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ASSOCIATION OF PHYSICAL MATURATION AND VISUAL ACUITY IN SCHOOL CHILDREN OF LOURENCO MARQUES (MOZAMBIQUE)

By

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FOREWORD

My acknowledgment spans two continents. First I have a deep debt to those in America who assisted me so greatly. The Committee, comprised of Dr. Samuel M. Wishik, Dr. Antonio Ciocco, Dr. William G. Everett, Dr. Douglass Thompson, Dr. Waldo L. Treuting, and Dr. Marc Vincent, guided me in the structure of my thesis and its development. The nature of my work required extensive help from the faculty and personnel of the Department of Biostatistics. The generosity with which this was given was heartening to me. My thanks are also due to Dr. Kenneth D. Rogers, Miss Catherine M. Brosky and Miss Dorothy Vaughan for their help.

I give my sincere gratitude to the people of Mozambique who assisted me so unstintingly in the gathering of the data used in this thesis. To the personnel of School Health Services and the medical staff of the Eye Clinic in the Hospital Miguel Bombarda who helped collect the necessary material I give my very warm thanks.

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I. INTRODUCTION

The future of developing countries lies to a large extent in the education that can be provided for their children. It is self-evident that children in poor health or with a communications handicap can not benefit fully from whatever educational program is offered them. A common communication handicap in children of school age is impaired visual acuity. An important part, therefore, of any school health program is recognition of children with these impairments so that appropriate corrective measures may be instituted. Knowledge of the distribution of visual defects within the school population (sex, age, race, or other subgroups) may be valuable for planning vision screening programs in developing countries to give high case finding while, at the same time, conserving the required amount of professional services which are involved. For example, if the prevalence of visual defects is found to be relatively constant at different ages in certain groups or in all groups at certain ages, routine vision screening may be scheduled with different frequency according to these facts and not given at fixed intervals for all children.

The author, from her experience as Director of School Health in Mozambique, has arrived at certain impressions regarding the distribution of defects in visual acuity in school children of that country. These impressions are that the per cent of children with defective visual acuity and refractive errors increases with age and that females appear to exceed males and White children to exceed Negro children in rates of abnormal visual acuity and refractive errors.

A study, therefore, was undertaken to test the accuracy of these observations and to achieve better understanding of vision in school children. The entire population of school children 9-16 in the official (government) schools of the capital city of Mozambique, Lourenco Marques, comprised the study group.

This thesis focuses in depth on a portion of the data to assess the relationship between visual acuity and growth, most specifically to test the following hypothesis:

The impairment of visual acuity in a child is influenced significantly by factors which also display themselves in the child's pattern of growth, especially at adolescence. Evidence can be obtained to show associative relationship between visual acuity and maturational characteristics of children.

II. REVIEW OF THE LITERATURE

A. Development of Studies of Human Growth and Maturation

Change in physical size, proportion and function is one of the most self-evident facts of human growth and has been noted throughout recorded history. The association of certain bodily disfunctions with body type, age, race, and sex also has been made repeatedly over the years both in folk and scientific literature. It was not until the end of the 19th or early in the 20th century that orderly studies of human growth were undertaken and predictive indices and explanations developed. Early studies of children consisted largely of gross morphologic measures, e.g., height, weight, chest circumference, crown rump, rump heel length, etc., of children of different chronologic ages. From such studies "norms" were derived for children of given age and sex. In addition to study of gross body characteristics, studies were made also of the size, weight, and structure of various organs and organ systems. Thus norms were established for the weight of the heart, liver, spleen, etc., of children of different ages.

Early studies shared common failures -- failure to identify the universe from which their sample was selected and failure to recognize the bias which entered into the selection. As an example of the latter shortcoming were studies made of dead children from which inferences were made concerning the size and structure of organs in living children. The morphologic studies had many values, however. They established the association between certain measures such as height, weight, chronologic age, head and chest circumference, etc. They identified individual differences and showed that children proceeded in their growth in an orderly way and tended through time to maintain a constant relative rank in respect to chronological cohorts. Morphologic studies also identified the growth characteristics of different body systems, e.g., neural, musculo-skeletal, gonadal, lymphoid. Finally, these descriptive studies allowed establishment of certain age periods with common characteristics, e.g., fetal, neonatal, adolescent, etc.

In addition to morphological (gross and microscopic) descriptions of growth and development, physiologic and functional measures were made of children of varying ages. Some of these measures were: epiphyseal maturation, Vogt (1938);[1] estrogen level, Nathanson (1941);[2] I. Q. Gesell (1947);[3] alkaline phosphatase, Talbot (1947);[4] the "chronology of the human dentition," Logan (1933),[5] etc. These measures were seen to have high association and, at certain age periods, to be better indices of physiologic age than the commonly used chronological age.

