimeters should be carefully investigated before applying any prediction formulae. (Aust Orthod J 2017; 33: 236-248)

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Introduction

Assessments of dental arch size and shape are of considerable importance to orthodontists and a number of diagnostic and analytical indices have been developed to help forecast dental arch development and assist in treatment planning.¹ A range of investigative indices is available for the determination of dental arch development.² Extraction or non-extraction treatment methods can be used for the management of various malocclusions and, although arch expansion is frequently advised, its stability has been questioned.³

Several expansion indices have been proposed to predict arch width.⁴⁻⁶ Correlations of mesiodistal widths of the maxillary incisors with arch width were reported originally by Pont,⁶ and the application of this correlation has seen a recent revival.⁷ Pont’s index was established in 1909 to predict maxillary dental arch width in the interpremolar and intermolar regions.⁶ Based on an ideal occlusion, the values of 80 and 64 were calculated for the premolar index and the molar index, respectively. Pont also prepared a prediction table from which ideal interpremolar and intermolar arch width could
be directly determined following measurement of the mesiodistal diameters of the maxillary incisor teeth. The following equation was proposed to predict arch width in the respective areas of the maxilla.

\[
\text{Interpmolar arch width (IPW)} = \frac{\text{Sum of the incisal widths (SIW)}}{80} \times 100
\]

\[
\text{Intermolar arch width (IMW)} = \frac{\text{Sum of the incisal widths (SIW)}}{64} \times 100
\]

Pont’s index has been investigated in different human populations with varying and equivocal outcomes.\(^{1,2,4,7-13}\) To date, the index has not been applied to digital models. In addition, there have not been any alternative formulae explored to predict the arch width dimensions in a Pakistani population.

Therefore, the aims of the present study were to:

- determine the gender differences in the sum of the incisors, arch width and expansion indices of the maxillary and mandibular arches;
- determine new anterior expansion indices for intercanine arch width prediction in the maxilla and mandible;
- determine and compare the sum of the incisors, arch width and expansion indices of the maxillary and mandibular arches in relation to different arch length groups;
- determine and compare the sum of the incisors, arch width and expansion indices of the maxillary and mandibular arches in relation to different arch perimeter groups;
- determine alternative values for indices in the maxilla and mandible.

**Materials and methods**

Ethical approval was granted by the Ethics Committee of the Universiti Sains Malaysia (USM/JEPEM/140376), and informed consent was obtained from all subjects. The investigation was designed and conducted according to the guidelines of Strengthening the Reporting of Observational studies in Epidemiology (STROBE), and the STROBE guidelines were applied to this manuscript.\(^{14}\)

**Sample size calculation**

The sample size was calculated at a power of 80%, utilising estimated standard deviations of 0.6 mm,\(^{15}\) a biologically meaningful mean difference of 0.3 mm, and equal sample sizes.\(^{16}\) The calculated sample size was 128 subjects (64 males and 64 females). The following inclusion and exclusion criteria were applied.

**Inclusion criteria:**

- All patients were of Pakistani origin determined via interviews, and an assessment of mutual paternities and ancestors.
- The subjects were aged from 18 to 24 years.
- The maxillary and mandibular arches were well aligned, with normal patterns of growth and development.
- None of the participants had received orthodontic treatment, and all erupted permanent teeth were present and sound (except third molars).
- An ideal occlusion with a Class I molar and canine relationship with the incisors classified according to the British Standards Institute.\(^{17}\)
- No crowding, crossbites or spacing.
- A straight profile.
- No craniofacial anomalies.

**Exclusion criteria:**

- Interproximal caries or restorations.
- Missing or supernumerary teeth.
- Abnormal size or morphology of teeth.
- Tooth wear that affected the tooth size measurements.
- Damage to casts.

Oral and dental examinations were carried out following the careful selection of the subjects. A cross-examination of participants was done to diminish sample bias and error. An experienced orthodontist and dentists contributed throughout the screening sessions. Dental casts of the upper and lower arches of each subject were obtained using alginate impression material (Zhermack Orthoprint alginate ISO 1563 – ADA 18, Italy) and poured with dental stone (Type III hard plaster quick stone, China) according to the manufacturer’s instructions. Fourteen variables were measured on each study cast as indicated in Figures 2 and 3.

