Epidemiological Studies Of Malalignment, Applicability Of Statistical Tests To Malocclusion Studies

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Three basic groupings associated with malocclusion from a descriptive epidemiological standpoint are: (1) malposition of individual teeth, (2) malrelation, and (3) maldevelopment of dental arches. Statistical tests, based on a normal distribution, are important research tools used in epidemiological studies to determine the significance of differences in population groups. The question this study seeks to answer is whether anatomical variables such as tooth size, dental arch breadth and length, and palatal vault height have normal distribution patterns, so that conclusions based on these analyses will be sound.

Materials and Method

To study the shape of the distribution patterns for the anatomical variables involved, 343 midshipmen and their maxillary lab-stone casts were examined. Selection was based on a full complement of permanent teeth mesial to M_2 and no history of orthodontic intervention. From the measurement of the mesiodistal diameters of anterior teeth, dental arch breadths and lengths, and palatal vault heights, frequency distribution tables were made. Means, modes, medians and standard deviations were calculated for each variable under consideration. An example of one of the frequency tables is Table 1. From these data, distribution patterns were drawn on standard graph paper, as shown in Figures 2 and 3. To test the normality of the distribution of each variable, the cumulative percentage values were plotted on arithmetic probability paper and the regression line tested for goodness of fit.

The mesiodistal diameters of the central and lateral incisors, and dental arch breadths and lengths of both arches were measured directly in the oral cavity. Arch breadths were measured in three locations: cuspid, P_1, and P_2. Since all of the arch breadth distribution patterns were similar, only the pat-

TABLE 1

FREQUENCY DISTRIBUTION OF ARCH LENGTH

Arch Length	Frequency	Cumulative Frequency	Cumulative Per Cent
27 mm	2	2	.006
29	11	13	.038
30	19	32	.093
31	49	81	.236
32	74	155	.452
33	79	234	.682
34	48	282	.822
35	34	316	.921
36	15	331	.965
37	9	340	.991
38	1	341	.994
39	2	343	1.000

$\bar{X} = 32.793$ mm; s = 2.391; Mode = 33.00 mm; Median = between 171-172 individual (33.00 mm)

$\bar{X}$ = Mean; s = standard deviation.

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tern for maxillary P_2 will be presented. The distribution patterns for the other variables of each arch were likewise similar; for this reason mandibular patterns have been excluded. The anatomical landmarks used for measuring points were chosen because of their recognizability. These points, along with the other physical attributes of this group, are described in a previous publication.[1] The mesiodistal diameter of the canines and palatal vault heights were measured on lab-stone casts. All measurements were made to the nearest 0.1 mm.

A modification of the Palate Height Index was used to determine arching, or palatal vault height. Palatal vault height is characterized by the formula,

$$\frac{\text{palate height} \times 100}{\text{palate breadth}}.$$

A low palate is chamestaphyline, a high palate is hypsistaphyline, and the intermediate group is orthostaphyline.[2] A Korkhaus #14 three-dimensional orthodontic caliper was used to measure arch breadth from the lingual of M_1, at the gingivocervical margin at a point bisected by a line formed by the lingual fissure, across the dental arch to the corresponding landmark on the homologous tooth. Palate height was obtained simultaneously with the vertical rod of the caliper from the midpoint of the axis established at M_1, to the highest point on the palate, as shown in Figure 1. If a torus was present, the palate was not measured or included.

Standard statistical procedures were used throughout this study to illustrate the significance of results. Most of these statistical tools are based on the assumptions of: (1) a random sample, and (2) a normal distribution. From a random sample two constants or parameters are estimated: (1) the arithmetic mean, and (2) standard deviation. The mean locates the center of the sample. The standard deviation measures the spread of variation about the mean of individual scores in the sample. Bell-shaped symmetry about the mean as center is the typical feature of the normal distribution. The greatest frequency of measurements is at the center with a trailing away at each end.[3] The present results were obtained in a unique population of midshipmen selected according to superior standards of health and physical development.

Fig. 1

Results

Each of the six variables presented a distribution pattern and regression line indicative of a normal curve as shown in Figures 2 and 3. Means, medians and modes were, for example, similar for each variable. Although Chi square tests established that the study patterns were near enough to normal to be treated as such, three of them seemed to be combinations of two different kinds of individuals. The apparent bimodal pattern of P_2 arch breadth, the convexity occurring in the lateral incisor pattern at 6.0 mm, and the small irregularity in the curve commencing at a score of 52 for palatal height invited special attention.

