PART III

Standardization

Reliability

Validity

Evaluation and Measurement

CHAPTER VIII

STANDARDIZATION

The Meaning of Standardization:-

A test is standardized in the following respects:-

(i) In form and construction.

(ii) In the way it is administered.

(iii) In the way of evaluating its results so that the performance of any examinee can be compared with the performance of the whole group.

The form and construction and the way of administration have already been standardized in the Pilot and Final Run of the test. In this chapter the way of evaluating the results will be dealt with.

As regards standardization of a group test of intelligence for establishing Intelligence Quotients, it is done by one of the following methods:-

(i)Adoption.

(ii)Direct Standardization.

(iii)Indirect Standardization.

Adoption:-

When a test is translated from another test previously standardized, the norms are adopted straightway from the original test. These norms are not usually valid because translation can never be done on very rigid lines and the population to which both the tests are applied differ in many respects. It is followed only when a quick and rough estimate of intelligence is required in the absence of any other standardized test in that language.

Direct Standardization:-

Intelligence Quotients are derived by dividing mental age by chronological and multiplying by 100. It is a method which is indeed the most logical one but in practice it raises many difficulties.

In the first place it needs a very wide range of mental ages to account for all the lowest and the highest scores obtained in the group test. To determine the scores (norms) to be assigned to that wide range, Mental age is not directly possible for a group test is applicable to a very narrow range of ages. For example, if a test is applicable for five year range, say from 10-14 (both inclusive) norms by directly averaging the scores of pupils of various age groups can be obtained for only five ages from 10 to 14. But for determining norms for ages lower than 10 and higher than 14 other artificial methods have to be adopted.

Further it is found that the consecutive norms obtained by directly averaging the scores of various age groups differ very little from eachother with the result that the variability (Standard Deviation) of I.Q's increases very much. In such a case very high and very low I.Q.'s are obtained by moderately superior and moderately dull children respectively. Since commonly people are acquainted with Binet I.Qs which have a comparatively low variability, the I.Qs obtained in such a test look very strange and may be misinterpreted, by less sophisticated persons.

However if every test has its own characteristics, the I.Q ceases to be stable unit of measurement of brightness. For such reasons the present tendency is to think of some other ways of measuring the brightness. They are usually indirect procedures of standardization.

Indirect Standardization:-

In view of the above difficulties in the direct standardization method, different indirect methods of standardization are adopted. The most popular of such methods is that of Deviation I.Qs. The following steps are involved in this method of indirect standardization:-

i) Mean and the Standard Deviation of scores of each group are calculated and if the standard Deviations are found to be almost equal in all ages or some of the age group, a common Standard Deviation is fixed for these age groups.

ii) A standard scatter (S.D) of I.Qs of children tested is obtained from a standard test like Binet or its adaptation.

iii) The standard scatter of I.Qs is superimposed on the scatter of scores of various age groups.

Norms : -

Several bases for norms on the intelligence tests have been accepted by test makers. These are grade norms, age norms, and occupational norms. Sometimes separate norms for rural and urban areas are also determined to show the effect of varying environment. If the sex difference is found to be appreciable, separate norms for boys and girls are calculated. The different values of norms serve many useful purposes of comparison. Age norms, for instance, are essential for comparing the performance of an individual child with the average score of the age population. Likewise grade norms may be useful in determining whether the group for which the norms are valid is normal, advanced or backward comparing them with its grade averages. Grade norms like other norms show the average performance of pupils of a particular grade.

Types of Norms : -

The difference between the types and varieties of norms should be clearly understood. In many a work on educational testing the two terms are often interchangeably used. The different varieties of norms are as referred to above whereas the different types of norms will be :

a) Means.

b) Deviation I.Qs.

c) Percentiles.

d) Stanines.

Means :-

Means represent the averages of scores. A mean may be defined as the sum of scores divided by the number of scores. Mathematically it can be represented as follows : -

Mean = $\frac{\Sigma X}{N}$ where N is the number of scores or items and X stands for the scores. If the value of the Mean is to be calculated from an ungrouped data, all that has to be done is to add all the scores together and then devide the sum by the total number of scores. In case of the data being grouped as frequency distribution the value of the Mean is calculated by applying the formula.

$$\text{Mean} = \frac{\Sigma FX}{N}$$

where F stands for the number of frequencies in each class interval and X stands for the middle point of class intervals.

Although Mean is the easiest to define yet it suffers from certain defects because of which it cannot always be used as a satisfactory average. The handicaps in the use of Mean may be summarised as under:-

i) A single high or low score unduly pulls up or pulls down the value of the Mean which does not then really represent the group.

ii) Sometimes the value of the Mean comes out in fractions which in certain situations does not have any sense.

Deviation I.Qs.: -

The standard deviations of intelligence quotients obtained by the relation M.A/C.A (Mental age / Chronological age) are not always of the same, or nearly the same size at all age levels. For example, at one age level, S.D might be 12; at another 16; at still another 18. The differences such as these create problems and irregularities in the interpretation of the relative meaning of a given I.Q. Thus, for example, in the first instance, an I.Q of 88(-1 S.D.) signifies a percentile rank of 16; in the second instance, an I.Q of 84 has the same percentile equivalent, while in the third an I.Q of 82 also signifies a percentile rank of 16.

In order to overcome this difficulty the "deviation I.Q" is used with some tests. This index is an adaptation of the standard score (z) technique. The method of determining the deviation I.Q can be shown by using the Wechsler Tests' procedure as an illustration. For each individual, the raw score is converted into a weighted score by using a conversion table. The mean weighted score of the group is given a deviation I.Q value of 100, the standard deviation of the scores is equated with a deviation I.Q value of 15. Thus, a person whose point score places him at - 1 S.D. will have a deviation I.Q of 85. One whose score is at -2 SD will have a rating of 70. Similarly, positive S.D values will give ranks above 100 : + 1 S D equals 115 deviation I.Q ; + 2 S D equals 130; and so forth.

Percentiles : -

If K percentage of the members of a sample have scores less than a particular value, that value is the Kth percentile point. If a frequency distribution is represented graphically and ordinates raised at all percentile points, the total area under the frequency distribution is divided into 100 equal parts. Percentile points may be represented by the symbols P_0, P_1, P_2 ---- , P_{100} . The points P_0 and P_{100} are limits which include all members of the sample. A percentile point is a value on the transformed scale corresponding to the percentile point. As in all transformations values on the original scale correspond to the percentile point. As in all transformations values on the original scale correspond to the certain values on the transformed scale. It will be recalled in this connection that the median is a value of the variable above and below which 50% of the cases lie. The median is the 50th percentile P_{50}. The upper quartile is a value of the variable above which

25% of the cases and below which 75% of the cases lie. Decile points are sometimes used. These, as the name implies, involve a dividing into tenths. A decile point is the value of the variable below which a certain percentage of individuals fall, the percentages being taken in the units of 10.

Stanine : -

Scores on tests, are converted to stanines in the following way : -

i) A coarse grouping is used, only of nine score categories being allowed. The transformed values are assigned the integers 1 to 9. The mean of the stanine scale is 5 and the S.D. is 1.96 . The percentage of cases in the Stanine score categories from 1 to 7 are 4, 7, 12, 17, 20, 17 and 4. Thus 4% have a stanine score 1, 7, 10, a score 2, 12, a score 3 and so on. If a set of scores is ordered from the lowest to the highest the lowest 4% assigned a score 1, the next lowest a score 2, the next lowest a score 3 and the score of 7, the transformed scores are roughly normal and form a stanine scale. Stanine scores correspond to equal intervals in standard deviation units on the base line of the unit normal curve. A stanine of 5 covers the intervals from .25 to .25 in standard deviation units. Roughly 20 % of the area of the unit normal curve falls within this interval. The interval used one half of a standard deviation unit, a Stanine of 9 includes all cases above 2.25 and a

Stanine of all cases below 2.25 standard deviation units. Test scores can rapidly be converted to Stanine. A Stanine transformation is a simple method of converting score to an approximately normal form. The grouping, although coarse, is sufficiently refined for many practical purposes.

Mean and Deviation I.Qs. have already been discussed and adopted in the present analysis and need not be considered again .

Calculation of Norms - the present Study : -

There were 5372 booklets in all. The total raw scores of 5372 children were counted and entered at the top of the page of the booklets. The booklets were classified age wise. In each age group the scores were arranged in the frequency distribution order and then Mean and Standard Deviations were calculated for each age group. The weighted average and standard deviation for each group was computed. In the third step one common S.D was decided for all the ages from 12 to 17 years in view of the fact that the S.D from age group to age group did not vary significantly. The standard scatter for I.Q distribution was arbitrarily fixed on the basis of the findings of Dr. V.V. Kamat and Dr. N.N.Shukla. Both these test constructors have fixed 16.4 as the S.D. of I.Q distribution. To obtain the value of I.Q from the observed score in the test, the following formula was used.

$$I.Q = 100 + (S - M)\frac{\sigma_1}{\sigma_2}$$

where,

S = Score obtained on the test.

M = Norm for a particular age.

σ_1 = Standard Deviation of I.Q distribution (16.4 in the present case)

σ_2 = Uniform S.D for all the ages (12-17) years (18.5 in the present case)

The above formula is used to serve as a ready reckoner to get I.Qs by knowing the deviation of a score from the norm. The simplified formula arrived at is :-

$$I.Q. = 100+(S - M)\frac{16.4}{18.5}$$

$$= 100+(S - M) \times .8865.$$

<u>The Method of Correcting Norms</u> : -

When the scores representing mental growth of children of a particular age group are plotted, the curve may reflect at places some irregular tendencies. Many reasons can be attributed to this Phenomenon. Possibly the irregularity of the curve may have occurred due to some children being exceptionally brighter or abnormally dull in the same age group. Random fluctuations may also contribute to the observed phenomenon. Other things being equal, it can safely be assumed that the observed fluctuations ar a result of the chance factors operating, smoothened by free hand drawing to represent regular mental growth. In this way different norms for different age groups can readily be ascertained.

To rectify the abnormality in the mean scores of the age groups in the present research, the method as mentioned above was followed.

All these statistical data are shown in the tables that follow. The tables will give a clear idea of the interval of scores, their mean standard deviation (S.D) along with their I.Qs.

Table No. 13

The frequency distribution of scores (in different intervals) of children in each age group.

Interval of scores	12^+	13^+	14^+	15^+	16^+	17^+	Total
1-10	12	14	4	8	0	0	38
11-20	26	36	19	29	4	2	116
21-30	56	90	57	76	15	8	302
31-40	85	160	129	152	43	27	596
41-50	90	200	216	220	95	62	883
51-60	71	185	264	244	158	111	1033
61-70	40	127	254	206	201	147	975
71-80	15	60	172	126	191	143	907
81-90	4	21	89	59	139	107	419
91-100	1	5	34	23	77	59	199
101-110	0	1	10	5	33	24	73
111-120	0	1	2	1	10	7	21
121-130	0	0	1	1	3	2	7
131-140	0	0	1	0	1	1	3
141-150	0	0	0	0	0	0	0
Total	400	900	1252	1150	970	700	5372
Mean	42.9	48.1	58	64.2	69.1	70.2	58
Standard Deviation	16.9	17.5	18.5	18.1	19	18.5	18.5
Norm	43	48	58	64	69	70	58

Common σ = 18.5

σ of I.Q from Binet scale = 16.4

The plus$^+$ sign associate with each age of each age group indicated that the chronological age of children is distributed in the centre i.e. for children of 12^+ group the average age is 12.5 etc.

Table No. 14

Frequency distribution of I.Qs of 5372 children of different ages (12^+ - 17^+) in different I.Q. class interval).

