THE NORMAL HILAR HEIGHT RATIO IN KENYAN AFRICANS;
A STUDY AT KENYATTA NATIONAL HOSPITAL, NAIROBI.

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by

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DECLARATION

CANDIDATE:

This dissertation is my original work and has not been presented for a degree in any other university

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AIMS

1. To determine the normal left hilar height ratio.
2. To determine the normal right hilar height ratio.
3. To determine whether there is any statistical difference in the normal hilar height ratio between the sexes.
4. To determine whether there is any statistical difference in the normal hilar height ratio between the age groups 15-24 years, 25-34 years and 35-44 years.
5. To determine whether there is any statistical difference between the left and the right hilar height ratio.

SUMMARY

The Hilar Height ratio (HHR) is a numerical expression of the radiographic observation that in the normal state the right hilus is positioned in the lower half of the right hemithorax while the left hilus is situated in the upper half of its hemithorax. It is calculated by dividing the distance from the hilus to the lung apex by the distance from the hilus to the diaphragm.

This study was done to establish standard baseline values in the Kenyan African and to compare the figures obtained with studies done previously, mainly in the non-African Caucasian population.

Chest radiographs (Posterior anterior view) of Kenyan Africans which are taken for routine screening exams were analysed in this study. These radiographs were used to determine the hilar height ratio. The study was both retrospective and prospective.

The left hilar height ratio was found to be 0.857 while the right hilar height ratio was found to be 1.195. In no instance was the left hilar height ratio greater than one or the right hilar height ratio less than one. This compares favourably with a study done by Homer M.J. in 1978 (he found the left HHR to be 0.84 and the right HHR to be 1.31). I suggest therefore that this ratio be adopted in evaluating PA erect chest films to aid in diagnosis of chest and subpulmonic diseases.

INTRODUCTION AND LITERATURE REVIEW

The use of X-rays in the diagnosis of chest pathology dates back to the last century, one year after the discovery of X-rays by Conrad Roentgen in November 8, 1895. Dr. Williams F. H. in the Boston Medical and Surgical Journal (Now the New England Journal of Medicine) of April 30, 1896 was reported to have demonstrated the use of this new imaging modality in diagnosis of diseases of the chest.[2]

Today, even with the proliferation of different and more sophisticated imaging modalities (Ultrasound, Computerised tomography, Magnetic resonance imaging), the chest X-ray is still a widely used primary investigation for diseases of the chest and it is also used for routine medical examinations in some parts of the world. This is because the chest X-ray is easy to do, comparatively cheaper to perform and still provides valuable clues to diagnosis of chest pathology. Harrison's Principles of Internal Medicine puts it this way "The roentgenographic examination of the chest represents the cornerstone of the diagnostic workup of the patient with suspected pulmonary disease."[6]

In a study done by Onditi E. in Nyeri provincial hospital in 1989 the commonest radiological investigation requested was the chest X-ray [9] and this is generally true for most of the other hospitals in Kenya, Kenyatta National Hospital included (the area of this study). In this same study in Nyeri provincial hospital the commonest cause of lung morbidity was found to be lung infections (Pneumonias 35%, Tuberculosis 11%)[9]

In a study conducted in 1983 by Aluoch J.A. on passive case finding in pulmonary tuberculosis in Kenya he noted that 13% of patients were diagnosed within one month of reporting to a health unit, 62% were diagnosed after 6 months and 13% were diagnosed after 6 months. 50% were diagnosed by microscopy, 42% were diagnosed by both microscopy and radiology and 9% by radiology alone. He concluded therefore that there was need to improve diagnostic procedures for tuberculosis in Kenyan health services.[1]

Alterations of pulmonary volume accompanies many chest infections and recognition of these alterations is important in establishing pathological changes in the lung.

Hilar displacement is among the important signs of pulmonary volume change. The classic papers by Robbins and Hale[9] and later investigations by Lumbert and Krause establish the usefulness of the recognition of the hilar positional change in the evaluation of lobar volume loss[10,11]. While these authors detailed the characteristic hilar changes in each type of lobar collapse, they did not attempt to quantify how much hilus must be displaced before it can be considered abnormally positioned.

In a study conducted by Felson he found the left hilus to be higher than the right in 97% of cases and at the same height in 3%. The right hilus was never higher than the left.[3] When volume changes exist without alterations of the relative hilar heights, then this observations are of little help in their detection.

Homer M.J. in October 1978 suggested a method of evaluating Hilar positional changes other than by comparison with the opposite side and proposed the Hilar Height ratio.[7]

The Hilar Height ratio is a numerical expression of the radiographic observation that in the normal state, the right hilus is positioned in the lower half of the right hemithorax while the left hilus is situated in the upper half of its hemithorax. Standard textbooks of chest radiology do not make reference to its relationship nor discuss its usefulness.[5,14]

Knowledge of the normal HHR allows evaluation of hilar positional changes even when the relative hilar positions are not altered. Lobar collapse or over-aeration can be confirmed by an abnormal HHR. Subpulmonic and subdiaphragmatic processes may alter the HHR and therefore this ratio is useful in their detection.

STATEMENT OF PROBLEM

Alteration of the pulmonary volume can be diagnosed on a chest radiograph when there is reversal of the normal relative positions of the hili. However bilateral volume changes or early unilateral changes may be present without affecting the relative hilar heights. It is advantageous therefore to establish a way of evaluating hilar positional changes other than by comparison with the contralateral side.

Knowledge of the normal HHR allows evaluation of hilar positional changes even when the relative hilar positions are not altered. Lobar collapse or over-aeration can be confirmed by an abnormal HHR. Subpulmonary and subdiaphragmatic processes may alter the HHR and therefore this ratio is useful in their detection.

METHODOLOGY

Chest radiographs (Posterior anterior view) of patients who came for routine screening exams were used in this study. To be classified as normal, the clinical history had to state that the radiograph was obtained as a routine screening exam and the films had to be reported as normal by a consultant radiologist. The inspiratory effort was judged to be adequate if the cupola of the right diaphragm was positioned between the 5^{th}-6^{th} ribs anteriouly. The films that were used had to have good tissue penetration so that the anatomical landmarks could be clearly visualised.

The hilar landmarks on the right side was the angle formed by the main right upper lobe pulmonary vein coursing inferiorly, and the right basal pulmonary artery coursing inferiorly. This lateral angle is a convenient landmark of the midpoint of the right hilus.

The midpoint of the left hilus was that point which is equidistance from the superior edge of the hyparterial left bronchus and the uppermost vessel contributing to the density of the hilus.

The hilar height ratio was evaluated on the right and left side for each patient. A line parallel to the thoracic spine was drawn from the highest point of the pulmonary apex to the diaphragm. An intersecting line was then drawn from the midpoint of the hilus perpendicular to the vertical line. The ratio of the distances from the pulmonary apex to the hilus, and the hilus to the diaphragm was obtained. Measurements were determined to the nearest 5 mm (this is a practical measure of accuracy for the Hilar Height ratio since the accuracy of the landmarks are not more precise than this). This information was then recorded along with the patients age and sex in a questionnaire. A sample of the questionnaire used is shown on the next page.

HILAR HEIGHT RATIO QUESTIONNAIRE

Case number

Age; X-ray Number

Sex(M/F)

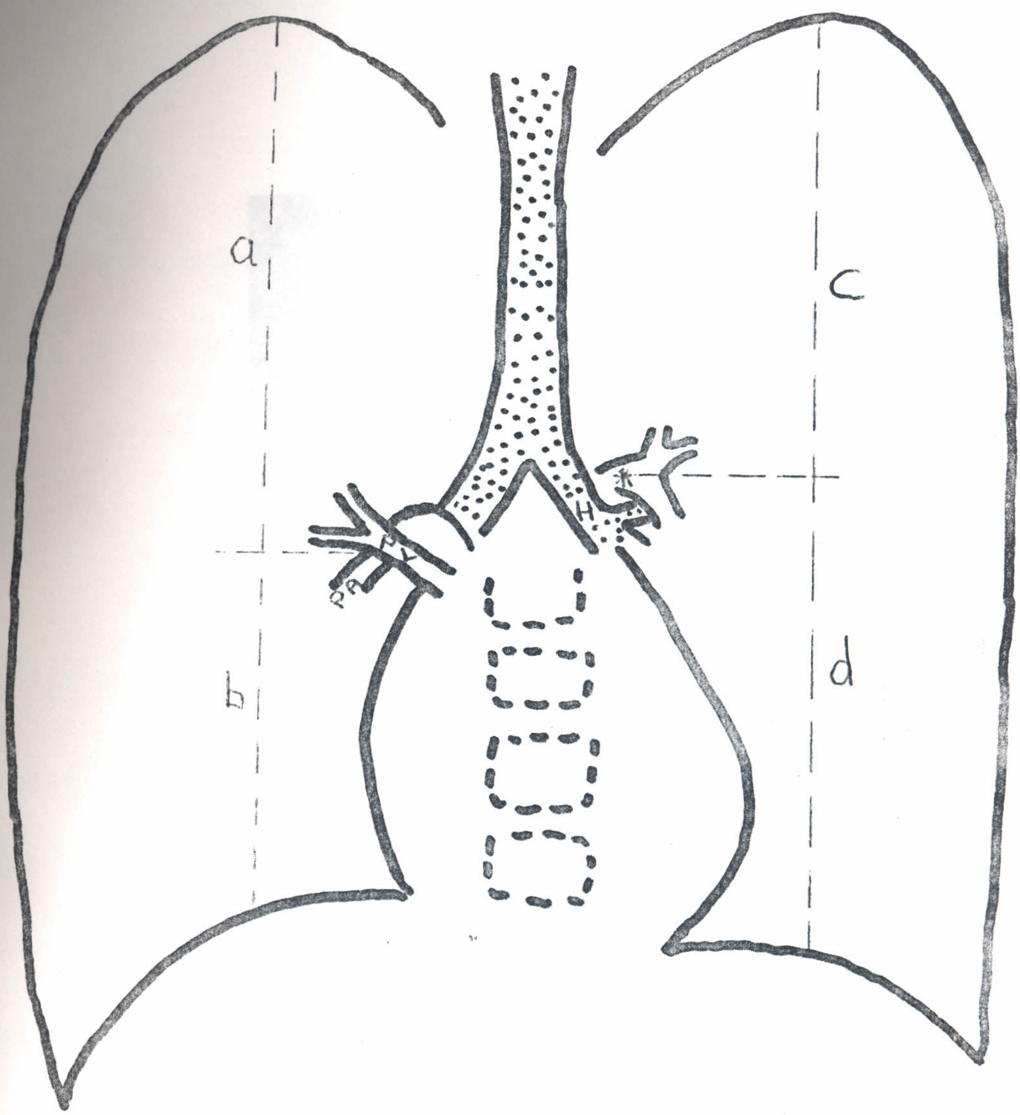
Hilar Height measurements

Left a________ b_________

Right a________ b_________

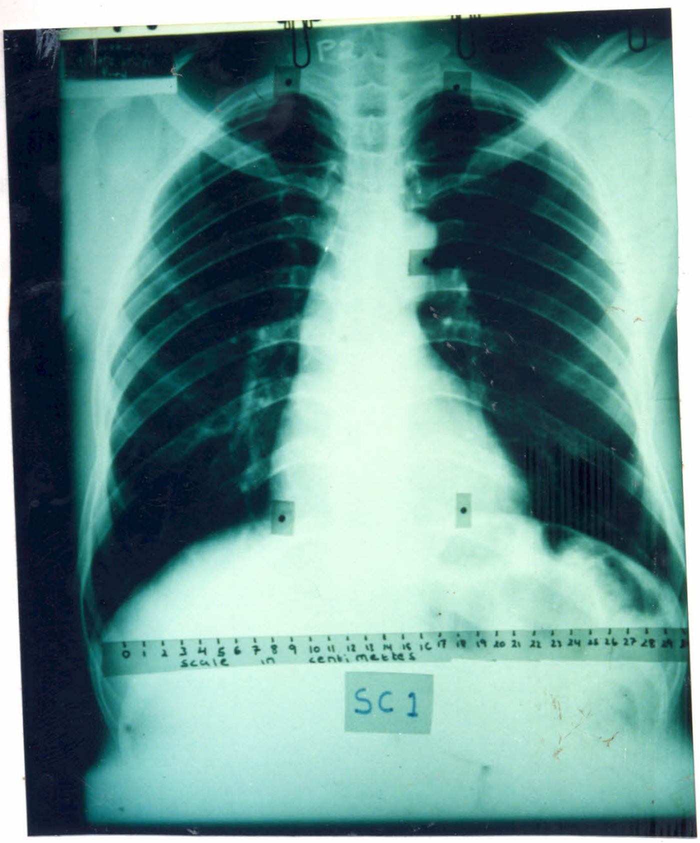
Comments (if Any)

DIAGRAMMATIC ILLUSTRATION OF THE HILAR HEIGHT RATIO (HHR) CALCULATION.