The individual examination cards were sorted according to tooth alignment scores. The scoring system used estimates the relative displacement of

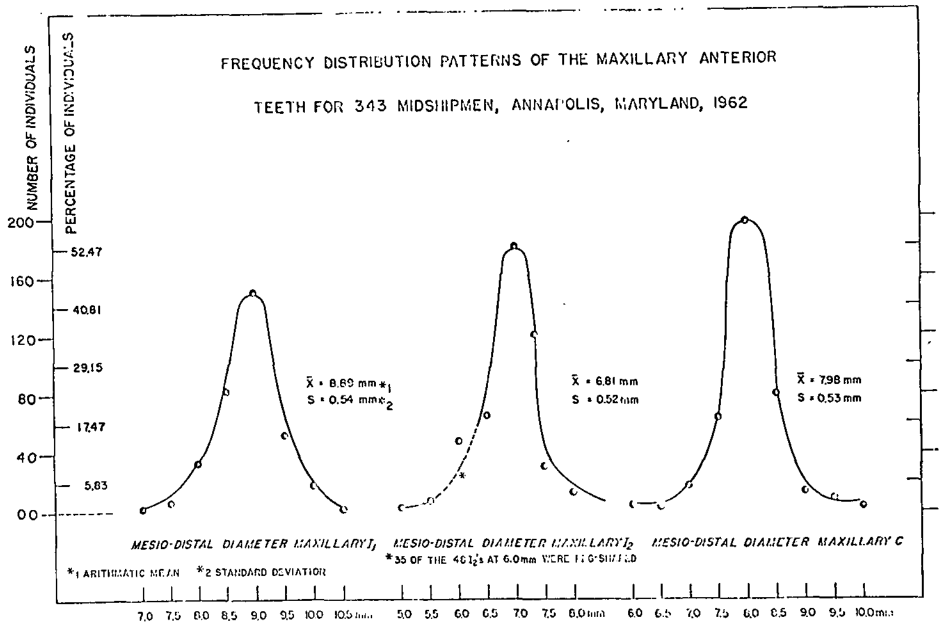
FREQUENCY DISTRIBUTION PATTERNS OF THE MAXILLARY ANTERIOR
TEETH FOR 343 MIDSHIPMEN, ANNAPOLIS, MARYLAND, 1962
NUMBER OF INDIVIDUALS
PERCENTAGE OF INDIVIDUALS
X̄ = 8.69 mm *1
S = 0.54 mm *2
X̄ = 6.81 mm
S = 0.52 mm
X̄ = 7.98 mm
S = 0.53 mm
MESIO-DISTAL DIAMETER MAXILLARY I1
MESIO-DISTAL DIAMETER MAXILLARY I2
MESIO-DISTAL DIAMETER MAXILLARY C
*1 ARITHMATIC MEAN *2 STANDARD DEVIATION

Fig. 2

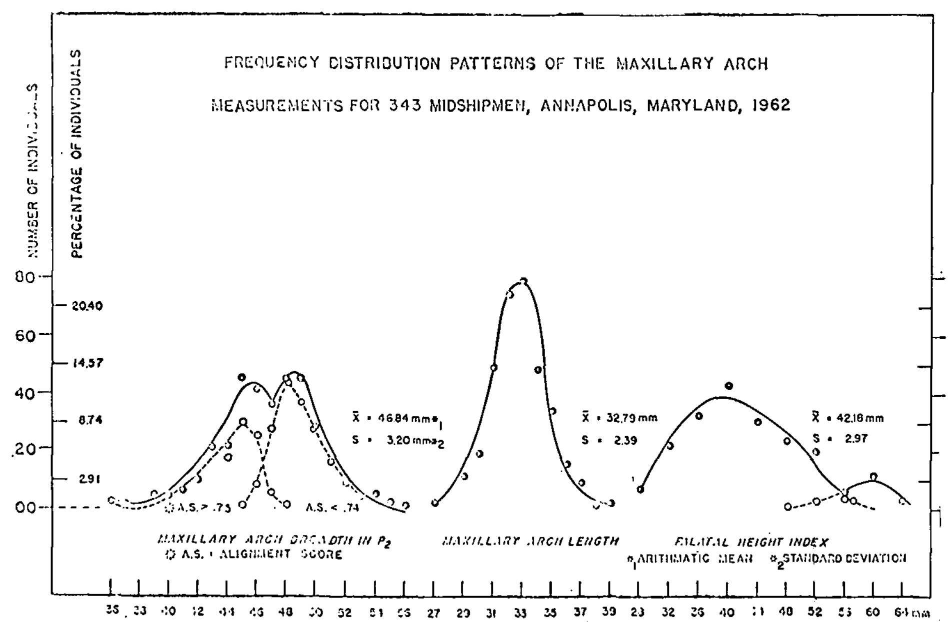
FREQUENCY DISTRIBUTION PATTERNS OF THE MAXILLARY ARCH
MEASUREMENTS FOR 343 MIDSHIPMEN, ANNAPOLIS, MARYLAND, 1962
PERCENTAGE OF INDIVIDUALS
X̄ = 46.84 mm *1
S = 3.20 mm *2
X̄ = 32.79 mm
S = 2.39
X̄ = 42.18 mm
S = 2.97
MAXILLARY ARCH LENGTH
*1 ARITHMATIC MEAN *2 STANDARD DEVIATION

