

Section VII

Results and Discussion

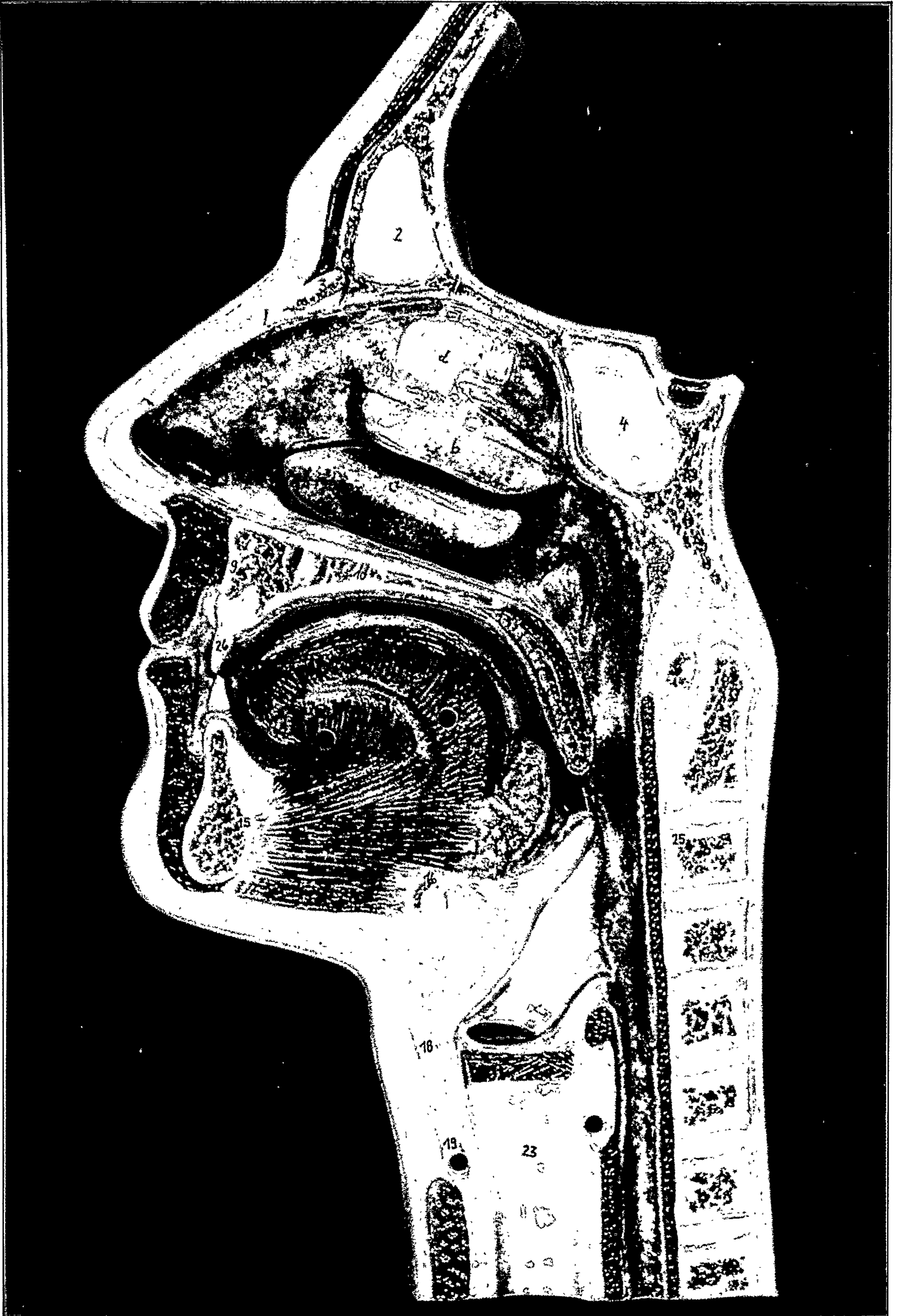


Fig. 80. Model showing structures in the mid-sagittal plane of nasopharyngeal region (Author's material)

SECTION VII: RESULTS AND DISCUSSION

1. CONFIGURATION OF THE NASOPHARYNGEAL SPACE

It was observed in this investigation that the configuration of the human nasopharyngeal space occurs in numerous forms quite unrelated to the shape seen on a lateral skull radiograph. By applying CT, the soft tissue delineation of the region is clearly discernible. The orientation and level of the CT slice, moreover, can be readily ascertained by the spatial relationship of adjacent landmarks.

Furthermore, five out of the seventeen subjects in the first group displayed lateral borders of the nasopharyngeal space extending beyond the medial pterygoid plates, especially in the posterior portion. This is contrary to the belief of Rizzuti and Whalen (1972), and indeed many others, who regarded the bihamular distance as the anatomical width of the nasopharyngeal space.

Findings also showed a range of capacity of the nasopharyngeal space from 11.0 c.c. to 33.7 c.c. (see Appendix 3.1). This is within the lower limit of the 32 c.c. to 48 c.c. as suggested by Bloch and Quantrill (1968), but considerably higher than the bony nasopharyngeal volume of 10.5 c.c. given by Bergland (1963).

Computed Tomography, therefore, is deemed to be useful in the examination and quantification of the human nasopharynx.

2. SELECTION OF A RELIABLE CEPHALOMETRIC QUANTITY

As noted in Section VI, simple correlation analyses expressed as scattergrams were applied to scan-based nasopharyngeal volume determinations (Y) and various radiographic quantifications (X1 to X15) obtained from the fifteen subjects selected in the first group.

While definitions are set out on Table 3, and actual measurements obtained tabulated on Appendix 3.1, the scattergrams plotted are included under Appendix 1.1. A summary of the values of correlation coefficients (r) so derived, however, is given by Table 13.

Dependent variable (Y): Mean = 19.9; S.D. = 6.84. (cm³).
 Sample size (N) = 15.

Independent variables	Mean	S.D.	Correlation coefficient (r)	Significance
X1 (cm)	2.27	0.20	0.459*	0.086
X2 (cm)	1.96	0.28	0.335	0.223
X3 (cm)	1.54	0.34	0.144	0.609
X4 (cm)	2.54	0.33	-0.001	0.996
X5 (cm)	2.22	0.22	0.175	0.533
X6 (cm)	2.47	0.23	0.150	0.533
X7 (cm)	2.40	0.24	0.475*	0.074
X8 (cm)	1.73	0.38	0.231	0.407
X9 (cm)	2.29	0.28	0.118	0.676
X10 (cm)	0.60	0.23	<i>0.553*</i>	<i>0.033</i>
X11 (cm ²)	2.16	0.41	0.397	0.142
X12 (cm ²)	1.44	0.26	0.461*	0.083
X13 (cm ²)	3.11	0.68	0.355	0.194
X14 (cm ²)	3.52	0.78	0.371	0.173
X15 (cm ²)	6.11	1.17	<i>0.803**</i>	<i>0.001</i>

Notes:

* Moderate correlation; substantial relationship

** High correlation; marked relationship

Light italic indicates values significant at 0.05 level.

Table 13. Values of correlation coefficients between scan-based nasopharyngeal volumes and radiographic quantifications.

It can be seen that values of moderate correlation included:

- X1: Linear distance between pterygomaxillare and adenoid surface on the line PMF-Ba (Brader 1957; Linder-Aronson 1970), and has been proven to correlate well with incidence of mouth breathing.
- X7: Linear distance from posterior nasal spine to point of greatest concavity or convexity (Mergen and Jacobs 1970), substantiated by the authors to associate with Class II malocclusions.
- X10: The shortest distance between soft palate and posterior pharyngeal wall (Wolfe 1942), which has been in use for a long time as a basis to study velopharyngeal functions.
- X12: The sagittal plane area bound by the triangle PMF-S₀-Ba (Linder-Aronson and Henrikson 1973) occupied by airway, was also found to correlate well with mouth breathing.

However, the only value of high correlation and marked relationship is X15, the sagittal plane area bound by the total soft tissue boundary, a quantity contrived by the author in view of its inclusion of the portion of nasopharyngeal space below the palatal plane, a fact overlooked by most researchers.

Though further substantiation on a larger sample involving younger age groups is recommended, X15 is selected to be a reliable cephalometric quantity representing the volume of nasopharyngeal space for the purpose of this investigation.

3. TESTS OF 'ADENOID FACIES PATH'

While definitions of variables used in this section are listed on Table 4, actual measurements obtained are tabulated on Appendix 3.2.

3.1 SIMPLE CORRELATION ANALYSES

Simple correlation analyses were performed on pairs of all the variables chosen to represent linkages in the 'Adenoid Facies Path'. The means, standard deviations, and correlation coefficients are set out in the form of a correlation matrix on Appendix 1.2.

Each of the variables can therefore be looked at in turns as a dependent variable, affected by the remaining variables and qualified

by the value of the respective correlation coefficients. It is felt that interpretation will be more meaningful if only values of r significant at 0.05 level ($r \geq 0.35$ approximately) are considered. Such values are summarised in Table 14.

3.1.1 Nasopharyngeal variable (AA)

The moderate but substantial relationship of AA with S5 (MP:OP) and D4 (OP:MP) indicates that posture of the mandible and inclination of the occlusal plane are most affected by the size of nasopharyngeal space per se. The inverse relationship infers a dorsal rotation of the mandible when there is diminished nasopharyngeal space, accompanied by a steepening of the occlusal plane in relation to mandibular plane.

These results support the more recently elaborated theory of the posture of the mandible being affected by airway patency (Thurrow 1973; Martens 1979), though no relationship was discovered in this study between measurements of airflow and scan-based nasopharyngeal volumes (as indicated by AA).

3.1.2 Airflow variable (BI)

The value of Blockage Index was found to be inversely proportional to the incidence of nasal breathing. It seems logical to assert a tendency to breathe through the mouth when there is a decrease in nasal patency.

3.1.3 Mode of breathing variable (MB)

Incidence of nasal breathing bears a definite but small relationship to cross-bite (D7), besides having a negative relationship with nasal resistance (BI).

3.1.4 Skeleton variable S1 (angle SNA)

Results show that in the present sample, angle SNA is highly correlated to angle SNB, moderately to angle ANB, but negatively related to mandibular plane to SN and to height of palatal vault.

Dependent variable	Independent variables significant at 0.05 level with value of r in brackets	
	Positive relationship	Negative relationship
AA	Nil	S5 (-0.46); D4 (-0.47)
B1	Nil	MB (-0.39)
MB	D7 (0.39)	B1 (-0.39)
S1	S2 (0.76); S3 (0.42)	S4 (-0.40); S7 (-0.49)
S2	S1 (0.76)	S4 (-0.45); D3 (-0.37) D5 (-0.35)
S3	S1 (0.42); S6 (0.38) D2 (0.48)	D7 (-0.40)
S4	S5 (0.78); S7 (0.37) D3 (0.56); D4 (0.61)	S1 (-0.40); S2 (-0.45) S6 (-0.49)
S5	S4 (0.78); D4 (0.73)	AA (-0.46); S6 (-0.60)
S6	S3 (0.38)	S4 (-0.49); S5 (-0.60) S7 (-0.38)
S7	S4 (0.37)	S1 (-0.49); S6 (-0.38)
D1	Nil	D3 (-0.49)
D2	S3 (0.48); D6 (0.57)	Nil
D3	S4 (0.56)	S2 (-0.37); D1 (-0.49)
D4	S4 (0.61); S5 (0.73)	AA (-0.47)
D5	Nil	S2 (-0.35)
D6	D2 (0.57)	Nil
D7	MB (0.39)	S3 (-0.40)
D8	Nil	Nil

Table 14 Summary of relevant correlation coefficients in simple correlation analyses of 'Adenoid Facies Path'

3.1.5 Skeleton variable S2 (angle SNB)

While a high value of angle SNB is frequently associated with a high value of angle SNA in the samples, it appears to be moderately inversely proportional to MP:SN, OP:SN, and upper molar arch width.

3.1.6 Skeleton variable S3 (angle ANB)

A moderate positive relationship was observed between this variable and angle SNA, face index and lower incisors to SN, but negative tendency to cross-bites.

3.1.7 Skeleton variable S4 (MP:SN)

This value showed a high relationship to MP:PP, height of palatal vault, OP:SN and OP:MP. But negative relationships were found with angle SNA, angle SNB and face index.

3.1.8 Skeleton variable S5 (MP:PP)

A high MP:PP was found to associate with high OP:MP and MP:SN, but low nasopharyngeal size and face index.

3.1.9 Skeleton variable S6 (SN/NGn or face index)

It is found to bear a moderate positive relationship with angle ANB, but negatively with MP:SN, MP:PP, and height of palatal vault.

3.1.10 Skeleton variable S7 (Ht. at M_1-M_1 or palatal vault)

Subjects of the sample tested showed a high palatal vault together with a high MP:SN, but low angle SNA and face index.

3.1.11 Dentition variable D1 (/I:SN)

Proclined upper incisors seemed to correlate with low OP:SN.

3.1.12 Dentition variable D2 (/I:MP)

Proclined lower incisors were found to associate with a high angle ANB and high lower arch length.

3.1.13 Dentition variable D3 (OP:SN)

The inclination of occlusal plane to SN bears a positive relationship with MP:SN, and negatively with angle SNB and angle of upper incisors with SN.

3.1.14 Dentition variable D4 (OP:MP)

Individuals from the sample showed a high value of OP:MP with high MP:SN and MP:PP, but low nasopharyngeal size.

3.1.15 Dentition variable D5 (upper molar arch width)

The arch width at upper molars region showed a negative relationship with angle SNB.

3.1.16 Dentition variable D6 (Lower arch length)

From the sample tested, this variable correlated positively with the angulation of lower incisors to mandibular plane.

3.1.17 Dentition variable D7 (cross-bite)

Incidences of cross-bite relate well with frequencies of nasal breathing but correlates inversely with angle ANB.

3.1.18 Dentition variable D8 (Angle's classification)

No significant relationship was discovered between Angle's classification of molars and any of the variables selected in this study involving the 'Adenoid Facies Path'.

3.1.19 Summary

The most significant discovery in the above analyses is the association of mandibular posture with nasopharyngeal size. Also, nasal resistance

bears a negative relationship to nasal breathing. The latter was also found to coexist with cases of cross-bite.

3.2 MULTIPLE REGRESSION ANALYSES OF NASOPHARYNGEAL VOLUME WITH DENTOFACIAL ANOMALIES

As noted previously, characteristics of 'adenoid facies' in this study are represented by two groups of variables (skeleton and dentition). This procedure is designed to test whether there is a direct association between the nasopharyngeal volume (i.e., the first linkage in the 'Adenoid Facies Path') and dentofacial anomalies (i.e., the last linkage in the Path). And if there is, the strength of such relationship.

This is achieved by introducing skeleton and dentition variables *en block* in turn, and then together. The square of the multiple correlation coefficient (R^2 or coefficient of determination) derived after each step gives the strength of the relationship. The R^2 change induced by each variable gives the proportion of variation attributed to that variable in the regression equation.

The rationale of statistical procedure used was related in Section VI, and the order of introduction of variables in the multiple regression analyses (MRA) was listed on Table 12.

It is decided that values of R^2 , if less than 0.30, is deemed weak; if higher than 0.50, satisfactory. R^2 change, however, is regarded as relevant if higher than 0.10 for individual variables.

Results are listed in two tables under each section. Only significant results and relevant values for statistical tests were recorded. Regression statistics are given for all variables entered into the equation up to and including the current step. Explanations of statistical notations have been given in Section VI or defined in Appendix 2.

Table (a) is headed with the sample size (N) and the designations of excluded variables, if any. The following format is adopted:

(a) N = 30; * (variables excluded)

Variables	R^2 /S.D.	SS_{reg}/DF_1	SS_{res}/DF_2	F/Sig.
...	...	...	...	...

- Variables: Except for the first step, each additional step of introduction of variables are preceded by the sign (+).
- R^2 : Coefficient of determination.
- S.D. : Standard deviation of estimate for the prediction equation.
- SS_{reg} : The sum of squares explained by the entire equation.
- DF_1 : k degrees of freedom.
- SS_{res} : The residual (unexplained) sum of squares.
- DF_2 : (N-k-1) degrees of freedom.
- F : Overall F ratio for test of R^2 , or goodness of fit of the regression equation.
- Sig. : Significance.
- k : Number of independent variables in the equation.

Table (b) relates statistical information regarding variables in the regression equation with R^2 change higher than 0.10, and is headed with the sample size (N), and the number of independent variables in the final regression equation (k). The following format is used:

(b) N = 30; k = (18 - 1 - number of variables excluded, if any)

Variable	R^2 change	B	S.E. of B	F/Sig.
...	...	...	...	...
Constant	...	...	...	...

- Variable : Selected variables are entered according to their R^2 change in the order of strength.
- Constant : Y intercept of the final regression equation.
- R^2 change: Change in the coefficient of determination after introduction of the corresponding variable.
- B : Unstandardized regression coefficient.
- S.E. of B: Standard error of B, which can be used in a t test or in establishing confidence limits for the B's.
- F/Sig. : The F ratio and the significance of individual B's with 1 and N-k-1 degrees of freedom.

3.2.1 MRA of nasopharyngeal variable (AA) with skeleton variables

Table 15. MRA of AA with S1-S7

(a) N = 30; ** S2 excluded

Variables	R^2 /S.D.	SS_{reg}/DF_1	SS_{res}/DF_2	F/Sig.
S1-S7	0.352/1.24	19.2/6	35.4/23	2.08/0.095

(b) N = 30; k = 6

Variable	R^2 change	B	S.E. of B	F/Sig.
S5	0.138	-0.165	0.736E-01	5.04/0.035
S7	0.112	0.249	0.139	3.20/0.087
Constant		-11.4	14.8	0.591/0.449

It can be seen that the total skeleton variables give a weak R^2 (0.352), implying that the skeleton characteristics of 'adenoid facies' do not adequately explain the variability of the nasopharyngeal space.

It is relevant, however, that the nasopharyngeal space does show a positive relationship with the height of the palatal vault (S7), contrary to the contention of some authors (Wustrow 1917; Massler, Poncher and Schour 1945).

The fact that a small nasopharyngeal space is associated with a steep mandibular plane (S5) again supports the notion of the posture of the mandible adapting to function in providing a patent airway (Thurrow 1973; Martens 1979).

3.2.2 MRA of nasopharyngeal variable (AA) with dentition variables

Table 16. MRA of AA with D1-D8

(a) N = 30; None excluded

Variables	R^2 /S.D.	SS_{reg}/DF_1	SS_{res}/DF_2	F/Sig
D1-D8	0.261/1.39	14.3/8	40.3/21	0.931/0.512

(b) N = 30; k = 8

Variable	R ² change	B	S.E. of B	F/Sig.
D4	0.166	-0.147	0.773E-01	3.62/0.071
Constant		13.3	7.42	3.23/0.087

Dentition variables themselves also show a very weak R², can cannot explain the variability of the nasopharyngeal variable. Amongst those variables, the inclination of occlusal plane to mandibular plane (D4) shows a negative relationship with the size of nasopharyngeal space.

3.2.3 MRA of nasopharyngeal variable (AA) with skeleton and dentition variables

Table 17. MRA of AA with S1-S7 + D1-D8

(a) N = 30; ** S2 excluded

Variables	R ² /S.D.	SS _{reg} /DF ₁	SS _{res} /DF ₂	F/Sig.
S1-S7	0.352/1.24	19.2/6	35.4/23	2.08/0.095
+ D1-D8	0.487/1.37	26.6/14	28.0/15	1.02/0.484

(b) N = 30; k = 14

Variable	R ² change	B	S.E. of B	F/Sig.
S5	0.138	-0.130	0.101	1.66/0.216
S7	0.112	0.285	0.162	3.07/0.100
Constant		-13.9	20.9	0.447/0.514

The final R² is close to, but not quite, satisfactory. One can therefore conclude that the characteristics of 'adenoid facies' do not adequately explain the variability of nasopharyngeal quantity. Also, the nasopharyngeal variable is found to be directly proportional to the height of palatal vault (S7), but inversely to the inclination of mandibular plane to palatal plane (S5).