**Measurement of tooth size and arch dimensions**

Maxillary and mandibular dental models of each subject were scanned using a Hirox digital stereomicroscope.
(SM) (HIROX KH7700, Japan) to construct digital models (Figure 1). Tooth size and arch dimension measurements were performed on the scanned digital models. An SM is a reputable, valid and reliable measurement tool with a known accuracy of \(0.1 \times 10^{-6}\) mm. The measurements of tooth size and arch dimensions were obtained according to the following definitions:

**Tooth size measurement**
Mesiodistal crown widths of maxillary and mandibular incisors were measured from the anatomical contact of one tooth to another on the occlusal surface perpendicular to the long axis of the teeth (Figure 2a).

**Arch dimensions measurements**

*Arch width of maxillary and mandibular variables* (Figure 2b)
- Maxillary and mandibular intercanine widths were measured between the cusp tips.
- Maxillary interpremolar widths were measured between the distal pits of the maxillary premolars.
- Maxillary intermolar widths were measured between the central fossae of the maxillary first molars.
- Mandibular interpremolar widths were measured between the buccal cusp tips.
- Mandibular intermolar widths were measured between the distal cusp tips.

*Arch length, arch perimeter measurement and grouping*

**Arch length**
Arch length was obtained using triangular shaped lines between the mesiobuccal cusp tips of the first permanent molars and the central point between the incisors of each respective arch (Figure 3a).

**Arch perimeter**
Arch perimeter was measured as a segmental sum of the lines on the right and left side of the arches (Figure 3b). The subjects were further grouped into:

1. Arch length groups (small, average and large).
   The numbers of subjects for small, average and large arch length groups in the maxilla and mandible were 46, 44 and 38 respectively.

2. Arch perimeter groups (small, average and large).
   The numbers of subjects for small, average, and large arch perimeter groups in the maxilla and mandible were 44, 45 and 39 respectively.

Figure 1. Fabrication of digital models via the Hirox digital stereomicroscope

Figure 2. Measurement of maxillary and mandibular arches: (a) incisor mesiodistal crown diameter; (b) arch widths.
These groups were defined based on data values of the Mean ± 2 SD, >2 SD and <2 SD, which determined the average, large and small groups, respectively.19

Error study
Twenty percent of the dental casts were randomly selected and remeasured to determine intra-observer errors. The time interval between the first and second measurements was approximately two weeks. The method error (ME) was analysed using Dahlberg’s formula: ME = (∑ (x₁-x₂)²/ 2(28))^1/2 in which x₁ was the first measurement, x₂ the second measurement and n the number of repeated measurements.21

Statistical analyses
The data were verified and analysed statistically using IBM SPSS Statistics Version 22.0 (IBM Corp., NY, USA) with the confidence level set at 5% (p < 0.05) to test for significance. Independent t-tests were applied to compare mean values between males and females for arch length and arch perimeter groups in relation to all variables. An analysis of variance (ANOVA) was applied to evaluate the difference in the values for arch length and arch perimeter groups. Pearson’s correlation coefficient was used to quantify the associations between measured and predicted arch widths.

Results

Method error
Dahlberg’s formula, used to determine the method error, did not exceed 0.005 mm and 0.032 mm for the linear variables of tooth size and arch width, respectively. The combined errors for all of the variables were small and considered to be within acceptable limits.21

Gender disparities
Tables I and II show the significant differences between the genders for the measured variables with p values (***p ≤ 0.001), (**p ≤ 0.01) and (*)p ≤ 0.05) in the maxillary and mandibular arch respectively.

Disparities in relation to arch length and arch perimeter groups in the maxilla and mandible
Tables III and IV show the mean values and standard deviations for all variables in relation to maxillary and mandibular arch length groups. There were significant differences observed in large versus small, average versus small and average versus large arch length groups (p ≤ 0.05) in the maxilla, while a significant difference was observed in the mandibular arch only for large versus small arch length groups.