Diagrammatic illustration of the hilar height ratio (HHR) calculation. Right HHR =a/b; Left HHR = c/d. The lateral angle, designating the midpoint of the right hilus, is formed by the right upper lobe pulmonary vein (PV) crossing the right basal pulmonary artery (PA). The left hyparterial bronchus (H) must be identified in order to determine the midpoint of the left hilus(*).[7]

Routine chest X-ray of a healthy 24 year old male. Both hilar height ratios were normal.



SAMPLE SIZE DETERMINATION

The ideal sample size for this study would have ideally been estimated using the formulae given below

$$n = \frac{[z(1-a/2)]^2 p(1-p)}{d^2}$$

Where

n = approximate sample size

p = estimated Kenyan African population over 15 years of age

d = Required precision of confidence interval (10%)

z(1-a/2) = Standard deviation (1.96)

To carry out a study of the above magnitude would however have required a lot of resources as it would have had to be done country wide and have involved active recruitment of clients. This study was a pilot study whereby no active recruitment of clients took place. In future, with more resources a country wide study can be done to get a more statistically accurate HHR ratio. In the study by Homer he analysed 90 films [7] . In my study I analysed 189 chest films.

ANALYSIS OF DATA

The data collected was analysed by computer. The computer used was an IBM compatible and the package used was SPSS (statistical package for the social sciences).[13]

The data was entered into the computer using SPSS/DE a data entry module of SPSS. This data was cleaned and verified using this same package. The analysis was than done using SPSSPC the analysis module of SPSS. The final write was done using WORD PERFECT a word processing package.

The statistics that were used in the study are

1. **Mean**[13]

$$\bar{X} = \sum_{i=1}^{N} X_i/N$$

Where

$\bar{X}$= Mean

Σ=Sigma (i.e. Total)

N= Number of cases

X_i=Value of Variable (Here HHR) for the i^{th} case

(i.e. the sum of all values for HHR divided by the total number of cases)

2. **Variance**[13]

$$S^2 = \sum_{i=1}^{N} (X_i-\bar{X})^2/N-1$$

Where

$\sum$=Sigma (i.e. Total)

N=number of cases

X_i=Value of Variable(HHR) for the ith case

$\bar{X}$= Mean

(i.e. Variance is calculated by summing the squared differences from the mean for all observations and dividing by one less the number of observations)

3. **Standard deviation**[13]

This is the square root of the variance and is therefore the value denoted by S above.

4. **Standard error**[13]

This is the standard deviation of the sampling distribution of the mean and is given by

$S_x = S/N^{0.5}$

Where S is the sample standard deviation

N is the sample size (Raised to power 0.5 i.e. square root)

4. **T-Test**[13]

In analysing the data a statistical test was used to check whether the observed differences in the mean HHR were statistically significant. To do this the T-Test was used to test the null hypothesis that there is no statistical difference in the observed differences for the various subpopulations that were compared (i.e. Different age groups, Different sexes, Difference between left and right HHR). The formula that was used to calculate the t value is shown below.

$$t = \frac{\bar{X}_1 - \bar{X}_2}{(S_1^2/N_1 + S_2^2/N_2)^{0.5}}$$

Where

$\bar{X}_1$= Sample Mean of group 1 and $\bar{X}_2$=Sample mean of group 2

S_1^2=Variance of Group 1 and S_2^2= Variance of group 2

N_1= Sample size of group 1 and N_2=Sample size of group 2

The t value and the degrees of freedom (a function of the sample size in the two groups) is used in establishing the observed significance level. If this is less then 5%(0.05) then the above null hypothesis is rejected.

All the above calculations were done using the above mentioned SPSS package.

RESULTS

A total of 189 cases were collected and analysed in this study. Out of these cases 135 were males and 54 cases were female (Figure 1).

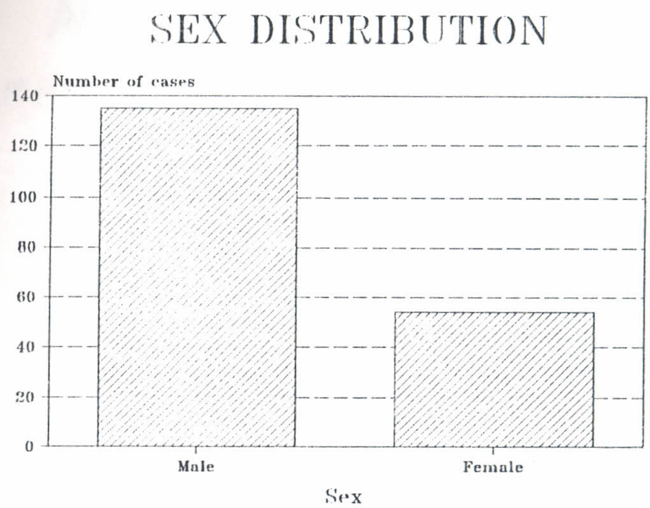


Figure 1

The age distribution for the whole group studied is illustrated in the table below (Table 1)

Table 1; Age distribution of the whole study group

Age Groups	Frequency	Percent	Valid Percent
15-24 Years	30	22.2	34.5
25-34 Years	33	24.4	37.9
35-44 Years	21	15.6	24.1
>=45	3	2.2	3.4
No age Given	48	35.6	-------
	Total	100	100

The mean age distribution of all the cases studied was 27.625 years, with a minimum of 15 years and a maximum of 47 years (standard deviation 7.965 years). 128 cases had the age given while 61 cases did not have their age given. The age distribution is illustrated graphically in figure 2 below

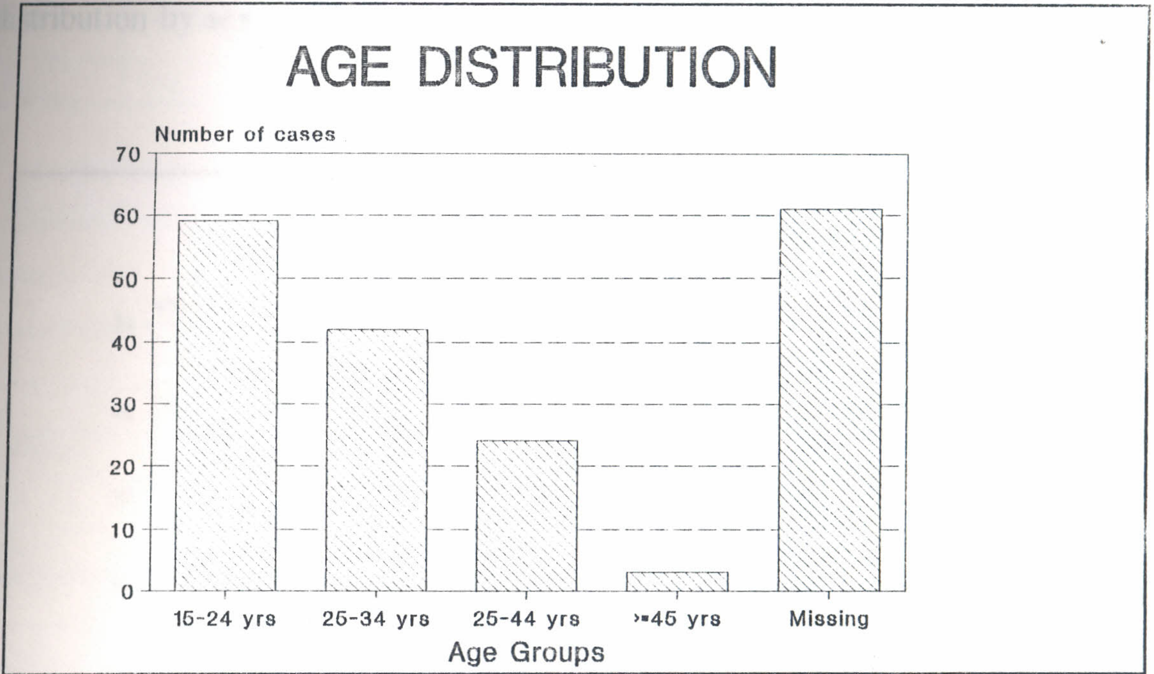


Figure 2

Hilar height ratios were calculated for all the 189 cases collected. It was necessary therefore to carry out statistical tests between the various age groups for the cases where the age was known and between the sexes to find out whether there was a statistical difference in the observed HHR means.

The mean male age was 29.517 years with a minimum of 15 years and a maximum of 47 years. Cases where the age was given were 87 while 48 did not have there ages listed. The mean female age was 23.610 years with a minimum of 15 years and a maximum of 41 years. 41 cases had there ages listed while 13 cases did not have there ages listed.

The t-test was performed on the various age groups each sex individually for both the left and the right Hilar Height ratio. A breakdown of the age distribution by sex is illustrated in figure 3.

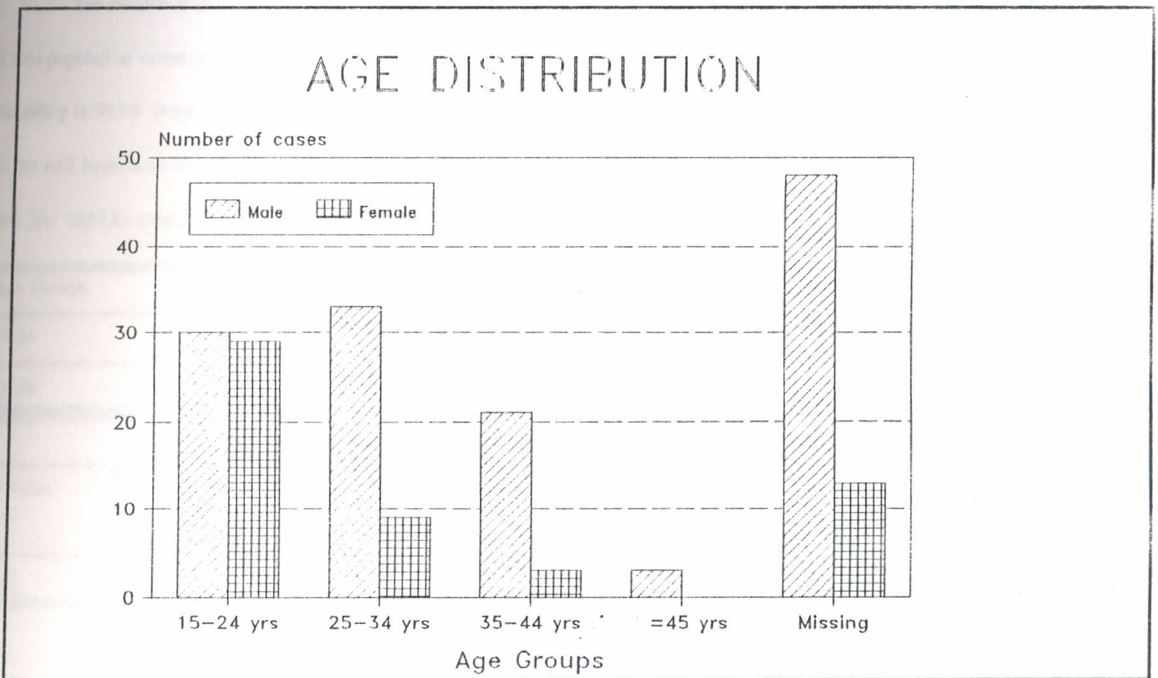


Figure 3

The t-test results for the male population is tabulated below

T-TEST RESULTS FOR THE MALE POPULATION.