3.2.4 Summary

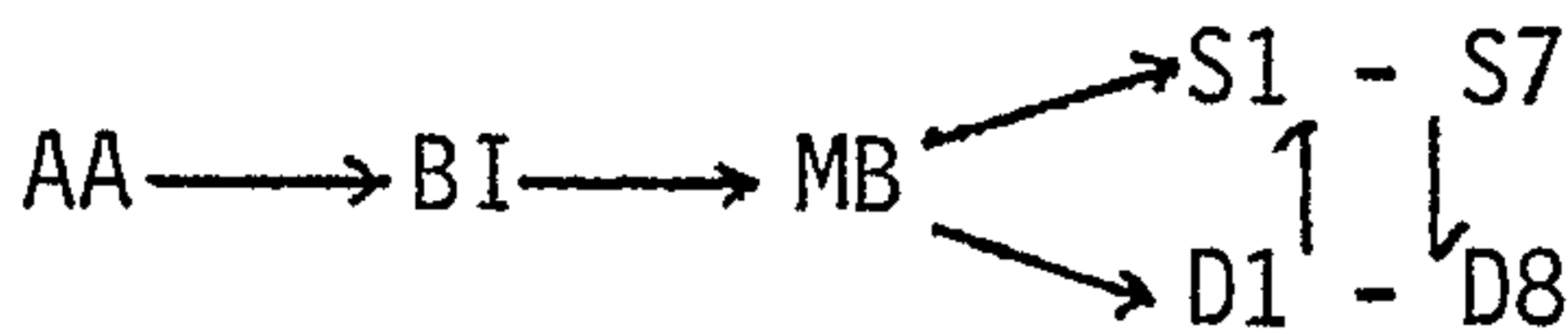
In this study, results infer that there is no substantial direct

relationship between features of 'adenoid facies' and nasopharyngeal dimensions *per se*. The latter quantity, however, relates inversely to the steepness of mandible and occlusal plane, but directly to the height of palatal vault.

3.3 STEPWISE MULTIPLE REGRESSION ANALYSES OF VARIABLES IN THE 'ADENOID FACIES PATH'

In this procedure, each variable of the 'Adenoid Facies Path' (i.e., AA, BI, MB, S1-S7, and D1-D8) was being tested in turn as a dependent variable on the rest of the variables. The latter, pre-grouped as linkages of the Path, were introduced in a stepwise fashion, so that the accumulative effects can be decomposed and described.

Typically, the order of introduction follows the predetermined sequence of:



in three or four steps, each step comprising of one or two linkages in the Path. Details are given in Table 12.

How adequately can each linkage in the Path explain the variability of the dependent variable under test is assessed by firstly, the value of R^2 so derived, and secondly, by the R^2 change caused by each additional step or linkage.

It is possible, too, to evaluate the relative strength of, say, nasopharyngeal dimensions (AA) within a group of variables with significant associations with, say, the angle of mandibular plane to palatal plane (S5). This is, of course, indicated by the R^2 change caused by the respective variable.

In the following assessment of results, only relevant values based on the level of significance and of acceptable strength, as discussed in the preceding section (3.2), are recorded and interpreted. The format of tabulation is also identical to that used formerly.

3.3.1 MRA of nasopharyngeal variable (AA) with other variables

Table 18. MRA of AA with other variables

(a) N = 30; ** S2 excluded

Variables	R^2 /S.D.	SS_{reg}/DF_1	SS_{res}/DF_2	F/Sig.
MB	0.070			
+ BI	0.072/1.37	3.89/2	50.7/27	1.03/0.369
+ S1-S7	0.406/1.24	22.2/8	32.5/21	1.79/0.135
+ D1-D8	0.523/1.42	28.6/16	26.1/13	0.891/0.593

(b) N = 30; k = 16

Variable	R^2 change	B	S.E. of B	F/Sig.
S5	0.150	-0.126	0.105	1.43/0.153
S7	0.126	0.270	0.172	2.48/0.139
Constant		-6.58	24.1	0.744E-01/0.789

Though the value of R^2 (0.523) gives a satisfactory explanation of the variability of the nasopharyngeal variable (AA), there is almost negligible attribution by mouth breathing ($R^2 = 0.070$), Blockage Index ($R^2 = 0.072$), and skeleton variables ($R^2 = 0.406$) together.

As discovered previously, the inclination of mandibular plane to palatal plane (S5) showed an inverse relationship with the size of nasopharyngeal space (AA). The height of palatal vault (S7), however, bears a positive relationship with AA, in a manner somewhat contrary to the innovation behind events leading to 'adenoid facies'.

Most of the R^2 changes caused by individual variables are rather low, the lowest in the vicinity of 0.0002.

There is a sharp rise in R^2 at step two when skeleton variables were included (from 0.071 to 0.406), and hardly as much when dentition variables were added (from 0.406 to 0.523). This indicates that the variability of the nasopharyngeal variable as explained by the remaining Path linkages is due largely to the effects of skeleton base.

3.3.2 MRA of airflow variable (BI) with other variables

Table 19. MRA of BI with other variables

(a) N = 30; * S1 excluded

Variables	R^2 /S.D.	SS_{reg}/DF_1	SS_{res}/DF_2	F/Sig.
AA	0.018			
+ MB	0.153/17.5	1504.6/2	8278.4/27	2.45/0.105
+ S1-S7	0.435/16.2	4258.1/8	5524.9/21	2.02/0.094
+ D1-D8	0.670/15.8	6552.6/16	3230.4/13	1.65/0.184

(b) N = 30; k = 16

Variable	R^2 change	B	S.E. of B	F/Sig.
MB	0.150	-3.42	0.925	13.7/0.003
S6	0.136	3.70	1.63	5.13/0.041
Constant		-407.7	144.3	2.78/0.119

The total R^2 (0.670) gives a satisfactory coefficient of determination though the relationship displayed between nasopharyngeal size (AA) and airflow is very weak ($R^2 = 0.018$). Again, the relatively large increment of R^2 (from 0.153 to 0.435) after inclusion of S1-S7 infers the importance of skeleton variables as determinants of air-flow. The slight R^2 change shown by D1-D8 asserts a less crucial role played by the dentition variables in this connection.

An increase in nasal patency, by definition, is indicated by a decrease in Blockage Index. Results suggest a negative relationship between incidences of mouth breathing and nasal patency. In this study, data are programmed in such a way that a positive sign preceding the mode of breathing variable (MB) means a direct relationship with nasal breathing, or an indirect relationship with mouth breathing.

It can be concluded from this analysis that individuals showing decreased nasal patency (i.e., high BI) have higher incidence of mouth breathing and a higher face index. The latter observation is indeed contrary to the belief of a long, slender face with mouth breathers.

3.3.3 MRA of mode of breathing variable (MB) with other variables

Table 20. MRA of MB with other variables

(a) N = 30; * S1 excluded

Variables	R ² /S.D.	SS _{reg} /DF ₁	SS _{res} /DF ₂	F/Sig.
AA	0.070			
+ BI	0.199/4.23	120.2/2	483.9/27	3.36/0.050
+ S1-S7	0.477/3.88	288.4/8	315.7/21	2.40/0.052
+ D1-D8	0.766/3.29	462.8/16	141.3/13	2.66/0.041

(b) N = 30; k = 16

Variable	R ² change	B	S.E. of B	F/Sig.
BI	0.129	-0.150	0.405	13.7/0.003
S6	0.104	0.642	0.362	3.14/0.100
Constant		-61.1	53.7	1.29/0.276

The rather high value of R² (0.766) asserts the innovation that all the variables in the 'Adenoid Facies Path' explains 76.6% of the variability of the mode of breathing in the regression equation. The nasopharyngeal variable only ascribes a very small proportion of the determination (R² = 0.070). In this case, the dentition variables displayed a similar amount of increment to that caused by skeleton variables.

The mode of breathing, again, shows an inverse relationship with the Blockage Index. Incidence of mouth breathing therefore occurs with a lower nasal patency. Furthermore, a high face index (S6) exhibits a direct relationship with nasal breathing.

It can be concluded that while the total inclusion of all variables explains adequately the variability of the mode of breathing, both skeleton and dentition characteristics are equally important. Individuals with mouth breathing concurrently show a low nasal patency and a low face index. The goodness of fit of the regression equation is comfortably around the 0.05 level at all steps.

3.3.4 MRA of angle SNA (S1) with other variables

Table 21. MRA of S1 with other variables

(a) N = 30; *** S3 excluded

Variables	R^2 /S.D.	SS_{reg}/DF_1	SS_{res}/DF_2	F/Sig.
AA	0.037			
+ BI	0.041/4.10	19.5/2	453.9/27	0.579/0.567
+ MB	0.075/4.11	35.3/3	438.1/26	0.699/0.561
+ S2-S7	0.746/2.39	353.2/8	120.3/21	7.70/0.000
+ D1-D8	0.829/2.49	392.4/16	81.1/13	3.93/0.008

(b) N = 30; k = 16

Variable	R^2 change	B	S.E. of B	F/Sig.
S2	0.580	1.02	0.280	13.3/0.003
Constant		-16.4	42.4	0.150/0.705

Even though the resultant R^2 gives a high value, most of the explanation was due to a high R^2 change caused by S2 (0.580). The remaining variables in fact show an almost negligible relationship with angle SNA (S1).

From this analysis it is shown that individuals with a high angle SNA (S1) also have a high angle SNB (S2). The variability of the angle SNA can hardly be explained by the remaining variables of the 'Adenoid Facies Path'. The overall goodness of fit of the regression equation after inclusion of skeleton and dentition variables is nonetheless significant at 0.05 level.

While Linder-Aronson (1970) was able to show that small values for the angle SNA was common in association with features of 'adenoid facies' and in children indicated for adenoidectomies, this notion is not supported by data from this study.

3.3.5 MRA of angle SNB (S2) with other variables

Table 22. MRA of S2 with other variables

(a) N = 30; *** S3 excluded

Variables	R^2 /S.D.	SS_{reg}/DF_1	SS_{res}/DF_2	F/Sig.
AA	0.019			
+ BI	0.031/3.86	12.9/2	402.9/27	0.435/0.652
+ MB	0.144/3.70	59.8/3	356.1/26	1.46/0.249
+ S1-S7	0.858/1.68	356.7/8	59.2/21	15.8/0.000
+ D1-D8	0.905/1.74	376.6/16	39.4/13	7.76/0.000

(b) N = 30; k = 16

Variable	R^2 change	B	S.E. of B	F/Sig.
S1	0.493	0.496	0.136	13.3/0.003
S4	0.148	-0.416	0.483	0.743/0.404
MB	0.148	0.132	0.142	0.869/0.368
Constant		60.6	24.5	6.11/0.028

Though the results showed a very high value of the coefficient of determination for the effects of all the variables together ($R^2 = 0.905$), the principal determinant is S1 (R^2 change = 0.493). The next strongest relationship is displayed by variable S4 (R^2 change = 0.148), which is the angle between the mandibular plane and nasion-sella plane. The mode of breathing is also moderately correlated with angle SNB (S2), indicating a decrease in mouth breathing when there is an increase in angle SNB.

The results therefore infer that in individuals with a high angle SNB, they also exhibit a high angle SNA, a steep mandibular plane angle (or dorsal rotation of the mandible), and a lower incidence of mouth breathing.

As a small angle SNB was said to associate with mouth breathing and characteristics of 'adenoid facies' (Linder-Aronson 1970), results obtained from this analysis would seem to support this idea.

3.3.6 MRA of angle ANB (S3) with other variables

Table 23. MRA of S3 with other variables

(a) N = 30; * S1 excluded

Variables	R^2 /S.D.	SS_{reg}/DF_1	SS_{res}/DF_2	F/Sig.
AA	0.010			
+ BI	0.014/2.75	2.98/2	204.9/27	0.196/0.823
+ MB	0.054/2.75	11.2/3	196.7/26	0.493/0.691
+ S2-S7	0.421/2.39	87.6/8	120.3/21	1.91/0.112
+ D1-D8	0.610/2.50	126.8/16	81.1/13	1.27/0.335

(b) N = 30; k = 16

Variable	R^2 change	B	S.E. of B	F/Sig.
S6	0.148	0.129	0.304	0.180/0.679
S7	0.120	-0.430	0.308	1.94/0.187
D2	0.106	0.238	0.134	3.14/0.100
Constant		-16.4	42.4	0.150/0.705

All the variables of the Path included in the regression equation as determinants of the angle ANB (S3) have a satisfactory coefficient of determination ($R^2 = 0.610$). Whilst the size of the nasopharyngeal space (AA), nasal patency (BI), and mode of breathing (MB) showed no significant associations with the antero-posterior relationship of the jaws (i.e., angle ANB), skeleton variables as a group caused a large increment in R^2 (from 0.054 to 0.421). The latter therefore assumes an important role in explaining the variability of S3.

Variables showing a relevant relationship with S3 are S6 (face index), S7 (height of palatal vault), and D2 (inclination of lower incisors), all of which relate positively with S3.

This analysis does not disclose any relationship between angle ANB and other linkages in the 'Adenoid Facies Path', but rather, this variable is strongly influenced by other dentofacial quantities.

3.3.7 MRA of angle MP:SN (S4) with other variables

Table 24. MRA of S4 with other variables

(a) N = 30; ** S2 excluded

Variables	R^2 /S.D.	SS_{reg}/DF_1	SS_{res}/DF_2	F/Sig.
AA	0.079			
+ BI	0.090/5.46	79.9/2	804.3/27	1.34/0.278
+ MB	0.090/5.56	79.9/3	804.3/26	0.862/0.473
+ S1-S7	0.815/2.80	720.3/8	163.9/21	11.5/0.000
+ D1-D8	0.986/0.971	871.9/16	12.3/13	57.8/0.000

(b) N = 30; k = 16

Variable	R^2 change	B	S.E. of B	F/Sig.
S3	0.287	0.130	0.150	0.743/0.404
S6	0.207	-0.937	0.116	0.652/0.434
S1	0.131	-0.148	0.101	2.15/0.166
Constant		4.46	16.5	0.726E-01/0.792

The variables of nasopharyngeal space, blockage index and mode of breathing together give almost negligible coefficient of determination for the angle between mandibular plane and Sella-Nasion plane (S4), i.e., a total R^2 of 0.090. Out of the very high final coefficient of determination ($R^2 = 0.986$), skeleton variables play a crucial role (causing a R^2 change from 0.090 to 0.815). Overall confidence limit is very high (significance = 0.000).

The dentition variables appear to affect S4 in a minor aspect (causing a R^2 change from 0.815 to 0.986) only. The main increment, however, is due to the positive relationship with S3 (angle ANB), and the negative relationship with S6 (face index), and S1 (angle SNA). The last observation agrees with the findings by Bjork (1947), Solow (1966), and Linder-Aronson (1970).

It can be concluded, therefore, that the angle between the mandibular plane and SN plane obtained from this sample bears a strong relationship with other skeleton variables, and virtually unrelated to other linkages in the 'Adenoid Facies Path'.

3.3.8 MRA of angle MP:PP (S5) with other variables

Table 25. MRA of S5 with other variables

(a) N = 30; ** S2 excluded

Variables	R^2 /S.D.	SS_{reg}/DF_1	SS_{res}/DF_2	F/Sig.
AA	0.213			
+ BI	0.252/5.14	240.9/2	713.9/27	4.56/0.020
+ MB	0.263/5.20	251.2/3	703.6/26	3.09/0.044
+ S1-S7	0.768/3.25	733.2/8	221.5/21	8.69/0.000
+ D1-D8	0.830/3.54	792.1/16	162.6/13	3.96/0.008

(b) N = 30; k = 16

Variable	R^2 change	B	S.E. of B	F/Sig.
S6	0.286	-0.266	0.427	0.389/0.543
AA	0.213	-0.786	0.658	1.43/0.253
S4	0.122	1.07	0.965	1.24/0.286
Constant		18.7	60.2	0.973E-01/0.760

All the independent variables included in this regression equation as determinants of the angle between the mandibular plane and palatal plane (S5) have a high coefficient of determination ($R^2 = 0.830$).

An interesting observation is that the size of nasopharyngeal space (AA) displays a moderate negative relationship with S5, having a R^2 change of 0.213, although the main bulk of the increment of R^2 was due to the face index (S6), and the angle between the mandibular plane and SN plane (S4).

The goodness of fit of the overall equation is rather high, having a significance of 0.008. Results in this analysis are conclusive that individuals having a high angle of mandibular plane to palatal plane also have a small nasopharyngeal space, small face index, but high angle between the mandibular plane and SN plane. Again, the posture of the mandible exhibits a significant association with the size of airway.

3.3.9 MRA of the face index (SN/NGn or S6) with other variables

Table 26. MRA of S6 with other variables

(a) N = 30; * S1 excluded

Variables	R^2 /S.D.	SS_{reg}/DF_1	SS_{res}/DF_2	F/Sig.
AA	0.040			
+ BI	0.041/3.38	13.1/2	307.8/27	0.574/0.570
+ MB	0.042/3.44	13.5/3	307.4/26	0.381/0.768
+ S1-S7	0.716/2.08	229.8/8	91.1/21	6.62/0.000
+ D1-D8	0.792/2.27	254.2/16	66.7/13	3.09/0.023

(b) N = 30; k = 16

Variable	R^2 change	B	S.E. of B	F/Sig.
S5	0.258	-0.109	0.175	0.389/0.543
S7	0.166	-0.367	0.282	1.69/0.216
S2	0.164	-0.529	0.207	6.50/0.024
Constant		121.7	18.9	41.3/0.000

Though the total value of R^2 (0.792) gives a satisfactory explanation of the variability of the face index (S6), it is almost due entirely to skeleton variables. The size of nasopharyngeal airway, nasal patency, and mode of breathing do not attribute to such variability. Even the dentition variables together only cause a small R^2 increment (from 0.716 to 0.792), and is hardly sufficient to explain the variability of S6. The overall goodness of fit of the regression equation is most significant after inclusion of skeleton variables (significance = 0.000).

The face index (i.e., SN/NGn x 100%) is therefore seen to exhibit inverse proportions with the angle between mandibular plane and palatal plane (S5), height of palatal vault (S7), and angle SNB (S2).

Although some researchers believe in the association between adenoids (i.e., size of nasopharyngeal space) and a long slender face (i.e., low face index), data from this study do not support this contention. Instead, the face index is very much a morphological pattern determined jointly by other skeleton manifestations.

3.3.10 MRA of Ht. at M_1-M_1 (S7) with other variables

Table 27. MRA of S7 with other variables

(a) N = 30; ** S2 excluded

Variables	R^2 /S.D.	SS_{reg}/DF_1	SS_{res}/DF_2	F/Sig.
AA	0.010			
+ BI	0.015/2.16	1.96/2	125.6/27	0.210/0.812
+ MB	0.051/2.16	6.51/3	121.1/26	0.466/0.708
+ S1-S7	0.474/1.79	60.5/8	67.1/21	2.37/0.054
+ D1-D8	0.552/2.10	70.4/16	57.1/13	1.00/0.506

(b) N = 30; k = 16

Variable	R^2 change	B	S.E. of B	F/Sig.
S1	0.254	-0.244	0.225	1.18/0.297
S6	0.164	-0.314	0.241	1.69/0.216
Constant		59.1	31.8	3.45/0.086

This multiple regression analysis shows that the height of palatal vault index (S7) cannot be adequately explained by the size of naso-pharyngeal space, nasal patency, and mode of breathing (i.e., AA, BI, and MB) taken together, each of which displays a very small R^2 change.