B. Growth and Development of the Eyeball

Certain aspects of growth of the eye have been studied extensively while others have been studied hardly at all. Scarcity of some of these observations has been due largely to difficulties inherent in making measurements. Also, many of the measures which have been made have been open to question as to their representativeness and their accuracy since they have been made from cadaver material. The various measures which have been reported are: eyeball diameters (sagittal, horizontal, vertical), eyeball weight and volume, corneal horizontal diameter, corneal curvature, and lens curvature.

Most of the post-natal growth of the cornea occurs in the first 12 months of life and leads to only an approximately 25-30 per cent increase in horizontal diameter over that present at birth. The weight and the volume of the globe also increase steeply in the first 12 months of life but continue their rapid growth during the following year or two. Thereafter, growth continues slowly, but final values are two or more times those observed at birth. The optic nerve at birth is 24.4 mm. long with a diameter of 2.7 mm. Post-natal growth in length is 60 per cent to a mean of 39.04 mm. and in diameter, 14 per cent to a mean of 2.74 mm.

Scammon (1925)[6] summarized the figures of various observers on the post-natal growth of the eyeball. A total of 1,000 observations were made of lineal measures of the eyes of cadavers. Approximately the same technique was used by the various observers. The weight in post-natal life was represented by 39 cases. Although they were few the author found them sufficient to indicate the general course of growth of the organ after birth.

Todd (1940)[7] studied with a precise technique 150 pairs of adult eyeballs (total cadavers) and gave data upon growth in weight. He reported some interesting sex and race differences in adult eyeball weight. Sex and race ratios of eyeball weights were: MW/FW = 1.075, MW/MN = 0.923, MN/FN = 0.987, FW/FN = 0.917. Female eyeballs were

Mean Measures of the Human Eyeball
(Scammon)

Age	Sagittal mm. N=10,000	Transverse mm. N=10,000	Vertical mm. N=1,000
Birth	17.5	17.1	16.5
1-2 years	20.2	20.5	20.2
2-5 years	20.3	21.1	21.1
5-10 years	21.8	21.8	21.3
10-15 years	21.2	21.9	21.5
Adult female	23.9	23.4	23.0
Adult male	24.5	24.2	23.6

Age	Wt. (grams) N=39
Birth	3.25
1 year	3.33
2 years	4.67
3-4 years	5.07
5 years	5.71
7-8 years	5.69
9-10 years	6.43
14 years	5.95
16 years	6.50
Adult	7.18

Mean Measures of the Human Eyeball
(Todd)

Group	Number	Right Eyeball Weight (gms.)		Left Eyeball Weight (gms.)		Cranial Capacity	Stature
		Av.	S.D.	Av.	S.D.		
Male White	63	7.85	.60	7.82	.60	1445 cc.	1734 mm.
Male Negro	45	8.51	1.00	8.47	.97	1393 cc.	1742 mm.
Female White	18	7.29	.65	7.28	.65	1261 cc.	1590 mm.
Female Negro	24	7.95	.80	7.94	.78	1273 cc.	1669 mm.

absolutely smaller, but relatively larger than male when considered in relation to cranial capacity and stature. American Negro eyeballs were larger than those of American Whites. In both sexes the right eyeball was consistently larger than the left, although the differences were quite small.

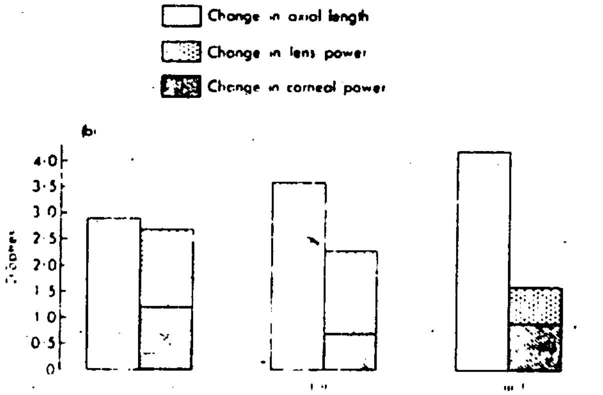
Studies by Todd and Todd and by Zimmerman and Scammon, summarized by Krogman,[31] showed that in the fetal life the eyeballs attain their maximum convergence before the bony orbits are formed. From mid-second to the end of the third fetal month convergence is rapid; the angle goes from 180 degrees to 105 degrees, or 69 per cent of total fetal convergence. From the end of the third month to term the angle goes from 105 degrees to 71 degrees, the remaining 31 per cent of the fetal convergence. Postnatally, there is an additional three degrees of convergence which occurs very slowly.