Fig. 3

individual teeth in the dental arch.[1] Those individuals with scores of 0.74 or less were treated as one group, and those with scores of 0.75 or more as the second group. Means, standard deviations, and standard errors were calculated for each group, Table 2. There was a mean difference of 3.17 mm of arch breadth between the two groups. This difference could happen by chance alone one time in a thousand, ($P < 0.001$). Each of these two groups is represented on the P_2 arch distribution pattern by the small circle (o) and broken line (—) curve as shown in Figure 3.

The examination cards for those individuals with I_2 mesiodistal diameters ranging between 5.5 mm and 6.5 mm were withdrawn. The lateral incisors in this range were of two morphologic types: (1) fully formed but small, and (2) peg- or cone-shaped. If peg- or cone-shaped lateral incisors were deleted, the convexity in the curve in this area was corrected. The irregularity occurring in the distribution pattern of palatal heights, commencing with scores of 52, Figure 3, resulted from the measurement of 31 individuals with a high posteriorly constricted palate.

TABLE 2

MAXILLARY ARCH BREADTH AT P_2 ACCORDING TO ALIGNMENT SCORE GROUPINGS

Group #1 Alignment Score <0.74	Group #2 Alignment Score >0.75
$N = 224$	$N = 119$
$\overline{X} = 48.25$ mm	$\overline{X} = 45.08$ mm
$s = 2.38$	$s = 2.78$
$s_{\overline{X}} = 0.194$	$s_{\overline{X}} = 0.311$

$$t = \frac{48.25 - 45.08}{\sqrt{(0.194)^2 + (0.311)^2}}$$

$$t = \frac{3.17}{0.367} = 8.6376$$

$P < 0.001$

$\overline{X}$ = mean; s = standard deviation; $s_{\overline{X}}$ = standard error of the mean; t = Student's "t" test for significance of difference between two groups.

Discussion

These six variables are adequately described by a normal distribution. Statistical procedures based upon parametric methods are applicable for descriptive epidemiological studies of malocclusion. Errors arising from minor deviations would be small and not statistically significant.

Previous studies have demonstrated an inverse relationship between arch breadth and malaligned teeth.[1] Inspection of these distributions confirmed this relationship. Eighty percent of the persons with malaligned teeth were represented by that portion of the P_2 arch breadth curve below 46.00 mm. It appears that the tendency toward a bimodal distribution of these data is a result of this relationship between arch width and malalignment of teeth.

The slight convexity in the distribution pattern of the I_2 mesiodistal diameter, occurring between 5.5 and 6.5 mm, can be explained by the inclusion of those individuals with peg- or cone-shaped teeth. If these individuals are deleted from the distribution, the convexity in the curve is no longer apparent. Evidently this is a result of two morphologic types of maxillary lateral incisors and is to be expected for these teeth.

Thirty-one individuals with a high posteriorly constricted palate accounted for the aberration in the distribution pattern of palatal height index. These same individuals also presented with many malposed teeth which gave them a high alignment score.

The usual parametric and nonparametric statistical tools were efficient and practical for the purposes of describing this population.

Summary

Frequency distribution patterns means, medians, modes and standard deviations were determined for the measurement of arch breadth, arch length, crown diameters of anterior teeth and palatal height index for 343 young adult males at the United States Naval Academy, Annapolis, Md. Results indicated that these six anatomical variables distribute normally, and standard parametric and nonparametric statistical procedures are very efficient and useful.

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