Table 2a: MALE: Comparison of the mean Left HHR for age groups 15-24 and 25-34

Age Groups	Number of Cases	Mean (cm)	Standard Deviation	Standard Error
15-24	30	0.8536	0.084	0.015
25-34	33	0.8527	0.075	0.013

		Pooled Variance Estimate			Separate Variance Estimate		
F-Value	2-tail prob.	t-value	Degrees of freedom	2-tail prob.	t value	Degrees of freedom	2-tail Prob.
1.24	0.599	0.04	61	0.965	0.04	58.62	0.965

The F-value is used to test whether the two population variances are equal. If the probability of the F-value is small (<5%) then the two population variances are deemed to be different and the separate variance estimate for the t-value is used. In this case the F-value probability is 59.9% (>5%) and therefore the pooled variance estimate is used. The pooled variance estimate t-test probability is 96.5% and the null hypothesis that the 2 populations are the same is accepted.

Table 2b: MALE: Comparison of the mean Right HHR for age groups 15-24 and 25-34

Age Groups	Number of Cases	Mean	Standard Deviation	Standard Error
15-24	30	1.2060	0.119	0.022
25-34	33	1.1702	0.128	0.022

		Pooled Variance Estimate			Separate Variance Estimate		
F-Value	2-tail prob.	t-value	Degrees of freedom	2-tail prob.	t value	Degrees of freedom	2-tail Prob.
1.17	0.669	1.15	61	0.256	1.15	60.98	0.255

The F-value probability is 66.9%. The pooled variance estimate is used and the t-test probability is 25.6% (Null hypothesis accepted, there is no statistical difference between the 2 means).

Table 3a: MALE: Comparison of the mean Left HHR for age groups 15-24 and 35-44

Age Groups	Number of Cases	Mean	Standard Deviation	Standard Error
15-24	30	0.8536	0.084	0.015
35-44	21	0.8895	0.088	0.019

		Pooled Variance Estimate			Separate Variance Estimate		
F-Value	2-tail prob.	t-value	Degrees of freedom	2-tail prob.	t value	Degrees of freedom	2-tail Prob.
1.12	0.767	-1.48	49	0.147	-1.46	41.62	0.152

The F-value probability is 76.7% therefore the pooled variance estimate is used. The pooled variance estimate t-test probability is 14.7% (null hypothesis accepted).

Table 3b: MALE: Comparison of the mean Right HHR for age groups 15-24 and 35-44

Age Groups	Number of Cases	Mean	Standard Deviation	Standard Error
15-24	30	1.2060	0.119	0.022
35-44	21	1.1963	0.118	0.026

		Pooled Variance Estimate			Separate Variance Estimate		
F-Value	2-tail prob.	t-value	Degrees of freedom	2-tail prob.	t value	Degrees of freedom	2-tail Prob.
1.01	0.995	0.29	49	0.773	0.29	43.38	0.773

The F-value probability is 99.5%. The pooled variance estimate is used and the t-test probability is 77.3% (Null hypothesis accepted, there is no statistical difference between the 2 means).

Table 4a: MALE: Comparison of the mean Left HHR for age groups 25-34 and 35-44

Age Groups	Number of Cases	Mean	Standard Deviation	Standard Error
25-34	33	0.8527	0.075	0.013
35-44	21	0.8895	0.088	0.019

		Pooled Variance Estimate			Separate Variance Estimate		
F-Value	2-tail prob.	t-value	Degrees of freedom	2-tail prob.	t value	Degrees of freedom	2-tail Prob.
1.38	0.404	-1.64	52	0.108	-1.58	37.67	0.123

The F-value probability is 40.4% therefore the pooled variance estimate is used. The pooled variance estimate probability is 10.8 (null hypothesis accepted).

Table 4b: *MALE: Comparison* of the mean Right HHR for age groups 15-24 and 35-44

Age Groups	Number of Cases	Mean	Standard Deviation	Standard Error
15-24	33	1.1702	0.128	0.022
25-34	21	1.1963	0.118	0.026

		Pooled Variance Estimate			Separate Variance Estimate		
F-Value	2-tail prob.	t-value	Degrees of freedom	2-tail prob.	t value	Degrees of freedom	2-tail Prob.
1.19	0.698	-0.75	52	0.457	-0.76	45.43	0.449

The F-value probability is 69.8%. The pooled variance estimate is used and the probability is 45.7% (Null hypothesis accepted, there is no statistical difference between the 2 means).

The t-test was also carried out on the different female age groups as tabulated below;

Table 15a: FEMALE: Comparison of the mean Left HHR for age groups 15-24 and 25-34

Age Groups	Number of Cases	Mean	Standard Deviation	Standard Error
15-24	29	0.8399	0.087	0.016
25-34	9	0.8357	0.082	0.027

		Pooled Variance Estimate			Separate Variance Estimate		
F-Value	2-tail prob.	t-value	Degrees of freedom	2-tail prob.	t value	Degrees of freedom	2-tail Prob.
1.10	0.948	0.13	36	0.899	0.13	13.96	0.897

The F-value probability is 94.8% therefore the pooled variance estimate is used. The pooled variance estimate t-test probability is 89.9% (null hypothesis accepted).

Table 5b: FEMALE: Comparison of the mean Right HHR for age groups 15-24 and 25-34

Age Groups	Number of Cases	Mean	Standard Deviation	Standard Error
15-24	29	1.1966	0.114	0.021
25-34	9	1.2494	0.112	0.037

		Pooled Variance Estimate			Separate Variance Estimate		
F-Value	2-tail prob.	t-value	Degrees of freedom	2-tail prob.	t value	Degrees of freedom	2-tail Prob.
1.04	1.000	-1.22	36	0.231	-1.23	13.57	0.239

The F-value probability is 100%. The pooled variance estimate is used and the probability is 23.1% (Null hypothesis accepted, there is no statistical difference between the 2 means).

T-TEST RESULTS FOR THE FEMALE POPULATION

Table 6a: FEMALE: Comparison of the mean Left HHR for age groups 15-24 and 35-44

Age Groups	Number of Cases	Mean	Standard Deviation	Standard Error
15-24	29	0.8399	0.087	0.016
35-44	3	0.8443	0.105	0.061

		Pooled Variance Estimate			Separate Variance Estimate		
F-Value	2-tail prob.	t-value	Degrees of freedom	2-tail prob.	t value	Degrees of freedom	2-tail Prob.
1.47	0.493	-0.08	30	0.934	-0.07	2.29	0.949

The F-value probability is 49.3% therefore the pooled variance estimate is used. The pooled variance estimate t-test probability is 93.4% (null hypothesis accepted).

Table 6b: FEMALE: Comparison of the mean Right HHR for age groups 15-24 and 35-44

Age Groups	Number of Cases	Mean	Standard Deviation	Standard Error
15-24	29	1.1966	0.114	0.021
35-44	3	1.1553	0.084	0.048

		Pooled Variance Estimate			Separate Variance Estimate		
F-Value	2-tail prob.	t-value	Degrees of freedom	2-tail prob.	t value	Degrees of freedom	2-tail Prob.
1.85	0.822	0.61	30	0.549	0.78	2.83	0.494

The F-value probability is 82.2%. The pooled variance estimate is used and the probability is 54.9% (Null hypothesis accepted, there is no statistical difference between the 2 means).

Table 7a: FEMALE: Comparison of the mean Left HHR for age groups 25-34 and 35-44

Age Groups	Number of Cases	Mean	Standard Deviation	Standard Error
25-34	9	0.8357	0.082	0.027
35-44	3	0.8443	0.105	0.061

		Pooled Variance Estimate			Separate Variance Estimate		
F-Value	2-tail prob.	t-value	Degrees of freedom	2-tail prob.	t value	Degrees of freedom	2-tail Prob.
1.63	0.510	-0.15	10	0.885	-0.13	2.87	0.905

The F-value probability is 51% therefore the pooled variance estimate is used. The pooled variance estimate t-test probability is 88.5% (null hypothesis accepted).

Table 7b: FEMALE: Comparison of the mean Right HHR for age groups 25-34 and 35-44

Age Groups	Number of Cases	Mean	Standard Deviation	Standard Error
25-34	9	1.2494	0.112	0.037
35-44	3	1.1553	0.084	0.048

		Pooled Variance Estimate			Separate Variance Estimate		
F-Value	2-tail prob.	t-value	Degrees of freedom	2-tail prob.	t value	Degrees of freedom	2-tail Prob.
1.79	0.814	1.32	10	0.216	1.54	4.68	0.188

The F-value probability is 81.4%. The pooled variance estimate is used and the probability is 21.6% (Null hypothesis accepted, there is no statistical difference between the 2 means).

Because no statistical difference in the mean hilar height ratio was established between the age groups for the 2 sexes, it was considered appropriate to include the cases where no ages had been recorded. The t-test was then carried out on all the 189 cases to find out whether there was any difference in the mean hilar height ratio between the sexes. The results are tabulated below;

Table 8a: Comparison of the mean Left HHR for male and female

Age Groups	Number of Cases	Mean	Standard Deviation	Standard Error
Male	135	0.8625	0.081	0.007
Female	54	0.8446	0.083	0.011

		Pooled Variance Estimate			Separate Variance Estimate		
F-Value	2-tail prob.	t-value	Degrees of freedom	2-tail prob.	t value	Degrees of freedom	2-tail Prob.
1.04	0.848	1.36	187	0.175	1.35	96.11	0.180

The F-value probability is 84.8% therefore the pooled variance estimate is used. The pooled variance estimate t-test probability is 17.5% (null hypothesis accepted).

Table 8b: Comparison of the mean Right HHR for Male and female

Age Groups	Number of Cases	Mean	Standard Deviation	Standard Error
Male	135	1.1869	0.113	0.010
Female	54	1.2161	0.119	0.016

		Pooled Variance Estimate			Separate Variance Estimate		
F-Value	2-tail prob.	t-value	Degrees of freedom	2-tail prob.	t value	Degrees of freedom	2-tail Prob.
1.10	0.643	-1.58	187	0.116	-1.55	93.53	0.125

The F-value probability is 64.3%. The pooled variance estimate is used and the probability is 11.6% (Null hypothesis accepted, there is no statistical difference between the 2 means).

Therefore the mean HHR for both the left and right side of the chest show no statistical difference between the sexes.

COMPARISON BETWEEN THE LEFT HHR AND THE RIGHT HHR

The data for the hilar height ratio for both the left and the right side was pooled together and the t-test carried out to find out if their was a difference in the two ratios. The results are tabulated below.

Table 8b: Comparison of the Right HHR and the left HHR

Age Groups	Number of Cases	Mean	Standard Deviation	Standard Error
Left	189	0.8574	0.082	0.006
Right	189	1.1952	0.115	0.008

		Pooled Variance Estimate			Separate Variance Estimate		
F-Value	2-tail prob.	t-value	Degrees of freedom	2-tail prob.	t value	Degrees of freedom	2-tail Prob.
1.98	0.000	-32.90	376	0.000	-32.90	339.47	0.000

The F-value probability is 0.0%. The separate variance estimate is used and the probability is 0.0% (Null hypothesis rejected, there is a statistical difference between the 2 means).

There is therefore a statistical difference between the left and the right HHR.

THE LEFT HILAR HEIGHT RATIO

The measures of dispersion for the left hilar height ratio are tabulated below;

Mean	Median	mode	std. dev.	Range	Min	Max
0.857	0.857	0.958	0.082	0.346	0.654	1.000

A histogram of the distribution of the left HHR is illustrated in figure 4.