Sorsby et al. (1961)[8] studied the eyes of 1432 children three through 14 years of age. They found that ocular refraction in the vertical meridian declined with increasing age. There was very little diminution in ocular refraction after adolescence was reached. Between the ages of 3 and 15 the reduction amounted to 1.4 D for boys and 2.4 D for girls. The sagittal diameter of the globe was found to be about 23 mm. at age three -- an estimated increase of 5 mm. over the 18 mm. diameter at birth. In the ten years between the ages of three and 13 they observed axial elongation of only about 1 mm. and reported that the growth of the eyeball appeared to be completed by the age of 13 or 14 in both sexes. For all practical purposes, the change in corneal power between ages three and 13 was not important and while the lens power decreased steadily, the overall change in this same age range was not great -- less than 2 D. The increase in the depth of the anterior chamber was directly related to age and from 3 to 14 amounted to from 0.1 to 0.2 mm.

The differences found for the values of axial length during growth, between this study and that of Scammon, may be due to the fact that Scammon reported measures on cadavers using calipers and compasses, while Sorby et al. studied the axial length in every person using an optical method.

A most important concept of the growth of the eye was that set forth by Sorsby et al. who viewed the eye as a coordinated organ and not as an aggregate of separate structures. These observers noted that refraction remained relatively unchanged over time despite changes associated with the size and shape of the eye's optical structures. They inferred that this relative constancy was due to coordinated compensatory changes in the component parts of the eye. For example, the increase in the sagittal diameter of the eye from birth to age three of five mm. or more would cause a refractive change of as much as 20 D if other components of the optical system did not also change. In this instance, both the curvature of the cornea and the curvature and thickness of the lens change with growth -- the larger the globe, the flatter its surfaces. Thus, axial change is compensated by reduction in corneal and lens power. Sorsby represented these compensatory changes in the following schematic diagram: (Figure 1)

Figure 1
Growth Patterns of the Eye



The persistence of hypermetropia and the emergence of emmetropia and of myopia: three cases showing similar (and rather marked) degrees of axial elongation but different degrees of partial compensation -- fairly full in the first, moderate in the second, and rather poor in the third.

	(i)	(ii)	(iii)
Period between examinations	4 yrs.8 mths.	4 yrs.8 mths.	5 yrs.3 mth.
Initial refraction	+ 1.0 D	+1.3 D	+1.5 D
Axial elongation	1.3 mm	1.6 mm	1.7 mm
Refraction at 2nd examination	+ 0.7 D	0.0 D	-1.0 D

(From Sorsby, 1961)

In example (i) refraction did not change during a four-year and eight-month period despite axial elongation of 0.7 mm. because of full compensation by changes in the cornea and lens.

Example (ii) is one which emmetropia developed, during a four-year and eight-month period from an initial hypermetropia of +1.3 D. In this instance there are only partial compensation by the cornea and lens for an axial elongation of 1.6 mm.

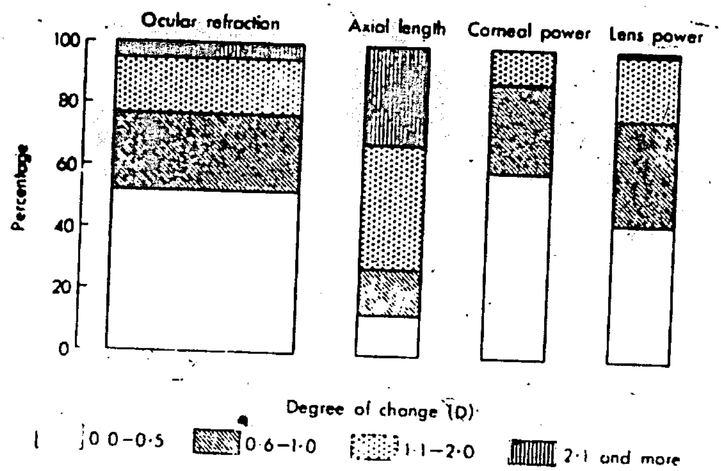
In the last example (iii), an initial hypermetropia of +1.5 D changed in 5 years 3 months to a myopia of -1.0 D. In this instance as in example (ii) the refractive power of the lens and cornea changed less than was needed to "balance" the change of 1.7 mm. in axial length.