I.Qs class interval	12^+	13^+	14^+	15^+	16^+	17^+	Total$^+$
60-64	2	5	4	8	7	5	31
65-69	3	8	11	10	8	6	46
70-74	6	14	20	18	16	11	85
75-79	15	26	37	34	28	20	160
80-84	18	40	60	52	44	32	246
85-89	27	61	85	78	67	48	366
90-94	34	79	110	101	86	61	471
95-99	42	95	132	122	104	74	509
100-104	48	110	152	139	118	85	652
105-109	47	107	148	137	116	85	638
110-114	45	107	141	131	109	79	606
115-119	37	83	115	95	80	64	474
120-124	28	64	88	82	69	42	382
125-129	21	47	65	62	52	37	284
130-134	12	27	38	36	30	21	164
135-139	8	18	24	23	19	13	45
140-144	4	8	12	12	9	7	52
145-149	2	4	6	6	5	3	26
150-above	1	3	4	4	3	2	17
Total	400	900	1252	1150	970	700	5372

Table No. 15

Conversion of Scores into Deviation Quotients :-

Col. I Deviation of Score from the Mean (S-M)	Col. II Plus Deviation	Col. III I.Q.	Col. IV Minus Deviation	Col. V I.Q
1	100+1x.8865	101	100-1x.8865	99
2	100+2x.8865	102	100-2x.8865	98
3	100+3x.8865	103	100-3x.8865	97
4	100+4x.8865	103	100-4x.8865	96
5	100+5x.8865	104	100-5x.8865	95
*6	100+6x.8865	105	100-6x.8865	94
7	100+7x.8865	106	100-7x.8865	94
8	100+8x.8865	107	100-8x.8865	93
9	100+9x.8865	108	100-9x.8865	92
*10	100+10x.8865	109	100-10x.8865	91
11	100+11x.8865	110	100-11x.8865	90
12	100+12x.8865	111	100-12x.8865	89
13	100+13x.8865	111	100-13x.8865	88
14	100+14x.8865	112	100-14x.8865	88
*15	100+15x.8865	113	100-15x.8865	87
*16	100+16x.8865	114	100-16x.8865	86
17	100+17x.8865	115	100-17x.8865	85
18	100+18x.8865	116	100-18x.8865	84
19	100+19x.8865	117	100-19x.8865	83
*20	100+20x.8865	118	100-20x.8865	82

Col. I Deviation of Score from the Mean (S.M)	Col. II Plus Deviation	Col.III I.Q	Col.IV Minus Deviation	Col.V I.Q.
*21	100+21x.8865	118	100-21x.8865	81
*22	100+22x.8865	119	100-22x.8865	80
23	100+23x.8865	120	100-23x.8865	80
24	100+24x.8865	121	100-24x.8865	79
25	100+25x.8865	122	100-25x.8865	78
*26	100+26x.8865	123	100-26x.8865	77
27	100+27x.8865	124	100-27x.8865	76
28	100+28x.8865	125	100-28x.8865	75
29	100+29x.8865	126	100-29x.8865	74
*30	100+30x.8865	126	100-30x.8865	73
*31	100+31x.8865	127	100-31x.8865	72
32	100+32x.8865	128	100-32x.8865	71
33	100+33x.8865	129	100-33x.8865	70
34	100+34x.8865	130	100-34x.8865	69
*35	100+35x.8865	131	100-35x.8865	68
*36	100+36x.8865	132	100-36x.8865	68
37	100+37x.8865	133	100-37x.8865	67
38	100+38x.8865	133	100-38x.8865	66
39	100+38x.8865	134	100-39x.8865	65
*40	100+40x.8865	135	100-40x.8865	64
*41	100+41x.8865	136	100-41x.8865	63
42	100+42x.8865	137	100-42x.8865	62
43	100+43x.8865	138	100-43x.8865	61
44	100+44x.8865	139	100-44x.8865	60
*45	100+45x.8865	140	100-45x.8865	60
46	100+46x.8865	141	100-46x.8865	59

Col. I Deviation of Score from the Mean (S-M)	Col. II Plus Deviation	Col. III I.Q.	Col. IV Minus Deviation	Col. V I.Q.
47	100+47x.8865	142	100-47x.8865	58
48	100+48x.8865	143	100-48x.8865	57
49	100+49x.8865	143	100-49x.8865	56
*50	100+50x.8865	144	100-50x.8865	55
*51	100+51x.8865	145	100-51x.8865	55
*52	100+52x.8865	146	100-52x.8865	54
53	100+53x.8865	147	100-53x.8865	53
*54	100+54x.8865	148	100-54x.8865	52
*55	100+55x.8865	149	100-55x.8865	51
*56	100+56x.8865	150	100-56x.8865	50
57	100+57x.8865	150	100-57x.8865	50
58	100+58x.8865	151	100-58x.8865	49
59	100+59x.8865	152	100-59x.8865	48
*60	100+60x.8865	153	100-60x.8865	47
61	100+61x.8865	154	100-61x.8865	46
*62	100+62x.8865	155	100-62x.8865	45
63	100+63x.8865	156	100-63x.8865	44
64	100+64x.8865	157	100-64x.8865	43
*65	100+65x.8865	158	100-65x.8865	42
*66	100+66x.8865	158	100-66x.8865	42
*67	100+67x.8865	159	100-67x.8865	41
*68	100+68x.8865	160	100-68x.8865	40
*69	100+69x.8865	161	100-69x.8865	39
*70	100+70x.8865	162	100-70x.8865	38
*71	100+71x.8865	163	100-71x.8865	37
*72	100+72x.8865	164	100-72x.8865	36
73	100+73x.8865	165	100-73x.8865	35

Explanation of Table No. 15 : -

Column I indicates the possible deviations of test scores of each group from its mean. The deviations here vary from 1-73. These deviations have been arranged serially in this column. This is not however to be understood that all the deviations given in this column have been observed in our test. For example the scores marked * are not observed ones and in order that the table may serve as a ready reckoner for these possible deviations, the Intelligence Quotients have been calculated for these. Thus by doing so the Intelligence Quotient of any individual can readily be ascertained by reference to this table given his chronological age. The norms (average) for each group are however given in the table No. 13.

Column II indicates the method adopted in the standardization of the present test and finding the I.Q.

$$I.Q = 100 \pm (S-M) \frac{\sigma_1}{\sigma_2}$$

where

S = Score obtained on the test.

M = Norms for a particular age

σ_1 = Standard deviation of I.Q.distribution (16-4 in the present case).

The standard scatter for I.Q. distribution was arbitrarily fixed on the basis of findings of Dr.V.V.Kamat and Dr. N.N.Shukla. Both these test constructors have fixed 16.4. as the σ of I.Q distribution

σ_2 = Uniform S.D for all the ages between 12-17 years (18.5 in the present case). After calculating the S.D. for each age group, one common S.D. was decided for all ages in view of the fact the difference in age group is not significant from one age group to other age group.

The value of

$$\frac{\sigma_1}{\sigma_2} = \frac{16.4}{18.4} = .8865$$

and is constant for all deviations. The figures in column I are multiplied by .8865 and added with or subtracted from 100 to obtain I.Q.

Column III represents Intelligence quotient in case of plus deviations.

Column IV indicates the method adopted in the standar -dization of the present test and finding the I.Q. when the deviation is minus.

Column V indicates the value of I.Q. in case of minus deviation.

Graphical Representation:-

Graphs 1-7 given subsequently show the frequency distribution of test scores according to different age groups.

Represented in histograms and frequency polygons, Graphs 1-7 show the frequency distribution of test scores of children of the age group 12^+ to 17^+. The graphs have been constructed on the basis of the data given in table No. 13. It is intresting to note that the mode of the distribution (the highest frequency) of age group 12^+ and 13^+ lies in the test score of 41-50 as against the test score of 51-60 of the two subsequent age groups. The highest frequency of the next two age groups (16^+ and 17^+) which lies in the interval of 61-70 is about (200, respectively) 160. The shape of the frequency distribution curve reflects more or less the same pattern and the distribution tapers to zero at the extremities.

Another significant point in this connection worth consideration is that with the increase in age of children the slope of the curve towards the extremities relatively diminishes indicating thereby the maturity of mental achievements or abilities at the higher ages.

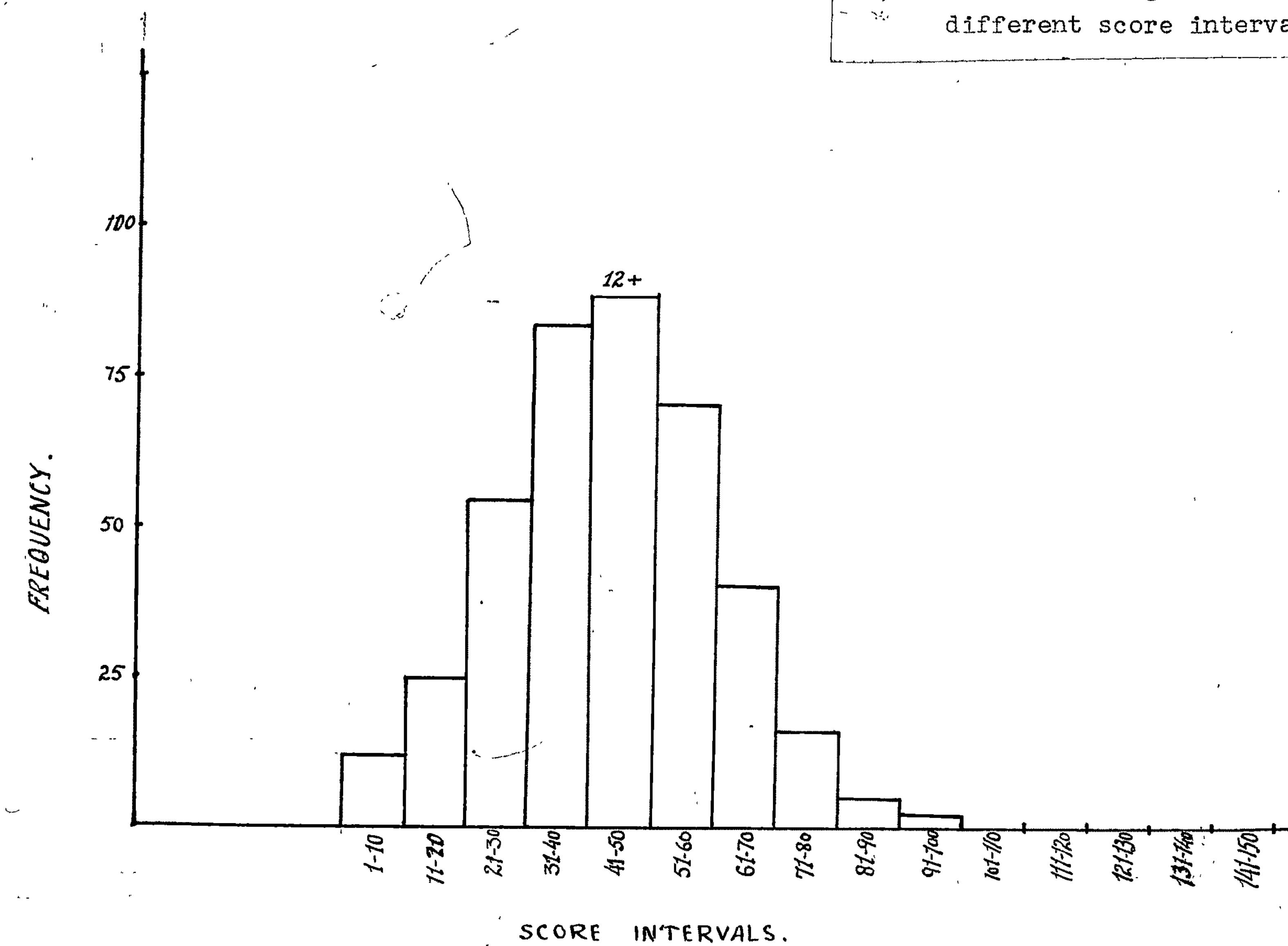
In graph Nos. I and Ia, II and IIa (as numbered), representing the score of age groups 12^+ and 13^+ years, the highest number of children (90 and 200 respectively) are in the interval of 41-50, whereas in the subsequent age groups the highest number of children have scored in the interval 51-60. Likewise, in the age group 16^+ and 17^+ the majority of the children (200, 160 respectively) have scored in the test score interval of 61-70.

The inspection of the curve thus plotted indicates that there is no significant variation in mental abilities (growth) between age group 16-17 the slope of the curve shows somewhat irregular tendency between the age group 11-13. This indicates that growth of mental ability is not continuous as the variation in age is observed between 11-13. The curve runs uniformly beyond the age 16 indicating thereby that the mental achievements are not subjected to rapid growth or change.

Thus with the exeeption of 12 and 13 year age group, the other graphs show a constant rise which is expected of a test.

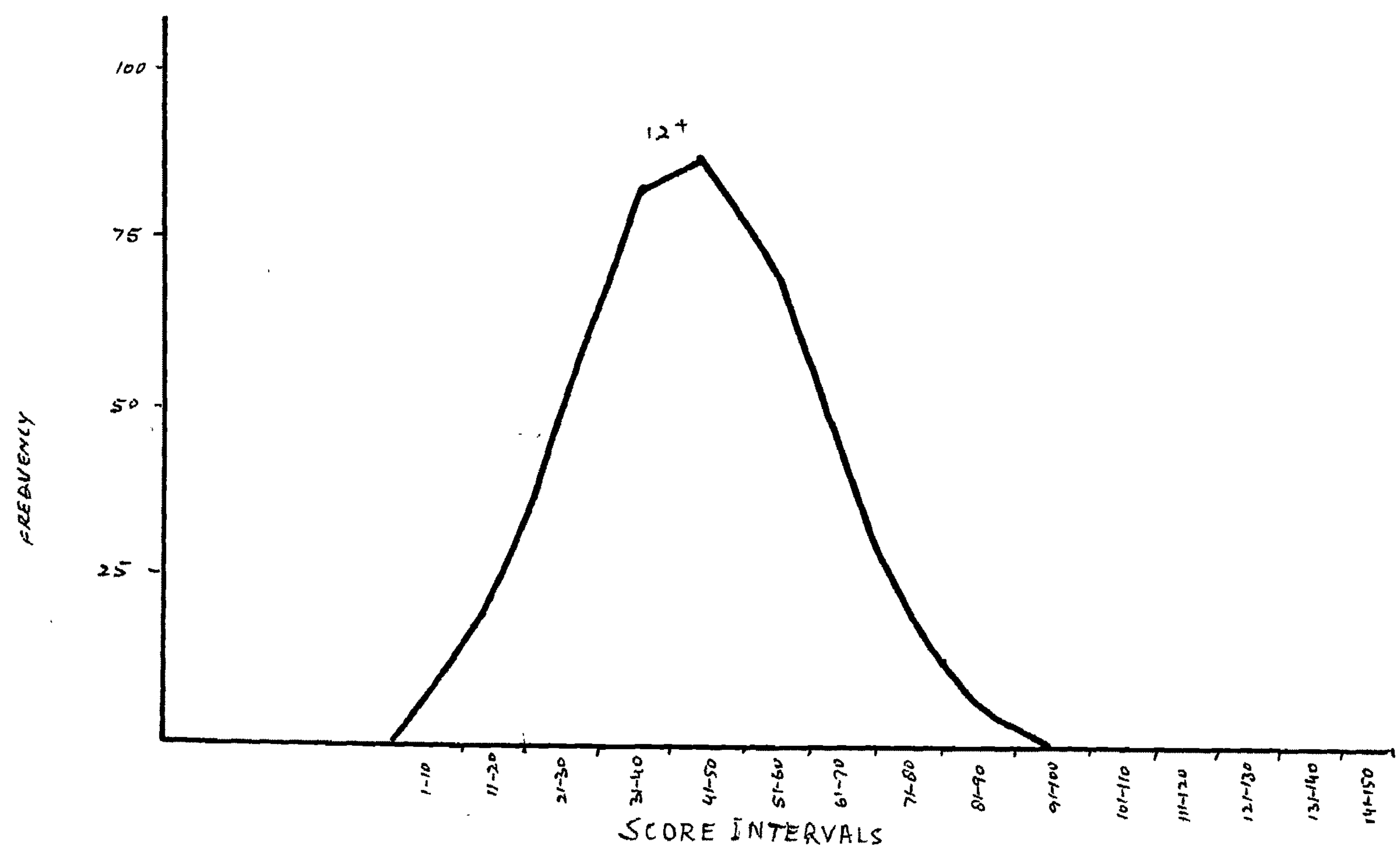
GRAPH NO. 1

Histogram of Test scores of children of Age-Group 12^+ in different score intervals.