Tables V and VI show the arch perimeter groups in the maxilla and mandible, respectively. There were significant differences observed in average versus small and large versus small arch perimeter groups (p ≤ 0.05) for the measured variables.

Table VII presents the correlation coefficients (r) and coefficients of determination (r²) for measured and predicted arch widths. There were significant differences observed in measured intermolar width (MIMW) and measured intermolar width (MIMW) in relation to Pont’s prediction (p ≤ 0.05). There were no significant differences in the measured intercanine width (MICW) and predicted intercanine width (PICW) (measured via a new anterior expansion index).
### Table I. Comparison of sexual disparities in the sum of the incisors, arch width and expansion indices for the maxillary arch.

| Variables | Male | Female | Mean diff. | 95% CI          | P    |
|-----------|------|--------|------------|-----------------|------|
| SI        | 31.38| 30.23  | 1.15       | 0.55 to 1.74    | 0.001|
| MICW      | 36.10| 34.26  | 1.83       | 1.08 to 2.59    | 0.001|
| MIPM      | 43.56| 42.00  | 1.56       | 0.64 to 2.48    | 0.001|
| MIMW      | 53.96| 52.15  | 1.81       | 0.95 to 2.66    | 0.001|
| PICW      | 36.30| 34.06  | 2.24       | 1.52 to 2.97    | 0.001|
| PIPMW     | 39.22| 37.79  | 1.43       | 0.69 to 2.18    | 0.001|
| PIMW      | 49.03| 47.23  | 1.79       | 0.86 to 2.72    | 0.001|
| CI*       | 87.01| 88.41  | -1.4          | -2.87 to 0.08   | 0.063|
| PMI       | 72.11| 72.20  | -0.10       | -1.54 to 1.34   | 0.895|
| MI        | 58.21| 58.00  | 0.21       | -0.86 to 1.28   | 0.696|

SI, sum of maxillary incisors; MICW, measured inter canine width; MIPM, measured inter premolar width; MIMW, measured inter molar width; PICW, predicted inter canine width; PIPMW, predicted inter premolar width; PIMW, Pont's predicted inter molar width; CI*, maxillary canine index; PMI, Premolar index; MI, molar index; CI, confidence interval; SD, standard deviation; Mean diff., mean differences (**p ≤ 0.01), (*)p ≤ 0.05).

### Table II. Comparison of sexual disparities in the sum of the incisors, arch width and expansion indices for the mandibular arch.

| Variables | Male | Female | Mean diff. | 95% CI          | P    |
|-----------|------|--------|------------|-----------------|------|
| SI        | 23.24| 22.75  | 0.49       | 0.05 to 0.93    | 0.0302|
| MICW      | 26.49| 25.93  | 1.48       | 0.56 to 1.06    | 0.0301|
| MIPM      | 35.94| 34.49  | 2.53       | 1.45 to 2.25    | 0.0004|
| MIMW      | 46.75| 45.16  | 2.36       | 1.59 to 2.44    | 0.0003|
| PICW      | 26.98| 26.24  | 1.82       | 0.74 to 1.40    | 0.0263|
| PIPMW     | 29.05| 28.44  | 1.62       | 0.61 to 1.16    | 0.0301|
| PIMW      | 36.31| 35.54  | 2.02       | 0.76 to 1.45    | 0.0303|
| CI*       | 86.51| 87.02  | -0.51       | -2.96 to 1.94   | 0.6801|
| PMI       | 64.76| 66.34  | 6.50       | -1.58 to 0.25   | 0.0905|
| MI        | 49.80| 50.49  | 0.69       | -1.86 to 0.49   | 0.2496|

SI, sum of mandibular incisors; MICW, measured inter canine width; MIPM, measured inter premolar width; MIMW, measured inter molar width; PICW, predicted inter canine width; PIPMW, predicted inter premolar width; PIMW, Pont's predicted inter molar width; CI*, maxillary canine index; PMI, Premolar index; MI, molar index; CI, confidence interval; SD, standard deviation; Mean diff., mean differences (**p ≤ 0.01), (*)p ≤ 0.05).