Sorsby *et al.* re-examined 386 children of their original 1432 child study group 2 to 6 years after their first examination. In Figure 2, reproduced from their study, it can be seen that the most striking change is in axial length. The authors state:

> It is clear therefore that during growth, axial elongation does in fact occur but that this elongation, with its tendency towards myopia, is countered by compensatory changes in the cornea and lens, leaving an essentially unchanged refraction, except in a minority of cases where this compensation has been inadequate or entirely lacking. A stationary refraction is not therefore evidence of an unchanged axial length. This, indeed, may be stationary, but it is more likely that there has been some elongation -- possibly a substantial one -- which has been adequately compensated for. It would seem probable that the lens plays a more active part in this compensation than the cornea.

The importance of coordination of the optical components is thus strikingly evident during growth of the eye. The study of Sorsby *et al.* concluded that refractive errors are to be explained not so much

Figure 2



The growth of the eye as a co-ordinated process: axial elongation compensated for by changes in cornea and lens (in 386 children re-examined after 2-6 years). (From Sorsby, 1962.)

in anatomical terms as by failure of the physiological mechanism of adjustment. The process of coordination is active throughout childhood. Full coordination and automatic adjustment give emmetropic eyes, and less full coordination results in errors falling within the range of ± 4.0 D. It appears from the study of Sorsby et al. that all but some 3 to 4 per cent of eyes in the general population have full or fairly full coordination.

C. Vision

There have been many studies of the changes in refraction and visual acuity with age. However, most of them deal with changes in eyes with refractive disorders or draw their samples from selected groups. Two of the largest studies are those of Brown (1938)[9] and Slataper (1950).[10] Their data, drawn from eye clinics, suggest that there is an increase in hypermetropia of about 1.6 D in early childhood till the age of 7 years, a reduction by nearly 2 D in the succeeding 8 years, and a further and slower decline during the next 15 years. (See Appendix 1.)

Gardiner, Karpinos and Post have studied the relation of vision to various other attributes. B. D. Karpinos (1960),[13] analyzing the 273,000 medical reports of registrants examined by the Armed Forces for distant vision, found better vision for the 51,000 Negroes examined than for the 220,000 White examinees. P. A. Gardiner (1954),[11] relating growth with myopia among a random selected number of school children from age 3 to 16 years attending the school clinic, saw that the rate of growth of myopic children differs from that of others, being in the main faster both in height and weight. In myopic girls the menarche was earlier in a significant proportion of cases and their state of growth rate appeared to fluctuate more than that of other children.

Gardiner (1958),[12] in a group of nearsighted children who attended the research clinic at Guy's Hospital and received extra animal protein, found that the rate of visual deterioration was much less than in a group who attended the ordinary school ophthalmic clinic and whose diet was not changed.

Richard H. Post (1962)[14] examined the allegation that populations with long histories of agricultural economy and or settled habitat have higher ratio of vision defects than populations now or until comparatively recently in a culture habitat of hunter or food collector. He based a large part of his studies on data collected by Hirsch (1953)[34] who refracted 2,574 men and 26,627 women and on different studies of average refraction for Orientals, Caucasians, Jews, etc.

D. Growth and Development in the Adolescent Period

The period of adolescence has many definitions. In general it is the period of life in which there is transition from somatic childhood to adulthood. Chronological ages 10 to 15 in females and 12 to 17 in males encompass the period of adolescent growth changes for most of the population. The most dramatic aspects of growth during the adolescent period are: (a) acceleration of growth in height and weight followed by cessation at adult levels and (b) acquisition of primary and secondary sex characteristics. Measures of somatic growth and of sexual maturity are highly associated as exemplified by the relation of menarche to peak velocities for height growth (Figure 3).