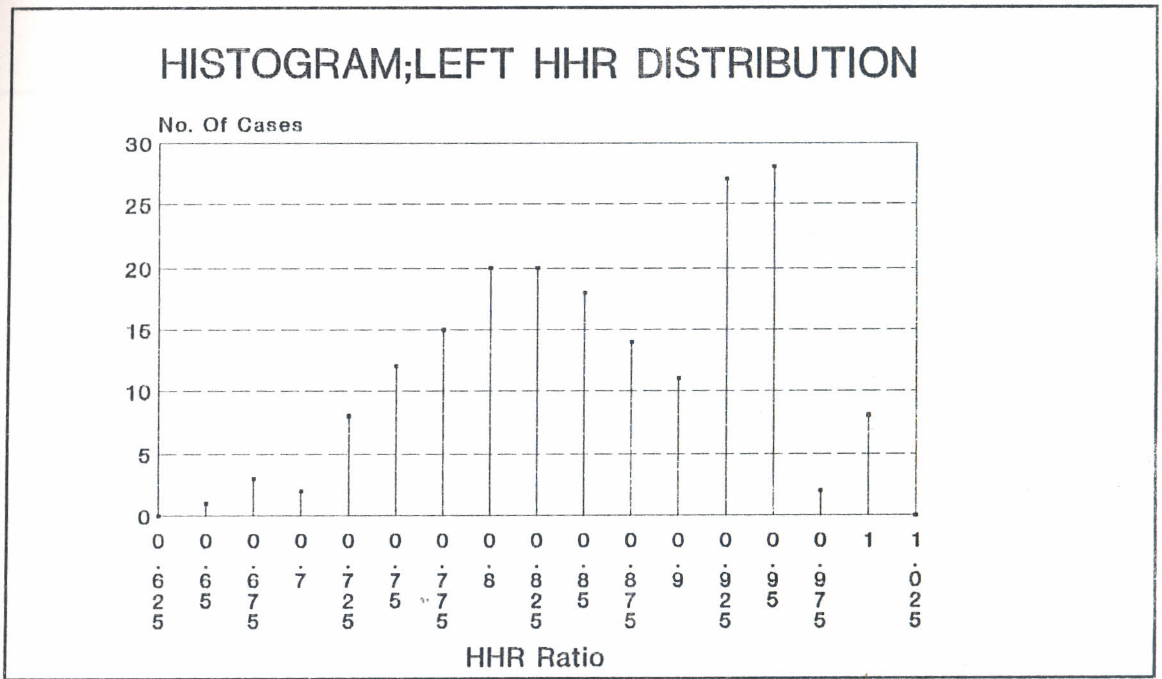


Figure 4

The 95% confidence limit is 2 standard deviation away from the mean. The **mean left hilar height ratio** is therefor **0.857** plus or minus 0.164. The left hilar height ratio was never larger then one.

THE RIGHT HILAR HEIGHT RATIO

The measures of dispersion for the right hilar height ratio are tabulated below;

Mean	Median	mode	std. dev.	Range	Min	Max
1.195	1.176	1.190	0.115	0.471	1.000	1.471

A histogram of the distribution of the right HHR is illustrated in figure 5.

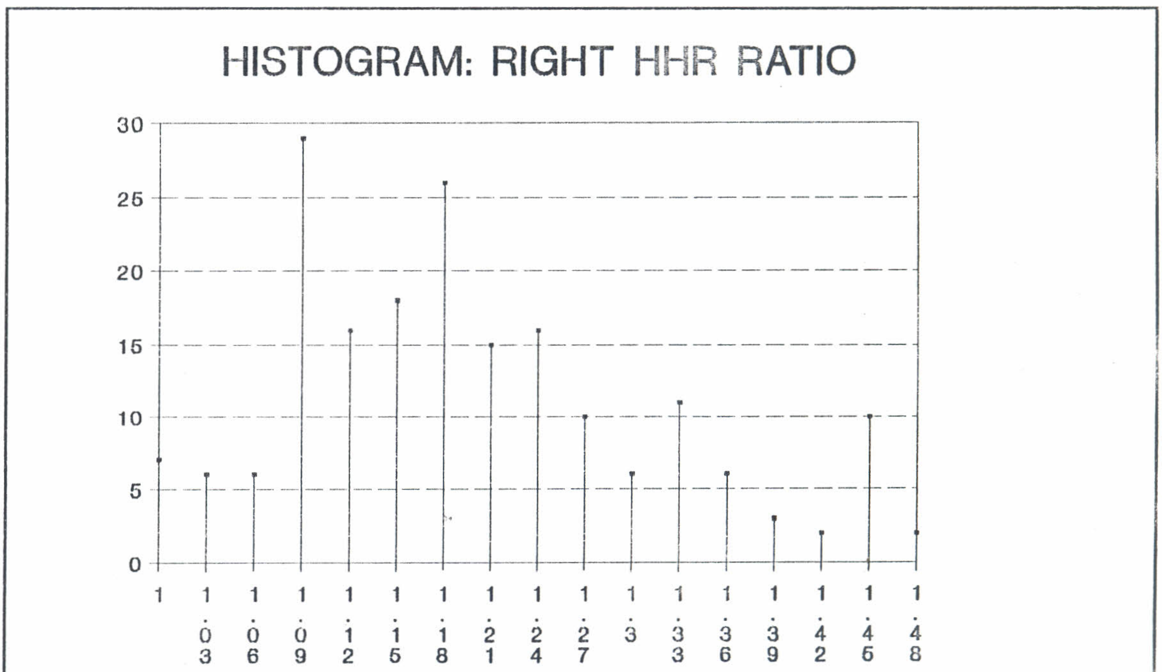


Figure 5

The 95% confidence limit is 2 standard deviation away from the mean. The **mean right hilar height ratio** is therefore **1.195** plus or minus 0.23. The right hilar height ratio was never less than one.

DISCUSSION

Hilar displacement is among the most important signs of pulmonary volume change. Robbins and Hale and later Lubert and Krause [9,10,11] established the usefulness of hilar positional change in evaluation of lobar pulmonary changes. While these authors detailed the characteristic hilar changes in each type of lobar collapse they did not attempt to quantify how much a hilus must be displaced before it is considered abnormal.

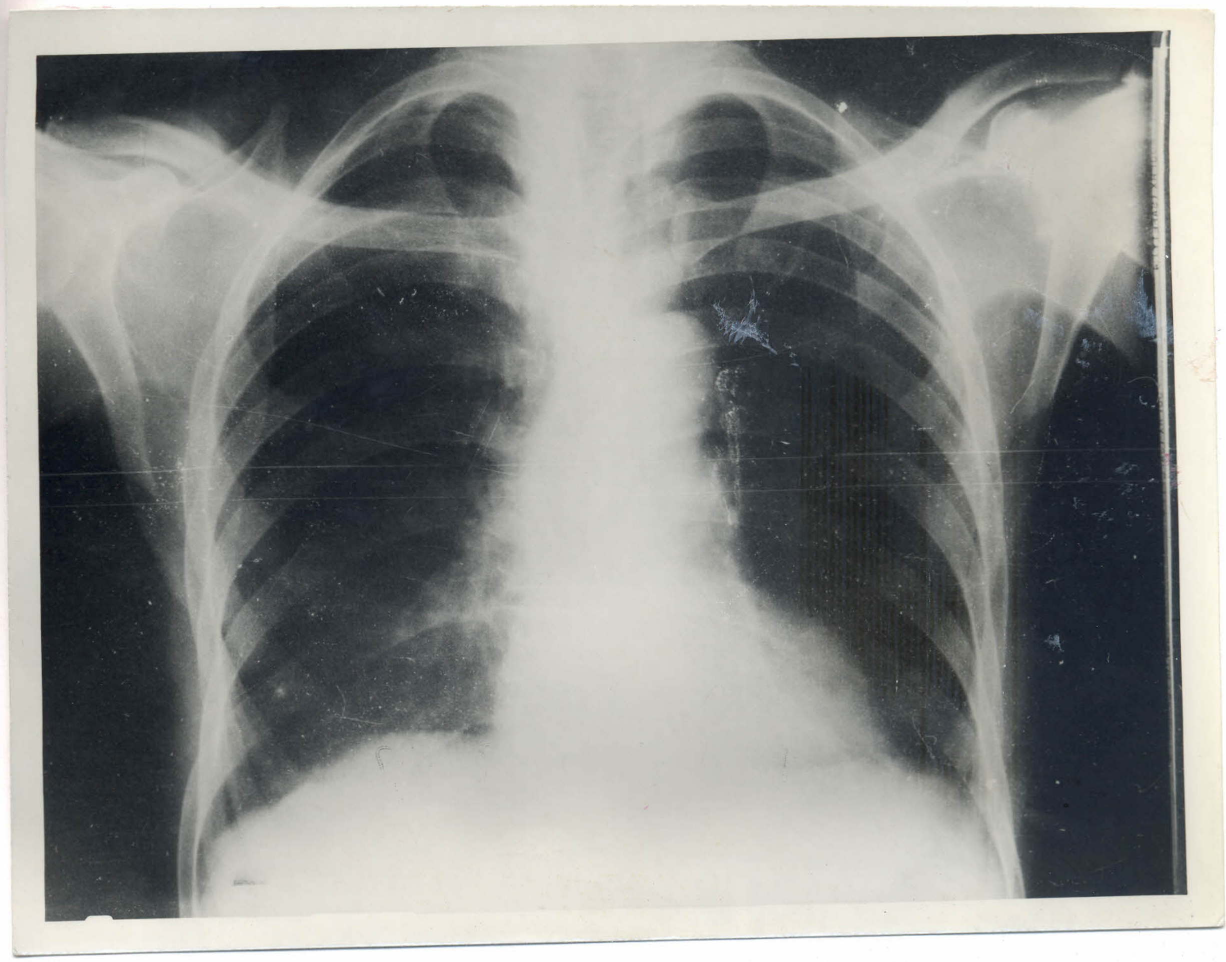
Felson in a survey of 500 radiographs found the left hilus to be higher than the right in 97% and at the same height in 3%. The right hilus was never higher then the left[3]. However when volume changes occur without change in relative hila heights these observations are of little help.

The HHR allows independent evaluation of each hemithorax without comparison with the contralateral side. It is easily derived and is useful in the detection of diverse pathologic processes.

Emphysema that predominantly involves the upper lobes leads to depression of both hila inferiorly. This increase both the left and the right HHR. This is a useful sign for the radiologist and calls for closer scrutiny of the radiograph[7].

Lobar volume collapse can be very subtle and in a setting where the radiologist is busy can sometimes be overlooked. Measurement of the HHR in every chest film can be very useful in alerting the radiologist to a pathologic process going on in the lung. Examples of patients with lobar collapse are given in the next pages.

Patient with collapse of the left lower lobe, The HHR is markedly altered on the left side. Left HHR=1.47 (the mean Left HHR =0.857 plus or minus 0.164, this value is greater than 2 standard deviation from the mean and is obviously abnormal)



Patient with collapse of the right lower zone. The HHR is markedly altered on the right side. Right HHR=2.31 (the mean right HHR=1.195 plus or minus 0.23, this value is greater than 2 standard deviation from the mean and is therefore abnormal).

An abnormal HHR may be caused by processes other than pulmonary volume change. Any disease that elevates the diaphragm alters the HHR. It can therefore be useful in the detection of a subphrenic abscess. A subpulmonic effusion can also alter the HHR.

There are some situations where the HHR cannot be applied. This ratio has been arrived at using erect films of adequate inspiratory effort. Supine and decubitus films can alter diaphragmatic heights due to positional effect alone. In many portable films the patients may not be totally upright and the inspiratory effort may not be adequate. Rib cage deformities can alter this ratio and reduce its usefulness. Patients with past history of diseases like tuberculosis may have altered HHR due to healing with fibrosis of lung tissue..

While an abnormal HHR should not be construed as absolute evidence of pathology, its recognition should prompt closer scrutiny for an underlying explanation.

CONCLUSION

In normal patients the right hilus is situated in the lower half of its hemithorax while the left hilus is situated in the upper half of its hemithorax. The left hilar height ratio was found to be 0.857 plus or minus 0.164 (95% confidence limits). It was never greater than one. The right hilar height ratio was found to be 1.195 plus ar minus 0.23 (95% confidence limits) and it was never less than one.

An abnormal HHR is not always an absolute sign of disease but it should cause the radiologist to carefully scrutinise a chest radiograph for underlying pathology.

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Finally I would like to thank members of my family and friends who extended valuable support, moral or otherwise, during the duration of this study.