Again, skeleton variables appear to be the chief determinants of this index. Both S1 (angle SNA) and S6 (face index) display a negative relationship with the index for palatal vault height, with R^2 changes of 0.254 and 0.164 respectively.

Dentition variables, on the other hand, do not exhibit a strong relationship with S7, having a R^2 change from 0.474 to 0.552 only. The goodness of fit of the equation is most significant after inclusion of skeleton variables (significance = 0.054).

The opinion of several authors that children who breathe through the mouth often have a high palatal vault (Massler, Poncher and Schour 1945; Ballard 1952) is not substantiated by this analysis.

3.3.11 MRA of angle /1:SN (D1) with other variables

Table 28. MRA of D1 with other variables

(a) N = 30; ** S2 excluded

Variables	R^2 /S.D.	SS_{reg}/DF_1	SS_{res}/DF_2	F/Sig.
AA	0.071			
+ BI	0.097/9.17	244.9/2	2269.9/27	1.46/0.251
+ MB	0.097/9.15	338.4/3	2176.5/26	1.35/0.281
+ D2-D8	0.585/7.41	1472.4/10	1042.5/19	2.68/0.031
+ S1-S7	0.785/6.46	1973.0/16	541.8/13	2.96/0.027

(b) N = 30; k = 16

Variable	R^2 change	B	S.E. of B	F/Sig.
D3	0.208	-3.56	1.53	5.43/0.037
Constant		-40.5	109.7	0.137/0.718

The variables included in this regression equation as determinants of variable D1 (angle between upper incisors and sell-nasion plane) have a satisfactory coefficient of determination ($R^2 = 0.785$), and the overall test of goodness of fit of the equation is significant at 0.05 level.

The totality of nasopharyngeal size (AA), nasal patency (BI), and mode of breathing (MB) does not amount up to significant relationships, though the value of R^2 (0.135) is comparatively higher than that displayed by AA, BI, and MB in other regression analyses so far looked at.

The relatively high R^2 change induced by the inclusion of D2-D8 asserts the importance of dentition variables in affecting the angle between upper incisors and SN plane. Amongst them, the value D3 (the angle between occlusal and SN planes) gives a relevant R^2 change of 0.208, and relates inversely with D1.

It is evident from this analysis that individuals having retroclined upper incisors also exhibit a large angle between occlusal and sella-nasion planes.

3.3.12 MRA of angle $\overline{I}$:MP (D2) with other variablesTable 29. MRA of D2 with other variables

(a) N = 30; * S1 excluded

Variables	R^2 /S.D.	SS_{reg}/DF_1	SS_{res}/DF_2	F/Sig.
AA	0.000			
+ BI	0.016/6.98	21.8/2	1314.1/27	0.224/0.801
+ MB	0.191/6.45	254.7/3	1081.1/26	2.04/0.133
+ D1-D8	0.692/4.66	924.0/10	411.9/19	4.26/0.003
+ S1-S7	0.791/4.64	1056.1/16	279.8/13	3.07/0.024

(b) N = 30; k = 16

Variable	R^2 change	B	S.E. of B	F/Sig.
D6	0.198	0.727	0.364	3.98/0.067
MB	0.174	-3.11	0.380	0.669/0.428
D8	0.113	0.517	0.277	3.47/0.085
Constant		68.5	76.9	0.792/0.390

The variables included in this regression equation as determinants of variable D2 (angle between lower incisors and mandibular plane) have a satisfactory coefficient of determination ($R^2 = 0.791$), and the overall test of goodness of fit of the equation is significant at 0.05 level.

Results also show that the variability of D2 cannot be explained by the nasopharyngeal size (AA) plus nasal patency (BI) because of the low value of R^2 (0.016). Mode of breathing (MB), however, plays a relevant role, increasing the value of R^2 from 0.016 to 0.191. It also indicates that incidence of mouth breathing increases as the angle between lower incisors and mandibular plane increases. Also, there is a direct relationship between D6 (lower arch length) and D8 (Angle's classification of molar relationship) with variable D2.

It can therefore be inferred that proclination of lower incisors is associated with long lower arch, increase in incidence of Class I molar relationship, and decrease incidence of mouth breathing.

3.3.13 MRA of angle OP:SN (D3) with other variablesTable 30. MRA of D3 with other variables

(a) N = 30; ** S2 excluded

Variables	R^2 /S.D.	SS_{reg}/DF_1	SS_{res}/DF_2	F/Sig.
AA	0.023			
+ BI	0.058/4.42	32.1/2	526.3/27	0.824/0.449
+ MB	0.063/4.49	35.0/3	523.5/26	0.579/0.634
+ D1-D8	0.449/4.02	250.8/10	307.7/19	1.55/0.198
+ S1-S7	0.977/0.984	545.9/16	12.6/13	35.2/0.000

(b) N = 30; k = 16

Variable	R^2 change	B	S.E. of B	F/Sig.
D1	0.226	-0.828E-01	0.355E-01	5.43/0.037
S4	0.207	0.962	0.881	119.2/0.000
S6	0.182	0.265E-01	0.120	0.486E-01/0.829
Constant		5.70	16.7	0.116/0.739

Though the value of R^2 (0.977) gives a very satisfactory explanation of the variability of the angle of occlusal plane to sella-nasion plane (D3), there is almost negligible attribution by the size of nasopharyngeal space ($R^2 = 0.023$), nasal patency ($R^2 = 0.058$), and the mode of breathing ($R^2 = 0.063$) taken together. The chief determinants are dentition and skeleton variables, giving the overall goodness of fit of the equation significant at 0.000 level.

The variable displaying the strongest relationship with D3 is the angle between upper incisors and sella-nasion plane (D1), but being inversely proportional. On the other hand, the angle between mandibular plane and SN plane (S4) and the face index (S6) are directly proportional to D3. The regression coefficients of D1 and S4 (B's) are highly significant (significance = 0.037 and 0.000).

It can be concluded that in subjects with high angles between occlusal and SN planes, they also show retroclination of upper incisors, high angle between mandibular and SN planes, and high face index.

3.3.14 MRA of angle OP:MP (D4) with other variables

Table 31. MRA of D4 with other variables

(a) N = 30; ** S2 excluded

Variables	R^2 /S.D.	SS_{reg}/DF_1	SS_{res}/DF_2	F/Sig.
AA	0.224			
+ BI	0.294/3.90	170.6/2	409.9/27	5.62/0.009
+ MB	0.303/3.94	176.0/3	404.5/26	3.77/0.023
+ D1-D8	0.564/3.65	327.2/10	253.3/19	2.45/0.044
+ S1-S7	0.976/1.04	566.5/16	14.0/13	32.8/0.000

(b) N = 30; k = 16

Variable	R^2 change	B	S.E. of B	F/Sig.
AA	0.224	-0.172E-01	0.203	0.715E-02/0.934
S4	0.133	0.984	0.117	71.3/0.000
D2	0.130	-0.417	0.610E-01	0.467/0.506
Constant		9.11	17.6	0.269/0.613

The variables included in this regression equation as determinants of variable D4 (the angle of occlusal plane to mandibular plane) have a satisfactory coefficient of determination ($R^2 = 0.976$), and the overall test of goodness of fit of the equation is significant at 0.000 level.

The strongest relationship is displayed by (AA) nasopharyngeal size in an inverse fashion, but with a low confidence limit (significance = 0.934). The next two strong relationships are exhibited by S4 (the angle between mandibular plane and sell-nasion plane), and D2 (the inclination of lower incisors to mandibular plane), with the regression coefficient of S4 being highly significant.

Amongst the variables in the 'Adenoid Facies Path', the size of nasopharyngeal space exhibited the strongest relationship to the angle between occlusal plane and mandibular plane, followed by other dento-facial variables.

3.3.15 MRA of maxillary molar width (D5) with other variables

Table 32. MRA of D5 with other variables

(a) N = 30; * S1 excluded

Variables	R^2 /S.D.	SS_{reg}/DF_1	SS_{res}/DF_2	F/Sig.
AA	0.003			
+ BI	0.010/2.94	2.47/2	234.0/27	0.143/0.868
+ MB	0.021/2.98	5.06/3	231.4/26	0.189/0.903
+ D1-D8	0.305/2.94	72.0/10	164.4/19	0.832/0.605
+ S1-S7	0.582/2.76	137.6/16	98.8/13	1.13/0.416

(b) N = 30; k = 16

Variable	R^2 change	B	S.E. of B	F/Sig.
S6	0.245	-0.422	0.317	1.77/0.206
D4	0.103	-0.846	0.698	1.47/0.247
Constant		75.6	42.2	3.22/0.096

Negligible contribution by the size of nasopharyngeal space (AA), nasal patency (BI), and mode of breathing (MB) to the variability of upper arch width at first molars region (D5) is observed ($R^2 = 0.021$). The total coefficient of determination, however, is satisfactory ($R^2 = 0.582$) though the test of goodness of fit of this regression equation is significant at 0.416 level only.

The variables showing the strongest relationship with variable D5 are S6 (face index), and D4 (the angle between occlusal plane and mandibular plane), both of which relate inversely with D4.

It is therefore evident that maxillary arch width bears no association with mouth breathing, nasal obstruction, or diminished nasopharyngeal airway. This is contrary to the notion held by some authors (Bowen and Balyeat 1934; Subtelny 1954). The chief determinants of this variable are skeleton and dentition variables.

3.3.16 MRA of mandibular arch length (D6) with other variables

Table 33. MRA of D6 with other variables

(a) N = 30; ** S2 excluded

Variables	R^2 /S.D.	SS_{reg}/DF_1	SS_{res}/DF_2	F/Sig.
AA	0.006			
+ BI	0.032/3.08	8.58/2	256.2/27	0.452/0.641
+ MB	0.144/2.95	38.2/3	226.7/26	1.46/0.249
+ D1-D8	0.447/2.78	118.5/10	146.4/19	1.54/0.201
+ S1-S7	0.531/3.09	140.8/16	124.1/13	0.922/0.568

(b) N = 30; k = 16

Variable	R^2 change	B	S.E. of B	F/Sig.
D2	0.220	0.323	0.162	3.98/0.067
MB	0.112	-0.101	0.258	0.153/0.702
Constant		-74.2	48.6	2.33/0.151

The variables included in this regression equation as determinants of variable D6 (mandibular arch length) have a satisfactory coefficient of determination ($R^2 = 0.531$) with an overall significance of 0.568.

Although the variability of D6 cannot be explained by the size of nasopharyngeal space (AA) and nasal patency (BI) together, the mode of breathing (MB) shows a moderate R^2 change of 0.112. It also relates inversely with variable D6, indicating that a long mandibular arch length is accompanied by incidence of mouth breathing in the present sample, opposing the concept held by Linder-Aronson (1970) and others.

The strongest association, however, is shown by variable D2 (inclination of lower incisors to mandibular plane), inferring a long mandibular arch length coexisting with proclined lower incisors.

From this analysis, one can conclude that a long mandibular arch length is concurrent with mouth breathing and proclined lower incisors, with skeleton variables playing only a minor part.

3.3.17 MRA of cross-bite (D7) with other variables

Table 34. MRA of D7 with other variables

(a) N = 30; * S1 excluded

Variables	R^2 /S.D.	SS_{reg}/DF_1	SS_{res}/DF_2	F/Sig.
AA	0.000			
+ BI	0.001/0.446	0.006/2	5.36/27	0.015/0.985
+ MB	0.176/0.412	0.947/3	4.42/26	1.86/0.162
+ D1-D8	0.381/0.418	2.05/10	3.32/19	1.17/0.367
+ S1-S7	0.598/0.410	3.18/16	2.18/13	1.18/0.384

(b) N = 30; k = 16

Variable	R^2 change	B	S.E. of B	F/Sig.
MB	0.175	0.601E-01	0.302E-01	3.97/0.068
S3	0.137	-0.700E-01	0.412E-01	2.89/0.113
Constant		3.73	6.92	0.290/0.599

The variables included in this regression equation as determinants of variable D7 (cross-bite of first molars) have a satisfactory coefficient of determination ($R^2 = 0.593$), though the overall test of goodness of fit of the equation is significant only at 0.384 level.

It is interesting, however, that both the size of nasopharyngeal space (AA) and nasal patency (BI) give almost nil explanation of the variability of D7. The mode of breathing (MB), on the other hand, relates positively with this variable, indicating an increase in incidence of cross-bite with nasal breathing, thus refuting the contention of many authors (Neivert 1939; Linder-Aronson 1970).

There is also an inverse relationship shown between cross-bite and angle ANB (S3), inferring a tendence towards Class III jaw relationship in individuals having cross-bites.

To conclude, this analysis does not lend support to the theory of association between mouth breathing and cross-bite, the latter being negatively related to angle ANB.

3.3.18 MRA of Angle's molar classification (D8) with other variables

Table 35. MRA of D8 with other variables

(a) N = 30; * S1 excluded

Variables	R^2 /S.D.	SS_{reg}/DF_1	SS_{res}/DF_2	F/Sig.
AA	0.042			
+ BI	0.080/4.32	43.6/2	503.9/27	1.17/0.326
+ MB	0.162/4.20	88.7/3	458.9/26	1.67/0.197
+ D1-D7	0.426/4.07	233.0/10	314.5/19	1.41/0.250
+ S1-S7	0.596/4.12	326.5/16	221.0/13	1.20/0.374

Although the variables included in this regression equation as determinants of variable D8 (Angle's classification of molar relationship) give a satisfactory coefficient of determination ($R^2 = 0.596$), no single variable exhibits a relevant R^2 change of higher than 0.100.

Results from this analysis would seem to refute the idea of some authors (Emslie, Massler and Zwemer 1952; Mergen and Jacobs 1970) in ascribing an association between distoclusion and small nasopharyngeal space or mouth breathing.

It can be concluded, therefore, that the antero-posterior relationship of molars is independent of any of the variables in the 'Adenoid Facies Path'.

3.3.19 Summary

Even when the size of the nasopharyngeal space, nasal patency, and mode of breathing are taken together, they do not adequately explain the variabilities of the dentofacial characteristics of 'adenoid facies' which were found to be determined by skeleton and dentition manifestations.

Section VIII

Summary

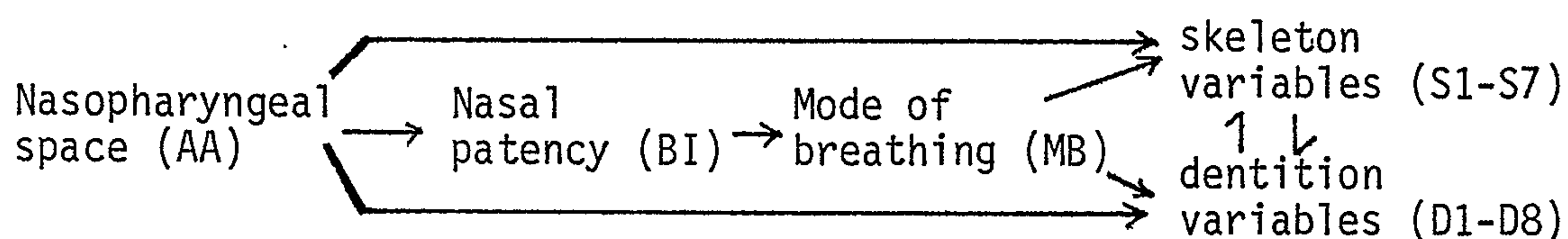
SECTION VIII: SUMMARY

The aim of the present investigation was to establish a valid cephalometric quantity representing the dimensions of nasopharyngeal space, and to relate this measurement with nasal patency, mode of breathing, and dentofacial anomalies believed to associate with 'adenoid facies'.

Using subjects selected from a private radiology clinic, a standardised method to evaluate the actual volume of the nasopharyngeal space with the aid of Computed Tomography was devised. This method was then applied to fifteen subjects of the same group to obtain scan-based volume determinations of the nasopharyngeal space.

Also, various radiographic nasopharyngeal quantifications obtained from tracings of lateral skull radiographs of the same sample were tested accordingly. A cephalometric quantity showing the highest statistical correlation to scan-based volume determinations was chosen as a valid indicator of actual nasopharyngeal space.

A number of variables known or believed to take part in the cause-effect relationship of adenoids and 'adenoid facies' were assembled and defined to become linkages of the 'Adenoid Facies Path':



A second group of subjects, comprising of thirty patients selected from the Orthodontic Department of United Dental Hospital, Sydney, were available for the subsequent test, and data were obtained accordingly.

Measurements for nasopharyngeal space, skeleton variables and dentition variables were derived from cephalometric lateral radiographs and study models taken concurrently. Nasal patency, expressed as 'Blockage Index' was evaluated using a mini Wright Peak Flow Meter. The respective

mode of breathing was recorded clinically at the time of examination.

Simple correlation analyses of the data revealed a significant negative relationship between the size of nasopharyngeal space and the steepness of mandible, as well as the inclination of occlusal plane. A decrease of nasal patency was also found to relate with mouth breathing and cross-bite of molars. Other dentofacial variables seemed to be affected mainly by craniofacial morphological conditions rather than factors associated with airway patency.

Multiple regression analyses of the dimensions of nasopharyngeal space and various dentofacial anomalies connected with 'adenoid facies' did not display any substantial relationship as such. An inverse proportion, however, is noted between the steepness of mandible and nasopharyngeal size. On the other hand, the height of palatal vault was found to correlate positively with nasopharyngeal space, contrary to the innovation of events leading to 'adenoid facies'.

Multiple regression analysis was then applied to each of the variables in turn, aiming to disclose the strength of relationships in the 'Adenoid Facies Path', if any. Again, the nasopharyngeal variable, nasal patency variable, and mode of breathing variable did not play a crucial role in explaining the variability of dentofacial variables in the multitude of regression equations so produced.

Special characteristics of dentofacial morphology associated with 'adenoid facies' were not proven by this investigation to display substantial relationships with nasopharyngeal conditions.

Because of the limited facilities and time, larger samples of a younger age group in the determination of a reliable cephalometric indicator using Computed Tomography was not possible. It is felt that this was a major part to be improved upon in further studies, though the hazard of radiation exposure renders it unjustifiable. Besides, investigations regarding the cause-effect relationship of adenoids and 'adenoid facies' necessitate a larger sample comprising of control and experimental groups on a longitudinal basis if the hypotheses are to be properly tested.

Section IX

Conclusions

SECTION IX: CONCLUSIONS

1. The method described in this study using a combination of serial computed tomograms and a lateral skull radiograph provides a reproducible and accurate means of evaluating the volume of nasopharyngeal space.
2. While the configuration of the nasopharyngeal space appeared irregular and sometimes extending laterally beyond the lateral pterygoid plates, the volume fell within the range of 11.0 c.c. to 33.7 c.c.
3. Of the numerous radiographic nasopharyngeal quantifications tested, the areal measurement of the mid-sagittal nasopharyngeal space on a lateral skull radiograph is a valid indicator of the actual capacity.
4. Other quantities of moderate validities are:
 - (a) Distance from pterygomaxillare to adenoids on the line PMF-Ba.
 - (b) Distance from PNS to the point of greatest concavity or convexity.
 - (c) The shortest distance between soft palate and posterior pharyngeal wall.
 - (d) The airway area within the triangle PMF-S₀-Ba.
5. In individuals with a diminished nasopharyngeal airway, there is a dorsal rotation of the mandible. This finding supports the conjecture that the posture of the mandible is altered to facilitate mouth breathing when there is a nasopharyngeal blockage.
6. There is, moreover, an inverse association between the degree of nasal patency as measured by the mini Wright Peak Flow Meter and mouth breathing.
7. The mini Wright Peak Flow Meter is therefore recommended as a simple and economical means to assess nasal patency.
8. Incidence of mouth breathing is also found to display a definite negative relationship with posterior dental cross-bite.
9. However, there is no substantial relationship found between the actual nasopharyngeal airway dimensions and certain dentofacial anomalies believed to be connected with 'adenoid facies'.