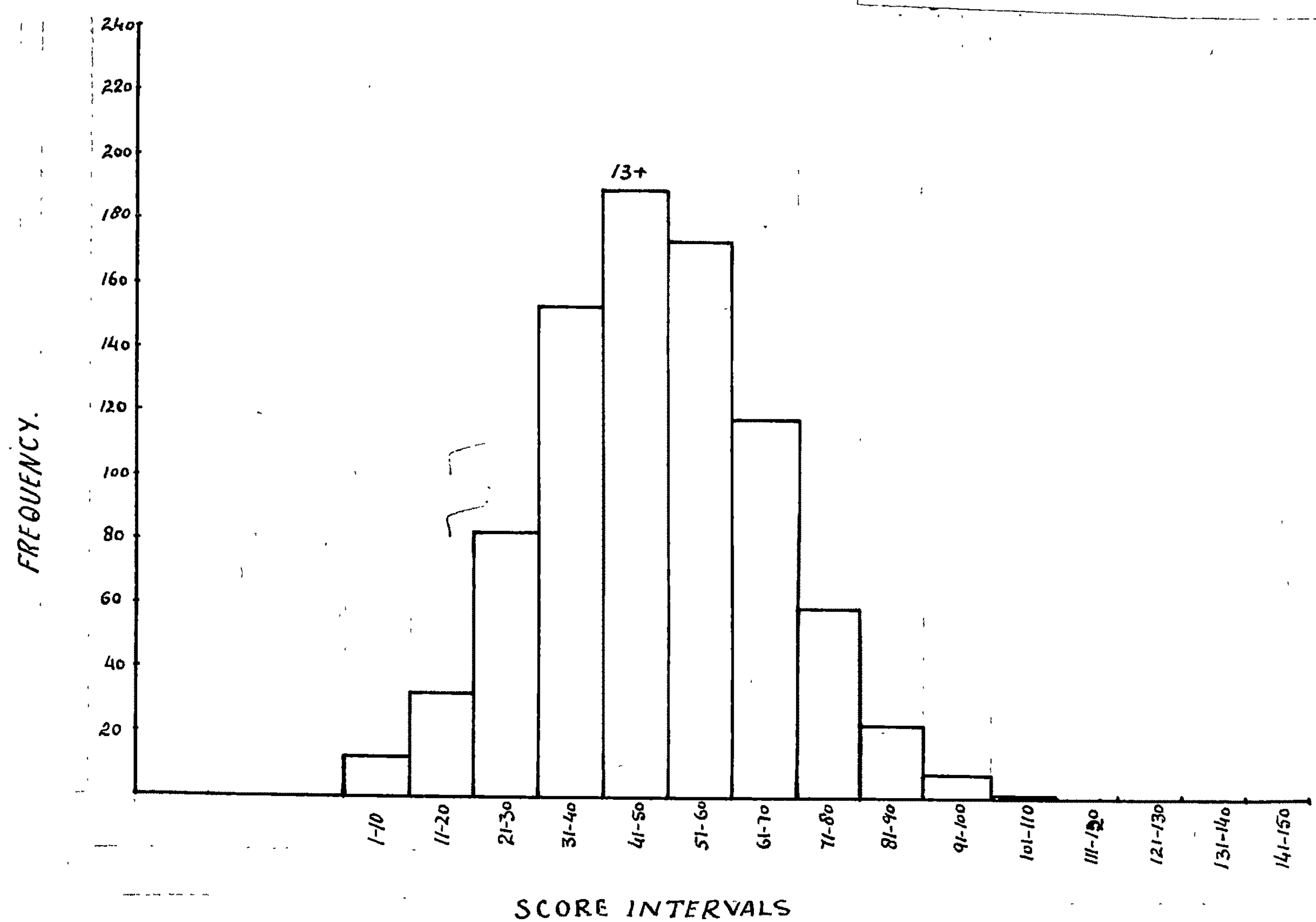
No. 1

THE FREQUENCY POLYGON SHOWING THE DISTRIBUTION OF CHILDREN OF AGE GROUP 12+ IN DIFFERENT SCORE INTERVALS.



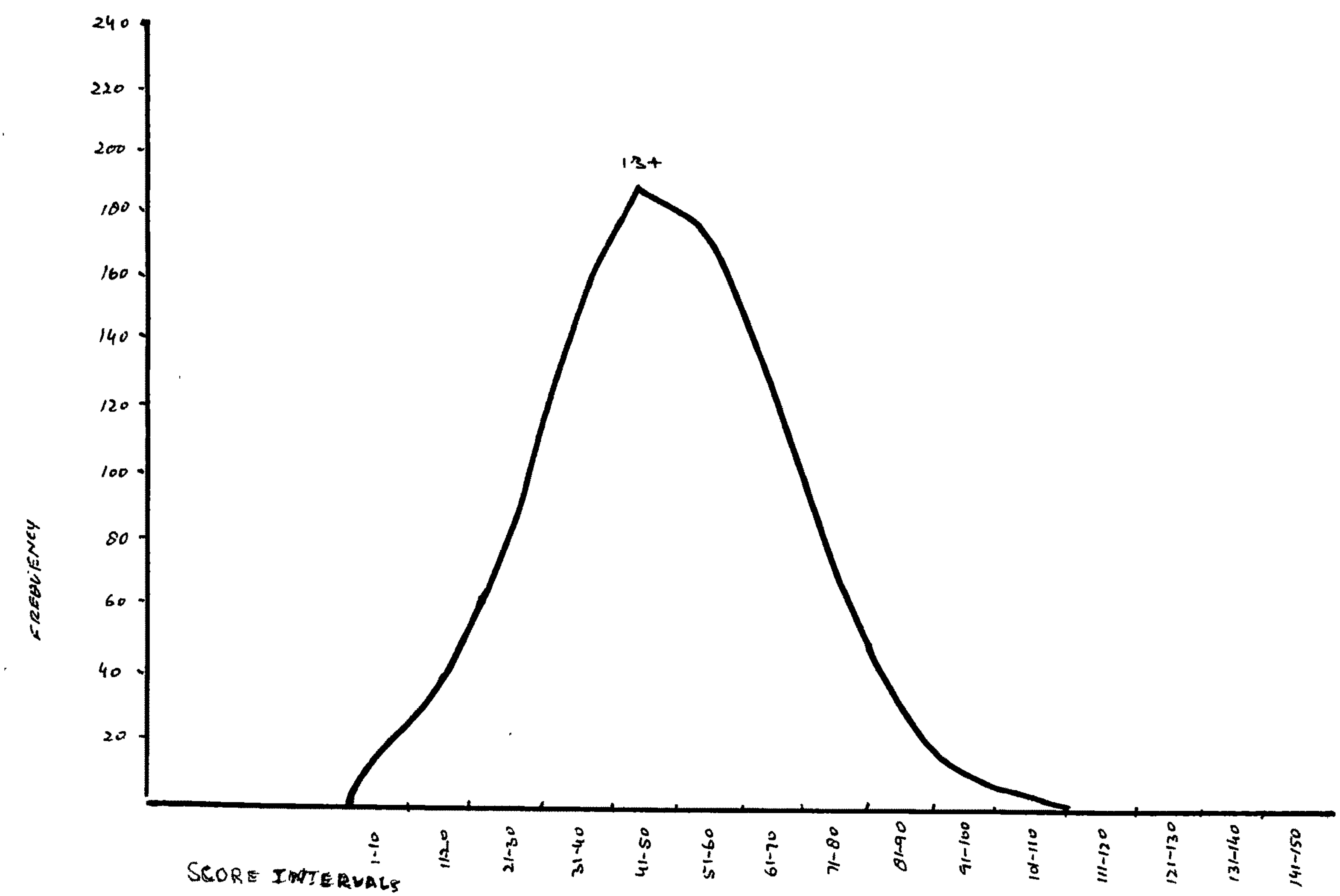
GRAPH NO. 2

Histogram of Test Scores of Children of Group 13+ in different Score Intervals.



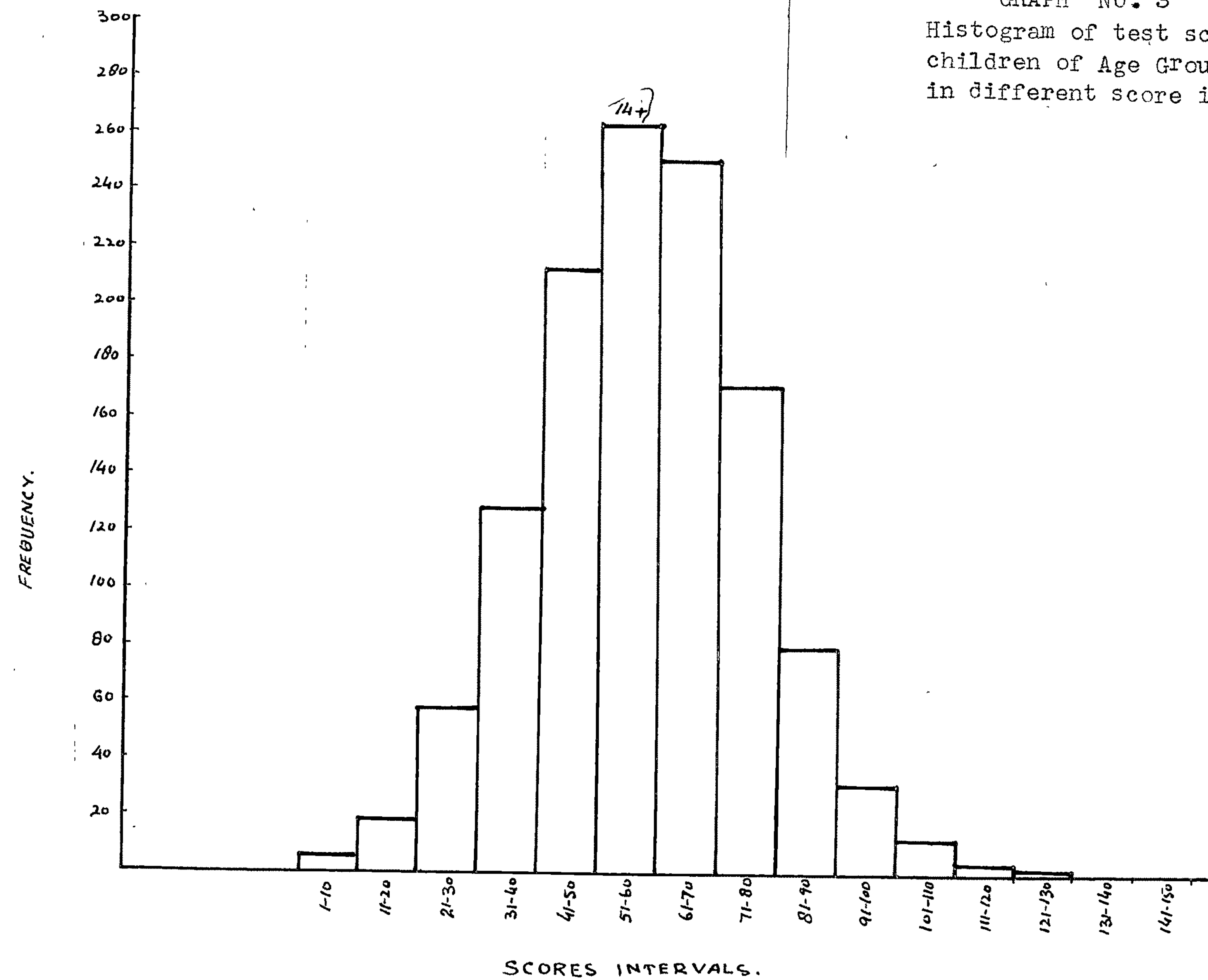
No 2 a

THE FREQUENCY POLYGON SHOWING THE DISTRIBUTION OF CHILDREN OF AGE GROUP 13+ IN DIFFERENT SCORE INTERVALS.