APPENDIX (Input & Output from spss)

The appendices contain a listing of the raw data from spss and the various frequencies and t-tests done in the analysis of data.

```
GET /FILE 'PWANF2.SYS'.
report /FORMAT AUTOMATIC LIST /VARIABLES CASE AGE XNUM SEX LHHRA LHHRB RHHRA
RHHRB LHHR RHHR RAGE(label).
REPORT problem requires 4088 bytes of memory to store specifications
for this task.
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SPSS/PC+ PAGE 1

Case Number	Age	X-ray Number	Sex	a Left HHR (cm)	b Left HHR (cm)	a Right HHR (cm)	b Right HHR (cm)	LHHR	RHHR	RAGE
1	24	2741.94	1	9.0	13.5	12.0	11.0	.67	1.09	15-24 years
2	36	2684.94	1	8.5	12.0	10.0	9.5	.71	1.05	35-44 years
3	27	2810.94	2	10.0	14.0	12.5	10.0	.71	1.25	25-34 Years
4	25	3160.94	1	10.0	12.5	13.0	12.0	.80	1.08	25-34 Years
5	28	0.00	1	10.0	13.0	10.5	9.0	.77	1.17	25-34 Years
6	24	3879.94	1	11.5	16.0	14.0	11.0	.72	1.27	15-24 years
7	27	60211.93	2	8.5	10.5	10.0	7.5	.81	1.33	25-34 Years
8	-1	4047.94	1	9.5	11.5	11.5	9.0	.83	1.28	.
9	34	3481.94	1	11.5	15.0	14.0	12.0	.77	1.17	25-34 Years
10	16	2901.94	1	10.0	11.5	10.5	10.5	.87	1.00	15-24 years
11	20	7367.93	1	11.5	12.0	13.0	9.0	.96	1.44	15-24 years
12	-1	7372.92	1	11.0	16.0	13.0	12.0	.69	1.08	.
13	-1	7459.93	1	11.5	15.0	13.0	11.0	.77	1.18	.
14	15	6585.93	1	9.5	12.0	11.0	9.0	.79	1.22	15-24 years
15	26	6825.93	2	9.5	11.0	11.5	8.0	.86	1.44	25-34 Years
16	17	6999.93	2	8.5	11.5	10.0	9.0	.74	1.11	15-24 years
17	-1	7296.93	1	10.0	12.0	11.5	8.5	.83	1.35	.
18	23	7323.93	2	10.0	12.0	11.5	10.5	.83	1.10	15-24 years
19	-1	7025.94	2	12.5	13.0	14.5	10.0	.96	1.45	.
20	16	5147.93	1	10.5	12.5	13.0	9.5	.84	1.37	15-24 years
21	24	5267.93	1	10.5	13.5	12.0	11.0	.78	1.09	15-24 years
22	20	5152.93	1	11.5	15.0	14.0	11.0	.77	1.27	15-24 years
23	23	4888.93	2	9.5	10.5	10.5	8.5	.90	1.24	15-24 years
24	25	4503.93	1	11.5	13.5	13.5	11.0	.85	1.23	25-34 Years
25	-1	4505.93	1	10.5	12.5	11.0	10.0	.84	1.10	.
26	23	4710.93	1	10.5	13.0	12.5	9.5	.81	1.32	15-24 years
27	22	4429.93	2	10.5	11.5	11.5	10.0	.91	1.15	15-24 years
28	32	4432.93	2	9.5	12.0	11.0	8.5	.79	1.29	25-34 Years
29	24	4433.93	1	11.0	12.0	11.5	11.0	.92	1.05	15-24 years
30	24	4442.93	2	10.0	13.5	11.5	10.5	.74	1.10	15-24 years
31	-1	4425.93	2	10.5	13.5	12.0	10.5	.78	1.14	.
32	22	4386.93	2	10.5	13.0	12.0	10.0	.81	1.20	15-24 years

Case Number	Age	X-ray Number	Sex	a Left HHR (cm)	b Left HHR (cm)	a Right HHR (cm)	b Right HHR (cm)	LHHR	RHHR	RAGE
33	24	4371.93	1	11.0	12.0	12.5	9.0	.92	1.39	15-24 years
34	27	4349.93	1	11.0	14.5	13.0	10.5	.76	1.24	25-34 Years
35	23	4343.93	2	11.5	14.5	14.0	11.0	.79	1.27	15-24 years
36	23	4342.93	2	9.5	10.0	10.5	8.5	.95	1.24	15-24 years
37	18	4138.93	1	11.0	11.5	12.0	10.5	.96	1.14	15-24 years
38	-1	3352.93	1	12.0	13.0	12.0	10.0	.92	1.20	.
39	37	3957.94	2	11.5	12.5	12.5	10.0	.92	1.25	35-44 years
40	15	9661.93	1	9.5	10.5	10.5	9.0	.90	1.17	15-24 years
41	26	10643.93	2	10.0	12.5	11.0	9.0	.80	1.22	25-34 Years
42	24	10195.93	1	11.0	12.0	12.5	11.5	.92	1.09	15-24 years
43	27	9788.93	1	10.5	13.0	12.5	10.5	.81	1.19	25-34 Years
44	-1	5898.94	1	9.0	10.5	10.0	9.0	.86	1.11	.
45	-1	4693.94	1	11.5	12.0	12.0	11.0	.96	1.09	.
46	-1	4638.94	2	10.0	12.0	11.5	8.0	.83	1.44	.
47	28	6538.94	1	9.5	14.0	12.0	10.0	.68	1.20	25-34 Years
48	-1	6537.94	2	10.0	11.5	10.5	10.0	.87	1.05	.
49	-1	4075.94	1	12.0	13.0	12.5	10.0	.92	1.25	.
50	26	4044.94	2	10.0	10.5	10.0	9.0	.95	1.11	25-34 Years
51	-1	65482.93	1	12.0	14.5	14.0	12.0	.83	1.17	.
52	-1	2742.94	1	10.0	12.5	11.5	10.0	.80	1.15	.
53	15	3959.94	2	10.0	11.0	11.0	9.0	.91	1.22	15-24 years
54	20	3997.94	1	11.5	14.5	12.5	10.5	.79	1.19	15-24 years
55	-1	3965.94	1	12.0	13.5	12.5	11.5	.89	1.09	.
56	24	3879.94	1	12.5	13.5	13.5	11.5	.93	1.17	15-24 years
57	-1	2746.94	1	10.0	13.5	12.0	10.0	.74	1.20	.
58	23	2615.94	1	11.5	12.0	13.0	10.0	.96	1.30	15-24 years
59	-1	2741.94	1	10.5	12.0	12.5	10.5	.88	1.19	.
60	-1	4773.94	1	10.0	12.5	12.0	10.0	.80	1.20	.
61	-1	8062.94	2	10.0	10.5	11.0	8.0	.95	1.38	.
62	-1	4716.93	2	9.0	12.0	11.0	9.5	.75	1.16	.
63	41	14163.95	1	11.0	12.0	12.5	8.5	.92	1.47	35-44 years
64	38	14136.95	1	12.0	12.5	13.0	11.0	.96	1.18	35-44 years
65	34	14138.95	1	9.0	9.5	9.5	9.0	.95	1.06	25-34 Years
66	33	14146.95	1	11.0	13.0	12.0	11.5	.85	1.04	25-34 Years
67	29	14149.95	1	11.0	14.5	12.5	12.0	.76	1.04	25-34 Years
68	28	14142.95	1	13.0	14.5	13.0	12.0	.90	1.08	25-34 Years
69	40	14144.95	1	12.0	13.0	12.5	10.0	.92	1.25	35-44 years
70	38	14143.95	1	12.0	12.5	12.5	10.0	.96	1.25	35-44 years
71	42	14141.95	1	13.0	15.5	14.5	13.0	.84	1.12	35-44 years
72	33	14139.95	1	11.5	12.0	12.0	9.5	.96	1.26	25-34 Years
73	33	14137.95	1	12.0	14.0	13.0	12.0	.86	1.08	25-34 Years
74	38	13477.95	1	11.0	11.0	12.0	9.0	1.00	1.33	35-44 years
75	28	14140.95	1	11.0	11.5	10.5	10.5	.96	1.00	25-34 Years
76	45	14160.95	1	11.5	12.0	11.5	9.5	.96	1.21	45.00
77	47	13471.95	1	10.5	14.5	12.0	12.0	.72	1.00	47.00
78	-1	13476.95	1	11.0	12.0	12.0	9.5	.92	1.26	.
79	40	14088.95	1	12.0	14.0	13.5	11.5	.86	1.17	35-44 years
80	-1	13478.95	1	11.5	13.0	12.0	11.0	.88	1.09	.
81	-1	14091.95	1	12.0	13.0	13.0	12.0	.92	1.08	.
82	34	14094.95	1	11.5	12.5	12.5	11.5	.92	1.09	25-34 Years

Case Number	Age	X-ray Number	Sex	a Left HHR (cm)	b Left HHR (cm)	a Right HHR (cm)	b Right HHR (cm)	LHHR	RHHR	RAGE
83	42	14095.95	1	11.5	12.0	13.5	10.5	.96	1.29	35-44 years
84	-1	14099.95	1	14.0	16.5	15.0	13.5	.85	1.11	.
85	-1	14100.95	1	13.5	14.0	14.0	10.5	.96	1.33	.
86	-1	14104.95	1	12.0	13.5	12.0	11.0	.89	1.09	.
87	-1	14083.95	1	11.5	11.5	12.0	9.0	1.00	1.33	.
88	-1	14108.95	1	12.0	13.0	13.0	10.5	.92	1.24	.
89	35	14089.95	1	13.0	13.5	13.0	10.5	.96	1.24	35-44 years
90	34	14086.95	1	11.5	12.5	12.0	10.5	.92	1.14	25-34 Years
91	-1	14105.95	1	10.0	11.0	11.0	9.0	.91	1.22	.
92	-1	14092.95	1	12.5	13.0	13.5	11.5	.96	1.17	.
93	31	14085.95	1	11.5	13.0	13.0	10.0	.88	1.30	25-34 Years
94	-1	14106.95	1	13.0	14.0	13.5	12.0	.93	1.13	.
95	-1	14087.95	1	12.5	13.5	12.5	10.5	.93	1.19	.
96	42	14084.95	1	11.5	12.5	12.0	10.5	.92	1.14	35-44 years
97	33	13473.95	1	11.5	12.0	12.5	10.0	.96	1.25	25-34 Years
98	-1	13475.95	1	11.5	12.0	12.5	10.5	.96	1.19	.
99	-1	13474.95	1	10.0	10.5	11.0	9.5	.95	1.16	.
100	-1	13479.95	1	12.0	13.0	12.5	11.5	.92	1.09	.
101	-1	14082.95	1	12.0	15.0	12.5	12.0	.80	1.04	.
102	47	14096.95	1	12.0	13.0	13.0	11.0	.92	1.18	47.00
103	36	14165.95	1	10.5	12.0	11.0	9.0	.88	1.22	35-44 years
104	31	14152.95	1	13.0	16.5	13.5	12.5	.79	1.08	25-34 Years
105	33	14159.95	1	12.0	13.0	12.0	10.5	.92	1.14	25-34 Years
106	28	14154.95	1	10.5	13.0	11.5	10.5	.81	1.10	25-34 Years
107	32	14150.95	1	12.0	14.5	13.0	11.5	.83	1.13	25-34 Years
108	37	14151.95	1	13.0	14.0	13.0	12.0	.93	1.08	35-44 years
109	41	14153.95	1	13.0	14.0	13.5	13.0	.93	1.04	35-44 years
110	36	14147.95	1	10.0	10.0	11.0	8.0	1.00	1.38	35-44 years
111	32	14158.95	1	10.0	12.0	11.0	8.5	.83	1.29	25-34 Years
112	34	14161.95	1	12.5	12.5	13.0	9.0	1.00	1.44	25-34 Years
113	29	14157.95	1	11.0	12.0	11.5	8.5	.92	1.35	25-34 Years
114	30	14156.95	1	11.0	13.5	11.0	11.0	.81	1.00	25-34 Years
115	33	14155.95	1	10.5	13.5	12.0	11.0	.78	1.09	25-34 Years
116	15	5915.93	2	11.0	11.5	11.0	9.5	.96	1.16	15-24 years
117	40	14175.95	1	12.5	14.5	13.0	12.5	.86	1.04	35-44 years
118	34	14148.95	1	12.0	12.5	13.0	9.0	.96	1.44	25-34 Years
119	38	14139.95	1	9.0	13.0	10.0	9.5	.69	1.05	35-44 years
120	33	14320.95	1	11.0	13.5	11.0	11.0	.81	1.00	25-34 Years
121	35	14321.95	1	11.0	11.5	11.5	9.0	.96	1.28	35-44 years
122	40	9912.94	1	9.5	11.0	11.0	9.0	.86	1.22	35-44 years
123	-1	9896.94	1	12.0	12.5	13.5	9.5	.96	1.42	.
124	18	15336.94	2	9.5	10.0	11.0	8.5	.95	1.29	15-24 years
125	20	17524.94	2	9.0	9.5	10.0	8.0	.95	1.25	15-24 years
126	33	19094.94	1	10.0	12.0	12.0	8.5	.83	1.41	25-34 Years
127	21	3835.92	2	11.0	12.5	12.0	9.0	.88	1.33	15-24 years
128	20	7373.92	1	11.0	13.0	12.0	10.5	.85	1.14	15-24 years
129	-1	7837.92	1	11.0	14.0	12.5	10.5	.79	1.19	.
130	19	8673.92	2	10.0	13.0	11.5	9.5	.77	1.21	15-24 years
131	-1	2746.94	1	10.5	12.5	11.5	10.5	.84	1.10	.
132	-1	7323.92	1	11.0	13.0	12.5	11.0	.85	1.14	.
133	-1	7036.92	1	12.5	16.0	14.0	13.0	.78	1.08	.

Case Number	Age	X-ray Number	Sex	a Left HHR (cm)	b Left HHR (cm)	a Right HHR (cm)	b Right HHR (cm)	LHHR	RHHR	RAGE
134	39	16825.93	1	9.0	11.0	10.5	8.5	.82	1.24	35-44 years
135	-1	8180.94	1	11.0	14.5	12.5	11.5	.76	1.09	.
136	-1	291.94	1	10.5	14.5	12.5	10.5	.72	1.19	.
137	-1	8194.94	2	9.0	10.5	10.0	8.5	.86	1.18	.
138	-1	8258.94	1	9.0	11.0	11.5	8.0	.82	1.44	.
139	-1	8259.94	1	9.5	11.5	10.5	9.5	.83	1.11	.
140	-1	8268.94	2	9.5	11.5	11.5	8.0	.83	1.44	.
141	-1	8404.94	2	10.5	12.0	11.5	9.5	.88	1.21	.
142	-1	8304.94	1	11.5	12.0	12.0	9.0	.96	1.33	.
143	-1	8405.94	1	11.0	14.0	12.5	10.5	.79	1.19	.
144	16	5006.93	2	9.0	10.5	10.0	9.0	.86	1.11	15-24 years
145	-1	4425.93	2	11.0	13.5	12.0	10.0	.81	1.20	.
146	24	4391.93	2	9.5	9.5	11.0	7.5	1.00	1.47	15-24 years
147	24	5703.93	2	8.5	13.0	10.5	9.5	.65	1.11	15-24 years
148	-1	5753.93	2	10.5	13.5	12.5	11.0	.78	1.14	.
149	-1	11784.94	2	9.5	10.5	10.5	9.0	.90	1.17	.
150	-1	14017.94	1	10.0	10.0	11.5	8.5	1.00	1.35	.
151	25	10094.94	1	10.0	12.0	12.0	9.0	.83	1.33	25-34 Years
152	36	10102.94	1	12.0	16.0	13.5	12.5	.75	1.08	35-44 years
153	-1	12041.94	1	11.5	15.0	14.0	12.5	.77	1.12	.
154	-1	5450.93	1	9.0	12.0	10.0	9.0	.75	1.11	.
155	22	4950.93	1	10.5	13.5	12.5	10.5	.78	1.19	15-24 years
156	27	4349.93	1	11.5	14.0	12.0	11.5	.82	1.04	25-34 Years
157	23	4343.93	2	12.0	15.0	14.0	11.0	.80	1.27	15-24 years
158	18	4138.93	1	10.0	13.0	12.0	11.0	.77	1.09	15-24 years
159	24	4433.93	1	11.0	12.0	12.0	11.0	.92	1.09	15-24 years
160	32	4432.93	2	9.5	12.5	10.5	9.5	.76	1.11	25-34 Years
161	25	4428.93	2	10.5	12.0	12.0	9.0	.88	1.33	25-34 Years
162	22	4429.93	2	10.5	12.0	11.5	10.0	.88	1.15	15-24 years
163	25	4366.93	2	10.5	11.0	11.0	9.5	.95	1.16	25-34 Years
164	23	4342.93	2	9.0	10.5	10.0	8.5	.86	1.18	15-24 years
165	24	4442.93	2	10.5	13.0	11.0	10.5	.81	1.05	15-24 years
166	22	4481.93	2	10.0	11.0	11.5	8.0	.91	1.44	15-24 years
167	25	4503.93	1	11.5	13.5	13.0	11.5	.85	1.13	25-34 Years
168	39	5222.93	2	8.0	9.0	9.0	8.0	.89	1.13	35-44 years
169	24	5267.93	1	11.0	13.0	12.0	10.5	.85	1.14	15-24 years
170	41	5322.93	2	10.5	14.5	12.0	11.0	.72	1.09	35-44 years
171	18	5497.93	1	8.5	10.5	10.0	8.0	.81	1.25	15-24 years
172	-1	4318.93	2	11.5	11.5	12.5	9.5	1.00	1.32	.
173	22	21943.93	1	10.0	11.5	11.0	9.5	.87	1.16	15-24 years
174	18	4144.93	2	9.5	12.5	12.0	9.5	.76	1.26	15-24 years
175	-1	14020.94	1	11.0	13.5	12.5	10.0	.81	1.25	.
176	-1	8270.94	1	12.5	13.5	14.0	11.0	.93	1.27	.
177	19	7382.92	1	11.0	11.5	12.5	9.5	.96	1.32	15-24 years
178	21	7104.92	1	11.0	11.0	11.5	10.5	1.00	1.10	15-24 years
179	19	7396.92	2	10.0	11.0	11.5	8.5	.91	1.35	15-24 years
180	21	4387.93	2	9.0	12.5	11.0	11.0	.72	1.00	15-24 years
181	17	6999.93	2	9.0	12.0	10.0	9.0	.75	1.11	15-24 years
182	23	4888.93	2	9.5	11.5	10.5	9.0	.83	1.17	15-24 years
183	23	50008.93	2	8.0	11.0	10.0	8.5	.73	1.18	15-24 years
184	21	5076.93	1	10.5	14.5	12.0	10.5	.72	1.14	15-24 years

Case Number	Age	X-ray Number	Sex	a Left HHR (cm)	b Left HHR (cm)	a Right HHR (cm)	b Right HHR (cm)	LHHR	RHHR	RAGE
185	16	5147.93	1	11.0	12.0	13.0	9.0	.92	1.44	15-24 years
186	17	6109.93	1	11.0	13.5	12.5	10.5	.81	1.19	15-24 years
187	21	6108.93	2	8.5	10.5	10.0	10.0	.81	1.00	15-24 years
188	-1	6185.93	1	8.5	10.5	10.0	8.5	.81	1.18	.
189	20	20987.93	1	10.5	12.0	11.5	8.5	.88	1.35	15-24 years

REPORT problem required an additional 792 bytes of memory.

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This procedure was completed at 20:45:17
set /more on /listing 'spss.lis'.

(-1 under the age refers to age unknown.)
(under sex 1=male 2=female)

SEX DISTRIBUTION OF THE SAMPLE STUDIED

FREQUENCIES /VARIABLES SEX /BARCHART.

***** Memory allows a total of 10734 Values, accumulated across all Variables.
There also may be up to 1342 Value Labels for each Variable.

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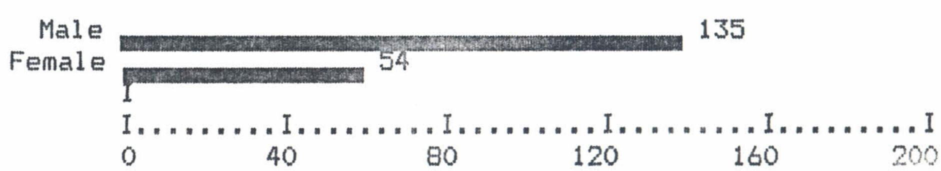
SEX Sex

Value Label	Value	Frequency	Percent	Valid Percent	Cum Percent
Male	1	135	71.4	71.4	71.4
Female	2	54	28.6	28.6	100.0
	TOTAL	189	100.0	100.0	



Valid Cases 189 Missing Cases 0

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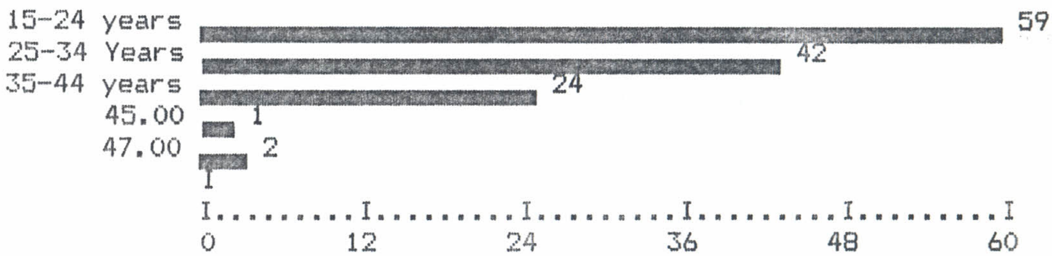
This procedure was completed at 22:58:36
set /more off /listing 'spss.lis'.

AGE DISTRIBUTION OF THE STUDY GROUP