10. Even when the size of the nasopharyngeal airway, nasal patency, and mode of breathing are considered together, they do not adequately explain the variabilities of the dentofacial characteristics of 'adenoid facies'.
11. Most of the characteristics of the so-called 'adenoid facies' are found to be determined by skeleton and dentition manifestations.
12. Results from this investigation therefore direct the notion that 'adenoid facies' is a type of natural physiognomy related to hereditary factors rather than a product of airway dysfunction.

Section X

Appendix

SECTION X: APPENDIX

1. RESULTS OF ANALYSES

- 1.1 Scattergrams of Y with X1-X15. See Figs. 81-95 (pages 210-224).
 1.2 Correlation coefficient matrix of variables used in 'Adenoid Facies Path'. See Table 36 (page 225).

2. STATISTICAL NOTATIONS

The statistical terms and formulae used in this study are taken from McClymont (1975), Nie et al (1975), and Duncan, Knapp and Miller (1977).

2.1 MEAN

The mean ($\bar{x}$) of a set of observations of x is expressed by:

$$\bar{x} = \frac{\sum x}{N} ; \quad \text{where}$$

$\sum$ = the sum of

x = variate or individual observations

N = number of observations.

2.2 STANDARD DEVIATION

The standard deviation in small samples (S.D.), using Bessel's correction, is expressed by:

$$S.D. = \sqrt{\frac{(x - \bar{x})^2}{N - 1}}$$

The standard deviation of estimate in a regression equation, however, is best expressed by the following:

$$S.D. = \sqrt{\frac{SS_{res}}{N-k-1}} = \sqrt{\text{Mean Square}_{res}} ; \quad \text{where}$$

SS_{res} = residual sum of squares

k = number of variables in the regression equation

N = sample size.

The standard deviation of the mean difference in a double determination is also expressed as:

$$S.D. = \sqrt{\frac{\sum (d - \bar{d})^2}{N - 1}} = \sqrt{\left(\frac{\sum d^2}{N} - \bar{d}^2\right) \times \left(\frac{N}{N - 1}\right)} ; \text{ where}$$

$\bar{d} = \frac{\sum d}{N}$ = the mean of the differences in a sample N,

$\sum d$ = sum of the differences.

2.3 "t" VALUES

t represents the simplified formula for the two sample student's t-test, designed to test the mean difference between two samples of equal number and common variance. It is a test of whether differences are significantly different from zero.

$$t = \frac{\bar{d}}{SE_{\bar{d}}} = \frac{\bar{d}}{S.D. / \sqrt{N}} ; \text{ where}$$

$SE_{\bar{d}}$ = standard error of the mean difference,

$\bar{d}$, S.D., and N are defined as above. The value of t is entered at N-1 degrees of freedom in the table for t distribution.

2.4 VARIANCE

The variance of a sample is a measure of the variability, or lack of homogeneity, in a variable, and represents the average of the squared deviation:

$$\text{Variance} = S.D.^2 = \frac{\sum (x - \bar{x})^2}{N - 1} .$$

3. RAW DATA

3.1 Data obtained for selection of a reliable cephalometric nasopharyngeal quantity. See Table 37 (page 226).

3.2 Data of variables in the test for 'Adenoid Facies Path'. See Table 38 (pages 227-228).

FILE SKULL (CREATION DATE = 80/08/88.) ANALYSIS OF SKULL MEASUREMENTS

SCATTERGRAM OF (DOWN) Y ACTUAL NASOPHARYNGEAL VOLUME
(ACROSS) X1

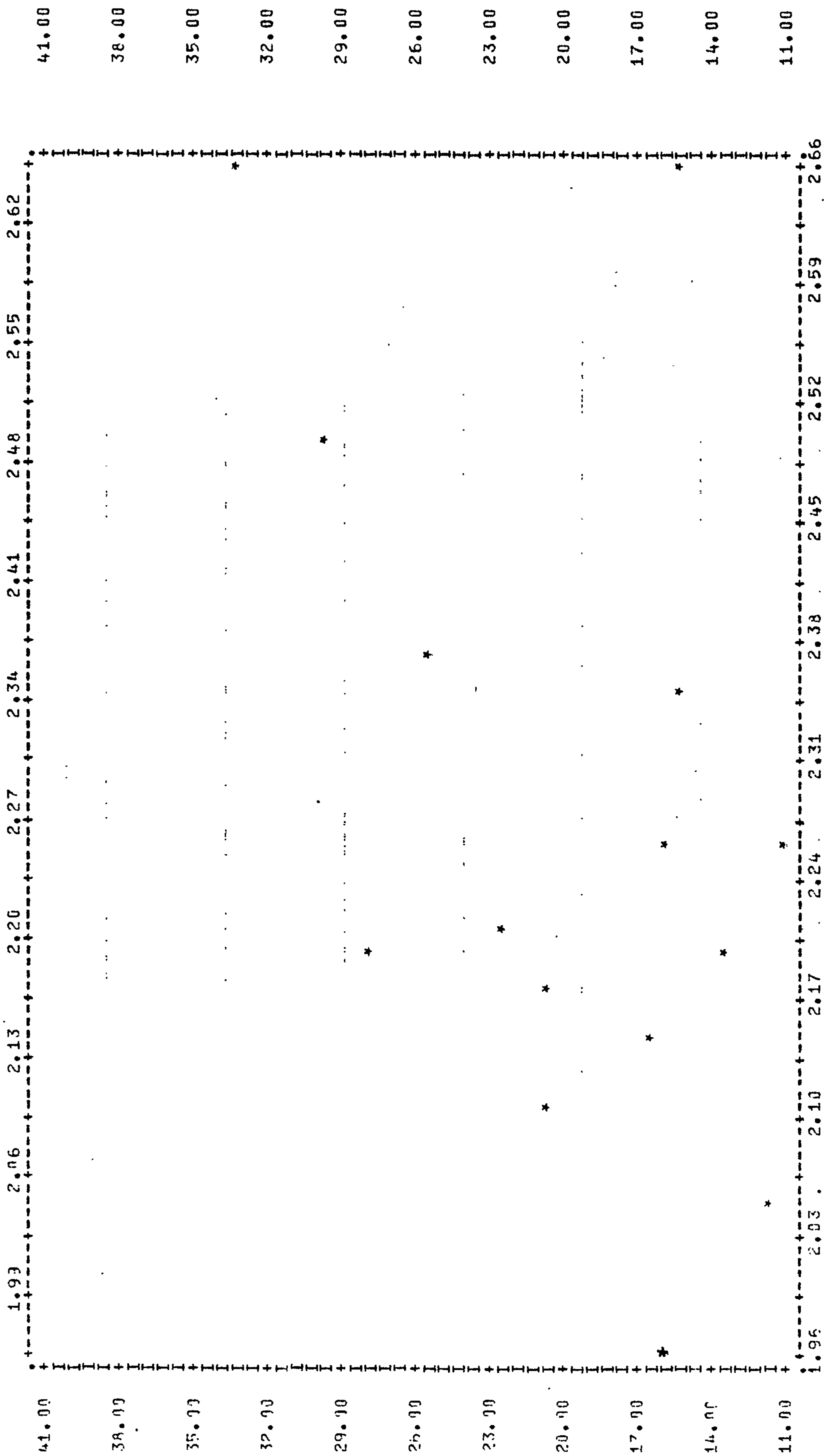
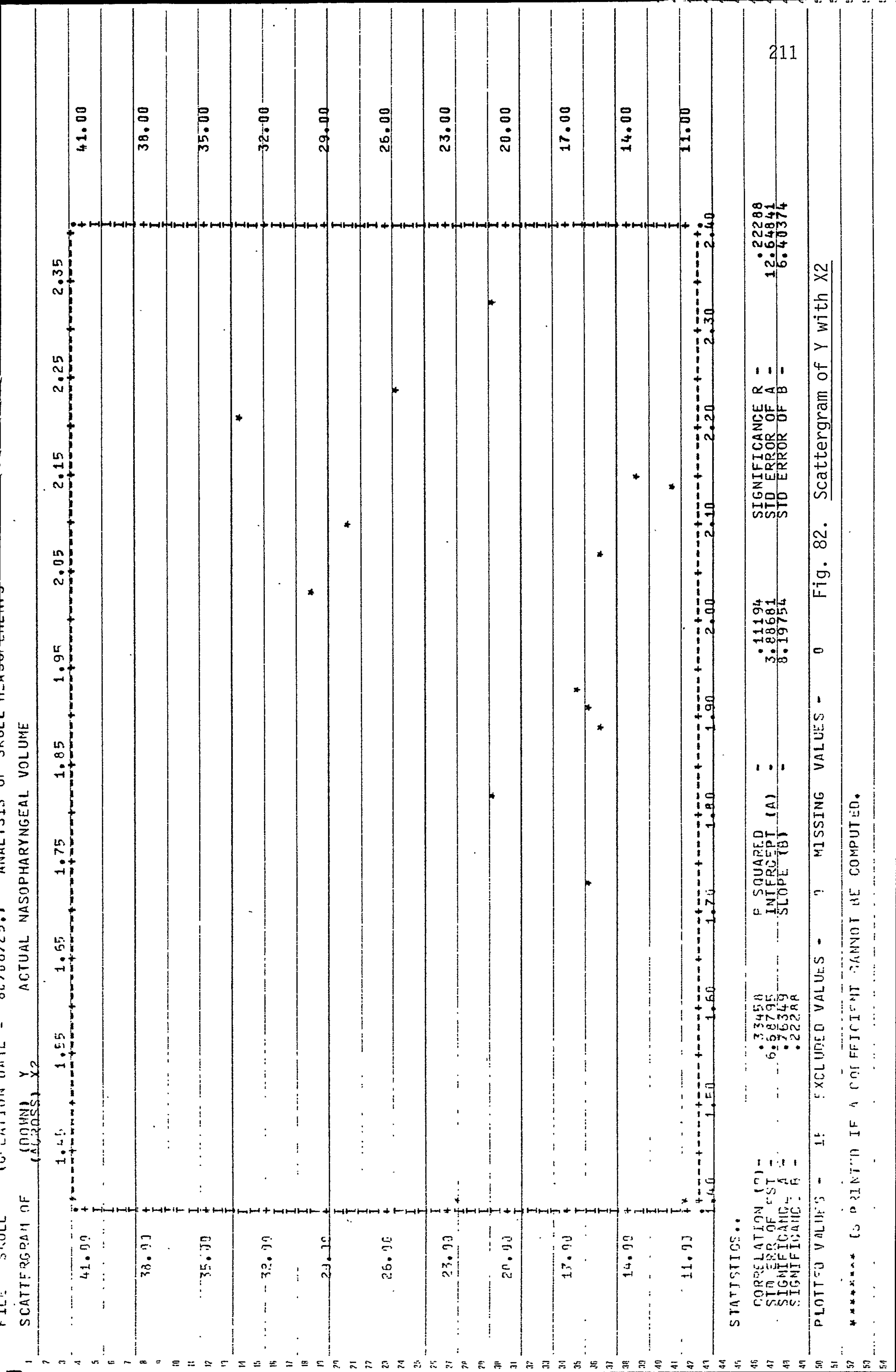


Fig. 81. Scattergram of Y with X1

STATISTICS..

CORRELATION (R) =	R SQUARED	SIGNIFICANCE R =
0.45911	0.21078	0.8515
STD ERR OF EST =	INTERCEPT (A) =	STD ERROR OF A =
6.30479	-15.18087	18.91142
SIGNIFICANCE A =	SLOPE (B) =	STD ERROR OF B =
0.43656	15.43415	8.283.7
SIGNIFICANCE B =		
0.08516		



SCATTERGRAM OF (DOWN) Y ACTUAL NASOPHARYNGEAL VOLUME
(ACROSS) X3

41.00	.96	1.09	1.22	1.35	1.48	1.61	1.74	1.87	2.00	2.13	41.00
38.00											38.00
35.00											35.00
32.00											32.00
29.00											29.00
26.00											26.00
23.00											23.00
20.00											20.00
17.00											17.00
14.00											14.00
11.00											11.00

STATISTICS..

CORRELATION (R) =	.14390	R SQUARED	.02071	SIGNIFICANCE R =	.60890
STD ERR OF EST =	7.02310	INTERCEPT (A) =	15.43169	STD ERROR OF A =	8.76321
SIGNIFICANCE A =	.10173	SLOPE (B) =	2.91881	STD ERROR OF B =	5.56723
SIGNIFICANCE B =	.60890				

PLOTTED VALUES - 15 EXCLUDED VALUES - 0 MISSING VALUES - 0 Fig. 83. Scattergram of Y with X3

***** IS PRINTED IF A COEFFICIENT CANNOT BE COMPUTED.

SCATTERGRAM OF (DOWN) Y ACTUAL NASOPHARYNGEAL VOLUME

(ACROSS) X4

2.16	2.29	2.42	2.55	2.68	2.81	2.94	3.07	3.20	3.33	
41.00										41.00
38.00										38.00
35.00										35.00
32.00										32.00
29.00										29.00
26.00										26.00
23.00										23.00
20.00										20.00
17.00										17.00
14.00										14.00
11.00										11.00
2.16	2.23	2.36	2.49	2.62	2.75	2.88	3.01	3.14	3.27	3.40

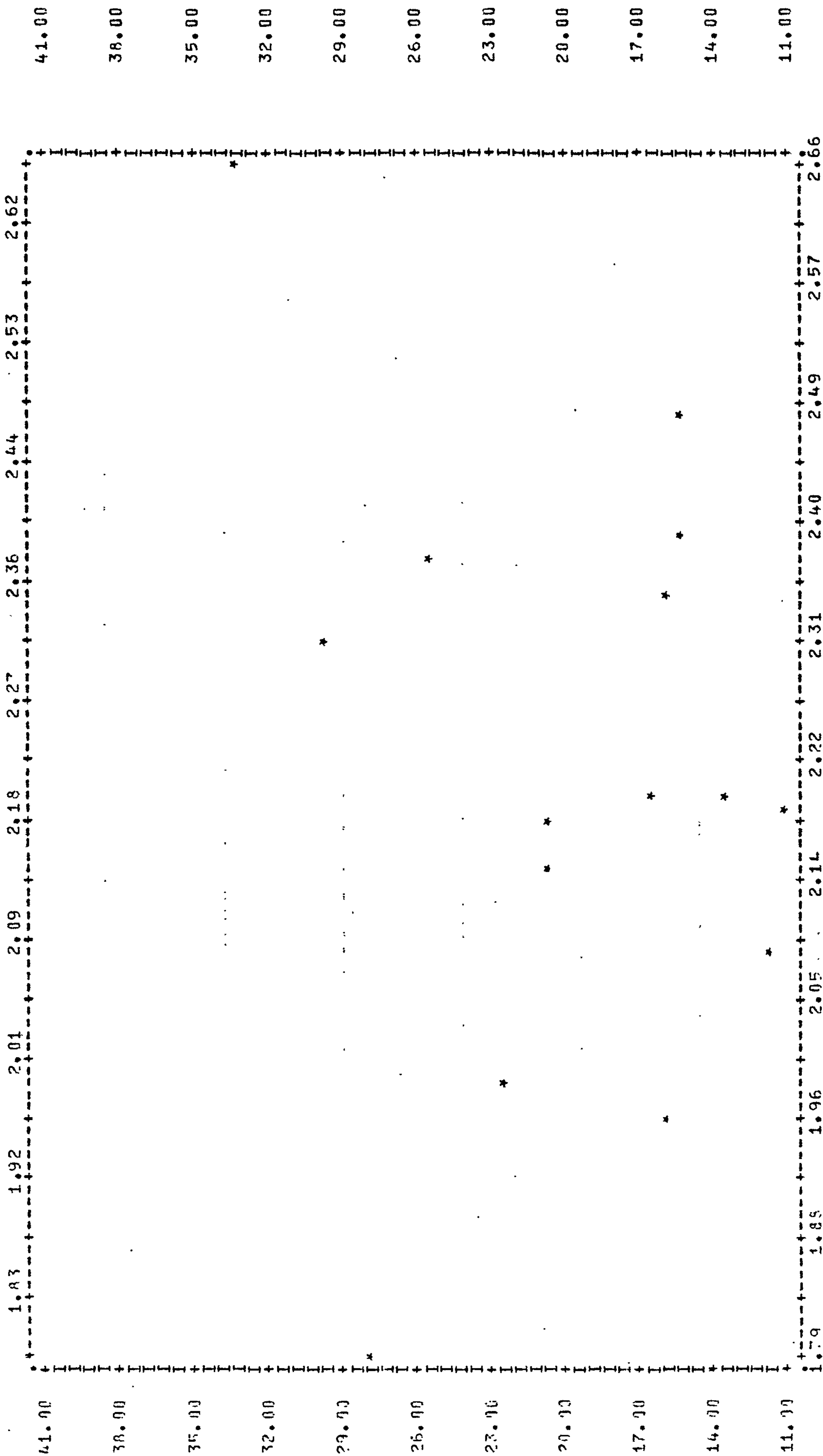
STATISTICS..

CORRELATION (R) -	-.00140	R SQUARED	.00000	SIGNIFICANCE R -	.99605
STD ERR OF EST -	7.69896	INTERCEPT (A) -	19.99999	STD ERROR OF A -	14.63553
SIGNIFICANCE A -	.19294	SLOPE (B) -	-.02888	STD ERROR OF B -	5.71968
SIGNIFICANCE B -	.99605				

PLOTTED VALUES - 15 EXCLUDED VALUES - 0 MISSING VALUES - " Fig. 84. Scattergram of Y with X4

***** IS PRINTED IF A COEFFICIENT CANNOT BE COMPUTED.

SCATTERGRAM OF (DOWN) Y ACTUAL NASOPHARYNGEAL VOLUME



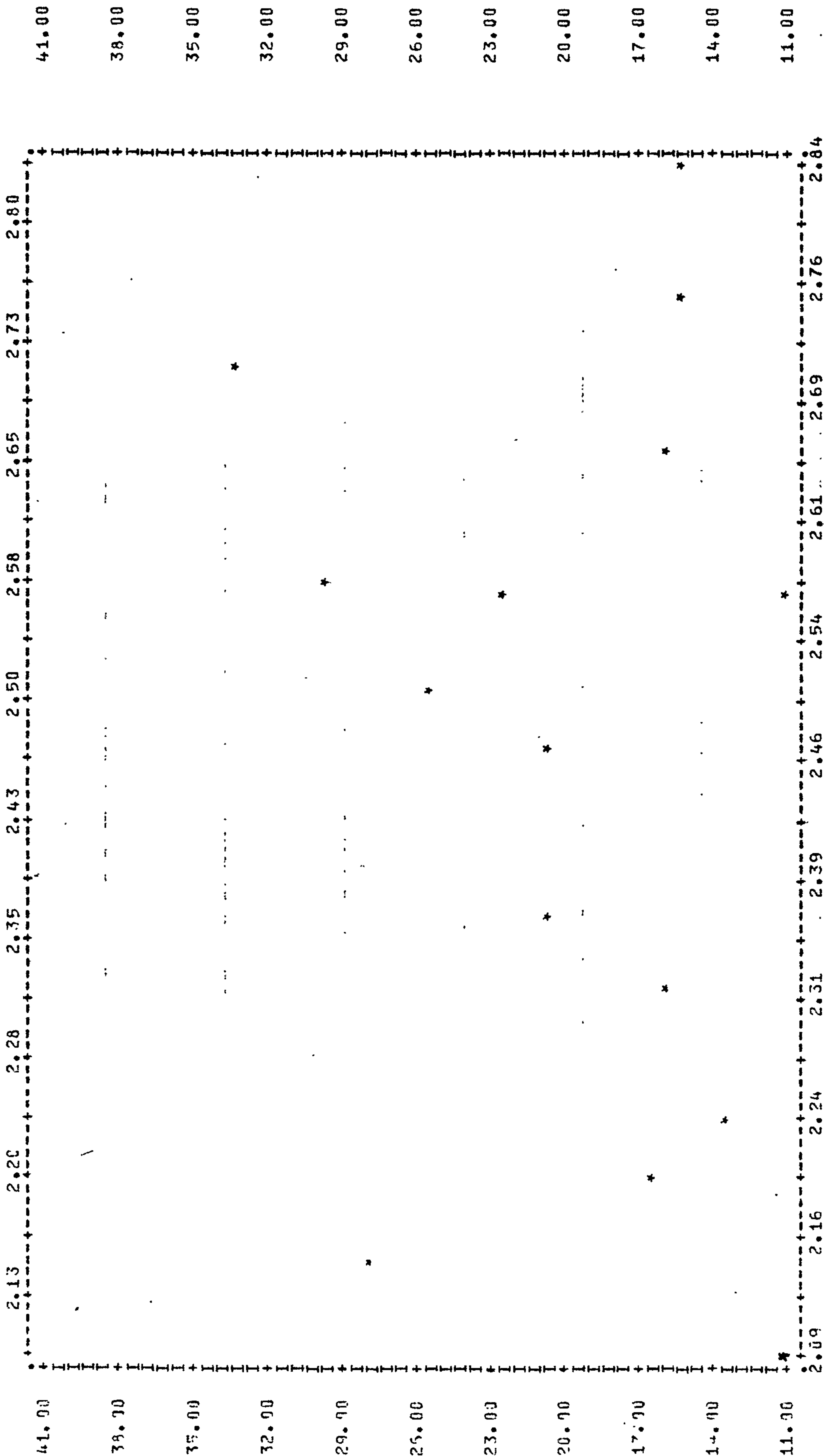
STATISTICS..