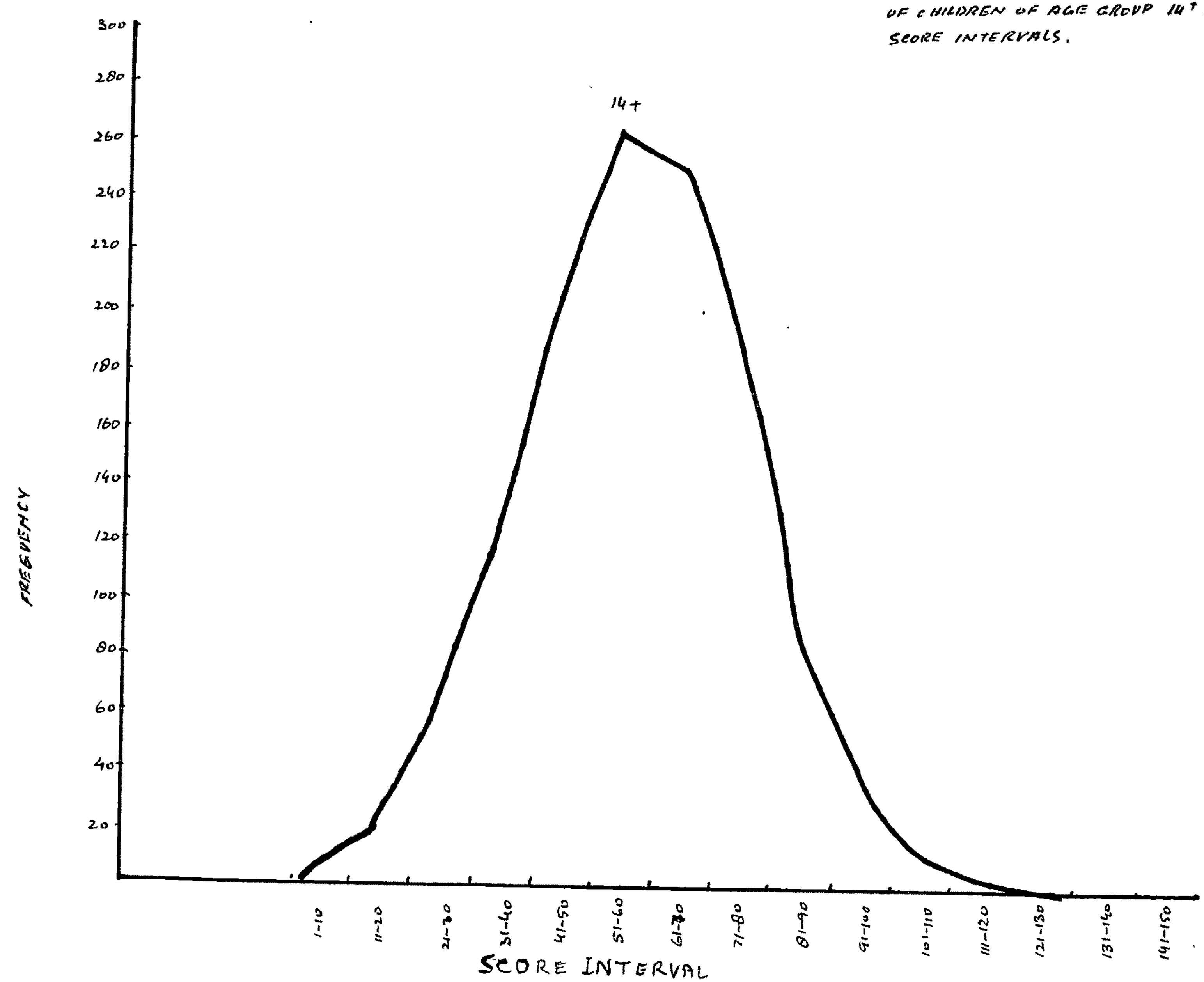
GRAPH NO. 3

Histogram of test scores of children of Age Group 14+ in different score intervals.



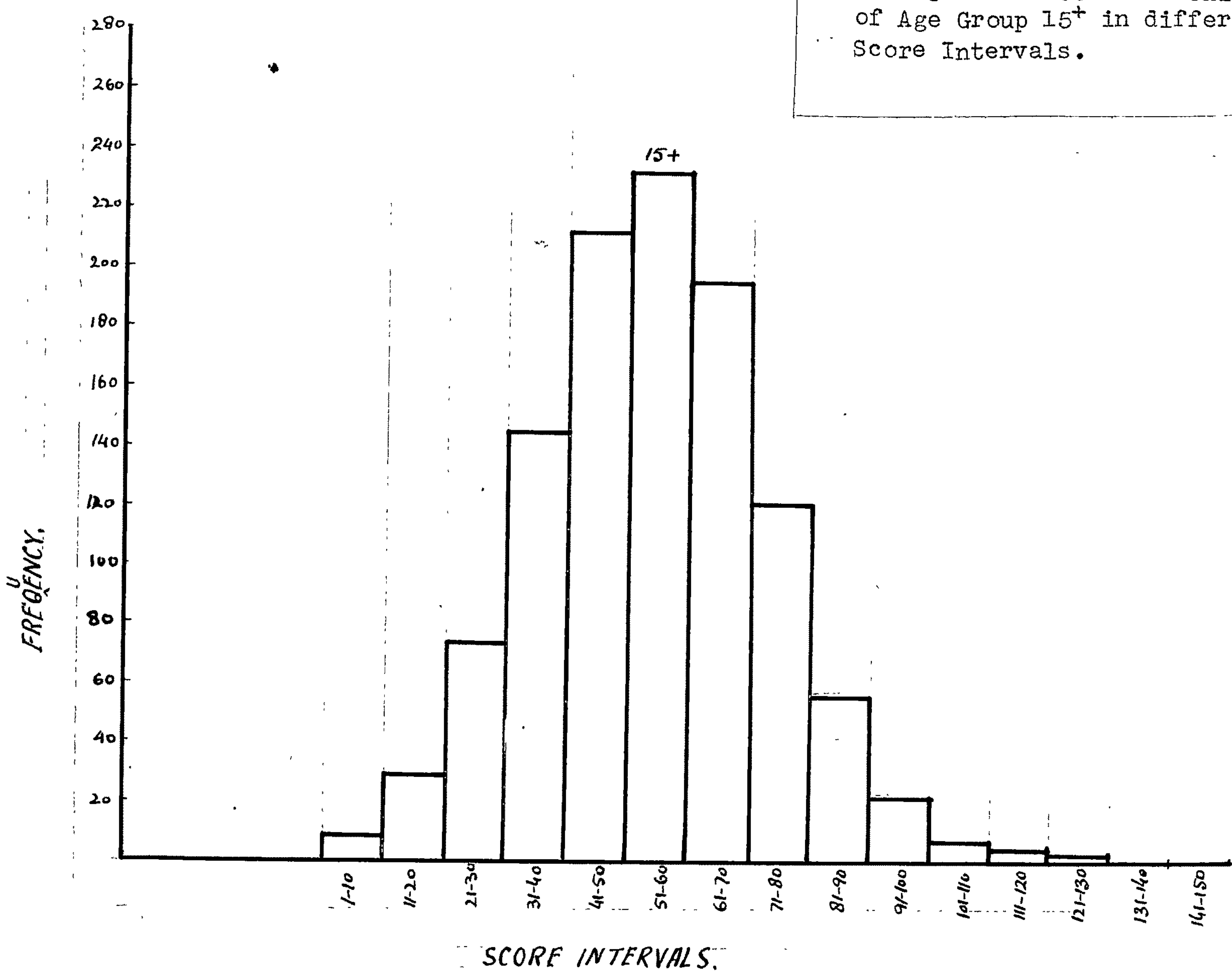
No 3. a

THE FREQUENCY POLYGON SHOWING THE DISTRIBUTION OF CHILDREN OF AGE GROUP 14+ IN DIFFERENT SCORE INTERVALS.



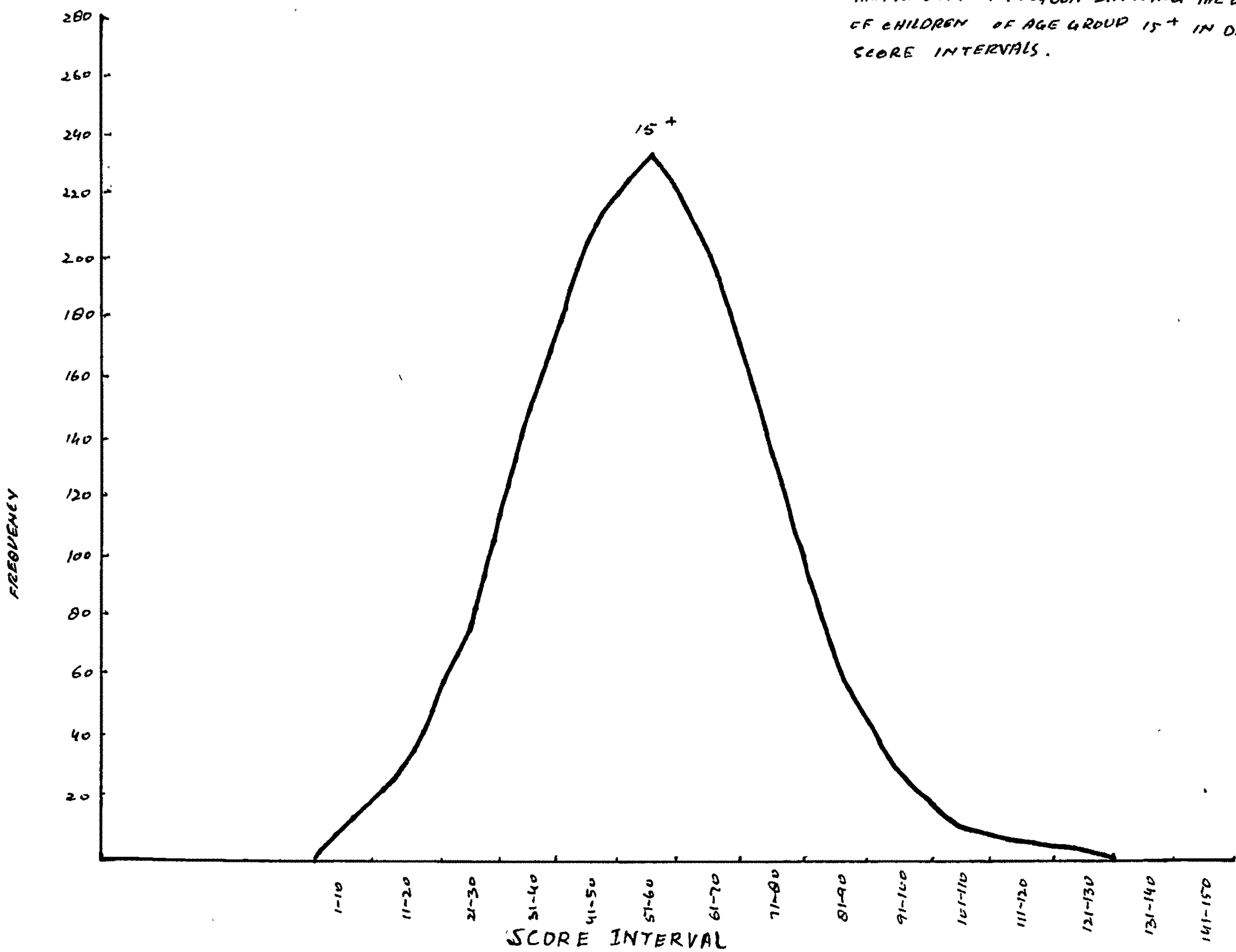
GRAPH NO. 4

Histogram of Scores of Children of Age Group 15^+ in different Score Intervals.