### Comparison with Pont’s prediction

Figure 4 shows interpmolar and intermolar arch width differences between measured and predicted values for males and females, respectively. There was a consistent trend for the Pont’s predicted value to be lower than the actual interpmolar and intermolar arch widths in the maxilla for both genders. The average discrepancy for interpmolar width was -4.33 mm for males and -4.21 mm for females, and for intermolar width was -4.93 mm for males and -4.92 mm for females.

### Maxillary canine index

Figure 5 shows the new intercanine predicted values in the maxillary arch in relation to the measured intercanine arch width. The average error in prediction was 0.34 mm and 0.20 mm for males and females, respectively.
Table III. Comparison of the sum of the incisors, arch width and expansion indices in relation to various arch length groups (ALG) of the maxillary arch.

| Variables | ALG       | NO. | Mean  | SD    | 95% CI | Lower | Upper |
|-----------|-----------|-----|-------|-------|--------|-------|-------|
| SI        | Sm§       | 44  | 30.17 | 1.42  | -1.94  | -0.06 |
|           | Av*       | 46  | 31.12 | 2.01  | 0.06   | 1.84  |
|           | Lar       | 38  | 31.17 | 1.72  | -0.98  | 0.88  |
| MICW      | Sm§§      | 44  | 34.24 | 1.85  | -3.04  | -0.63 |
|           | Av        | 46  | 35.35 | 2.56  | -0.04  | 2.26  |
|           | Lar       | 38  | 36.07 | 2.26  | -1.92  | 0.47  |
| MIPM      | Sm§§      | 44  | 41.97 | 2.15  | -3.27  | -0.43 |
|           | Av        | 46  | 42.68 | 3.30  | -0.64  | 2.06  |
|           | Lar       | 38  | 43.82 | 2.24  | -2.55  | 0.27  |
| MIMW      | Sm§§§     | 44  | 51.95 | 2.46  | -2.90  | -0.36 |
|           | Av        | 46  | 52.90 | 2.30  | -0.27  | 2.17  |
|           | Lar***    | 38  | 54.53 | 2.40  | -3.87  | -1.30 |
| PICW      | Sm        | 44  | 35.08 | 2.03  | -2.18  | 0.31  |
|           | Av        | 46  | 34.81 | 2.54  | -1.47  | 0.93  |
|           | Lar       | 38  | 35.75 | 2.41  | -1.92  | 0.59  |
| PIPMW     | Sm§       | 44  | 37.71 | 1.77  | -2.42  | -0.08 |
|           | Av*       | 46  | 38.90 | 2.52  | 0.07   | 2.30  |
|           | Lar       | 38  | 38.96 | 2.15  | -1.22  | 1.10  |
| PIMW      | Sm§       | 44  | 47.13 | 2.22  | -1.52  | 1.37  |
|           | Av*       | 46  | 48.62 | 3.14  | 0.09   | 2.88  |
|           | Lar       | 38  | 48.70 | 2.69  | -3.02  | -0.10 |
| CI*       | Sm        | 44  | 88.22 | 3.86  | -0.61  | 3.93  |
|           | Av        | 46  | 88.17 | 4.06  | -2.22  | 2.10  |
|           | Lar†      | 38  | 86.56 | 4.79  | -0.64  | 3.85  |
| PMI       | Sm        | 44  | 71.97 | 3.60  | -0.25  | 4.07  |
|           | Av        | 46  | 73.12 | 4.57  | -0.93  | 3.22  |
|           | Lar       | 38  | 71.21 | 3.89  | -1.42  | 2.95  |
| MI        | Sm        | 44  | 58.14 | 2.80  | -0.67  | 2.54  |
|           | Av        | 46  | 58.83 | 3.10  | -0.83  | 2.22  |
|           | Lar†      | 38  | 57.20 | 3.06  | 0.04   | 3.22  |