CORRELATION (R) -	.17493	R SQUARED	.03060	SIGNIFICANCE R -	.53291
STD. ERROR OF EST.	6.98753	INTERCEPT (A) -	7.76545	STD. ERROR OF A -	19.96958
SIGNIFICANCE A -	.69947	SLOPE (B) -	5.47638	STD. ERROR OF B -	8.54880
SIGNIFICANCE B -	.53291				

PLOTTED VALUES - 15 EXCLUDED VALUES - 0 MISSING VALUES - 0 Fig. 85. Scattergram of Y with X5

***** IS PRINTED IF A COEFFICIENT CANNOT BE COMPUTED.

SCATTERGRAM OF (DOWN) Y (ACROSS) X6 ACTUAL NASOPHARYNGEAL VOLUME



STATISTICS..

CORRELATION (R) -	.02245	SIGNIFICANCE R -	.59402
STD. ERR OF EST -	7.01684	STD. ERROR OF A -	26.04331
SIGNIFICANCE A -	.66012	STD. ERROR OF B -	8.03354
SIGNIFICANCE B -	.59402		

Fig. 86. Scattergram of Y with X6

SCATTERGRAM OF (DOWN) Y ACTUAL NASOPHARYNGEAL VOLUME
(ACROSS) X8

	1.06	1.19	1.32	1.45	1.58	1.71	1.84	1.97	2.10	2.23	
41.00											41.00
38.00											38.00
35.00											35.00
32.00						*					32.00
29.00								*			29.00
26.00							*				26.00
23.00		*									23.00
20.00											20.00
17.00								*			17.00
14.00							*				14.00
11.00									*		11.00
1.00	1.13	1.26	1.39	1.52	1.65	1.78	1.91	2.04	2.17	2.30	

STATISTICS..

CORRELATION (R) -	.23105	R SQUARED	.05339	SIGNIFICANCE R -	.40737
STD ERR OF EST -	6.90493	INTERCEPT (A) -	12.65249	STD ERROR OF A -	8.68050
SIGNIFICANCE A -	.16869	SLOPE (B)	4.21284	STD ERROR OF B -	4.92014
SIGNIFICANCE B -	.40737				

PLOTTED VALUES - 15 EXCLUDED VALUES - 0 MISSING VALUES - 0 Fig. 88. Scattergram of Y with X8

***** IS PRINTED IF A COEFFICIENT CANNOT BE COMPUTED.

[illegible]

[illegible]

FILE	SCATTERGRAM OF	(DOWN) Y	ACTUAL NASOPHARYNGEAL VOLUME	1.38	1.53	1.68	1.83	1.98	2.13	2.28	2.43	2.58	2.73	41.00
1														
2														
3														
4														41.00
5														
6														
7														
8														38.00
9														
10														
11														
12														35.00
13														
14														
15														32.00
16														
17														
18														
19														29.00
20														
21														
22														
23														26.00
24														
25														
26														23.00
27														
28														
29														
30														20.00
31														
32														
33														
34														17.00
35														
36														
37														
38														14.00
39														
40														
41														11.00
42														
43														
44														
45														
46														
47														
48														
49														
50														
51														
52														
53														
54														
55														
56														
57														
58														
59														

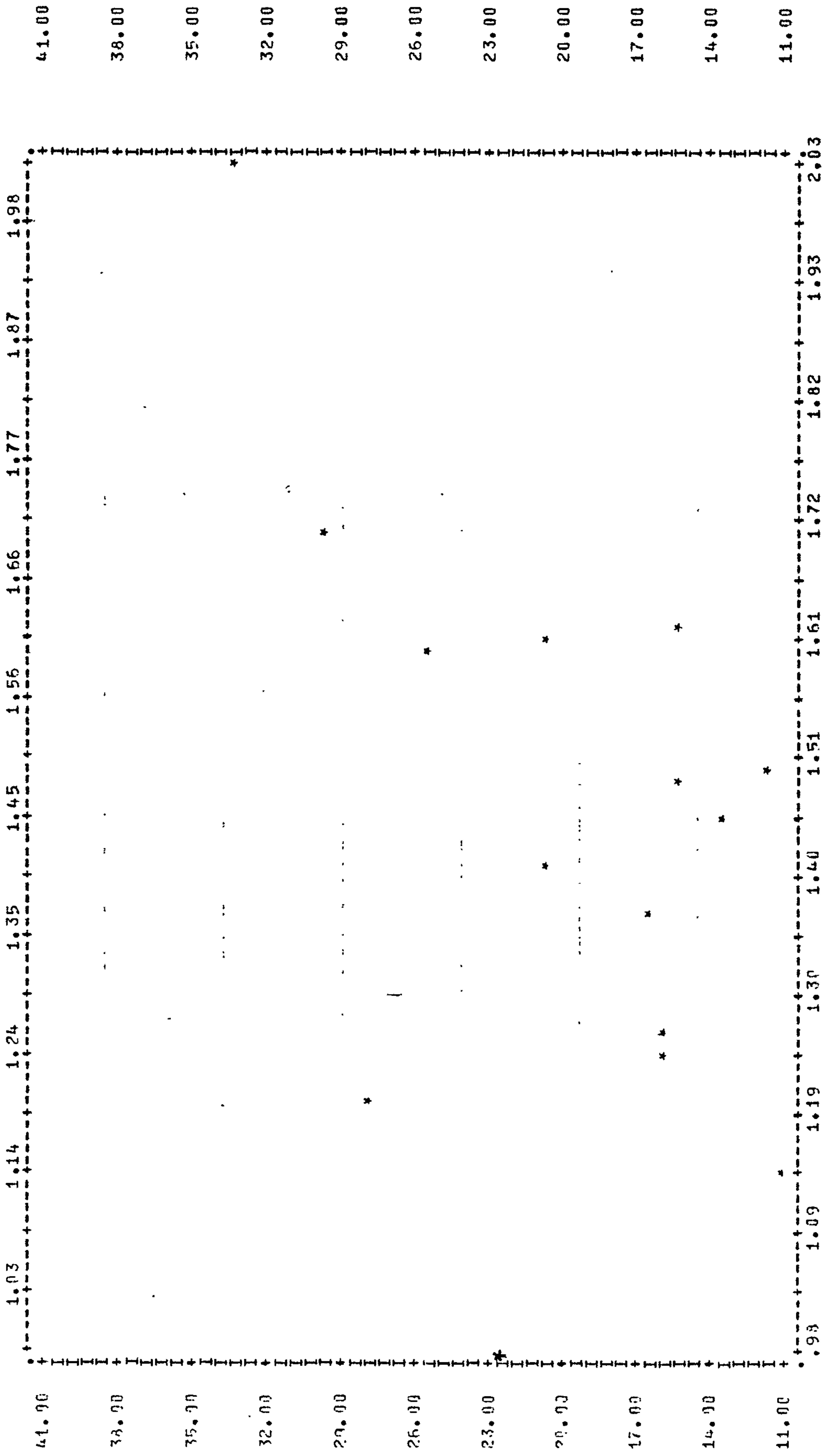
STATISTICS..

CORRELATION (R) = .39738 R SQUARED = .15791 SIGNIFICANCE R = .14245
STD ERR OF EST = 6.21257 INTERCEPT (A) = 5.45563 STD ERROR OF A = 9.41971
SIGNIFICANCE A = .27237 SLOPE (B) = 6.69336 STD ERROR OF B = 4.28696
SIGNIFICANCE B = .14245

PLOTTED VALUES - 15 EXCLUDED VALUES - 0 MISSING VALUES - 0 Fig. 91. Scattergram of Y with X11

***** IS PRINTED IF A COEFFICIENT CANNOT BE COMPUTED.

SCATTERGRAM OF (DOWN) Y (ACROSS) X12 ACTUAL NASOPHARYNGEAL VOLUME



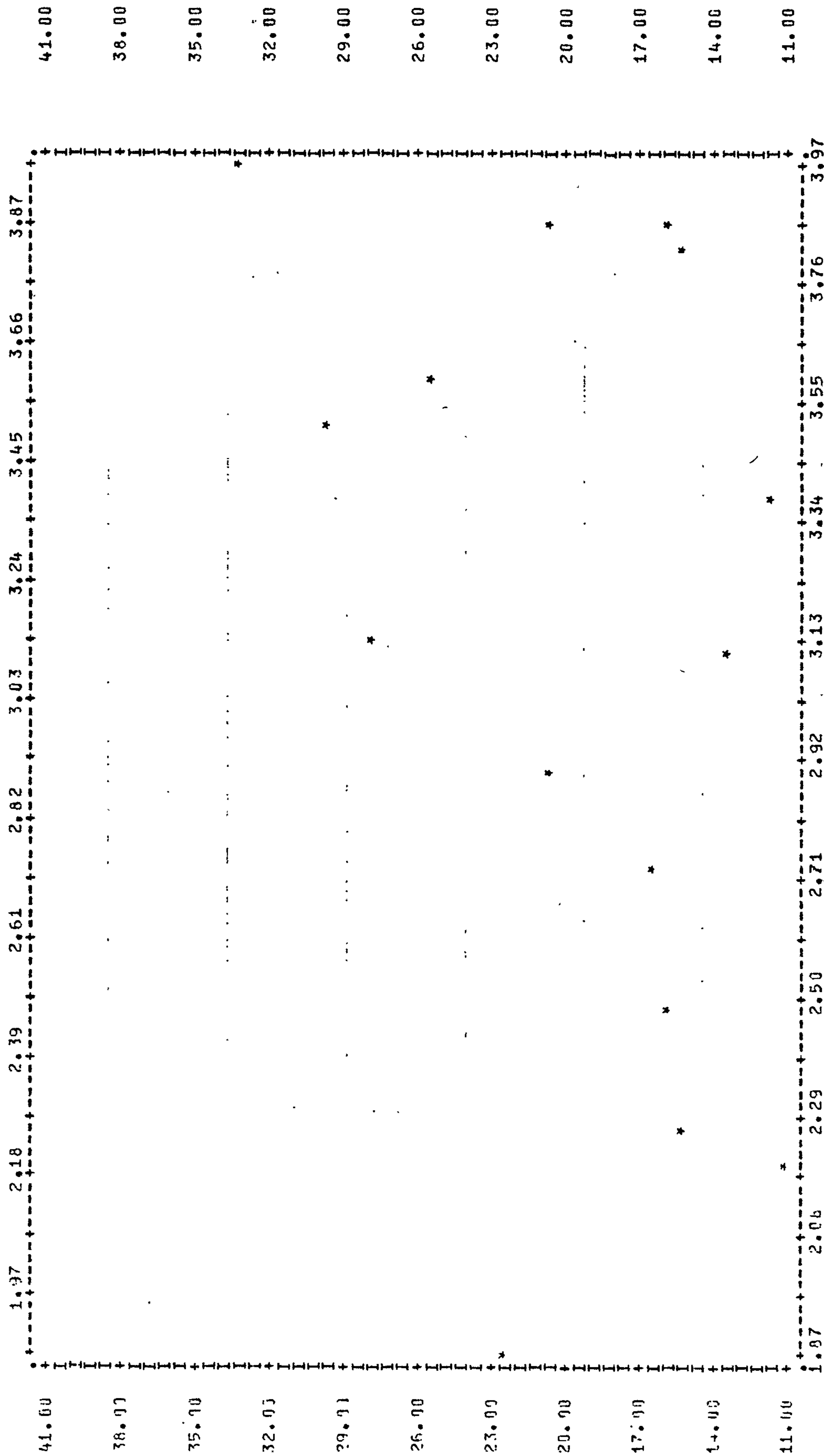
STATISTICS..

Fig. 92. Scattergram of Y with X12

CORRELATION (R) -	.46145	R SQUARED -	.21294	SIGNIFICANCE R -	.03337
STD ERR OF EST -	6.29619	INTERCEPT (A) -	2.44008	STD ERROR OF A -	9.46273
SIGNIFICANCE A -	.80023	SLOPE (B) -	12.15194	STD ERROR OF B -	6.47904
SIGNIFICANCE B -	.08337				

PLOTTED VALUES - 15 EXCLUDED VALUES - 0 MISSING VALUES - 0

SCATTERGRAM OF (DOWN) Y ACTUAL NASOPHARYNGEAL VOLUME (ACROSS) X13



STATISTICS..

CORRELATION (R) =	.35533	R SQUARED	.12626	SIGNIFICANCE R =	.19370
STD ERR OF EST =	6.63382	INTERCEPT (A) =	8.83782	STD ERROR OF A =	8.26975
SIGNIFICANCE A =	.30465	SLOPE (B) =	3.56325	STD ERROR OF B =	2.59975
SIGNIFICANCE B =	.19370				

PLOTTED VALUES - 15 EXCLUDED VALUES - 0 MISSING VALUES - 0

Fig. 93. Scattergram of Y with X13

***** IS PRINTED IF A COEFFICIENT CANNOT BE COMPUTED.

SCATTERGRAM OF (DOWN) Y ACTUAL NASOPHARYNGEAL VOLUME

	2.31	2.54	2.77	3.00	3.23	3.46	3.69	3.92	4.15	4.38	
41.00											41.00
38.00											38.00
35.00											35.00
32.00											32.00
29.00											29.00
26.00											26.00
23.00											23.00
20.00											20.00
17.00											17.00
14.00											14.00
11.00											11.00
2.20	2.47	2.66	2.83	3.02	3.25	3.58	3.81	4.04	4.27	4.50	

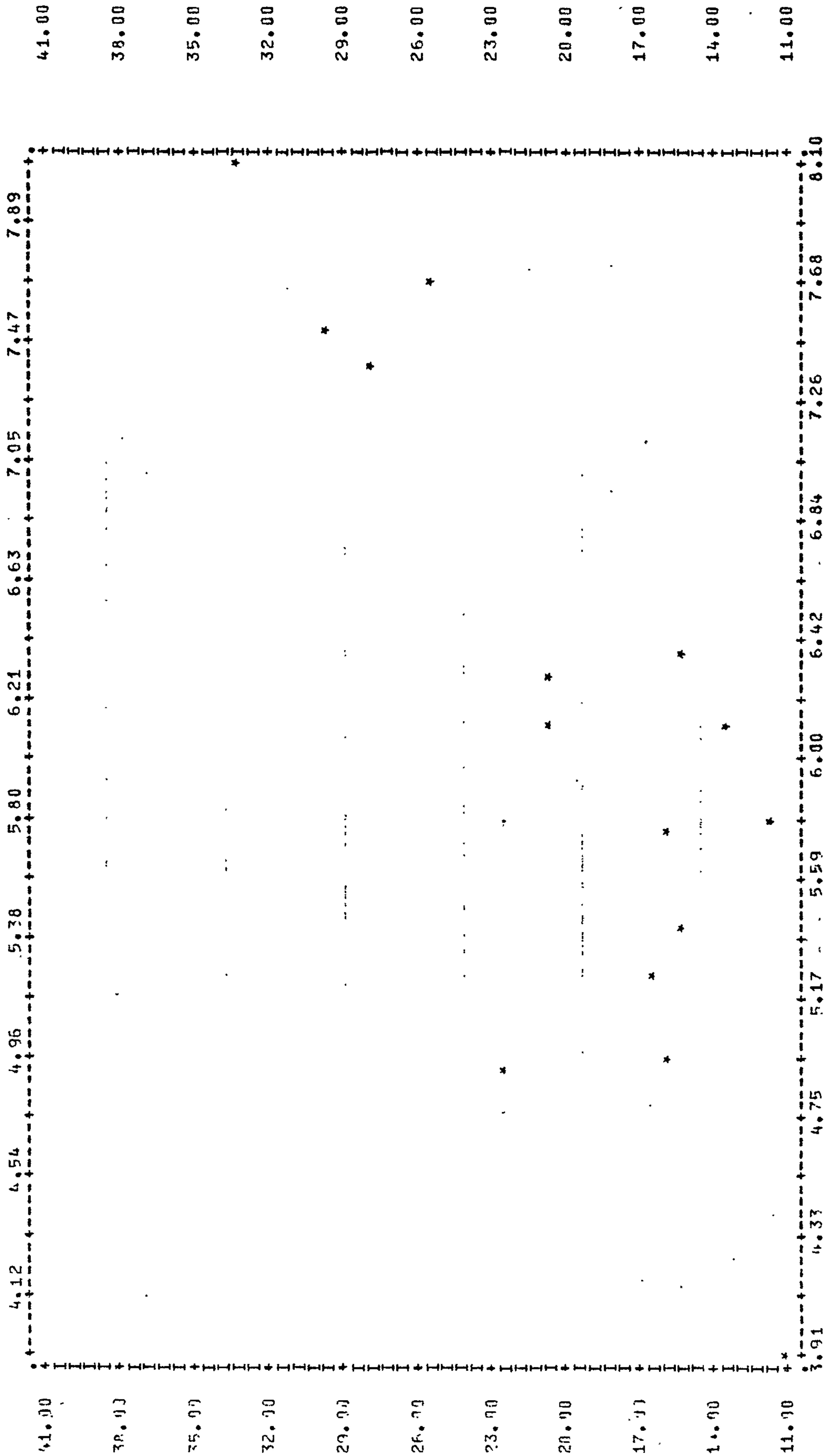
STATISTICS..

CORRELATION (R) =	.37120	R SQUARED	.13779	SIGNIFICANCE R =	.17313
STD ERR OF EST =	6.58989	INTERCEPT (A) =	8.25166	STD ERROR OF A =	8.27667
SIGNIFICANCE A =	.33587	SLOPE (B)	3.32558	STD ERROR OF B =	2.30722
SIGNIFICANCE R =	.17313				

PLOTTED VALUES - 15 EXCLUDED VALUES - 0 MISSING VALUES - 0 Fig. 94. Scattergram of Y with X14

***** IS PRINTED IF A COEFFICIENT CANNOT BE COMPUTED.

SCATTERGRAM OF (DOWN) Y (ACROSS) X15 ACTUAL NASOPHARYNGEAL VOLUME



STATISTICS..