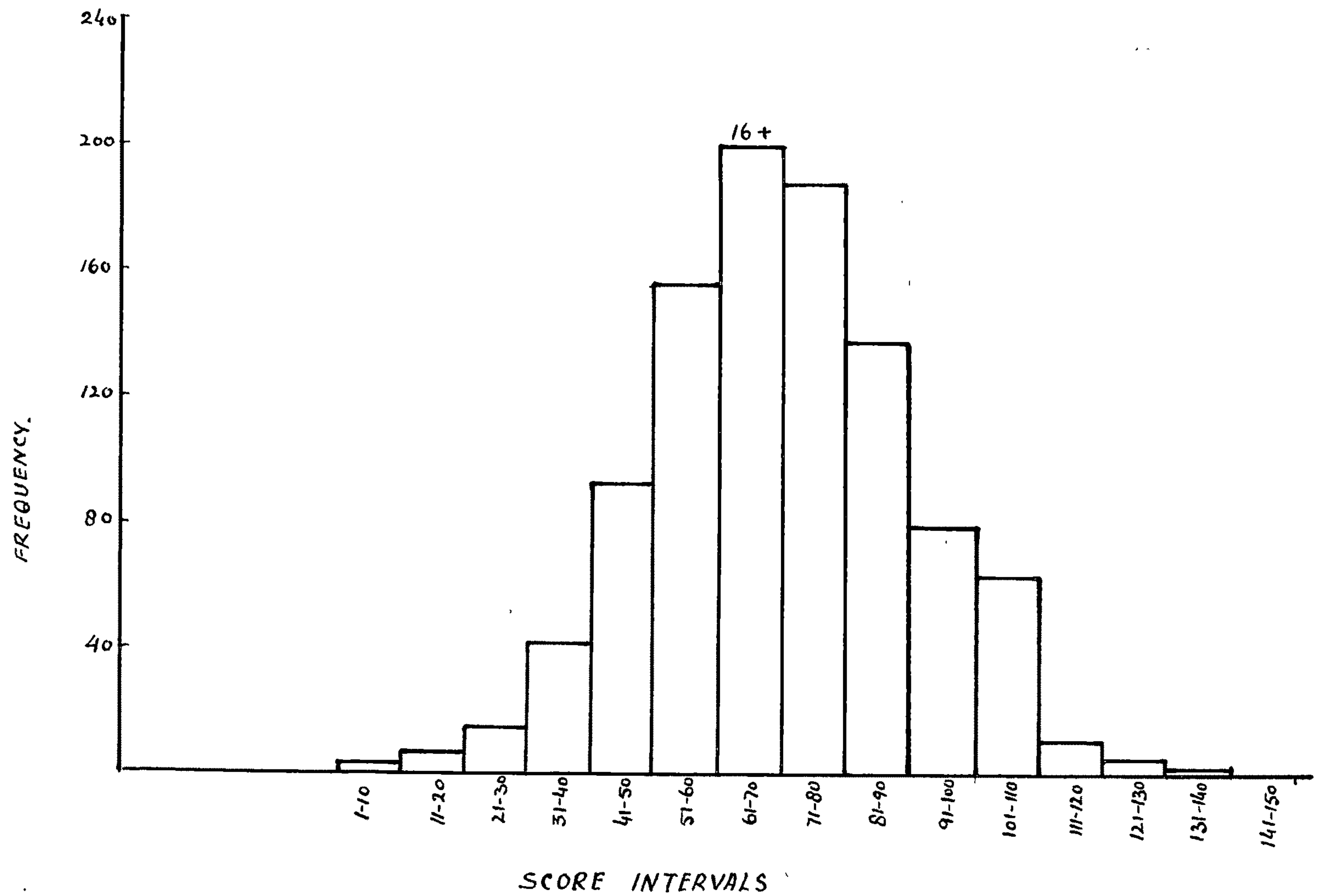


No 4 a

THE FREQUENCY POLYGON SHOWING THE DISTRIBUTION OF CHILDREN OF AGE GROUP 15+ IN DIFFERENT SCORE INTERVALS.

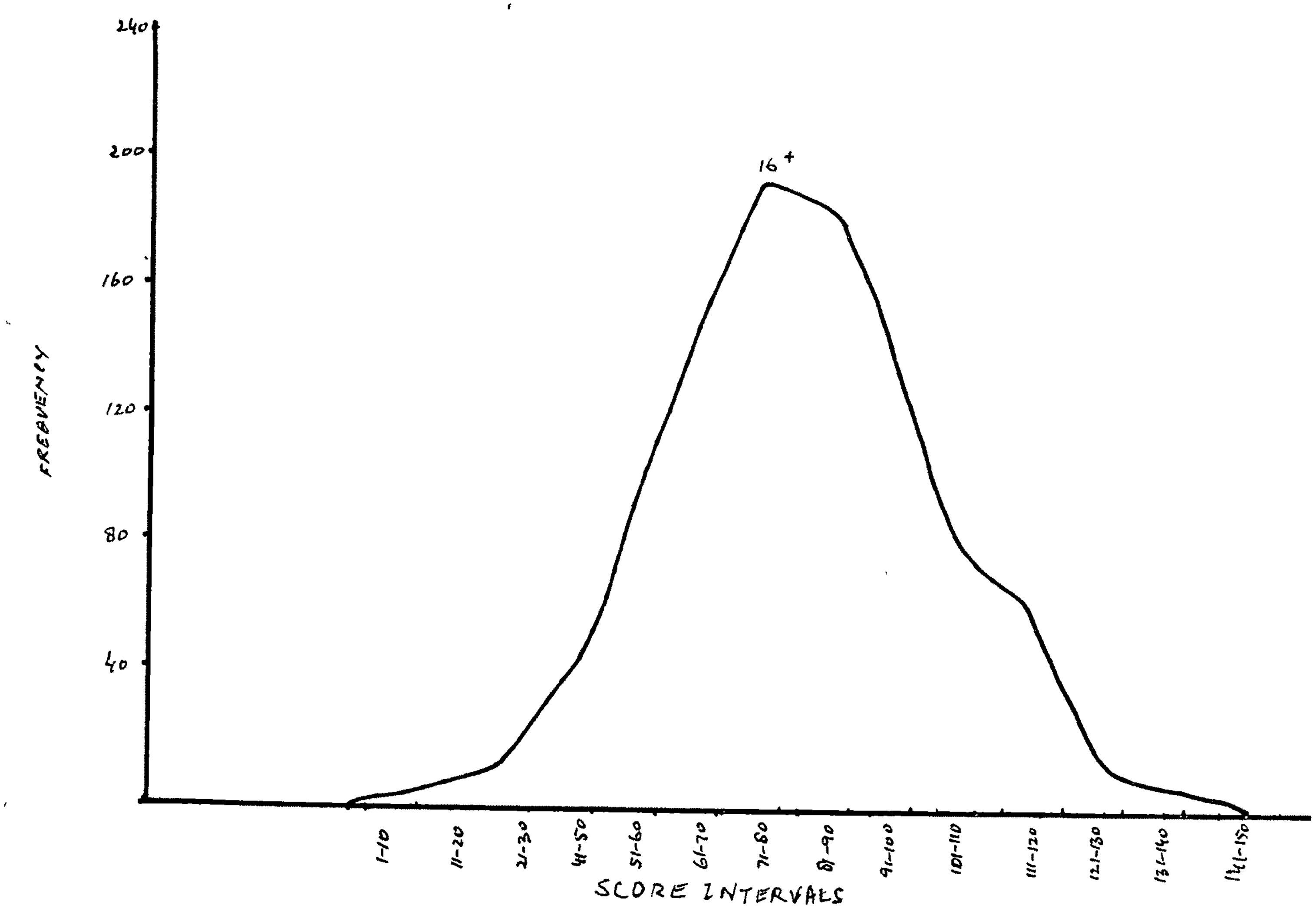


GRAPH NO. 5
Histogram of Scores of Children of Age Group 16^+ in different Score Intervals.

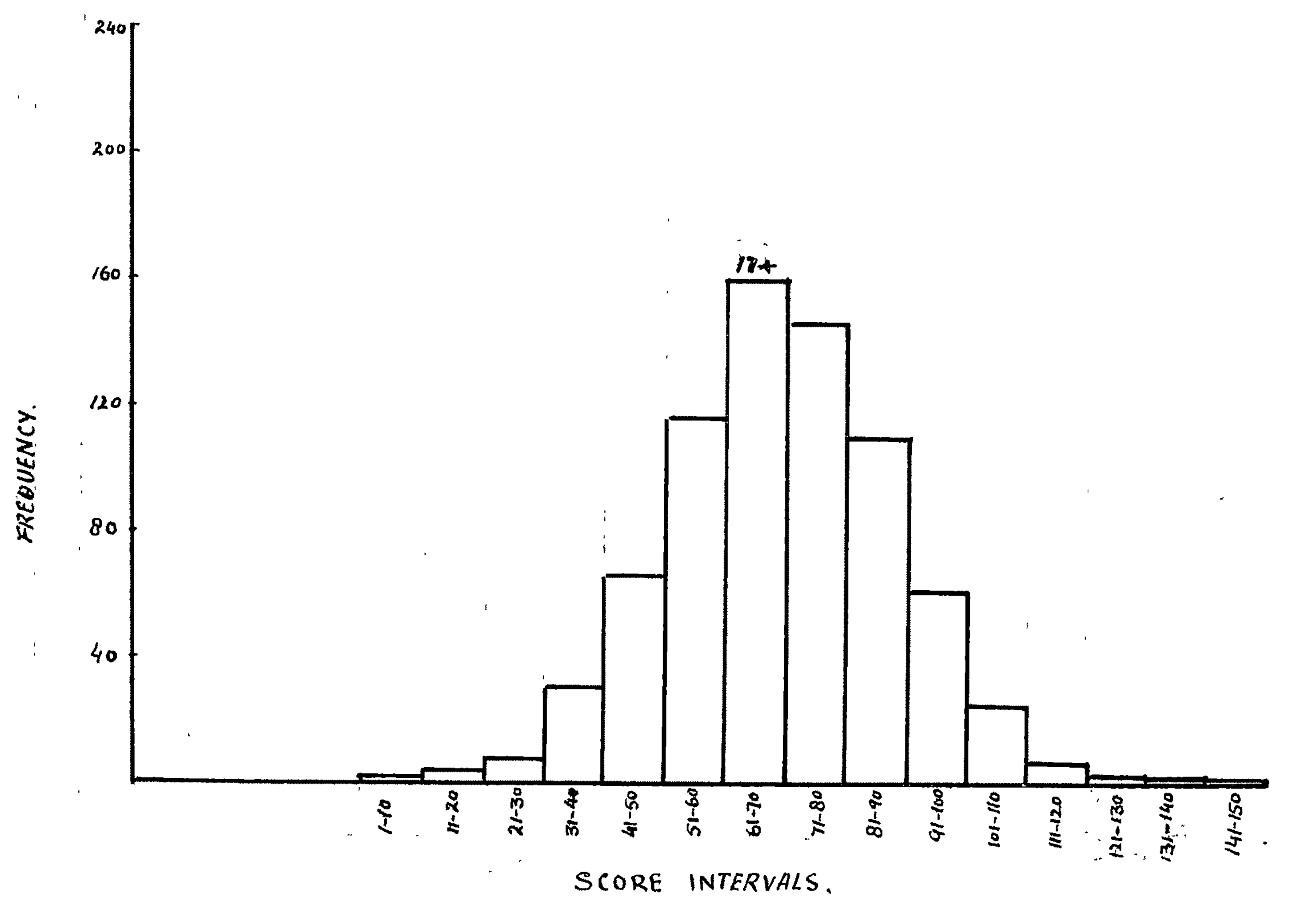


No. 5 a

THE FREQUENCY POLYGON SHOWING THE DISTRIBUTION OF CHILDREN OF AGE GOUP 16+ IN DIFFERENT SCORE INTERVALS.

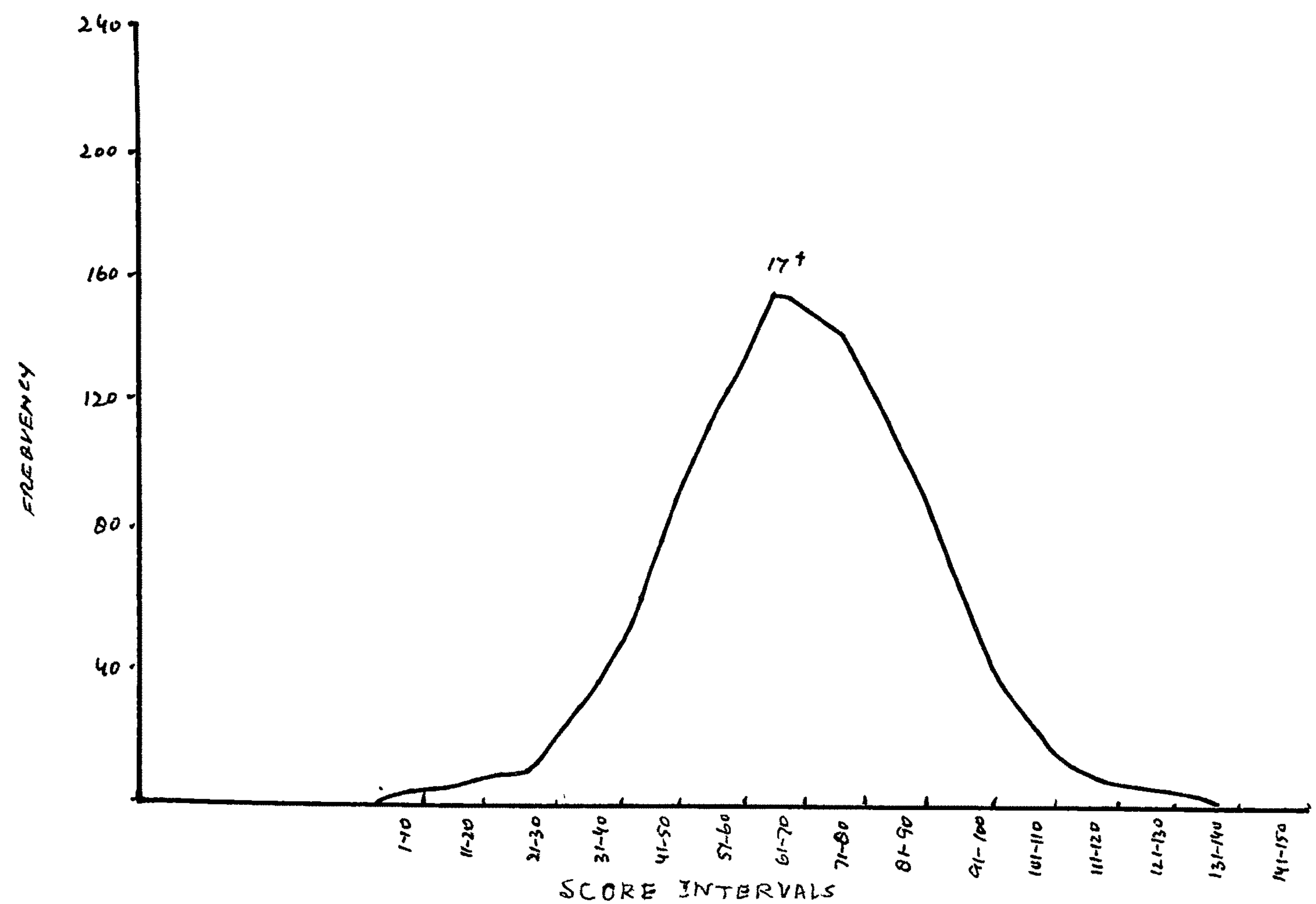


GRAPH NO. 6
Histogram of Scorés of Children of Age Group 17^{+} in different Score Intervals.