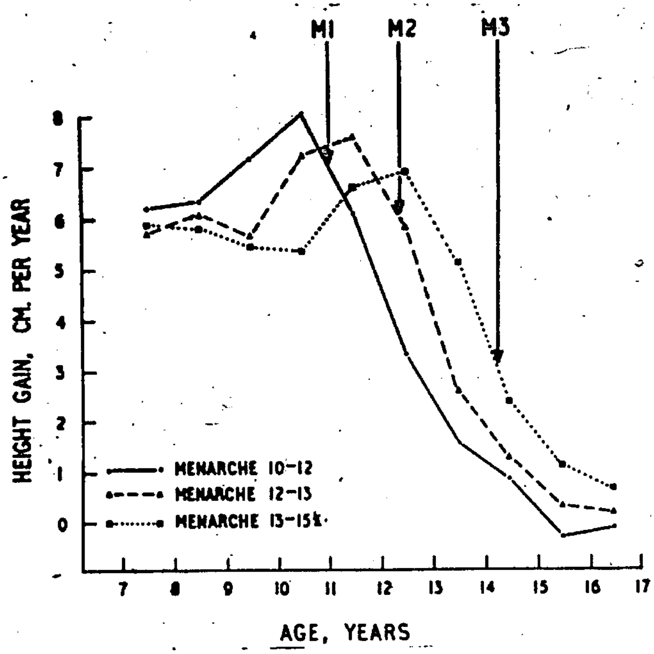
1. Height and Weight

The acceleration of height and weight growth in adolescence is seen in all children although it varies in duration and intensity between different children. Tanner (1955)[15] describes the growth "spurt" as follows:

> In boys it takes place, on the average, from age 13 to 15½, and is responsible for a gain in height of about 8 inches (range 4-12 inches) accompanied by a gain in weight of about 40 lb. (range 15-65 lb.). The peak velocity of height growth averages about 4 inches (10 cm.) per year, which is the rate the boy was growing at age 2. The time at which this maximum velocity is reached averages about 14 years, though it may lie anywhere between 12 and 17. In girls the spurt begins about 2 years earlier than in boys, lasts on the average from 11 to 13½, and is smaller in magnitude, the peak height velocity averaging 3¼ in. (8 cm.) per year. The sex difference can be seen in Fig. 4 which shows the velocity curves for a group of boys who have their peak velocity between 14 and 15, and a group of girls with their peak between 12 and 13.

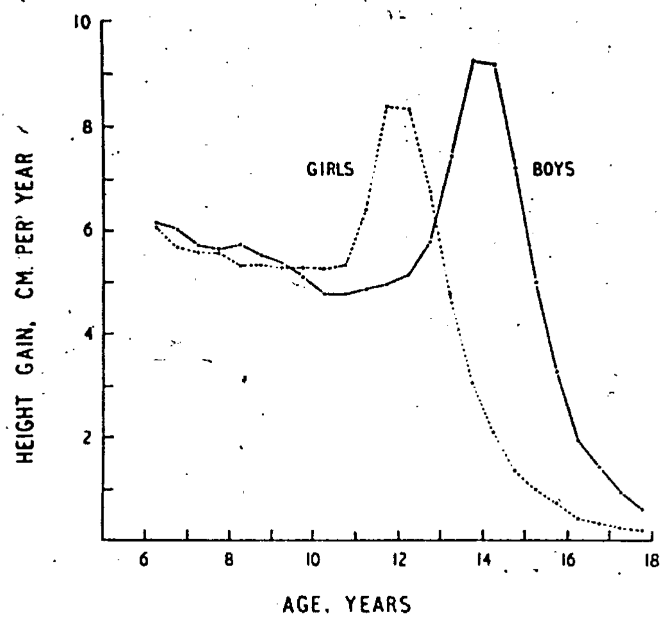
Because children mature at different chronological ages, the effect of the sharp spurt in height and weight which occurs in every child is not seen clearly when data for groups of children are averaged. Only by longitudinal rather than cross-sectional studies is it possible to demonstrate the growth spurt accurately. Data from Shuttleworth (1937) illustrate this (Figure 5).

Figure 3



Relation of peak velocities in height for early, average, and late maturing girls; and of time elapsing between peak velocity and menarche for the three groups.
M_1, M_2, M_3, average time of menarche for each group.
(Redrawn from Simmons and Greulich, 1943.)

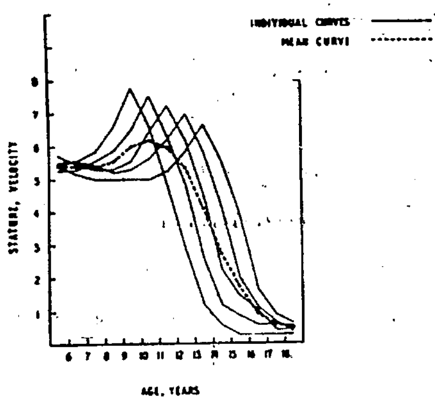
Figure 4



Adolescent spurt in height growth for girls and boys. The curves are from subjects who have their peak velocities during the modal years 12-13 for girls, and 14-15 for boys. (Actual mean increments, each plotted at centre of its 1/2 year period. Data from Shuttleworth, 1939, Tables 23 and 32.)

(From Tanner, 1955.)

Figure 5



Relation between individual and mean velocities during the adolescent spurt. The height curves are plotted against chronological age. (After Shuttleworth, 1937).