```
GET /FILE 'PWANF2.SYS'.
set /more off /listing 'freqage.lis'.
FREQUENCIES /VARIABLES rage /BARCHART.
```

RAGE

Value Label	Value	Frequency	Percent	Valid Percent	Cum Percent
15-24 years	1.00	59	31.2	46.1	46.1
25-34 Years	2.00	42	22.2	32.8	78.9
35-44 years	3.00	24	12.7	18.8	97.7
	45.00	1	.5	.8	98.4
	47.00	2	1.1	1.6	100.0
	.	61	32.3	MISSING	
	TOTAL	189	100.0	100.0	



RAGE

Valid Cases 128 Missing Cases 61

This procedure was completed at 23:01:44

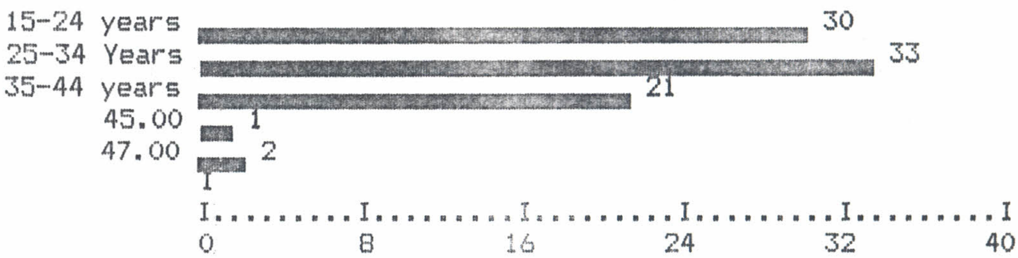
```
set /more off /listing 'spss.lis'.
```

MALE AGE DISTRIBUTION

```
GET /FILE 'PWANF2.SYS'.
select if (sex=1).
FREQUENCIES /VARIABLES rage /BARCHART.
```

RAGE

Value Label	Value	Frequency	Percent	Valid Percent	Cum Percent
15-24 years	1.00	30	22.2	34.5	34.5
25-34 Years	2.00	33	24.4	37.9	72.4
35-44 years	3.00	21	15.6	24.1	96.6
	45.00	1	.7	1.1	97.7
	47.00	2	1.5	2.3	100.0
	.	48	35.6	MISSING	
	TOTAL	135	100.0	100.0	



RAGE

Valid Cases 87 Missing Cases 48

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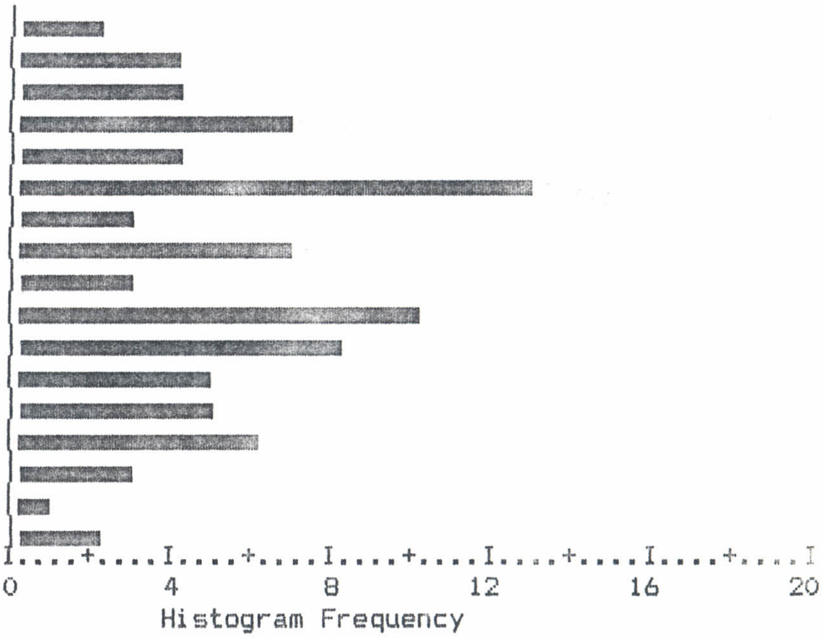
This procedure was completed at 23:09:00
set /more off /listing 'spss.lis'.

MALE AGE DISTRIBUTION OF THE SAMPLE