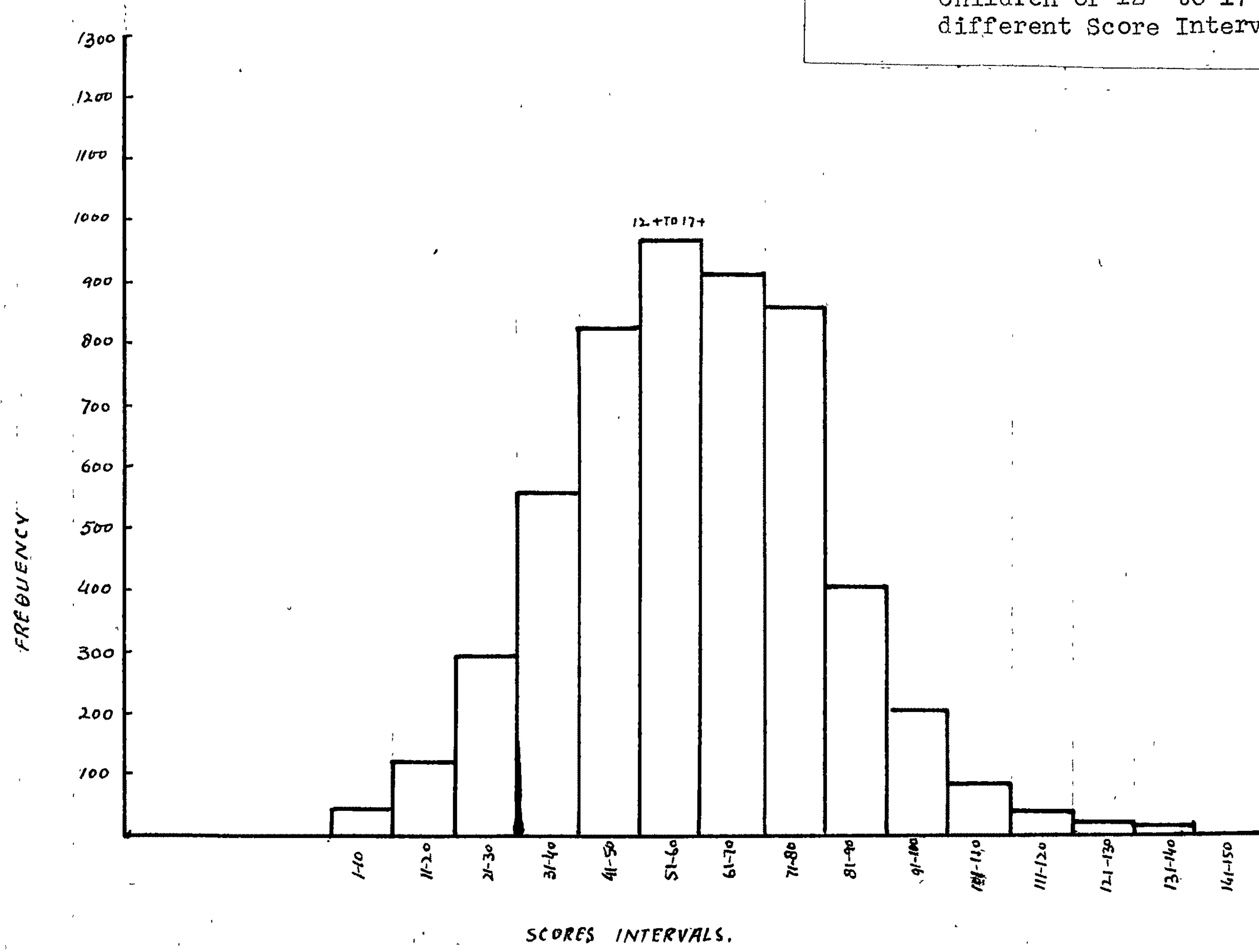
No 6a

THE FREQUENCY POLYGON SHOWING THE DISTRIBUTION OF CHILDREN OF AGE GROUP 17+ IN DIFFERENT SCORE INTERVALS.



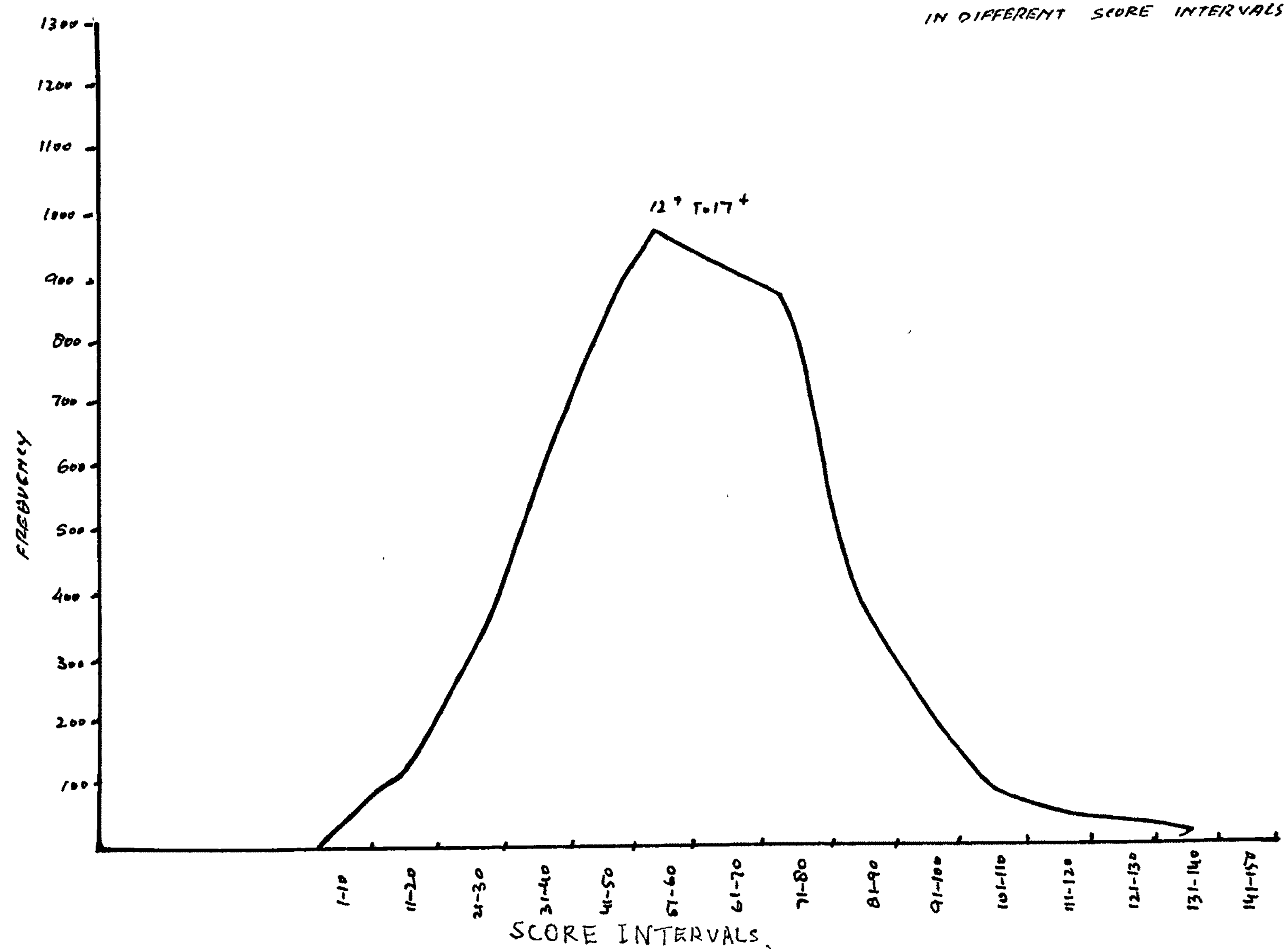
GRAPH NO. 7

Histogram of Scores of 5372 Children of 12^+ to 17^+ in different Score Intervals.



No 7 a

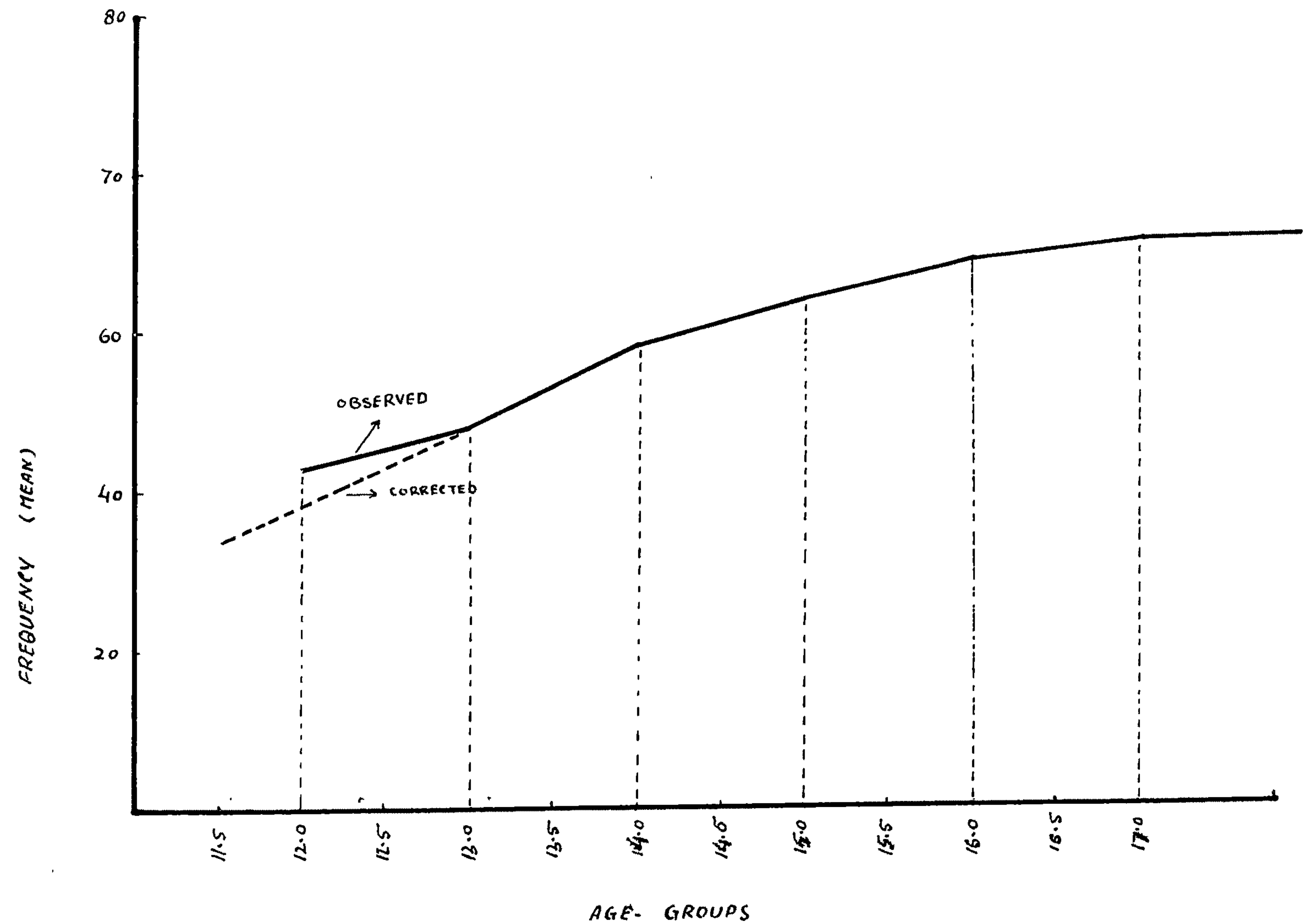
THE FREQUENCY POLYGON SHOWING THE DISTRIBUTION OF CHILDREN OF AGE GROUP 12^+ TO 17^+ IN DIFFERENT SCORE INTERVALS.