(From Tanner, 1955.)

The time of onset of rapid gain in weight during adolescence corresponds closely in both sexes with the gain in height. The duration of gain in weight, however, covers a longer span (Richey, 1937).[16] Comparison of height and weight curves offers insight into the behavior of weight. Normally, a child's weight curve is in the same channel as his height curve, and the two measures follow the same pattern of annual increments. The extent and direction of disparity between channels for a child's weight and his height help to separate weight changes due to maturation from those due to nutrition. If weight deviations parallel height deviations, they probably reflect normal variations related to maturation rate; where weight deviates alone, it is more apt to signify a change in nutritional status (Banger and Bayley, 1959).[17]

2. Measures of Sexual Maturity

The word "maturity" is not used to denote complete physical development. It is employed to indicate a physiological state that begins with the appearance of axillary hair in boys and first menstruation in girls. According to Watson and Lowrey (1954),[18] sexual maturity is directly related to weight and height and is preceded by the spurt in body growth. The menarche generally appears at a skeletal age of 13.5 or 14 years.

A number of factors appear to affect the menarche. Wilson and Sutherland (1953)[19] studied the effect of climate. They found that in girls in tropical countries the menarche can appear earlier or later than in European girls.

Kark (1956)[20] confirmed this lack of relationship between climate and menarche. She concluded that low socio-economic "status" plays a more important role than the factors of race or climate on onset of menarche. Tisserand-Perrier, Bertolini, and Bernier (1953)[21] cited the importance of other factors on late onset. Some of these were: poor general physical condition, undernourishment, poor social background, and high number of children in the family.

Shah (1958)[22] and Israel (1959)[23] studied the role of heredity in menarchal onset in Indian women by comparing the age of menarche of mothers and daughters. There was no association demonstrated.

It is difficult to obtain a measure of maturity for boys corresponding to the time of first menstruation in girls. Godin (1927)[24] states, with minor qualifications, that in males puberty is attained at the time of the appearance of axillary hair or about one year after the appearance of pubic hair, and that at this time pubic hair is far advanced in amount and area covered and has started to curl. His statements agree with conclusions reached by Crampton (1908).[25]

Many observers have noted that the development of sexual characteristics in males is more closely correlated with bone maturation than with chronological age, and that height and weight are better measures of maturation than chronological age.

3. Height and Weight Differences in Early and Late Maturing Children

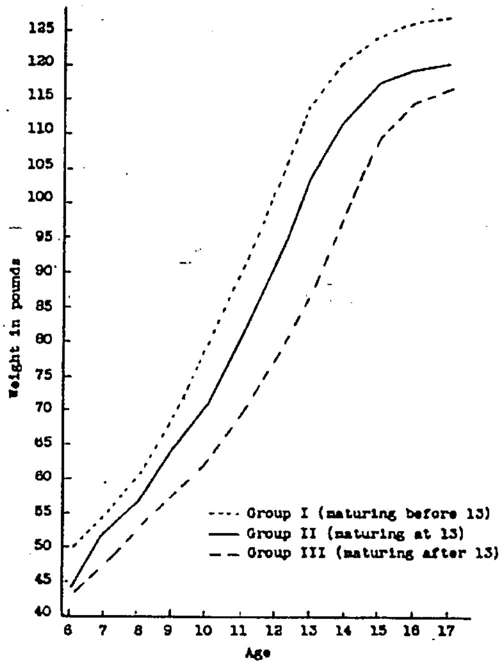
The relation of precocious, average and retarded puberty to weight, height and growth rates has been the subject of several studies. Richey (1937)[26] made a study of the heights and weights of 1871 girls and 1884 boys attending the Laboratory Schools of the University of Chicago. He divided children of each sex into three maturity groups. In boys

> if the hair in the armpits was noticed first at the examination of the fourteenth or an earlier birthday, the subject was placed in Maturity Group I. If no axillary hair was present on his fourteenth birthday but was present on his fifteenth, he was placed in Maturity Group II, and if no hair had appeared in the armpits by his fifteenth birthday, he was placed in Maturity Group III.
>
> The girls were also divided into three groups: 1) those menstruating before their thirteenth birthdays, 2) those who menstruated first between their thirteenth and fourteenth birthdays, and 3) those whose menstrual periods commenced after their fourteenth birthdays. These groups were referred to as Maturity Groups I, II, and III.

In both sexes, the early maturing children were taller and heavier at a given chronological age than the later maturing children, and the middle group in maturation age was midway between the early and late in height and weight measures. Richey's data are displayed in Figures 6, 7, 8 and 9.