```
GET /FILE 'PWANF2.SYS'.
select if (sex=1).
FREQUENCIES /VARIABLES age /FORMAT /STATISTICS /HISTOGRAM.
```

AGE Age

Count	Midpoint
2	15
4	17
4	19
7	21
4	23
13	25
3	27
7	29
3	31
10	33
8	35
5	37
5	39
6	41
3	43
1	45
2	47




```
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AGE        Age

Mean          29.517     Std Dev        8.167     Minimum       15.000
Maximum       47.000

Valid Cases       87     Missing Cases     48
```

This procedure was completed at 23:32:41

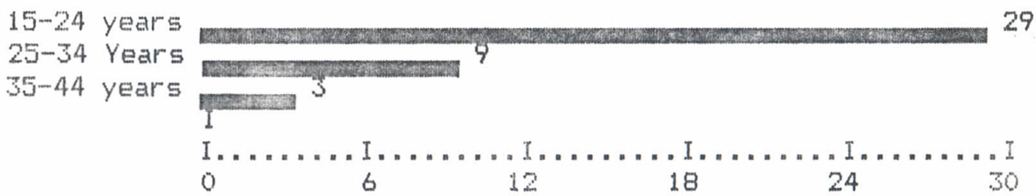
```
set /more off /listing 'spss.lis'.
```

FEMALE AGE DISTIBUTION

```
GET /FILE 'PWANF2.SYS'.
select if (sex=2).
FREQUENCIES /VARIABLES rage /BARCHART.
```

RAGE

Value Label	Value	Frequency	Percent	Valid Percent	Cum Percent
15-24 years	1.00	29	53.7	70.7	70.7
25-34 Years	2.00	9	16.7	22.0	92.7
35-44 years	3.00	3	5.6	7.3	100.0
	.	13	24.1	MISSING	
	TOTAL	54	100.0	100.0	



Valid Cases 41 Missing Cases 13

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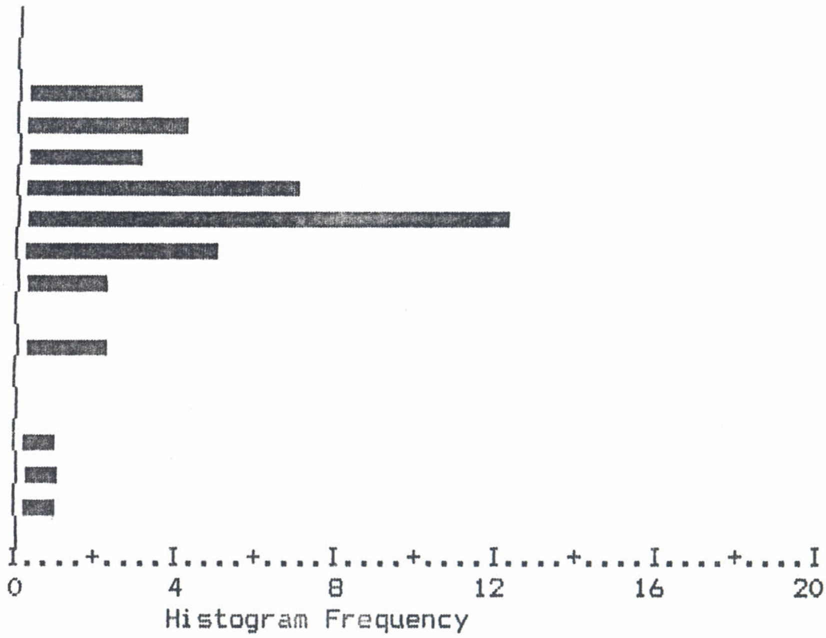
This procedure was completed at 23:13:47
set /more off /listing 'spss.lis'.

FEMALE AGE DISTRIBUTION OF THE SAMPLE

```
GET /FILE 'PWANF2.SYS'.
select if (sex=2).
FREQUENCIES /VARIABLES age /FORMAT /STATISTICS /HISTOGRAM.
```

AGE Age

Count	Midpoint
0	12
0	14
3	16
4	18
3	20
7	22
12	24
5	26
2	28
0	30
2	32
0	34
0	36
1	38
1	40
1	42
0	44



AGE Age

Mean	23.610	Std Dev	5.809	Minimum	15.000
Maximum	41.000				

Valid Cases 41 Missing Cases 13

```
This procedure was completed at 23:26:57
set /more off /listing 'spss.lis'.
```

```
get /file 'pwanf2.sys'.
select if (sex=1). (i.e male cases only)
t-test /groups rage (1,2) /variables lhhr rhhr.
The raw data or transformation pass is proceeding
    135 cases are written to the uncompressed active file.
```

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Independent samples of RAGE *(Rage1=15-24,rage2=25-34,rage3=35-44)*

Group 1: RAGE EQ 1.00 Group 2: RAGE EQ 2.00

t-test for: LHHR

	Number of Cases	Mean	Standard Deviation	Standard Error
Group 1	30	.8536	.084	.015
Group 2	33	.8527	.075	.013

		Pooled Variance Estimate			Separate Variance Estimate		
F Value	2-Tail Prob.	t Value	Degrees of Freedom	2-Tail Prob.	t Value	Degrees of Freedom	2-Tail Prob.
1.24	.559	.04	61	.965	.04	58.62	.965

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Independent samples of RAGE

Group 1: RAGE EQ 1.00 Group 2: RAGE EQ 2.00

t-test for: RHHR

	Number of Cases	Mean	Standard Deviation	Standard Error
Group 1	30	1.2060	.119	.022
Group 2	33	1.1702	.128	.022

		Pooled Variance Estimate			Separate Variance Estimate		
F Value	2-Tail Prob.	t Value	Degrees of Freedom	2-Tail Prob.	t Value	Degrees of Freedom	2-Tail Prob.
1.17	.669	1.15	61	.256	1.15	60.98	.255

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```
get /file 'pwanf2.sys'.
select if (sex=1).
t-test /groups rage (1,3) /variables lhhr rhhr.
The raw data or transformation pass is proceeding
    135 cases are written to the uncompressed active file.
```

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Independent samples of RAGE

Group 1: RAGE EQ 1.00 Group 2: RAGE EQ 3.00

t-test for: LHHR

	Number of Cases	Mean	Standard Deviation	Standard Error
Group 1	30	.8536	.084	.015
Group 2	21	.8895	.088	.019

		Pooled Variance Estimate			Separate Variance Estimate		
F Value	2-Tail Prob.	t Value	Degrees of Freedom	2-Tail Prob.	t Value	Degrees of Freedom	2-Tail Prob.
1.12	.767	-1.48	49	.147	-1.46	41.62	.152

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Independent samples of RAGE

Group 1: RAGE EQ 1.00 Group 2: RAGE EQ 3.00

t-test for: RHHR

	Number of Cases	Mean	Standard Deviation	Standard Error
Group 1	30	1.2060	.119	.022
Group 2	21	1.1963	.118	.026

		Pooled Variance Estimate			Separate Variance Estimate		
F Value	2-Tail Prob.	t Value	Degrees of Freedom	2-Tail Prob.	t Value	Degrees of Freedom	2-Tail Prob.
1.01	.995	.29	49	.773	.29	43.38	.773

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```
get /file 'pwanf2.sys'.
select if (sex=1).
t-test /groups rage (1,3) /variables lhhr rhhr.
The raw data or transformation pass is proceeding
    135 cases are written to the uncompressed active file.
```

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Independent samples of RAGE

Group 1: RAGE EQ 1.00 Group 2: RAGE EQ 3.00

t-test for: LHHR

	Number of Cases	Mean	Standard Deviation	Standard Error
Group 1	30	.8536	.084	.015
Group 2	21	.8895	.088	.019

		Pooled Variance Estimate			Separate Variance Estimate		
F Value	2-Tail Prob.	t Value	Degrees of Freedom	2-Tail Prob.	t Value	Degrees of Freedom	2-Tail Prob.
1.12	.767	-1.48	49	.147	-1.46	41.62	.152

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Independent samples of RAGE

Group 1: RAGE EQ 1.00 Group 2: RAGE EQ 3.00

t-test for: RHHR

	Number of Cases	Mean	Standard Deviation	Standard Error
Group 1	30	1.2060	.119	.022
Group 2	21	1.1963	.118	.026

		Pooled Variance Estimate			Separate Variance Estimate		
F Value	2-Tail Prob.	t Value	Degrees of Freedom	2-Tail Prob.	t Value	Degrees of Freedom	2-Tail Prob.
1.01	.995	.29	49	.773	.29	43.38	.773

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```
get /file 'pwanf2.sys'.
select if (sex=1).
t-test /groups rage (1,3) /variables lhhr rhhr.
The raw data or transformation pass is proceeding
    135 cases are written to the uncompressed active file.
```

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Independent samples of RAGE

Group 1: RAGE EQ 1.00 Group 2: RAGE EQ 3.00

t-test for: LHHR

	Number of Cases	Mean	Standard Deviation	Standard Error
Group 1	30	.8536	.084	.015
Group 2	21	.8895	.088	.019

		Pooled Variance Estimate			Separate Variance Estimate		
F Value	2-Tail Prob.	t Value	Degrees of Freedom	2-Tail Prob.	t Value	Degrees of Freedom	2-Tail Prob.
1.12	.767	-1.48	49	.147	-1.46	41.62	.152

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Independent samples of RAGE

Group 1: RAGE EQ 1.00 Group 2: RAGE EQ 3.00

t-test for: RHHR

	Number of Cases	Mean	Standard Deviation	Standard Error
Group 1	30	1.2060	.119	.022
Group 2	21	1.1963	.118	.026

		Pooled Variance Estimate			Separate Variance Estimate		
F Value	2-Tail Prob.	t Value	Degrees of Freedom	2-Tail Prob.	t Value	Degrees of Freedom	2-Tail Prob
1.01	.995	.29	49	.773	.29	43.38	.77

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```
get /file 'pwanf2.sys'.
select if (sex=1).
t-test /groups rage (2,3) /variables lhhr rhhr.
```

The raw data or transformation pass is proceeding
135 cases are written to the uncompressed active file.

Independent samples of RAGE

Group 1: RAGE EQ 2.00 Group 2: RAGE EQ 3.00

t-test for: LHHR

	Number of Cases	Mean	Standard Deviation	Standard Error
Group 1	33	.8527	.075	.013
Group 2	21	.8895	.088	.019

		Pooled Variance Estimate			Separate Variance Estimate		
F Value	2-Tail Prob.	t Value	Degrees of Freedom	2-Tail Prob.	t Value	Degrees of Freedom	2-Tail Prob.
1.38	.404	-1.64	52	.108	-1.58	37.67	.123

Independent samples of RAGE

Group 1: RAGE EQ 2.00 Group 2: RAGE EQ 3.00

t-test for: RHHR

	Number of Cases	Mean	Standard Deviation	Standard Error
Group 1	33	1.1702	.128	.022
Group 2	21	1.1963	.118	.026

		Pooled Variance Estimate			Separate Variance Estimate		
F Value	2-Tail Prob.	t Value	Degrees of Freedom	2-Tail Prob.	t Value	Degrees of Freedom	2-Tail Prob.
1.19	.698	-.75	52	.457	-.76	45.43	.449