GRAPH No. 8

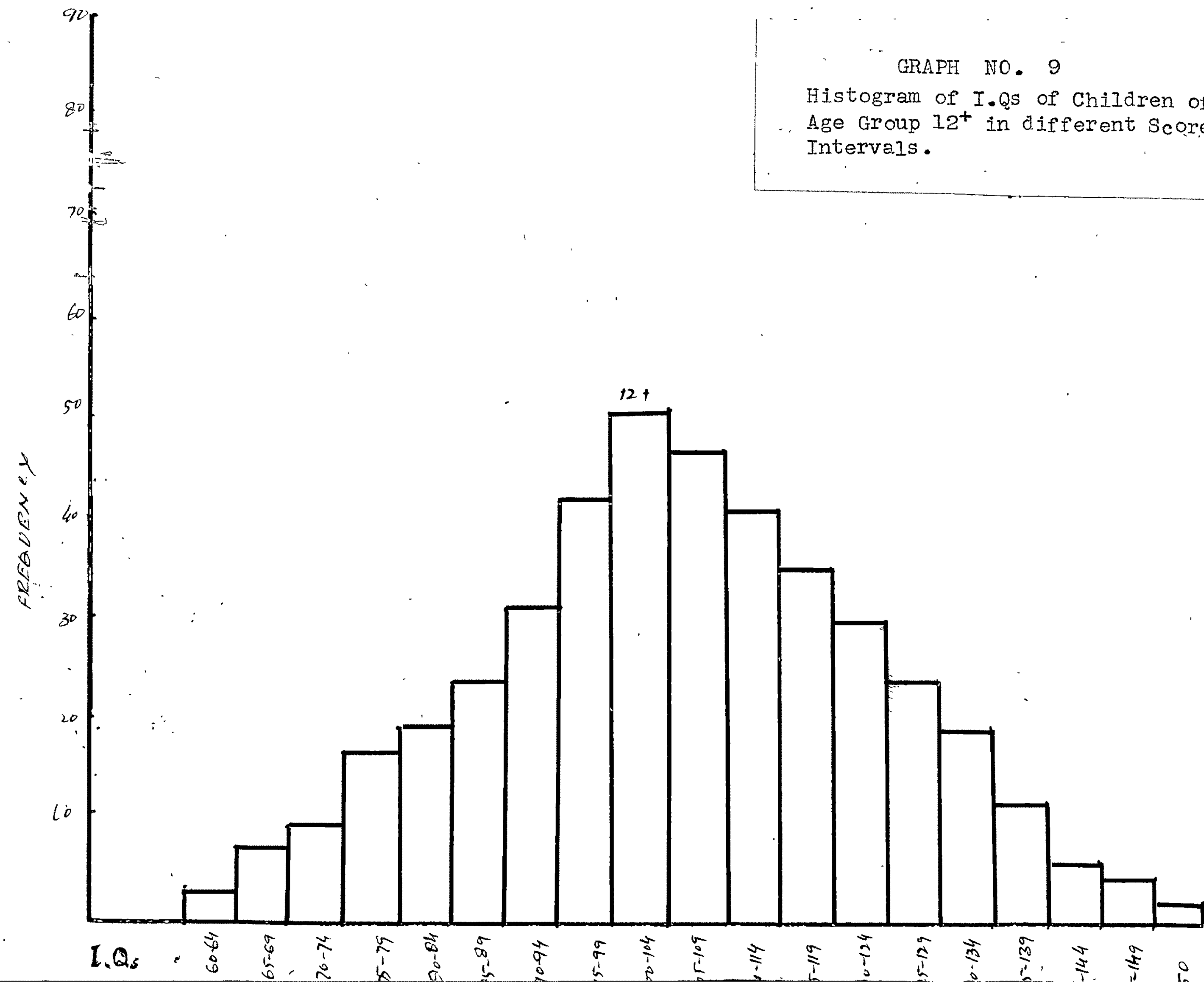
CURVE SHOWING MEAN SCORE OF CHILDREN IN DIFFERENT AGE GROUPS

(FROM 12+ to 17+)



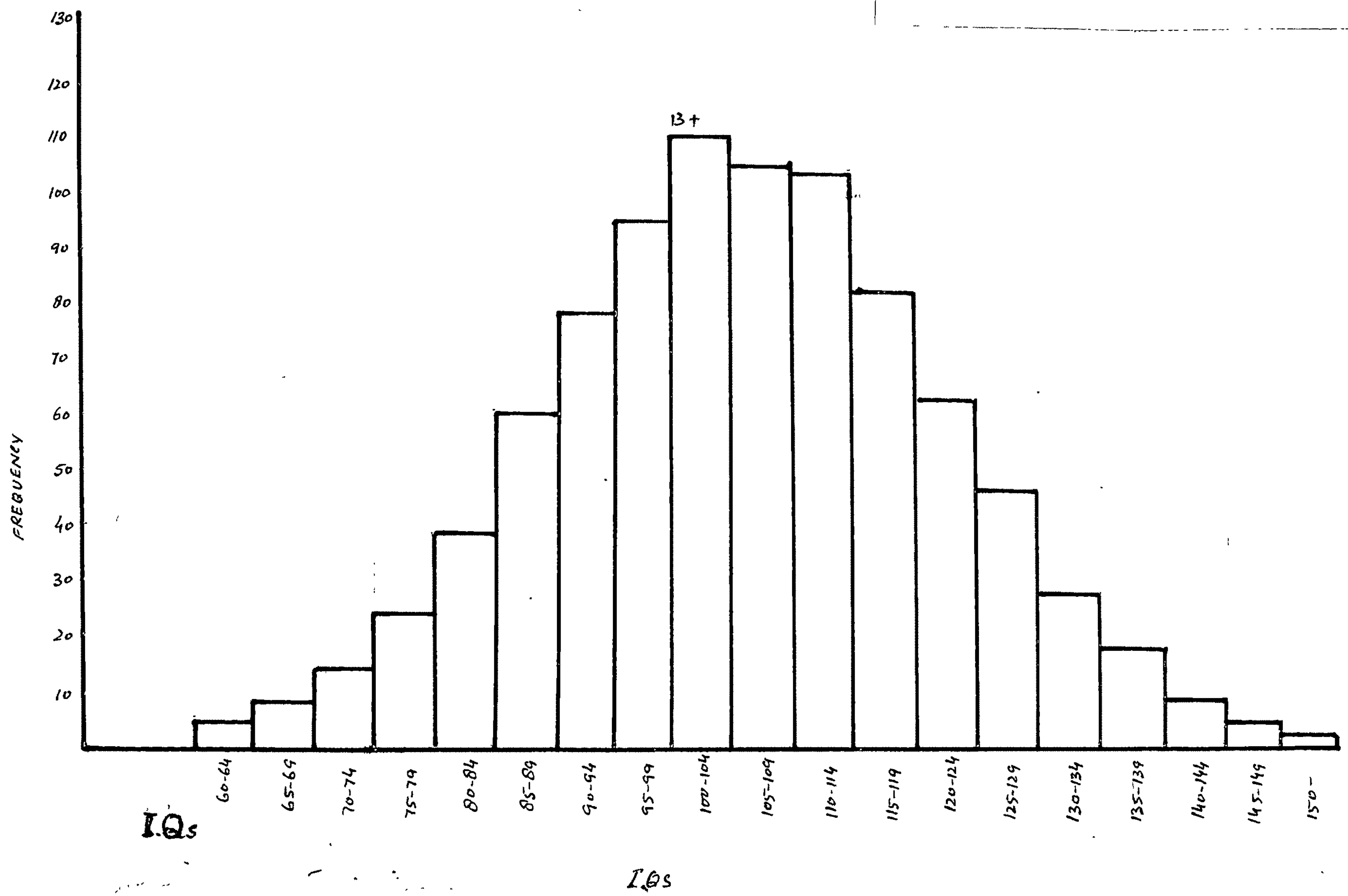
GRAPH NO. 9

Histogram of I.Qs of Children of Age Group 12+ in different Score Intervals.



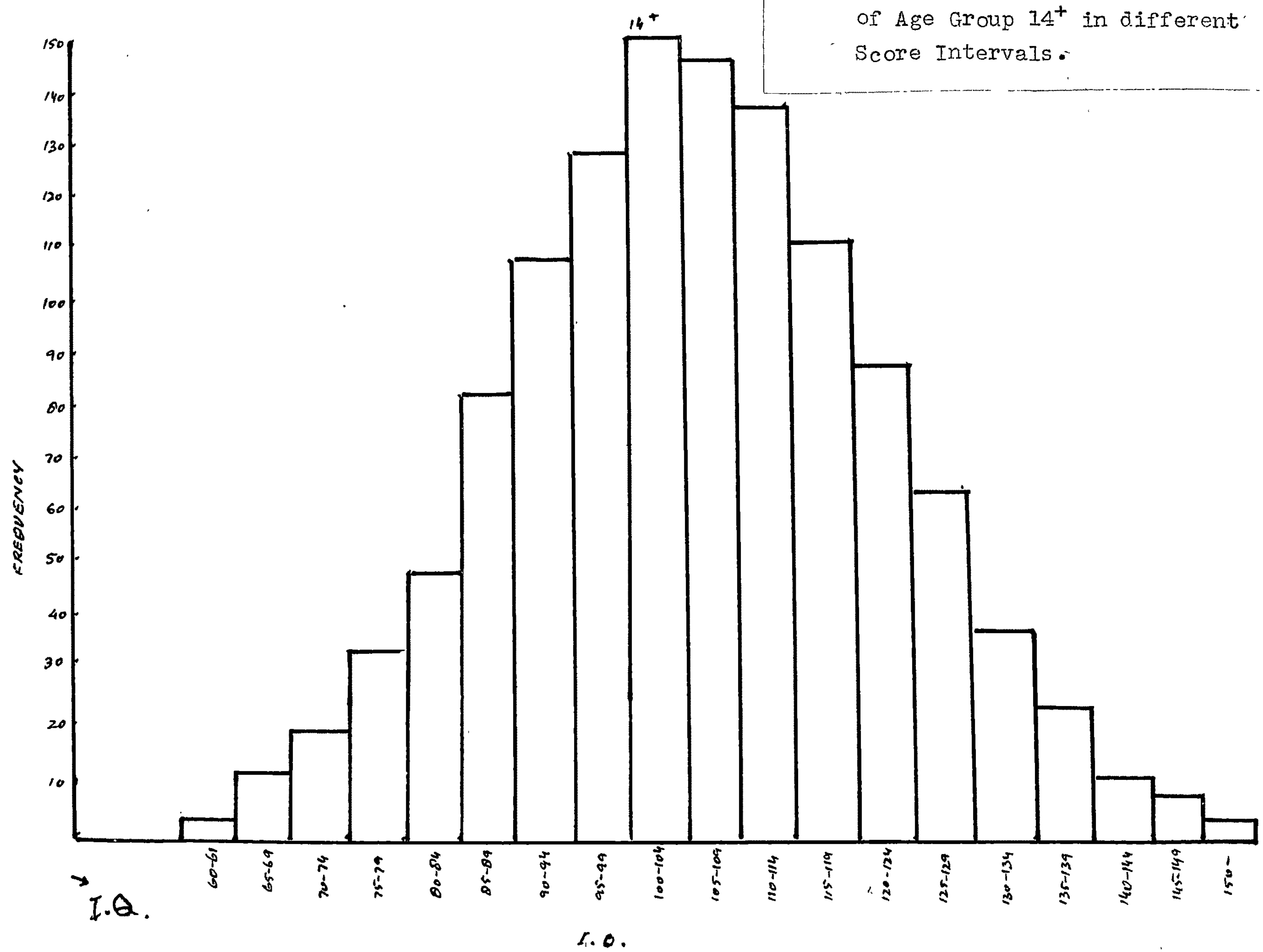
GRAPH NO. 10

Histogram of I.Qs of Children of Age Group 13+ in different Score Intervals.



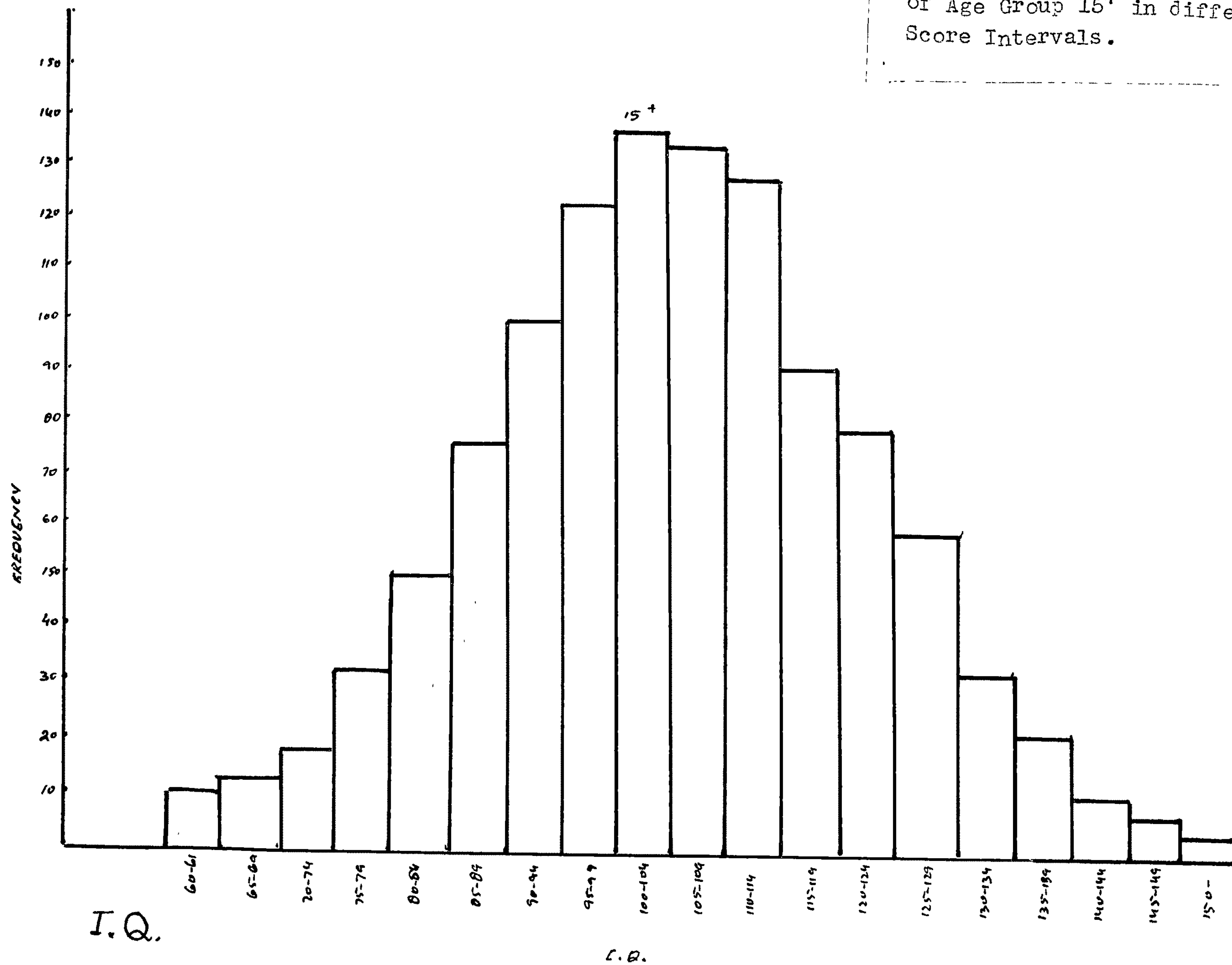
GRAPH NO. 11

Histogram of I.Qs of Children of Age Group 14^+ in different Score Intervals.