SI, sum of maxillary incisors; MICW, measured inter canine width; MIPM, measured inter premolar width; MIMW, measured inter molar width; PICW, predicted inter canine width; PIPMW, predicted inter premolar width; PMMW, predicted inter molar width; CI*, maxillary canine index; PMI, Premolar index; MI, molar index; SM, small arch length; AV, average arch length; LA, large arch length; CI, confidence interval; SD, standard deviation; Mean diff., mean differences. Av vs Sm*, Av vs Lar† and Lar vs Sm§ (***/†††/§§§ p ≤ 0.001), (***/††/§§ p ≤ 0.01) and */†/§ p ≤ 0.05).
### Table IV. Comparison of the sum of the incisors, arch width and expansion indices in relation to various arch length groups (ALG) of the mandibular arch.

| Variables | ALG | NO. | Mean | SD  | 95% CI Lower | 95% CI Upper |
|-----------|-----|-----|------|-----|--------------|--------------|
| SI        | Sm  | 44  | 22.66| 1.39| -0.65        | 0.69         |
|           | Av  | 46  | 23.17| 1.21| -1.17        | 1.16         |
|           | Lar | 38  | 23.15| 1.17| -0.15        | 1.32         |
| MICW      | Sm  | 44  | 25.84| 1.59| -0.74        | 0.79         |
|           | Av  | 46  | 26.42| 1.38| -0.15        | 1.32         |
|           | Lar | 38  | 26.40| 1.33| -1.34        | 0.21         |
| MIPMW     | Sm  | 44  | 34.28| 2.34| -3.12        | 0.68         |
|           | Av  | 46  | 35.31| 2.38| -0.14        | 2.19         |
|           | Lar | 38  | 36.18| 2.04| -2.08        | 0.33         |
| MIMW      | Sm  | 44  | 45.31| 2.38| -2.98        | 0.32         |
|           | Av  | 46  | 45.74| 2.60| -0.84        | 1.70         |
|           | Lar | 38  | 46.96| 2.44| -2.54        | 0.10         |
| MICW      | Sm  | 44  | 25.90| 2.01| -2.42        | -0.46        |
|           | Av  | 46  | 26.68| 1.95| -0.15        | 1.72         |
|           | Lar | 38  | 27.34| 1.39| -1.63        | 0.31         |
| MIPMW     | Sm  | 44  | 28.33| 1.74| -0.81        | 0.87         |
|           | Av  | 46  | 28.97| 1.51| -0.17        | 1.45         |
|           | Lar | 38  | 28.94| 1.46| -1.46        | 0.23         |
| PICW      | Sm  | 44  | 35.41| 2.18| -1.02        | 1.08         |
|           | Av  | 46  | 36.21| 1.89| -0.21        | 1.81         |
|           | Lar | 38  | 36.18| 1.82| -1.83        | 0.29         |
| PIPMW     | Sm  | 44  | 87.95| 8.11| -1.30        | 6.05         |
|           | Av  | 46  | 87.22| 6.78| -4.26        | 2.81         |
|           | Lar | 38  | 84.84| 5.38| -0.61        | 6.82         |
| PMI       | Sm  | 44  | 66.42| 6.35| -1.04        | 4.53         |
|           | Av  | 46  | 65.88| 4.95| -3.22        | 2.14         |
|           | Lar | 38  | 64.14| 3.98| -0.53        | 5.10         |
| MI        | Sm  | 44  | 50.11| 3.48| -0.39        | 3.17         |
|           | Av  | 46  | 50.80| 3.49| -1.02        | 2.40         |
|           | Lar | 38  | 49.40| 2.99| -1.09        | 2.50         |

SI, sum of mandibular incisors; MICW, measured inter canine width; MIPM, measured inter premolar width; MIMW, measured inter molar width; PICW, predicted inter canine width; PIPM, predicted inter premolar width; PMMW, predicted inter molar width; CI*, maxillary canine index; PMI, Premolar index; MI, molar index; SM, small arch length; AV, average arch length; LA, large arch length; CI, confidence interval; SD, standard deviation; Mean diff., mean differences. Av vs Sm*, Av vs Lar† and Lar vs Sm§ (***/††† p ≤ 0.001), (**/†† p ≤ 0.01) and (*)/† p ≤ 0.05).
### Table V. Comparison of the sum of the incisors, arch width and expansion indices in relation to various arch perimeter groups (APG) of the maxillary arch.