CORRELATION (R) -	.80269	R SQUARED	.64432	SIGNIFICANCE R -	.00032
STD ERROR OF EST -	4.23236	INTERCEPT (A) -	-8.73262	STD ERROR OF A -	6.00599
SIGNIFICANCE A -	.16966	SLOPE (B) -	4.69414	STD ERROR OF B -	.96731
SIGNIFICANCE B -	.00032				

PLOTTED VALUES - 15 EXCLUDED VALUES - 0 MISSING VALUES - 0 Fig. 95. Scattergram of Y with X15

***** IS PRINTED IF A COEFFICIENT CANNOT BE COMPUTED.

FILE REGR (CREATION DATE = 80/08/08.) DENTAL DATA FOR PREDICTION OF NASOPHARYNGEAL SPACE

***** MULTIPLE REGRESSION *****

VARIABLE	MEAN	STANDARD DEV	CASES
AA	5.7267	1.3726	30
AB	50.3000	18.3670	30
MB	6.1333	4.5644	30
SS	78.8667	4.6406	30
SS	2.2667	3.7873	30
SS	34.6333	2.6773	30
SS	28.7167	5.5219	30
SS	69.1967	5.7378	30
SS	13.1733	3.3263	30
SS	105.4333	2.0974	30
SS	187.9333	6.7127	30
SS	14.3667	4.3883	30
SS	129.0000	4.7441	30
SS	45.0567	4.8554	30
SS	27.1900	2.6220	30
SS	3.2333	3.4302	30
SS	3.5000	4.4345	30

CORRELATION COEFFICIENTS.

A VALUE OF 99.0000 IS PRINTED IF A COEFFICIENT CANNOT BE COMPUTED.

	AA	AB	RI	S1	S2	S3	S4	S5	S6	S7	D1
IB	-.3271	-.3910	-.1288	-.7679	-.2556	-.0362	-.7798	-.6076	-.3812	-.0617	-.3255
MB	-.1254	-.3352	-.1288	-.4229	-.4269	-.1802	-.4376	-.2953	-.1187	-.0722	-.4938
SS	-.1933	-.0933	-.1150	-.4002	-.1269	-.3845	-.0516	-.1837	-.2240	-.1505	-.3140
SS	-.1933	-.0719	-.1077	-.3550	-.1491	-.0022	-.0516	-.2679	-.2102	-.2671	-.0409
SS	-.2815	-.1482	-.1616	-.4995	-.2870	-.4820	-.5635	-.1482	-.3345	-.1077	-.1972
SS	-.2055	-.0677	-.1275	-.3203	-.1526	-.0088	-.1966	-.7320	-.2585	-.1109	-.0685
SS	-.1571	-.1974	-.1467	-.1758	-.3776	-.2085	-.6176	-.0959	-.3585	-.1094	-.1972
SS	-.1571	-.1204	-.1546	-.2703	-.1897	-.1396	-.1966	-.0239	-.2585	-.1109	-.0685
SS	-.0755	-.0486	-.1082	-.2541	-.3338	-.1163	-.1260	-.0239	-.2585	-.1109	-.0685
SS	-.0755	-.1519	-.1082	-.4798	-.0983	-.2115	-.0476	-.1017	-.2585	-.1109	-.0685
SS	-.2185	-.0322	-.1546	-.0013	-.2843	-.4002	-.0952	-.0432	-.1022	-.0968	-.2705

	D3	D4	D5	D6	D7
B3	-.2185	-.2788	-.0952	-.1466	-.0645
D4	-.2890	-.0610	-.2779	-.0710	-.0645
D5	-.0831	-.2326	-.2779	-.1466	-.0645
D6	-.5779	-.0358	-.1366	-.0710	-.0645
D7	-.1533	-.1835	-.1366	-.0710	-.0645
D8	-.1605	-.1835	-.1366	-.0710	-.0645

Table 36. Correlation Coefficient Matrix of variables in 'Adenoid Facies Path'

N Subject No.	Y (Scan-based volume) cm ³	X1 (cm)	X2 (cm)	X3 (cm)	X4 (cm)	X5 (cm)	X6 (cm)	X7 (cm)	X8 (cm)	X9 (cm)	X10 (cm)	X11 (cm ²)	X12 (cm ²)	X13 (cm ²)	X14 (cm ²)	X15 (cm ²)
1	11.0	2.26	1.40	1.13	2.44	2.19	2.57	1.85	1.22	2.17	0.27	1.47	1.14	2.20	2.36	3.91
2	12.1	2.05	2.14	1.96	2.23	2.09	2.09	2.41	2.09	2.32	0.46	2.40	1.49	3.39	3.89	5.80
3	13.9	2.20	2.15	1.75	2.69	2.20	2.24	2.42	1.88	2.38	0.45	2.33	1.45	3.10	3.94	6.12
4	15.3	2.66	1.89	1.26	3.33	2.39	2.84	2.21	1.17	2.07	0.90	2.27	1.62	2.27	2.43	5.43
5	15.4	2.35	2.07	1.47	2.58	2.48	2.76	2.67	1.84	2.53	0.64	2.24	1.48	3.82	3.91	6.39
6	16.2	1.96	1.73	1.50	2.23	1.96	2.32	2.23	1.46	2.32	0.64	1.90	1.24	2.48	2.65	4.97
7	16.3	2.26	1.91	1.60	2.44	2.35	2.66	2.58	2.13	2.62	0.27	2.05	1.26	3.87	4.26	5.76
8	16.9	2.15	1.93	1.17	2.51	2.20	2.20	2.38	1.52	2.24	0.58	1.93	1.37	2.73	3.30	5.23
9	20.7	2.11	2.33	2.11	2.20	2.15	2.47	2.56	2.24	2.33	0.76	2.66	1.61	3.86	4.27	6.12
10	21.2	2.18	1.82	1.41	2.50	2.18	2.37	2.32	1.55	2.05	0.55	1.99	1.41	2.90	3.31	6.29
11	22.5	2.21	1.40	0.95	3.07	1.99	2.57	2.21	1.08	1.76	0.32	1.30	0.978	1.87	2.28	4.90
12	25.6	2.37	2.24	1.79	2.55	2.37	2.51	2.37	1.88	2.37	0.76	2.56	1.60	3.60	4.50	7.69
13	28.0	2.20	2.10	2.01	2.19	1.79	2.15	2.42	2.15	2.15	0.67	2.16	1.20	3.12	3.36	7.37
14	30.1	2.50	2.03	1.50	2.28	2.31	2.58	2.38	1.93	2.05	0.61	2.42	1.70	3.50	3.91	7.50
15	33.7	2.66	2.21	1.49	2.84	2.66	2.71	2.93	1.76	2.93	1.08	2.75	2.03	3.97	4.46	8.10

Table 37 Data for selection of a reliable cephalometric quantity

Subject No.	AA (mm ²)	BI (%)	MB 'nasal : 10 oral : 01 oro- nasal : 00	Skeleton							Dentition							
				S1 (deg)	S2 (deg)	S3 (deg)	S4 (deg)	S5 (deg)	S6 (%)	S7 (mm)	D1 (deg)	D2 (deg)	D3 (deg)	D4 (deg)	D5 (mm)	D6 (mm)	D7 no = 10 yes = 1	D8 Class I : 10 Class II : 01 Class III : 00
1	2.5	54.7	01	74	73	+1	30.5	28	62.4	17.9	105	82	10.5	20	44.6	25.4	0	01
2	2.7	38.4	10	80.5	80.5	0	37.5	37	59.6	18.8	103.5	84.5	16	21	45	28	1	00
3	3.2	68.4	10	74	79	-5	43	38	54.8	22.2	110	76	11.5	31	41.7	23.2	1	10
4	3.6	56.4	10	83	76	+7	43	34	60.5	20.8	104	99	19.5	23.5	41.9	28.9	0	10
5	3.6	43.9	10	82	80	+2	31.5	28	62.9	17.9	115.5	90	11.5	20	42.4	29	1	10
6	4.1	51	00	84.5	84	+0.5	31.5	27.5	54.7	21.7	114.5	96	13.5	17.5	52.7	30.6	0	00
7	4.5	54.5	10	92	89	+3	32.5	35	53.3	15.7	114	81	8	24.5	50.4	26.3	0	10
8	4.6	77.9	01	79	79	0	37	30	58	18.6	102	88	18.5	18	47.9	29	0	01
9	4.8	81.5	00	80.5	75	+5.5	40	27.5	61.8	15.9	93	90	20	20	43.6	26.3	0	01
10	4.8	16.7	00	75	73	+2	40	27	58	21.8	102	95.5	20	20	45.9	29.5	0	01
11	4.9	77.4	00	80	77	+3	39	35	57	21.7	121	90	11	23	48.9	26.7	0	01
12	4.9	69.2	01	78.5	72.5	+6	49	40.5	57.3	22.1	110.5	91	17	31.5	42.7	33.4	0	01
13	4.9	60	10	84	80	+4	37	31	61.9	16.7	107	75	10	27	46.5	17.7	0	01
14	5	18.8	10	81	77	+4	31	28	63	16.7	104	92	11.5	19	43.3	27.4	0	01
15	5.2	34.4	10	78	76	+2	33	23.5	62.7	18.2	92	79	11.5	22	50.7	31.1	0	01
16	5.5	48.5	00	80	78	+2	33.5	26	61.3	19.3	125	96	11	22.5	42.7	28	0	10
17	5.6	12.5	10	82	80	+2	38	30	55.9	17.3	103	88	20.5	16	47.85	28	0	00
18	5.6	52.5	10	83.5	81.5	+2	34	25	61.6	18.7	109	89	15	18.5	46.7	27.2	0	10
19	5.7	46.4	10	85	82	+3	28	15	64.2	16.9	105	98	14	14	47.3	30.5	0	10
20	5.9	62.4	01	89	83	+6	26	23.5	65.3	17.5	121	90	10	16	45.4	28.7	0	01
21	6.2	66.7	01	80	78.5	+1.5	28.5	26.5	63.3	19.9	98.5	90	9	20	46.1	25.3	0	10
22	6.3	65.5	10	79	78	+1	31	25	62.5	18.6	103	88	15.5	16	47.1	23.4	0	10

Table 38 Data for variables in the test for 'Adenoid Facies Path'

Subject No.	AA (mm ²)	BI (%)	MB nasal : 10 oral : 01 oro- nasal : 00	Skeleton							Dentition							
				S1 (deg)	S2 (deg)	S3 (deg)	S4 (deg)	S5 (deg)	S6 (%)	S7 (mm)	D1 (deg)	D2 (deg)	D3 (deg)	D4 (deg)	D5 (mm)	D6 (mm)	D7 no = 0 yes = 1	D8 Class I : 10 Class II : 01 Class III : 00
23	6.4	31	10	81.5	78	+3.5	36	27	60.4	20.3	88	80	21	15.5	42.2	24.8	0	01
24	6.5	48.9	10	86	80.5	+5.5	24.5	17	65.9	16.1	107	97.5	10.5	14	44.6	27.2	1	01
25	6.7	25	10	77	73	+4	39	30.5	61.8	19.6	107	96	18	21	43.7	29.2	0	01
26	6.8	45.5	10	76.5	77	-0.5	28.5	23	60.4	23.6	89.5	77	10	18.5	45.4	23.8	0	01
27	6.9	65	10	81	85.5	-4.5	34	32.5	58.5	20.1	113	82	10.5	22.5	44.7	27.9	1	00
28	7.3	27.6	10	84.5	82	+2.5	30	21.5	56.5	20	107	87.5	14.5	16	42.2	25.2	1	00
29	7.3	52.4	10	80	78	+2	39	31.5	56.8	19.7	90	85	25	13.5	49.1	24.3	1	00
30	7.8	55.9	10	83	80	+3	35	25.5	63.6	20.9	99	85	16.5	18	46.4	29.7	0	01

Table 38 Data for variables in the test for 'Adenoid Facies Path' (cont'd)

Section XI

Bibliography

SECTION XI: BIBLIOGRAPHY

-
- ABRAMS, H.L. and McNEIL, B.J. (1978): *Medical implications of computed tomography (CAT scanning) Part I*, N. Engl. J. Med. 298: 255-260.
- ALFIDI, R.J., HAAGA, J., WEINSTEIN, M. and DeGROOT, J. (1977): *Computed tomography of the human body - an atlas of normal anatomy*, Saint Louis, The C.V. Mosby Company, 1st ed.
- AMBROSE, J. (1973): *Computerized transverse axial scanning (Tomography) Part II Clinical applications*, Br. J. Radiol. 46: 1023-1047.
- ANDERSON, J.E. (1978): *Grant's Atlas of anatomy*, Baltimore, The Williams & Wilkins Co., 7th ed.
- ANGLE, E.H. (1907): *Treatment of malocclusion of the teeth*, Philadelphia, S.S. White Dental Manufacturing Co., 7th edition.
- ARDRAN, G.M. and KEMP, F.H. (1972): *A function for adenoids and tonsils*. Am. J. Roentgenol. 114: 268-281.
- ARDRAN, G.M., KEMP, F.H. and WEGELIUS, C. (1957): *Swallowing defects after poliomyelitis*, Br. J. Radiol. 30: 169-189.
- ASCHAN, G., DRETTNER, B., and RONGE, H. (1958): *A new technique for measuring nasal resistance to breathing, illustrated by the effects of histamine and physical effort*, Ann. Acad. Reg. Sci. Uppsala 2: 111-126.
- BACKLUND, E. (1963): *Facial growth, and the significance of oral habits, mouthbreathing and soft tissues for malocclusion*, Acta Odont. Scand. Suppl. 36.
- BADGER, T.L. (1954): *The tonsil and adenoid question as seen by the internist*, J. Am. Med. Ass. 154: 568-571.
- BALLARD, C.F. (1948): *The upper respiratory musculature and Orthodontics, Part I*, Dent. Rec. 68: 1-5.
- BALYEAT, R.M. and BOWEN, R. (1934): *Facial and dental deformities due to perennial nasal allergy in childhood*, Int. J. Orthod. 20: 445-455.
- BAUMRIND, S. and FRANTZ, R.C. (1971): *The reliability of head film measurements, 1. Landmark identification*, Am. J. Orthod. 60: 111-127.
- BAUMRIND, S. and FRANTZ, R.C. (1971): *The reliability of head film measurements, 2. Conventional angular and linear measures*, Am. J. Orthod. 60: 505-517.
- BAYER, H.G.A. (1939): Quoted by Goldman and Bachman (1958).
- BENTZEN, S. (1903): Quoted by Linder-Aronson (1970).

BERGLAND, O. (1963): *The bony nasopharynx*, Acta Odont. Scand. Suppl. 35.

BILDERBACK, J.B. (1921): *The relation of the physician to the orthodontist*, Int. J. Orthod. 7: 412-415.

BJORK, A. (1947): *The face in profile*, Svensk tandlak-T 40: Suppl. 5B.

BJORK, A. (1950): *Some biological aspects of prognathism and occlusion of the teeth*, Acta Odont. Scand. 9: 1-40.

BJORK, A. (1955): *Cranial base development*, Am. J. Orthod. 41: 198-225.

BJORK, A. and SOLOW, B. (1962): *Measurement on radiographs*, J. Dent. Res. 41: 672-683.

BLOCH, S. and QUANTRILL, J.R. (1968): *The radiology of nasopharyngeal tumours including positive-contrast nasopharyngography*, S. Afr. Med. J. 42 (39): 1030-1036, October.

BLUESTONE, C.D. (1975): *Obstructive adenoids in relation to otitis media*, Ann. Otorhinolaryngol. 84: 44-48.

BOIES, L.R. (1954): *The tonsil and adenoid question as seen by the laryngologist*, J. Am. Med. Ass. 154: 575-577.

BOSMA, J.F. (1963a): *Oral and pharyngeal development and function*, J. Dent. Res. 42: 375-380.

BOSMA, J.F. (1963b): *Maturation of function of the oral and pharyngeal region*, Am. J. Orthod. 49: 94-104.

BOWEN, R. and BALLYEAT, R.M. (1934): *Facial and dental deformities due to perennial nasal allergy in childhood*, South Med. J. 27: 933-938.

BRACEWELL, R.N. (1956): *Strip integration in Radioastronomy*, Aust. J. Physics 9: 198-217.

BRADER, A.C. (1957): *A cephalometric X-ray appraisal of morphological variations in cranial base and associated pharyngeal structures: Implications in cleft palate therapy*, Angle Orthod. 27: 179-195.

BRASH, J.C. (1929): *The aetiology of irregularity and malocclusion of the teeth*, In Dent. Board U.K. pg. 214-230.

BROADBENT, B.H. (1931): *A new X-ray technique and its application to Orthodontics*, Angle Orthod. 1: 45-66.

BROADWAY, E.S., HEALY, M.J.R. and POYTON, H.G. (1962): *The accuracy of tracings from cephalometric lateral skull radiographs*, Dent. Practit. 12: 455-458.

BRODIE, A.G. (1941): *On the growth pattern of the human head*, Am. J. Anat. 68: 209-262.

- BRODIE, A.G. (1953): *Late growth changes in the human face*, Angle Orthod. 23: 146-157.
- BRODIE, A.G. (1971): *Emerging concepts of facial growth*, Angle Orthod. 41: 103-118.
- BROOKS, R.A. and CHIRO, G.D. (1975): *Theory of image reconstruction in computed tomography*, Radiology 117: 561-572.
- CANNON, E.R. (1954): *The tonsil and adenoid question as seen by the pediatrician*, J. Am. Med. Ass. 154: 571-573.
- CAPITANIO, M.A. and KIRKPATRICK, J.A. (1970): *Nasopharyngeal lymphoid tissue*, Radiology 96: 389-391.
- CASTELLI, W.A. RAMIREZ, P.C. and NASJLETI, C.E. (1973): *Linear growth study of the pharyngeal cavity*, J. Dent. Res. 52: 1245-1248.
- CASTEX (1921): *Patients simulating those suffering from adenoids*, Dent. Rec. 41: 99.
- CAVE, A.J.E. (1960): *The epipharynx*, J. Laryngol. Otol. 74: 713-717.
- CHO, Z.H., AHN, I., BOHM, C. and HUTH, G. (1974): *Computerised image reconstruction methods with multiple photon / x-ray transmission scanning*, Phys. Med. Biol. 19: 511-522.
- CLAIRMONT, A.A., HART, N.J., ROOKER, D.T. and FRANCH, R.H. (1975): *Upper airway obstruction and ventricular septal defect*, J. Am. Med. Ass. 233: 813-814.
- COCCARO, P.J., PRUZANSKY, S. and SUBTELNY, J.D. (1967): *Nasopharyngeal growth*, Cleft Palate J. 4: 214-226.
- COHEN, M.B. (1939): *The relation of allergic encroachment on the constitution to orthodontic deformity*, Angle Orthod. 9: 30-34.
- COMROE, J.H., FORSTER, R.E., DUBOIS, A.B., BRISCOE, W.A. and CARLSEN, E. (1955): *The lung*, Chicago; Year Book Medical Publishers.
- CONNELL, J.T. (1966): *An instrument for measuring the effective cross-sectional nasal airway*, J. Allergy 37: 127-134.
- CORMACK, A.M. (1963): *Representation of a function by its line integrals, with some radiological applications*, J. Appl. Physics 34: 2722-2727.
- COURTADE, (1902): Quoted by McCaffrey.
- DeBEER, G.R. (1977): *The development of the vertebrate skull*, Oxford, Oxford University Press, 3rd ed.
- DEYGAN, B.K. and LEACH, W. (1979): *Assessment of adenoidal hyperplasia*, South Med. J. 72: 588-590.
- DUKE, W.W. (1930): *Deformity of the face caused by nasal allergy in childhood*, Arch. Otolaryngol. 12: 493-498.