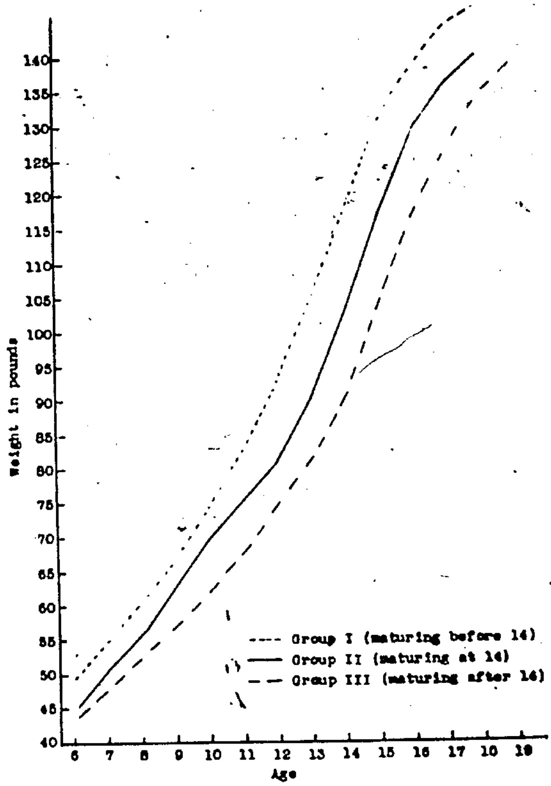
It is of interest to note that differences in height and weight of early and late maturing children are seen long before pubertal changes start and after they are finished. Richey noted that "the pre-pubertal 'spurt' increased the differences between the heights and weights of the three groups for a short while but differences in the heights and weights of different maturity groups of the same age are largely to be attributed to long continued differences in the average growth rates." These differences in height and weight at all ages for the different maturity groups suggest fundamental difference in body build in these three groups.

Figure 6



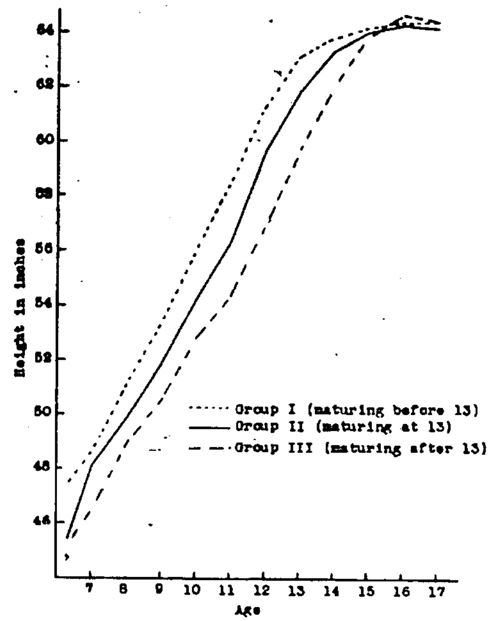
Average weights of girls of different maturity groups. (After Richey, 1937)

Figure 7



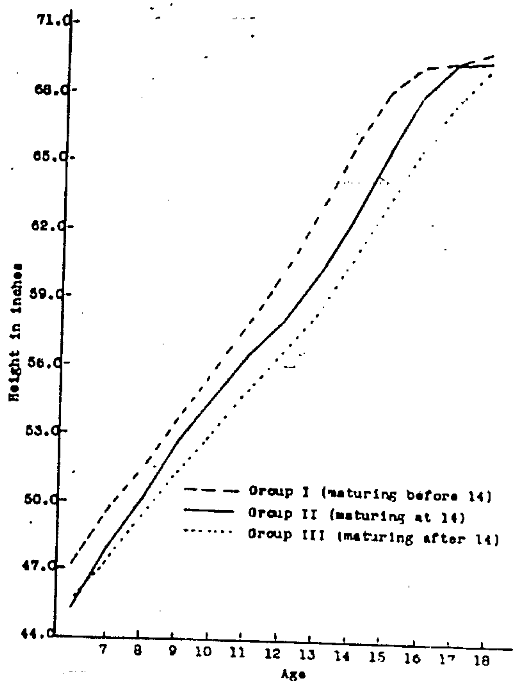
Average weights of boys of different maturity groups at ages 6 to 18. (From Richey, 1937.)

Figure 8



Average heights of girls of different maturity groups at ages 6 to 17. (From Richey, 1937.)