| Variables | APG     | NO. | Mean | SD  | Lower | Upper |
|-----------|---------|-----|------|-----|-------|-------|
| SI        | Sm§§§  | 45  | 30.04| 1.79| -2.26 | -0.45 |
|           | Av**    | 44  | 31.05| 1.49| 0.13  | 1.89  |
|           | Lar     | 39  | 31.40| 1.82| -1.26 | 0.56  |
| MICW      | Sm§§§  | 45  | 34.17| 2.64| -3.19 | -0.84 |
|           | Av*     | 44  | 35.33| 1.87| 0.02  | 2.30  |
|           | Lar     | 39  | 36.18| 2.04| -2.04 | 0.33  |
| MIPM      | Sm§§§  | 45  | 41.42| 3.05| -3.64 | -0.93 |
|           | Av**    | 44  | 43.35| 2.57| 0.62  | 3.24  |
|           | Lar     | 39  | 43.70| 1.77| -1.72 | 1.00  |
| MIMW      | Sm     | 45  | 51.48| 2.71| -2.35 | 0.09  |
|           | Av     | 44  | 53.38| 1.57| 0.73  | 3.08  |
|           | Lar    | 39  | 54.51| 2.41| -4.24 | -1.82 |
| PICW      | Sm     | 45  | 35.03| 2.38| -1.20 | 1.32  |
|           | Av     | 44  | 35.29| 2.21| -0.96 | 1.48  |
|           | Lar    | 39  | 35.23| 2.52| -1.45 | 1.06  |
| PIPMW     | Sm§§§  | 45  | 37.55| 2.24| -1.57 | 0.70  |
|           | Av**   | 44  | 38.82| 1.86| 0.17  | 2.36  |
|           | Lar    | 39  | 39.25| 2.28| -2.83 | -0.57 |
| PIMW      | Sm§§§  | 45  | 46.94| 2.80| -3.54 | -0.71 |
|           | Av**   | 44  | 48.52| 2.33| 0.21  | 2.95  |
|           | Lar    | 39  | 49.06| 2.85| -1.96 | 0.88  |
| CI*       | Sm     | 45  | 88.11| 3.83| -1.11 | 3.43  |
|           | Av     | 44  | 88.04| 4.62| -2.26 | 2.12  |
|           | Lar    | 39  | 86.88| 4.29| -1.03 | 3.49  |
| PMI       | Sm     | 45  | 72.67| 3.13| -2.28 | 2.11  |
|           | Av     | 44  | 71.83| 4.68| -2.96 | 1.28  |
|           | Lar    | 39  | 71.92| 4.42| -1.44 | 2.94  |
| MI        | Sm     | 45  | 58.40| 2.67| -1.09 | 2.16  |
|           | Av     | 44  | 58.21| 2.97| -1.76 | 1.38  |
|           | Lar    | 39  | 57.67| 3.50| -0.89 | 2.34  |

**SI**, sum of maxillary incisors; **MICW**, measured inter canine width; **MIPM**, measured inter premolar width; **MIMW**, measured inter molar width; **PICW**, predicted inter canine width; **PIPMW**, predicted inter premolar width; **PIMW**, predicted inter molar width; **CI***, maxillary canine index; **PMI**, Premolar index; **MI**, molar index; **SM**, small arch perimeter; **AV**, average arch perimeter; **LA**, large arch perimeter; **CI**, confidence interval; **SD**, standard deviation; **Mean diff.**, mean differences. **Av vs Sm**, **Av vs Lar** and **Lar vs Sm** (**§§§ p ≤ 0.001**), (**§§ p ≤ 0.01**) and (**§ p ≤ 0.05**).
Table VI. Comparison of the sum of the incisors, arch width and expansion indices in relation to various arch perimeter groups (APG) of the mandibular arch.