DUNCAN, R.C., KNAPP, R.G., CLINTON MILLER III, M. (1977): *Introductory biostatistics for the health sciences*, New York, John Wiley and Sons, Inc.

DUNN, G.F., GREEN, L.J. and GUNAT, J.J. (1973): *Relationships between variation of mandibular morphology and variation of nasopharyngeal airway size in monozygotic twins*, Am. J. Orthod. 43: 129-135.

ECKER, (1870): Quoted by Bergland (1963).

ELLER, J.L., ROBERTS, J.F. and ZITER Jr, F.M.H. (1971): *Normal nasopharyngeal soft tissue in adults*, Am. J. Roentgenol. 112: 537-541.

EMSLIE, R.D., MASSLER, M. and ZWEMER, J.D. (1952): *Mouth breathing: I. etiology and effects (a review)*, J. Am. Dent. Ass. 44: 506-521.

ENGMAN, L.T., SPRIESTERSBACH, D.C. and MOLL, K.L. (1965): *Cranial base angle and nasopharyngeal depth*, Cleft Palate J. 2: 32-39.

ERSKINE, R.G. (1978): *A comparison of xeroradiographs with conventional lateral skull radiographs*, Br. J. Orthod. 5: 193-195.

EVISON, G. (1968): *Contrast radiography of the nasopharynx*, Postgrad. Med. J. 44: 825-829.

FAIRCHILD, R.C. (1968): *A pediatrician views the tonsil and adenoid problem*, Am. J. Orthod. 54: 491-494.

FORD, E.H.R. (1958): *Growth of the human cranial base*, Am. J. Orthod. 44: 498-506.

FRAZER, (1946): *Anatomy of the human skeleton*, London, Churchill, 4th ed.

FRIEL, S. (1926): *An investigation into the relation of function and form*, Br. Dent. J. 47: 353-379.

FUCHS, A.M. (1939): *Allergy related to dental practice*, D. Outlook 26: 10-15.

FUJIOKA, M., YOUNG, L.W. and GIRDANY, B.R. (1979): *Radiographic evaluation of adenoidal size in children: Adenoidal-nasopharyngeal ratio*, Am. J. Roentgenol. 133: 401-404.

GALEN, (130): Quoted by Leela, Kanagasuntheram and Khoo (1974).

GARDINER, J.H. (1956): *A survey of malocclusion and some aetiological factors in 1000 Sheffield schoolchildren*, Dent. Practit. Dent. Rec. 6: 187-201.

GAY, I. and BRESLAW, Z. (1960): *Diagnosis of adenoid hypertrophy by means of lateral radiograph of nasopharynx*, Isr. Med. J. 19: 185-187.

GENERAL ELECTRIC: *Introduction to computed tomography*, Medical system division, Milwaukee, USA.

- GESELL, A. (1942): *Morphologies of mouth and mouth behaviour*, Am. J. Orthod. 28: 397-413.
- GIBB, A.G. (1969): *Unusual complications of tonsil and adenoid removal*, J. Laryngol. Otol. 83: 1159-1174.
- GOLDMAN, J.L. and BACHMAN, A.L. (1958): *Soft tissue roentgenography of the nasopharynx for adenoids*, Laryngoscope 68: 1288-1312.
- GORDON, R., BENDER, R. and HERMAN, G.T. (1970): *Algebraic reconstruction techniques (ART) for three-dimensional electron microscopy and x-ray photography*, J. Theor. Biol. 29: 471-481.
- GRABER, T.M. (1972): *Orthodontics, Principles and Practice*, Philadelphia, W.B. Saunders Co., 3rd ed.
- GRANDY, C.C. (1925): *Roentgenographic demonstration of adenoids*, Am. J. Roentgenol. 14: 114-115.
- GRANT and BASMAJJIAN (1965): *Grant's method of anatomy*, Baltimore, Williams and Wilkins Co.
- GRAVELY, J.F. and MURRAY BENZIES, P. (1974): *The clinical significance of tracing error in cephalometry*, Br. J. Orthod. 1: 95-101.
- GRAY, L.P. (1977): *The T's and A's problem - assessment and reassessment*, J. Laryngol. Otol. 91: 11-32.
- GRIFFIN, C.J. and McGRATH, P. (1978): *Embryogenesis, development and some anomalies of the upper respiratory tract including the septomaxillary syndrome and its treatment*, Sydney, Sydney University Press, 1st ed.
- GROTH, K.E. (1933): *Roentgen picture of the epipharynx of children under normal conditions and in adenoid vegetations*, Acta Radiol. 14: 463-469.
- GWYNNE-EVANS, E. (1948): *The upper respiratory musculature and Orthodontics, Part II*, Dent. Rec. 68: 5-21.
- GWYNNE-EVANS, E. and BALLARD, C.F. (1957): *The mouth-breather*, Br. Med. J. 5053: 1109.
- GWYNNE-EVANS, E. and BALLARD, C.F. (1958): *Discussion on the mouth-breather*, Proc. Roy. Soc. Med. 51: 279-282.
- HALLETT, G.E.M. (1959): *Inherent errors in cephalometric films and their reduction*, Dent. Practit. Dent. Rec. 9: 163-172.
- HANDELMAN, C.S. and OSBORNE, G. (1976): *Growth of the nasopharynx and adenoid development from one to eighteen years*, Angle Orthod. 46: 243-259.
- HANDELMAN, C.S. and PRUZANSKY, S. (1967): Quoted by Handelman and Osborne (1967).
- HANSEL, F.K. and CHANG, C.S. (1940): *Relation of allergy and tonsillectomy in children*, Arch. Otolaryngol. 31: 45-52.

- HANSON, M.L. and COHEN, M.S. (1973): *Effects of form and function on swallowing and the developing dentition*, Am. J. Orthod. 64: 63-82.
- HARRISON, D.F.N. (1972): *Cancer of the head and neck - role of chemotherapy*, J. Am. Med. Ass. 220: 405.
- HARTSOOK, J.T. (1946): *Mouth breathing as a primary etiologic factor in the production of malocclusion*, J. Dent. Child. 13: 91-94.
- HARVOLD, E.P., CHIERICI, G. and VARGERVIK, K. (1972): *Experiments on the development of dental malocclusions*, Am. J. Orthod. 61: 38-44.
- HARVOLD, E.P., VARGERVIK, K. and CHIERICI, G. (1973): *Primate experiments on oral sensation and dental malocclusion*, Am. J. Orthod. 63: 494-508.
- HASEGAWA, M., KERN, E.B. and O'BRIEN, P.C. (1979): *Dynamic changes of nasal resistance*, Ann. Otorhinolaryngol. 88: 66-71.
- HENDERSON, H. (1979): *A sideways look at scanners*, New Scientist 6 December 1979: 782-785.
- HENRIKSON, C.O., LINDER-ARONSON, S. and WESTBORG, B. (1975): *Roentgenological changes in anteroposterior nasopharyngeal dimension in 6 to 15 year olds*, Dentomaxillofac. Radiol. 4: 19-24.
- HERBST, (1910): Quoted by Emslie, Massler and Zwemer (1952).
- HIBBERT, J. and WHITEHOUSE, G.H. (1978): *The assessment of adenoidal size by radiological means*, Clin. Otolaryngology 3: 43-47.
- HIXON, E.H. (1956): *The norm concept and cephalometrics*, Am. J. Orthod. 42: 898-906.
- HO, H.C. (1972): *Cancer of the head and neck - radiologic diagnosis*, J. Am. Med. Ass. 220: 396-398.
- HOLMBERG, H. and LINDER-ARONSON, S. (1979): *Cephalometric radiographs as a means of evaluating the capacity of the nasal and nasopharyngeal airway*, Am. J. Orthod. 76: 479-490.
- HOOPLE, G.D. (1954): *The tonsil and adenoid question as seen by the otologist*, J. Am. Med. Ass. 154: 573-575.
- HOROWITZ, S.L., GRAF-PINTHUS, B., BETTEX, M., VINKKA, H. and GERSTMAN, L.J. (1976): *Factor analysis of craniofacial morphology in cleft lip and palate in man*, Arch. Oral Biol. 21: 465-472.
- HOROWITZ, S.L., OSBORNE, R.H. and DeGEORGE (1960): *A cephalometric study of craniofacial variation in adult twins*, Angle Orthod. 30: 1-5.
- HOUNSFIELD, G.N. (1973): *Computerized transverse axial scanning (Tomography): Part I. Description of system*, Br. J. Radiol. 46: 1016-1022.
- HOWARD, C.C. (1932): *Inherent growth and its influence on malocclusion*, J. Am. Dent. Ass. 19: 642-651.

- HOYTE, D.A.N. (1975): *A critical analysis of the growth in length of the cranial base, in Birth Defects: Original Article Series, XI/7*, Allan R. Liss, New York, pp. 255-282.
- HUBER, R.E. and REYNOLDS, J.W. (1946): *A dentofacial study of male students at the University of Michigan in the Physical Hardening program*, Am. J. Orthod. 32: 1-21.
- HUMPHREYS, H.F. and LEIGHTON, B.C. (1950): *A survey of antero-posterior abnormalities of the jaws in children between the ages of two and five and a half years of age*, Br. Dent. J. 88: 3-15.
- JAMES, W. and HASTINGS, S. (1932): *Mouth-breathing and nasal obstruction*, Dent. Rec. 52: 306-308.
- JING, B.S. (1970): *Tumors of the nasopharynx*, Radiol. Clin. North Am. 8 (3): 323-342, December.
- JING, B.S. and MCGRAW, J.P. (1965): *Contrast nasopharyngography in the diagnosis of tumour*, Arch Otolaryngol. 81: 365-371.
- JOHANNESSON, S. (1968): *Roentgenologic investigation of the nasopharyngeal tonsil in children of different ages*, Acta. Radiol. 7: 299-304.
- JOHNSON, L.R. (1936): *Relation of respiration to malocclusion*, J. Am. Dent. Ass. 23: 1212-1221.
- JOHNSON Jr, T.H., GREEN Jr, A.E. and RISE, E.N. (1967): *Nasopharyngography: its technic and uses*, Radiology 88: 1166-1169.
- KAISER, A.D. (1930): *Results of tonsillectomy: a comparative study of 2,200 tonsillectomized children with an equal number of controls three and ten years after operation*, J. Am. Med. Ass. 95: 837-842.
- KANAGASUNTHERAM, R., WONG, W.C. and CHAN, H.L. (1969): *Some observations on the innervation of the human nasopharynx*, J. Anat. 104: 361-376.
- KANTOROWICZ, A. (1916): Quoted by Linder-Aronson (1970).
- KEITH, A. and CAMPION, G. (1922): *A contribution to the mechanism of growth of the human face*, Int. J. Orthod. 8: 607-633.
- KERN, E.B. and ARBOUR, P.A. (1976): *The phenomenon of paradoxical nasal obstruction*, Arch. Otolaryngol. 102: 669-671.
- KHOO, F.Y., CHIA, K.B. and NALPON, J. (1967): *A new technique of contrast examination of the nasopharynx with cinefluorography and roentgenography*, Am. J. Roentgenol. 99: 238-248.
- KHOO, F.Y., KANAGASUNTHERAM, R. and CHIA, K.B. (1967): *Variations of the lateral recesses of the nasopharynx*, Arch. Otolaryngol. 86: 456-462.
- KHOO, F.Y., LEE, W.S., NG, H.W. and TYE, C.Y. (1974): *Four diameters of the roof and posterior wall of the nasopharynx in the lateral neck radiography*, Br. J. Radiol. 47: 763-768.

- KHOO, F.Y., TYE, C.Y., CHIA, K.B. and NG, H.W. (1977): *Detection of nasopharyngeal carcinoma from measurements made on the lateral neck radiograph*, Cancer 39: 66-70.
- KING, E.W. (1952): *A roentgenographic study of pharyngeal growth*, Angle Orthod. 22: 23-37.
- KINGSLEY, (1888): *A treatise on oral deformities as a branch of mechanical surgery*, New York, D. Appleton Co.
- KLAJAM, S. and SITKOWSKI, J. (1961): *A rhinospirometric method based on laminar (viscous) flow-meter*, O. R. L. 23: 362-372.
- KLAMI, O. and HOROWITZ, S.L. (1979): *An analysis of the relationship between posterior dental cross-bite and vertical palatal asymmetry*, Am. J. Orthod. 76: 51-58.
- KOSKI, K. and LAHDEMAKI, P. (1975): *Adaptation of the mandible in children with adenoids*, Am. J. Orthod. 68: 660-665.
- KUHL, D.E. and EDWARDS, R.Q. (1968): *Reorganising data from transverse section scans of the brain using digital processing*, Radiology 91: 975-981.
- LAME, E.L. and REDICK, J. (1969): *Autotomography applied to the pharynx and dens*, Am. J. Roentgenol. 105: 359-360.
- LANDE, M. (1952): *Growth behaviour of the human bony facial profile as revealed by serial cephalometric roentgenology*, Angle Orthod. 22: 78-90.
- LAYTON, T.B. (1914): *Tonsils and adenoids in children: a plea for fewer operations*, Lancet 1: 1106-1108.
- LEDERER, F.L. (1947): *Diseases of the ear, nose and throat*, Philadelphia, F.A. Davis Co.
- LEECH, H.L. (1958): *A clinical analysis of orofacial morphology and behaviour of 500 patients attending an upper respiratory research clinic*, Dent. Practit. Dent. Rec. 9: 57-68.
- LEELA, K., KANAGASUNTHERAM, R. and KHOO, F.Y. (1974): *Morphology of the primate nasopharynx*, J. Anat. 117: 333-340.
- LINDER-ARONSON, S. (1963): *Dimensions of face and palate in nose breathers and in habitual mouth breathers*, Odont. Revy 14: 187-200.
- LINDER-ARONSON, S. (1970): *Adenoids: their effect on mode of breathing and nasal airflow and their relationship to characteristics of the facial skeleton and the dentition*, Acta Otolaryngol. Supp. 265.
- LINDER-ARONSON, S. (1972): *Effects of adenoidectomy on dentition and nasopharynx*, Trans. Euro. Orthod. Soc.: 177-186.
- LINDER-ARONSON, S. (1973a): *Effects of adenoidectomy on the dentition and facial skeleton over a period of five years*, Trans. 3rd Int. Orthod. Congr. 1973 (Cook, J.T. Ed), Crosby Lockwood Staples 1976: 85-100.

LINDER-ARONSON, S. (1973b): *Effects of adenoidectomy on mode of breathing, size of adenoids and nasal airflow*, O.R.L. 35: 283-302.

LINDER-ARONSON, S. and BACKSTROM, A. (1960): *A comparison between mouth and nose breathers with respect to occlusion and facial dimensions*, Odont. Revy 11: 343-376.

LINDER-ARONSON, S. and HENRIKSON, C.O. (1973): *Radiocephalometric analysis of anteroposterior nasopharyngeal dimensions in 6 to 12 year old mouth breathers compared with nose breathers*, O.R.L. 35: 19-29.

LIPTON, M.J., HAYASHI, T.T., BOYD, D. and CARLSSON, E. (1978): *Measurement of left ventricular vast volume by computed tomography*, Radiology 127: 419-423.

LUNDSTROM, A. (1948): *An investigation of 202 pairs of twins regarding fundamental factors in the aetiology of malocclusion*, Trans. Euro. Orthod. Soc. 24: 161-176.

LUNDSTROM, A. (1955): *The significance of genetic and non-genetic factors in the profile of the facial skeleton*, Am. J. Orthod. 41: 910-916.

LUNDSTROM, A. (1959): *How much can we hope to reduce the incidence of malocclusion through prophylactic measures?* Dent. Practit. Dent. Rec. 9: 129-142.

MARAN, A.G.C., GIBB, A.G., GIBSON, W.J.A. and ASBURY, D.L. (1971): *Hypernasality, bony and soft tissue relationships*, J. Laryngol. Otol. 85: 105-111.

MARKS, M.B. (1965): *Allergy in relation to orofacial dental deformities in children: A review*, J. Allergy 36: 293-302.

MARTENS, D.M. (1979): *Tonsils, adenoids, and the airway*, Int. J. Orthod. 17: 8-13.

MASSLER, M., PONCHER, H.G. and SCHOUR, J. (1945): *The Oral Cavity*, in Nelson W.E. (ed.), *Textbook of Pediatrics*, Philadelphia, Saunders, 4th ed.

MASSLER, M. and ZWEMER, J.D. (1953): *Mouth breathing. II. Diagnosis and treatment*, J. Am. Dent. Ass. 46: 658-671.

MATTHEWS, E. (1948): *A mouth screen for use after adenoidectomy*, Br. Med. J. 2: 223.

MAZAHARI, M., KROGMAN, W.M., HARDING, R.L., MILLARD, R.T. and MEHTA, S. (1977): *Longitudinal analysis of growth of the soft palate and nasopharynx from six months to six years*, Cleft Palate J. 14: 52-62.

MELTZER, P.E. (1954): *Technique of removal of adenoid tissue of the nasopharynx in children*, J. Am. Med. Ass. 154: 228-230.

MENASHE, V.D., FARRCHI, C. and MILLER, M. (1965): *Hypoventilation and cor pulmonale due to chronic upper airway obstruction*, J. Pediat. 67: 198-203.

- MERGEN, D.C. and JACOBS, R.M. (1970): *The size of nasopharynx associated with normal occlusion and class II malocclusion*, Angle Orthod. 40: 342-346.
- MIGNON, (1898): Quoted by Goldman and Bachman (1958).
- MILES FOXEN, E.H., PRESTON, T.D. and LACK, J.A. (1971): *The assessment of nasal air-flow: a review of past and present methods*, J. Laryngol. Otol. 85: 811-825.
- MILLER, H.I. (1949): *The relation of long-continued respiratory allergy to occlusion*, Am. J. Orthod. 35: 780-789.
- MILLER, S.W., DINSOMORE, R.E., WITTENBERG, J., MATURI, R.A. and POWELL Jr, W.J. (1977): *Right and left ventricular volumes and wall measurements: Determination by computed tomography in arrested canine hearts*, Am. J. Roentgenol. 129: 257-261.
- MONTGOMERY, W.M., VIG, P.S., STAAB, E.V. and MATTESON, S.R. (1979): *Computed tomography: a three-dimensional study of the nasal airway*, Am. J. Orthod. 76: 363-375.
- MORAG, A. and OGRA, P.L. (1975): *Immunologic aspect of tonsils*, Ann. Otorhinolaryngol. 84: 37-43.
- MORRIS, H.L. (1975): *The speech pathologist looks at the tonsils and the adenoids*, Ann. Otorhinolaryngol. 84 (Suppl. 19): 63-66.
- MORRISON, M.D. (1969): *Nasal spirometry*, Arch. Otolaryngol. 90: 636-640.
- MOSS, M.L. (1956): *Malformations of the skull base associated with cleft palate deformity*, Plast. Reconstr. Surg. 17: 226-234.
- MOSS, M.L. (1962): *The functional matrix*, In Kraus B.S. and Riedel R.A. (ed.), *Vistas in Orthodontics*, Philadelphia, Lea and Febiger.
- MOSS, M.L. and SALENTIJN, L. (1969a): *The primary role of functional matrices in facial growth*, Am. J. Orthod. 55: 566-577.
- MOSS, M.L. and SALENTIJN, L. (1969b): *The capsular matrix*, Am. J. Orthod. 56: 474-490.
- MOSS, M.L. and SALENTIJN, L. (1971): *Differences between the functional matrices in anterior open-bite and in deep bite*, Am. J. Orthod. 60: 264-280.
- MOYERS, R.E. (1973): *Handbook of Orthodontics*, Chicago, Year Book, Medical Publishers, 3rd edition.
- MOYERS, R.E. and BOOKSTEIN, F.L. (1979): *The inappropriateness of conventional cephalometrics* Am. J. Orthod. 75: 599-617.
- MUIR, C.S. (1972): *Epidemiology and etiology, Cancer of the head and neck*, J. Am. Med. Ass. 220: 393.
- MURRAY, A.B. and ANDERSON, D.O. (1969): *The association of incisor*

protrusion with digit sucking and allergic nasal itching, J. Allergy Clin. Immunol. 44: 239-247.