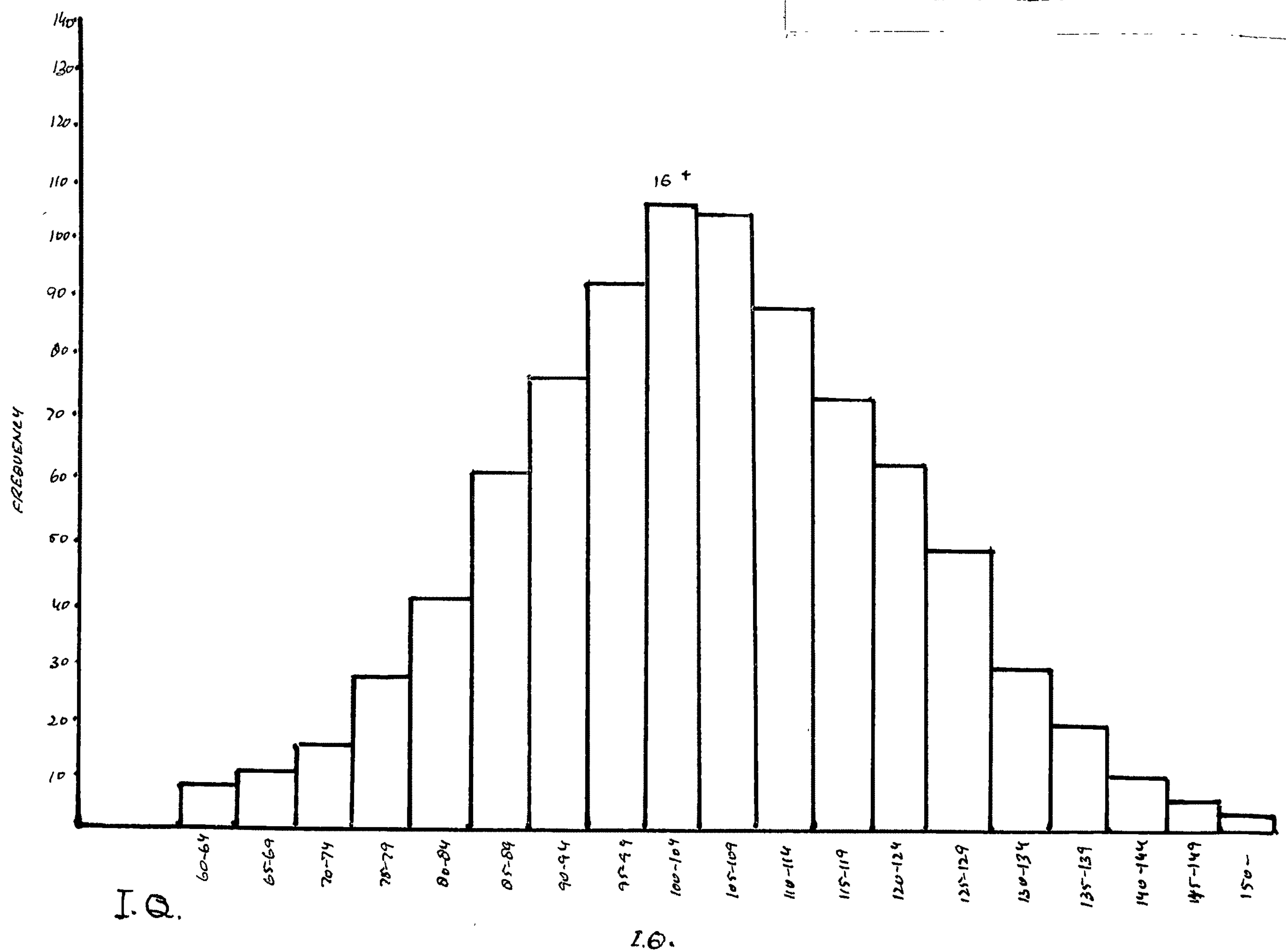
GRAPH NO. 12

Histogram of I.Qs of Children of Age Group 15+ in different Score Intervals.



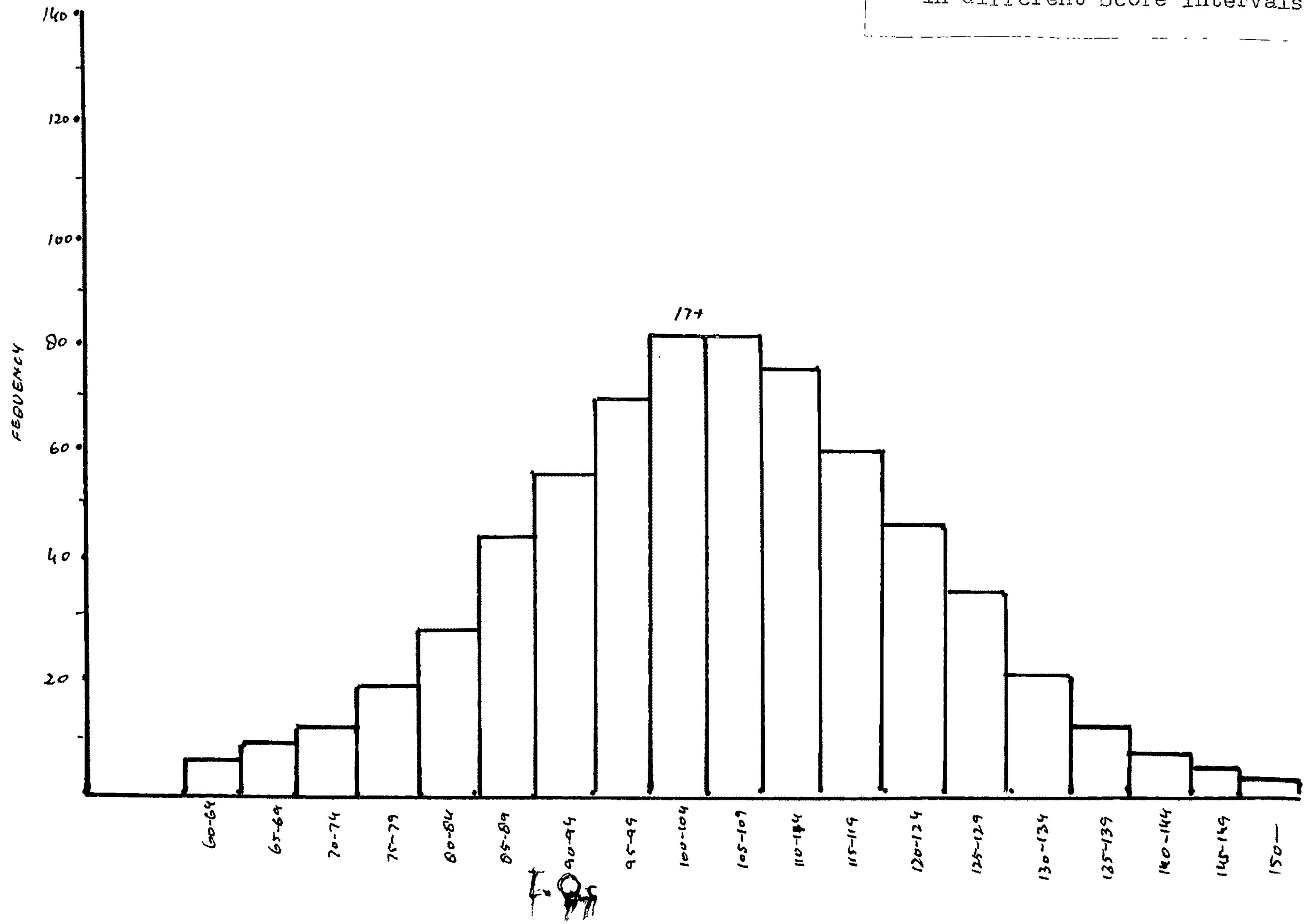
GRAPH NO. 13

Histogram of I.Qs of Children of Age Group 16^+ in different Score Intervals.



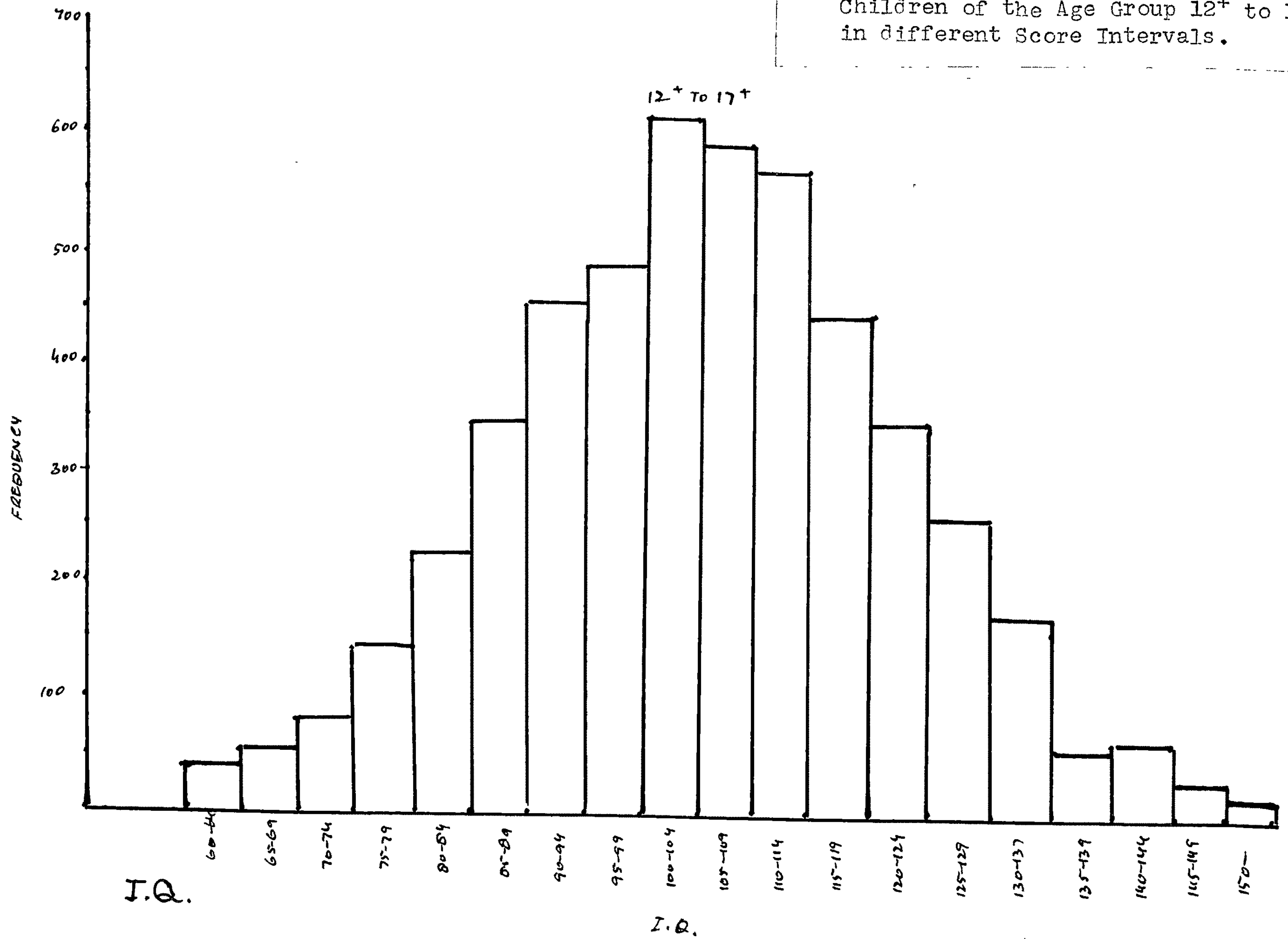
GRAPH NO. 14

Histogram of I.Qs of Children of 17^{+} Age Group in different Score Intervals.



GRAPH NO. 15

Histogram of I.Qs of 5372 Children of the Age Group 12^+ to 17^+ in different Score Intervals.



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