| Variables | APG | NO. | Mean  | SD   | Lower  | Upper  |
|-----------|-----|-----|-------|------|--------|--------|
| SI        | Sm  | 45  | 22.88 | 1.40 | -0.86  | 0.51   |
|           | Av  | 44  | 22.97 | 1.28 | -0.56  | 0.76   |
|           | Lar | 39  | 23.15 | 1.13 | -0.95  | 0.41   |
| MICW      | Sm  | 45  | 26.08 | 1.60 | -0.98  | 0.58   |
|           | Av  | 44  | 26.19 | 1.46 | -0.64  | 0.86   |
|           | Lar | 39  | 26.39 | 1.29 | -1.09  | 0.47   |
| MIPM      | Sm  | 45  | 26.08 | 1.60 | -0.98  | 0.58   |
|           | Av  | 44  | 26.19 | 1.46 | -0.64  | 0.86   |
|           | Lar | 39  | 26.39 | 1.29 | -1.09  | 0.47   |
| MIMW      | Sm  | 45  | 26.08 | 1.60 | -0.98  | 0.58   |
|           | Av  | 44  | 26.19 | 1.46 | -0.64  | 0.86   |
|           | Lar | 39  | 26.39 | 1.29 | -1.09  | 0.47   |
| PICW      | Sm  | 45  | 26.08 | 1.60 | -0.98  | 0.58   |
|           | Av  | 44  | 26.19 | 1.46 | -0.64  | 0.86   |
|           | Lar | 39  | 26.39 | 1.29 | -1.09  | 0.47   |
| PIPM      | Sm  | 45  | 26.08 | 1.60 | -0.98  | 0.58   |
|           | Av  | 44  | 26.19 | 1.46 | -0.64  | 0.86   |
|           | Lar | 39  | 26.39 | 1.29 | -1.09  | 0.47   |
| PIMW      | Sm  | 45  | 26.08 | 1.60 | -0.98  | 0.58   |
|           | Av  | 44  | 26.19 | 1.46 | -0.64  | 0.86   |
|           | Lar | 39  | 26.39 | 1.29 | -1.09  | 0.47   |
| CI*       | Sm  | 45  | 26.08 | 1.60 | -0.98  | 0.58   |
|           | Av  | 44  | 26.19 | 1.46 | -0.64  | 0.86   |
|           | Lar | 39  | 26.39 | 1.29 | -1.09  | 0.47   |

SI, sum of mandibular incisors; MICW, measured inter canine width; MIPM, measured inter premolar width; MIMW, measured inter molar width; PICW, predicted inter canine width; PIPM, predicted inter premolar width; PIMW, predicted inter molar width; CI*, maxillary canine index; PMI, Premolar index; MI, molar index; SM, small arch perimeter; AV, average arch perimeter; LA, large arch perimeter; CI, confidence interval; SD, standard deviation; Mean diff., mean differences. Av vs Sm*, Av vs Lar† and Lar vs Sm§ (***/†††/||| p ≤ 0.001), (**/††/|| p ≤ 0.01) and (*/†/| p ≤ 0.05).
Table VII. Correlation for measured arch width in relation to predicted arch width.

| Variables | N = 128 | B   | 95% CI        | t-statistics | r   | r²   | P   |
|-----------|---------|-----|---------------|--------------|-----|------|-----|
|           | Lower   | Upper |               |              |     |      |     |
| IPM       | 0.445   | 0.324| 0.567         | 7.256        | 0.543| 0.295| 0.001|
| IM        | 0.566   | 0.404| 0.729         | 6.906        | 0.524| 0.275| 0.001|
| IC        | 0.143   | -0.031| 0.318        | 1.624        | 0.143| 0.021| 0.107|

IC, inter canine width; IPM, inter premolar width; IM, inter molar width; CI, confidence interval; r, Correlation coefficients; r², coefficients of determination; (p < 0.05).

Table VIII. Prediction formulae.

| Maxillary arch | Mandibular arch |
|----------------|-----------------|
| MaxICW         | MaxICW |
| MaxIPMW        | MaxIPMW |
| MaxIMW         | MaxIMW |

Max, Maxillary arch; Mand, Mandibular arch; ICW, inter canine width; IPMW, inter premolar width; IMW, inter molar width.