```
get /file 'pwanf2.sys'.
select if (sex=2). (i.e female)
t-test /groups rage (1,2) /variables lhhr rhhr.
The raw data or transformation pass is proceeding
     54 cases are written to the uncompressed active file.
```

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Independent samples of RAGE

Group 1: RAGE EQ 1.00 Group 2: RAGE EQ 2.00

t-test for: LHHR

	Number of Cases	Mean	Standard Deviation	Standard Error
Group 1	29	.8399	.087	.016
Group 2	9	.8357	.082	.027

		Pooled Variance Estimate			Separate Variance Estimate		
F Value	2-Tail Prob.	t Value	Degrees of Freedom	2-Tail Prob.	t Value	Degrees of Freedom	2-Tail Prob.
1.10	.948	.13	36	.899	.13	13.96	.897

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Independent samples of RAGE

Group 1: RAGE EQ 1.00 Group 2: RAGE EQ 2.00

t-test for: RHHR

	Number of Cases	Mean	Standard Deviation	Standard Error
Group 1	29	1.1966	.114	.021
Group 2	9	1.2494	.112	.037

		Pooled Variance Estimate			Separate Variance Estimate		
F Value	2-Tail Prob.	t Value	Degrees of Freedom	2-Tail Prob.	t Value	Degrees of Freedom	2-Tail Prob.
1.04	1.000	-1.22	36	.231	-1.23	13.57	.239

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```
get /file 'pwanf2.sys'.
select if (sex=2).
t-test /groups rage (1,3) /variables lhhr rhhr.
The raw data or transformation pass is proceeding
     54 cases are written to the uncompressed active file.
```


Independent samples of RAGE

Group 1: RAGE EQ 1.00 Group 2: RAGE EQ 3.00

t-test for: LHHR

	Number of Cases	Mean	Standard Deviation	Standard Error
Group 1	29	.8399	.087	.016
Group 2	3	.8443	.105	.061

		Pooled Variance Estimate			Separate Variance Estimate		
F Value	2-Tail Prob.	t Value	Degrees of Freedom	2-Tail Prob.	t Value	Degrees of Freedom	2-Tail Prob.
1.47	.493	-.08	30	.934	-.07	2.29	.949

Independent samples of RAGE

Group 1: RAGE EQ 1.00 Group 2: RAGE EQ 3.00

t-test for: RHHR

	Number of Cases	Mean	Standard Deviation	Standard Error
Group 1	29	1.1966	.114	.021
Group 2	3	1.1553	.084	.048

		Pooled Variance Estimate			Separate Variance Estimate		
F Value	2-Tail Prob.	t Value	Degrees of Freedom	2-Tail Prob.	t Value	Degrees of Freedom	2-Tail Prob.
1.85	.822	.61	30	.549	.78	2.83	.494

```
get /file 'pwanf2.sys'.
select if (sex=2).
t-test /groups rage (2,3) /variables lhhr rhhr.
The raw data or transformation pass is proceeding
     54 cases are written to the uncompressed active file.
```


Independent samples of RAGE

Group 1: RAGE EQ 2.00 Group 2: RAGE EQ 3.00

t-test for: LHHR

	Number of Cases	Mean	Standard Deviation	Standard Error
Group 1	9	.8357	.082	.027
Group 2	3	.8443	.105	.061

		Pooled Variance Estimate			Separate Variance Estimate		
F Value	2-Tail Prob.	t Value	Degrees of Freedom	2-Tail Prob.	t Value	Degrees of Freedom	2-Tail Prob.
1.63	.510	-.15	10	.885	-.13	2.87	.905

Independent samples of RAGE

Group 1: RAGE EQ 2.00 Group 2: RAGE EQ 3.00

t-test for: RHHR

	Number of Cases	Mean	Standard Deviation	Standard Error
Group 1	9	1.2494	.112	.037
Group 2	3	1.1553	.084	.048

		Pooled Variance Estimate			Separate Variance Estimate		
F Value	2-Tail Prob.	t Value	Degrees of Freedom	2-Tail Prob.	t Value	Degrees of Freedom	2-Tail Prob.
1.79	.814	1.32	10	.216	1.54	4.68	.188

T-TEST BETWEEN MALE AND FEMALE

```
get /file 'pwanf1.sys'.
T-TEST /GROUPS sex (1,2) /variables lhhr rhhr.
```

Independent samples of SEX Sex *(sex=1 is male,sex=2 is female).*

Group 1: SEX EQ 1 Group 2: SEX EQ 2

t-test for: LHHR

	Number of Cases	Mean	Standard Deviation	Standard Error
Group 1	135	.8625	.081	.007
Group 2	54	.8446	.083	.011

		Pooled Variance Estimate			Separate Variance Estimate		
F Value	2-Tail Prob.	t Value	Degrees of Freedom	2-Tail Prob.	t Value	Degrees of Freedom	2-Tail Prob.
1.04	.848	1.36	187	.175	1.35	96.11	.180

Independent samples of SEX Sex

Group 1: SEX EQ 1 Group 2: SEX EQ 2

t-test for: RHHR

	Number of Cases	Mean	Standard Deviation	Standard Error
Group 1	135	1.1869	.113	.010
Group 2	54	1.2161	.119	.016

		Pooled Variance Estimate			Separate Variance Estimate		
F Value	2-Tail Prob.	t Value	Degrees of Freedom	2-Tail Prob.	t Value	Degrees of Freedom	2-Tail Prob.
1.10	.643	-1.58	187	.116	-1.55	93.53	.125

This procedure was completed at 1:25:44

```
set /more on /listing 'spss.lis'.
```

T_TEST FOR LEFT AND RIGHT SIDE

t-test /GROUPS side (1,2) /variables hhr.

Independent samples of SIDE Side

Group 1: SIDE EQ 1 (left) Group 2: SIDE EQ 2 (Right)

t-test for: HHR

	Number of Cases	Mean	Standard Deviation	Standard Error
Group 1	189	.8574	.082	.006
Group 2	189	1.1952	.115	.008

		Pooled Variance Estimate			Separate Variance Estimate		
F Value	2-Tail Prob.	t Value	Degrees of Freedom	2-Tail Prob.	t Value	Degrees of Freedom	2-Tail Prob.
1.98	.000	-32.90	376	.000	-32.90	339.47	.000

This procedure was completed at 1:36:59

set /more on /listing 'spss.lis'.

HISTOGRAM OF THE LEFT HHR

```
GET /FILE 'PWANF2.SYS'.
FREQUENCIES /VARIABLES LHHR /FORMAT NOTABLE /HISTOGRAM /STATISTICS MEAN
MEDIAN MODE STDDEV RANGE MINIMUM MAXIMUM .
```

***** Memory allows a total of 10734 Values, accumulated across all Variables.
There also may be up to 1342 Value Labels for each Variable.

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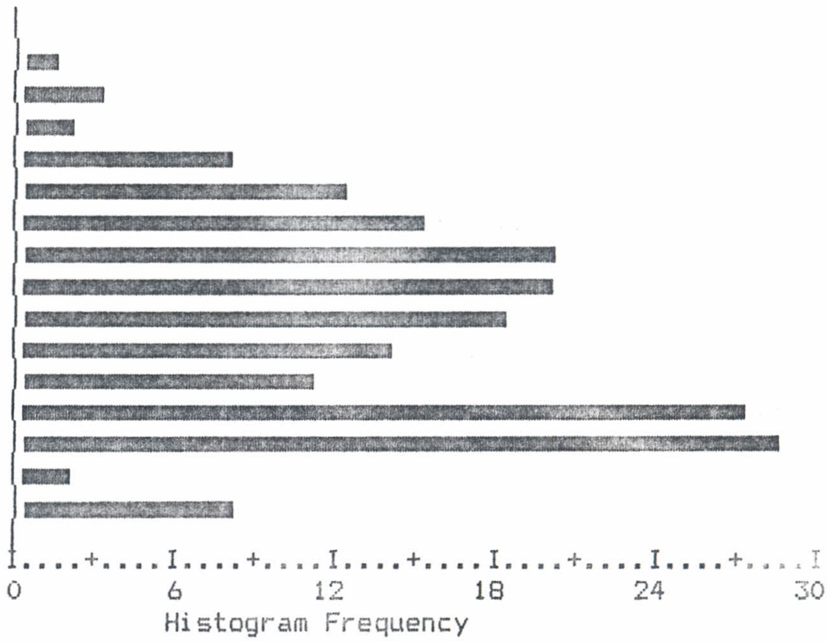
LHHR

Count	Midpoint
0	.625
1	.650
3	.675
2	.700
8	.725
12	.750
15	.775
20	.800
20	.825
18	.850
14	.875
11	.900
27	.925
28	.950
2	.975
8	1.000
0	1.025



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LHHR

Mean	.857	Median	.857	Mode	.958
Std Dev	.082	Range	.346	Minimum	.654
Maximum	1.000				

Valid Cases 189 Missing Cases 0

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This procedure was completed at 2:32:18

```
set /more on /listing 'spss.lis'.
```

HISTOGRAM OF RIGHT HHR

```
GET /FILE 'PWANF2.SYS'.
FREQUENCIES /VARIABLES rHHR /FORMAT NOTABLE /HISTOGRAM /STATISTICS MEAN
MEDIAN
MODE STDDEV RANGE MINIMUM MAXIMUM .
```

***** Memory allows a total of 10734 Values, accumulated across all Variables.
There also may be up to 1342 Value Labels for each Variable.

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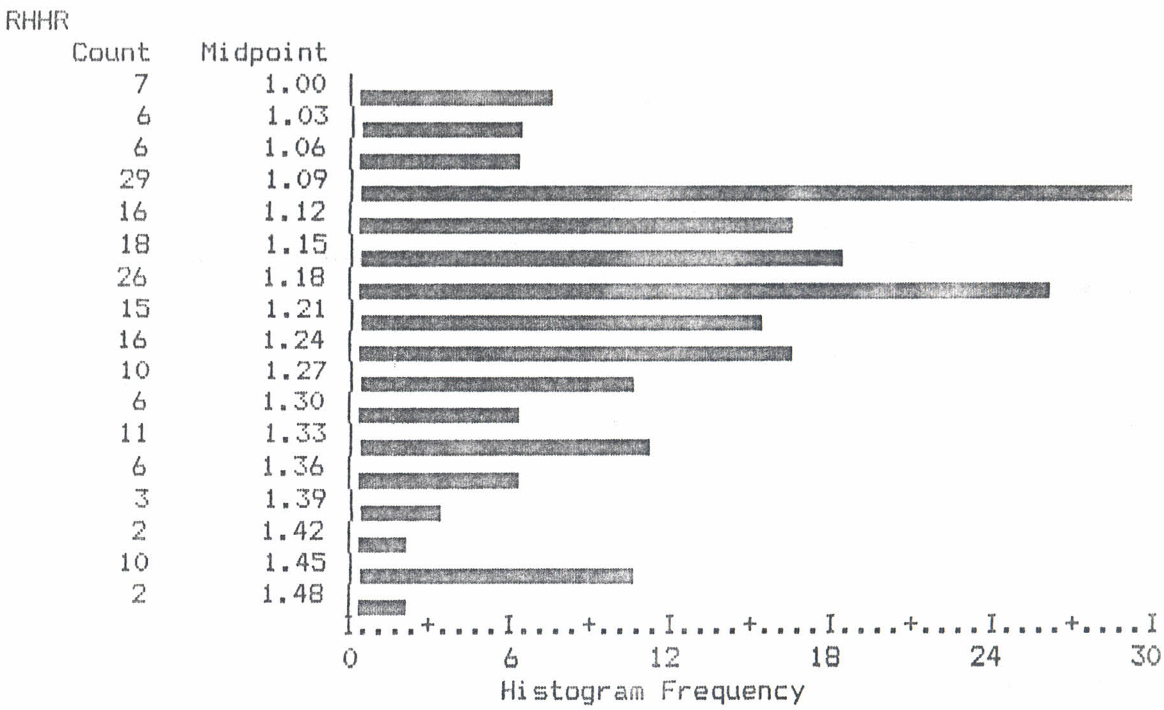

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RHHR

Mean	1.195	Median	1.176	Mode	1.190
Std Dev	.115	Range	.471	Minimum	1.000
Maximum	1.471				

Valid Cases 189 Missing Cases 0

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This procedure was completed at 2:35:38

```
set /more on /listing 'spss.lis'.
```