McCAFFREY, T.V. and KERN, E.B. (1979): *Clinical evaluation of nasal obstruction*, Arch. Otolaryngol. 105: 542-545.

McCARTHY, J.G., COCCARO, P.J. and SCHWARTZ, M.D. (1979): *Velo-pharyngeal function following maxillary advancement*, Plast. Reconstr. Surg. 64: 180-189.

McCARTHY, M.F. (1925): *Preliminary report of studies of the nasopharynx*, Ann. Otorhinolaryngol. 34: 800-813.

McCLYMONT, D.H. (1975): *Biostatistics for dentists*, Otago, University of Otago Dental School, Department of Preventive and Social Dentistry.

McCULLOUGH, E.C. and PAYNE, J.T. (1978): *Patient dosage in computed tomography*, Radiology 129: 457-463.

McKEE, W.J.E. (1963): *A controlled study of the effects of tonsillectomy and adenoidectomy in children*, Br. J. Prev. Soc. Med. 17: 49-69.

McKENZIE, A.M. (1909): *Adenoids, deformities of the palate and artificial infant feeding - an analysis of 222 cases*, Brit. Dent. J. 30: 159-167.

NEGUS, V.E. (1955): *Diseases of the nose and throat*, London, Cassel and Co., 1st ed.

NEIVERT, H. (1939): *The lymphoid tissue problem in the upper respiratory tract*, Am. J. Orthod. 25: 544-554.

NICHOLAS, K.C., BAYS, R.A. and LYON, E.D. (1975): *Periadenitis mucosa necrotica recurrens*, J. Oral Surg. 33: 65-70.

NIE, N.H., HULL, C.H., JENKINS, J.G., STEINBRENNER, K. and BENT, D.H. (1975): *Statistical package for the social sciences*, Chicago, McGraw-Hill Inc., 2nd ed.

NORDLUND, H. (1918): Quoted by Linder-Aronson (1970).

OGURA, J.H. (1964): *Experimental observation of the relationship between upper airway obstruction and pulmonary function*, Ann. Otolaryngol. 73: 381-403.

OGURA, J.H. and NELSON, J.R. (1968): *Nasal surgery, physiological considerations of nasal obstruction*, Arch. Otolaryngol. 88: 288-295.

OGURA, J.H. (1975): *Effect of upper airway obstruction on the lower airway and cardiovascular system*, Ann. Otorhinolaryngol. 84: 49.

OLENDORF, (1961): Quoted by Alfidi et al (1977).

OSBORN, A.G. and ANDERSON, R.E. (1978): *Direct sagittal computed tomographic scans of the face and paranasal sinuses*, Radiology 129: 81-87.

- OSBORNE, G.S., PRUZANSKY, S. and KOEPP-BAKER, H. (1971): *Upper cervical spine anomalies and osseous nasopharyngeal depth*, J. Speech Hear. Res. 14: 14-22.
- PAISNER, H.M. (1972): *Nasal obstruction*, Postgrad. Med. 52(2): 88-92 August.
- PANCOAST, H.K., PENDERGRASS, E.P. and SCHAEFFER, J.P. (1940): *The head and neck in roentgen diagnosis*, Springfield, Ill., Charles C. Thomas.
- PARADISE, J.L. (1976): *Clinical trials of tonsillectomy and adenoidectomy: Limitations of existing studies and a current effort to evaluate efficacy*, South Med. J. 69: 1049-1053.
- PERRY, B.J. and BRIDGES, C. (1973): *Computerised transverse axial scanning (Tomography) Pt. III Radiation dose consideration*, Br. J. Radiol. 46: 1048-1051.
- PIERSOL, G.A. (1936): *In Huber G.C. (ed), Human anatomy*, Philadelphia, J.B. Lippincott, 9th ed.
- PINESS, G. and MILLER, H. (1939): *Allergy of the upper respiratory tract in infancy and childhood*, J. Am. Med. Ass. 113: 734-740.
- PLANTES, Z. (1950): *Examen du troisieme et du quatrieme ventricule au moyende petites quantites d'ain*, Acta Radiol. 34: 399-414.
- PONCHER, H.G., SCHOUR, I. and MASSLER, M. (1945): see Massler, Poncher and Schour (1945).
- POOLE, M.N., ENGEL, G.A. and CHACONAS, S.J. (1980): *Nasopharyngeal cephalometrics*, Oral Surg. 49: 266-271.
- POPPIUS, H. and MATTSON, K. (1977): *Use of a new simple device, the air flowmeter, in detecting changes in airways obstruction*, Scand. J. Resp. Dis. 58: 269-272.
- PRATT, L.W. (1974): *Acquired nasopharyngeal stenosis*, Laryngoscope 84: 707-713.
- PRESTON, C.B. (1979): *Preliterate environment and the nasopharynx*, Am. J. Orthod. 76: 646-656.
- PRINCIPATO, J.J. and OZENBERGER, J.M. (1970): *Cyclical changes in nasal resistance*, Arch. Otolaryngol. 91: 71-77.
- PRUZANSKY, S. (1966): *Is roentgencephalometry being fully exploited as an instrument for clinical investigation?* Dent. Clin. North. Am: 211-217.
- PRUZANSKY, S. (1975): *Roentgencephalometric studies of tonsils and adenoids in normal and pathologic states*, Ann. Otorhinolaryngol. 84: 55-62.
- QUICK, C.A. and GUNDLACH, K.K.H. (1978): *Adenoid faces*, Laryngoscope 88: 327-333.

RADON (1917): Quoted by Alfidi et al (1977).

RASMUS, R.L. and JACOBS, R.M. (1969): *Mouth breathing and malocclusion: Quantitative technique for measurement of oral and nasal air-flow velocities*, Angle Orthod. 39: 296-302.

REED, G.F. (1963): *Nasal obstruction: causes and treatment*, Postgrad. Med. 34: 464-469.

REID, J.M. and DONALDSON, J.A. (1970): *The indications for tonsillectomy and adenoidectomy*, Otolaryngol. Clin. North Am. 3: 339-344.

RICHARDSON, A. (1966): *An investigation into the reproducibility of some points, planes, and lines used in cephalometric analysis*, Am. J. Orthod. 52: 637-651.

RICKETTS, R.M. (1954): *The cranial base and soft structures in cleft palate speech and breathing*, Plast. Reconstr. Surg. 14: 47-61.

RICKETTS, R.M. (1958a): *Respiratory obstructions and their relation to tongue posture*, Cleft Palate Bull. 8: 4-5.

RICKETTS, R.M. (1958b): *The functional diagnosis of malocclusion*, Trans. Euro. Orthod. Soc. 34: 42-67.

RICKETTS, R.M. (1960): *The influence of orthodontic treatment on facial growth and development*, Angle Orthod. 30: 103-133.

RICKETTS, R.M. (1968): *Respiratory obstruction syndrome*, Am. J. Orthod. 54: 495-514.

RIZZUTI, R.M. and WALEN, P. (1972): *The nasopharynx*, Radiology 104: 537-540.

ROBERTS, R.I. (1957): *Cineradiographic investigation of pharyngeal deglutition*, Br. J. Radiol. 30: 449-460.

ROSENBERGER, H.C. (1934): *Growth and development of the nasorespiratory area in childhood*, Ann. Otorhinolaryngol. 43: 495-522.

ROYDHOUSE, N. (1970): *A controlled study of adeno-tonsillectomy*, Arch. Otolaryngol. 92: 611-616.

RUBIN, P. (1972): *Nasopharyngeal cancer*, J. Am. Med. Ass. 220: 390-392.

RUBIN, R.M. (1979): *Facial deformity: a preventable disease?* Angle Orthod. 49: 98-103.

RUEDI, L. and ZUPPINGER, A.U. (1934): Quoted by Evison (1968).

SALMON, P.R. (1974): *Fibre-optic endoscopy*, London, Pitman Medical Publishing Co., Ltd., 1st ed.

SANJANIAN, M.H. (1975): *Nasal airway resistance and methods of measurement*, Ann. Allergy 34: 19-25.

- SCAMMON, R.E. (1930): *Measurement of Man, Minnesota Sigma X: Lectures*, Minnesota, University of Minnesota Press.
- SCHEIER, (1904): Quoted by Goldman and Bachman (1958).
- SCHILLER, K.F.R. and SALMON, P.R. (1976): *Modern topics in gastrointestinal endoscopy*, London, William Heinemann Medical Books Ltd., 1st edition.
- SCHRIVER, W.R., SWINTAK, E.F. and DARLAK, J.D. (1975): *Xerocephalography*, Oral Surgery 40: 705-708.
- SCHULHOF, R.J. (1979): *Consideration of airway in Orthodontics, Part 2, Bioprogressive Therapy*, Rockey Mountain Corp.
- SCHULLER, A. (1929): *X-ray examination of deformities of the nasopharynx*, Ann. Otorhinolaryngol. 38: 102-129.
- SCHVARCZ, J. (1959): *Autotomography of the fourth ventricle and the floor of the third ventricle*, Acta Radiol. 52: 465-469.
- SCHWEIGER, J.W. (1966): *Cranial base angle, amount of palatal tissue, and nasopharyngeal depth in individuals with clefts*, Cleft Palate J. 4: 115-119.
- SCOTT, J. (1969): *The doctrine of functional matrices*, Am. J. Orthod. 56: 38-44.
- SCOTT, J.H. (1935): *Craniofacial regions - a contribution to the study of facial growth*, Dent. Practit. Dent. Rec. 5: 208-214.
- SCOTT, W.R. and NEW, P.F. (1974): *Computerised acial tomography of intra-cranial and intraventricular hemorrhage*, Radiology 112: 73-80.
- SEEBOHM, P.M. and HAMILTON, W.K. (1958): *A method for measuring nasal resistance without intranasal instrumentation*, J. Allergy 29: 56-59.
- SHELTON Jr, R.L. and BOSMA, J.F. (1962): *Maintenance of the pharyngeal airway*, J. Appl. Physiol. 17: 209-214.
- SIEBENMANN, (1897): Quoted by Linder-Aronson (1970).
- SILLMAN, J.H. (1942): *Malocclusion in the deciduous dentition: serial study from birth to five years*, Am. J. Orthod. 28: 197-209.
- SKOLNICK, M.L., ZAGZEBSKI, J.A. and WATKIN, K.L. (1975): *Two dimensional ultrasonic demonstration of lateral pharyngeal wall movement in real time - A preliminary report*, Cleft Palate J. 12: 299-303.
- SOLOW, B. (1966): *The pattern of craniofacial associations*, Acta Odont. Scand. Suppl. 46.
- SPERBER, G.H. (1976): *Craniofacial embryology*, Bristol, John Wright and Sons Ltd., 2nd ed.
- SPIESS, (1899): Quoted by Uddstromer 1940.

SPRAWSON, E.C. (1947): *Foods and feeding as they affect teeth and their environment*, Br. Dent. J. 83: 227-235.

STEELE, C.H. (1968): *An otolaryngologist views the tonsil and adenoid problems*, Am. J. Orthod. 54: 485-491.

STEIN, S.K. (1967): *Calculus in the first three dimensions*, McGraw-Hill Book Co., pg. 14-19, 40.

STEINER, C.C. (1959): *Cephalometrics in clinical practice*, Angle Orthod. 29: 8-29.

STOKSTED, P. (1953): *Measurements of resistance in the nose during respiration at rest*, Acta Otolaryngol. Suppl. 109: 143-158.

STOKSTED, P. (1953): *Rhinometric measurements for determination of the nasal cycle*, Acta Otolaryngol. Suppl. 109: 159-175.

STRAUB, W.J. (1944): *Frequency of allergy in orthodontic patients*, J. Am. Dent. Ass. 31: 334-342.

SUBTELNY, J. (Ms) (1956): Quoted by Wildman 1961.

SUBTELNY, J.D. (1954): *The significance of adenoid tissue in Orthodontia*, Angle Orthod. 24: 59-69.

SUBTELNY, J.D. (1955): *Width of nasopharynx and related anatomic structures in normal and unoperated cleft palate children*, Am. J. Orthod. 41: 889-909.

SUBTELNY, J.D. and BAKER, H.K. (1956): *The significance of adenoid tissue in velopharyngeal function*, Plast. Reconstr. Surg. 17: 235-250.

SUBTELNY, J.D. (1957): *A cephalometric study of the growth of the soft palate*, Plast. Reconstr. Surg. 19: 49-62.

SUBTELNY, J.D. (1975): *Effect of diseases of tonsils and adenoids on dentofacial morphology*, Ann. Otorhinolaryngol. 84: 50-54.

SUCHATO, C., TUCHINDA, S. and PALAVATANA, C. (1973): *Pre-irradiation and postirradiation nasopharyngography*, Arch. Otolaryngol. 98: 92-96.

SWINSCOW, T.D.V. (1977): *Statistics at square one*, London, British Medical Association, 2nd ed.

TAKAGI, Y. (1962): *Human postnatal growth of vomer in relation to base of cranium*, Ann. Otolrhinolaryngol. 71: 238-247.

TALBOT, A.R. and ROBERTSON, L.W. (1973): *Cardiac failure with tonsil and adenoid hypertrophy*, Arch. Otolaryngol. 98: 277-281.

TAYLOR, G., MacNEIL, R. and FREED, D.L.J. (1973): *Assessing degree of nasal patency by measuring peak expiratory flow rate through the nose*, J. Allergy Clin. Immunol. 52: 193-198.

THANOPOULOS, B., IKKOS, D.D., MILINGOS, M. and FOUTAKIS, D. (1975): *Cardiorespiratory syndrome due to enlarged tonsils and adenoids*, Acta Paediatr. Scand. 64: 659-663.

THOMPSON, J.R. and BRODIE, A.G. (1942): *Factors in the position of the mandible*, J. Am. Dent. Ass. 29: 925-941.

THUROW, R.C. (1951): *Cephalometric methods in research and private practice*, Angle Orthod. 21: 104-116.

THUROW, R.C. (1973): *The survival factor in Orthodontics*, In Cook, J.T. (ed.) *Trans. 3rd Int. Orthod. Congr. 1973*, London, Crosby Lockwood Staples, pp. 17-25.

THURSTON, J.B., LARSON, D.L., SHANKS, J.C., BENNETT, J.E. and PARSONS, R.W. (1980): *Nasal obstruction as a complication of pharyngeal flap surgery*, Cleft Palate J. 17: 148-154.

TIERNEY, J.A. (1975): *Calculus and analytical Geometry*, Allyn & Bacon Inc., 3rd ed. pg. 214-219.

TIRK, T.M. (1948): *A study of the growth of the head by planimetric method*, Angle Orthod. 18: 76-94.

TODD, T.W. and TRACY, B. (1930): *Racial features in the American Negro Cranium*. Am. J. Phys. Anthropol. 15: 53-110.

TODD, T.W. (1932): *Hereditary and environmental factors in facial development*, Int. J. Orthod. 18: 799-808.

TODD, T.W. (1936): *Integral growth of the face*, Int. J. Orthod. 22: 321-334.

TODD, T.W. (1938): *Significance of developmental growth studies in evaluation of clinical allergy*, J. Allergy 9: 234-240.

TOMES, C.S. (1872): Quoted by Linder-Aronson (1970).

UDDSTROMER, M. (1940): *Nasal respiration: a critical survey of some current physiological and clinical aspects on the respiratory mechanism with a description of a new method of diagnosis*, Acta Otolaryngol. Suppl. 42: 3-146.

UNNO, T., NELSON, J.R. and OGURA, J.H. (1968): *The effect of nasal obstruction on pulmonary, airway and tissue resistance*, Laryngoscope 78: 1119-1139.

VAN DER LENDE, R., JANSSEN-KOSTER E.J., KNJPSTRA, S., PESET REIG, R. and BARKMEYER-DEGENHART, P. (1974): *Letter: Peak-flow meter versus peak-flow gauge*, Lancet 2 (7886): 950-951, October 19.

VENABLE, J.H. (1945): *The use of a plaimeter in volume studies of early embryos*, Science 102: 670-671.

VESALIUS, (1943): Quoted by Leela, Kanagasuntheram and Khoo (1974).

VIG, P.S. (1980): *Personal communications*, at an Australian Society of Orthodontists Meeting, Perth, Australia.

VIG, P.S., SHOWFETY, K.J. and PHILLIPS, C. (1980): *Experimental manipulation of head posture*, Am. J. Orthod. 77: 258-268.

- VINKKA, H. and KOSKI, K. (1975): *Variability of the craniofacial skeleton II. Comparison between two age groups*, Am. J. Orthod. 67: 34-43.
- WARWICK JAMES, W. (1921): *The anti-mouth breathing valve: an improvement*, Dent. Rec. 41: 68-73.
- WATSON, R.M., WARREN, D.W. and FISCHER, N.D. (1968): *Nasal resistance, skeletal classification, and mouth breathing in orthodontic patients*, Am. J. Orthod. 54: 367-379.
- WATSON, W.G. (1979): *The belabored lymphoids - a dentist - physician dilemma*, Am. J. Orthod. 75: 460-463.
- WEI, S.H.Y. (1968): *The variability of roentgenographic cephalometric lines of reference*, Angle Orthod. 38: 74-78.
- WEITZ, H.L. (1946): *Roentgenography of adenoids*, Radiology 47: 66-70.
- WHITAKER, R.H.R. (1911): *The relationship of nasal obstruction to contracted arches and dental irregularities*, Dent. Rec. 31: 425-433.
- WILDMAN, A.J. (1961): *Analysis of tongue, soft palate, and pharyngeal wall movement*, Am. J. Orthod. 47: 439-461.
- WISE, (1807): Quoted by Steele 1968.
- WISHAW, F. (1980): Personal communications.
- WOOD JONES, F. (1940): *The nature of the soft palate*, J. Anatomy 74: 147-170.
- WOODSIDE, D.G. and LINDER-ARONSON, S. (1979): *The channelization of upper and lower anterior face heights compared to population standards in males between ages 6 to 20 years*, Eur. J. Orthod. 1: 25-40.
- WORTZMAN, G. and HOLGATE, R.C. (1976): *Computerized tomography (CT) in Otolaryngology*, Laryngoscope 86: 1552-1562.
- WRIGHT, B.M. and MCKERROW, C.B. (1959): *Maximum forced expiratory flow rate as a measure of ventilatory capacity*, Brit. Med. J. 2: 1041-1047.
- WUSTROW, E. (1917): Quoted by Linder-Aronson (1970).
- YIP, A.S.G. and CLEALL, J.F. (1971): *Cinefluorographic study of velarpharyngeal function before and after removal of tonsils and adenoids*, Angle Orthod. 41: 251-263.
- YOUNG, I.S. (1962): *Adenoidectomy: How often is tonsillectomy necessary later?* J. Laryngol. Otol. 76: 791-796.
- ZANJANIAN, M.H. (1975): *Nasal airway resistance and methods of measurement*, Ann. Allergy 34: 19-25.
- ZINGESER, M.R. (1960): *Nasomaxillary proportional constancy*, Am. J. Orthod. 46: 674-684.

ZUCKERMAN, S. (1955): *Age changes in the basiscranial axis of the human skull*, Am. J. Phys. Anthrop. 13: 521-539.

ZUPPINGER, A.U. (1931): Quoted by Groth (1933).

ZWAARDEMAKA, (1889): Quoted by Seebohm (1958).

ZWIEFACH, E. (1954): *The radiographic examination of the adenoid mass and the upper air passages*, J. Laryngol. Otol. 68: 758-764.