Discussion

The determination of dental arch form and its dimensions is relevant in clinical orthodontics for aesthetics and for long-term occlusal stability through the maintenance of the presenting mandibular intercanine width and preservation of the original arch form.22 Pont’s index is a simple method that can provide valuable arch information but its use remains controversial. Some professionals support the application of Pont’s index for the prediction of arch widths,7,8 while others believe that its use should be avoided because of inherent inaccuracies.1,12,27,28

Pont suggested that the reliability of the index should be tested in other populations. Additional studies have supported his proposed procedure for arch width predictions,8,24 whereas others have questioned the reliability of Pont’s index for clinical purposes.1,12,27,28

The current study was conducted to evaluate the applicability of Pont’s index using SM digital dental models. SM-scanned digital dental models are easy to store and manipulate using a computer. For measurements and reproducibility, SM digital models have been shown to be valid and reliable.18

In addition, it is possible to view digital models at any location provided there is a link to the internet.18,19,29 Scanned models allow patients to be treated in multiple clinics that allow access to individual digital records. The new digital models have advantages over conventional plaster study models related to storage and damage, while recent state-of-the-art innovations have enhanced the process of cast fabrication and manipulation.30

In comparison, with an SM-scanned digital model, the use of a digital caliper (DC) has the disadvantages of excessive time application, difficulty in the manipulation of the device which is prone to error and, concerningly, the damage to the dental models due to sharp caliper beaks. Therefore, the present study assessed the indices via valid digital models to avoid the shortcomings of plaster models.18

The results revealed that Pont’s formula significantly underestimated inter premolar and inter molar widths, suggesting that the index is not reliable for application on a Pakistani population. Dental arch expansion is a method that may relieve arch crowding and adjusts arch length via a non-extraction approach. However, avoiding relapse after arch expansion is a treatment priority but remains problematic.31 The current study proposes a new modified index for arch width evaluation that can be used for the prediction of the actual arch widths in a Pakistani population.

Agnihotri and Gulati reported statistically significant
correlations between the combined maxillary incisor crown widths and maxillary intermolar and interpremolar arch widths, which were at variance with the results of the present study.\(^7\) Agnihotri and Gulati applied a corrected index of 81.66 in the premolar region and a value of 65.44 in the molar region.\(^7\) However, the current study identified that the premolar and molar indices were 72.11 and 58.21, respectively.

The present study determined that the discrepancies between the measured and estimated arch width values using Pont’s index for each individual were large and generated an under-prediction. The interpremolar and intermolar width discrepancies were -10 mm and -14.5 mm, and -12.5 mm and -10 mm for males and females, respectively (Figure 4).

Alam and colleagues investigated intermaxillary tooth size ratios in relation to arch length, arch width and arch perimeter groups and noted significant differences relative to the arch groupings.\(^19\) The current investigation explored a sample of Pakistanis with ideal occlusions and also found significant differences. Therefore (average versus small and large versus small) arch length and perimeter groups should be carefully investigated when using prediction formulae. The prediction formulae investigated for maxilla and mandibular variables are shown in Table VIII.

The current study developed an anterior expansion index to predict intercanine width in the maxilla and mandible, with definitive values for males and females. For stability of expanded arch dimensions after treatment, the patient’s existing or pretreatment arch form appears to be the best indicator because of the tendency to relapse back to its original shape.\(^32\)-\(^35\) An assessment of the facial profile and soft tissues, future growth status, the determination of Angle’s classification, the relationship of upper and lower
Jaws to one another, and the midline are other parameters that need to be taken into consideration when contemplating arch expansion. Arch width and expansion indices need to be evaluated according to arch length and arch perimeter groups for other populations.

Conclusion

- Gender differences were observed in the sum of maxillary incisors (SI) and interarch widths, with no significant differences in canine index (CI), premolar index (PMI) and molar index (MI).
- New anterior expansion indices were determined for intercanine width prediction in the maxilla and mandible.
- Maxillary and mandibular arch length groups and arch perimeter groups (average versus small and large versus small) showed significant differences and should be carefully investigated with mathematical prediction formulae.
- New index values were determined for arch width prediction in the interpremolar and intermolar region in the maxilla and mandible.
- Pont’s index underestimated interpremolar and intermolar arch widths of Pakistani males and females.
- Pont’s index has questionable clinical value as a predictor of arch width measurements.
- Pont’s index should not be applied to the Pakistani population.

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