Figure 9



Average heights of boys of different maturity groups at ages 6 to 18. (From Richey, 1937.)

4. Racial Differences in Maturation and Body Measurements

Studies of the growth and development of children of different races has shown striking differences in the time of onset of puberty and in the rate of growth of different racial groups. However, as noted earlier, it is impossible to untangle the effects of nutritional and socio-economic status from those of race in these studies. Poor nutrition, as well as chronic illness, as well as many other factors, have been shown to delay the maturation process. In studies where nutrition and socio-economic conditions have been controlled, the differences between races have not been as great but some differences, presumably on a genetic basis, have persisted.

There have been numerous studies of birth weights and early maturation patterns of Negro and White infants in the United States -- Palmer and Ciocco (1945),[27] Christie (1917)[28] -- but few which compared growth throughout childhood in different races.

The information even on height and weight of African children is extremely limited. Roberts (1960)[29] compared Southern Sudan children with London children and concluded that African children attain their adult size at a later age than London children. No comparative growth studies have been made of the various racial groups residing in Mozambique.

E. Relation of Height, Weight, Menarchal Age to Eyeball Growth and Refraction

Sorsby et al. correlated heights and weights of 1345 children three to 15 years of age with refraction in the vertical meridian and with axial length. Only a few of the numerous correlations were statistically significant, suggesting that at "most there is only a very slight tendency for larger children to have longer eyes, and any such tendency would account for only a small proportion of the variation in axial length." Annual rates of increase in axial length in relation to rates of bodily growth were determined for 183 boys and 178 girls examined two to six years apart. The authors concluded that "there is little to suggest that at any age the higher annual rates of axial elongation are related to the higher annual rates of bodily growth."

Menarchal age was determined for 89 girls in the same study. As is shown in the Table reproduced from that study (Figure 10) there was nothing to suggest that early menarche -- and presumably puberty -- tended to precipitate undue axial elongation.

Figure 10

Axial elongation in relation to age at onset of menstruation: data for 89 girls re-examined 2-6 years after 1st examination.

Age at onset of menstruation (years)	No. of children				
	Degree of axial elongation (mm)				Total
	0 – 0·5	0·6 – 1·0	1·1 – 2·0	2·1 and over	
9		–	1	–	1
10	–	–	2	-	2
11	3	6	3	-	12
12	8	8	7	2	25
13	9	13	5	2	29
14	7	6	1		14
15	2	1	3	–	6

Annual Rates of Change

(From Sorsby, 1962)

III. METHOD

A. Study Population

It is hypothesized that relationships between physical maturation and refractive errors, if they existed, would be shown most clearly during the period of the school child's life characterized by rapid physical growth. Therefore a study population was sought whose ages spanned this period of change. The observations of Slataper (1950)[10] and Hirsch (1952)[30] indicated that refraction changes in the direction of myopia continuously from at least age 6 to maturity, but it appears that a particularly rapid rate of change occurs at about 11 to 12 in girls and 13 to 14 in boys. Tanner (1962)[32] has shown that rapid change in body size of girls lasts about from 10.5 to 13 years and that in all instances the period of most rapid linear growth has ceased by the end of the 16th year. Males, however, continue to grow after this age.

The selected study population was composed of all children from nine through 16 years of age attending the official (government) schools in Lourenco Marques, Mozambique, during the school years 1961-62 and 1962-63. In the instance of females, it was considered that this age span would encompass the most rapid period of change while in the instance of males, observation of older subjects was desirable but not possible because school attendance after age 16 terminates for most pupils.

There were 4831 children; 2157 male and 2674 female. Sixty per cent were White, 9 per cent Negro, 13 per cent of mixed racial groups, 10 per cent Indian, and one per cent Chinese. (Tables I and II).

Because physical maturation is known to vary by age, sex and race, the study population was sub-grouped by these variables in order more clearly to observe the relationship, if any, between physical maturation and refractive errors.

B. Measures of Maturation

1. General Problems

The problem facing the investigator was the selection of a relatively simple index or indices of physical maturation which could be collected at little expense, with simple or no equipment, by health visitors and clerks. Precise anthropological measures, hormonal assays, x-ray determination of epiphyseal maturation, and other elaborate measures therefore were ruled out. Observations of genital, breast and pubic hair development were also discarded as methods of assessing maturation because of the anticipation that such observations would be disturbing within the culture of the schools.

Three measures of maturation finally were selected. These were body height, body weight, and — in females — menarchal age.

2. Height and Weight

The original observations were made during the school year 1961-62 on the female population. It was recognized that because of the wide range of individual differences in body size, a cross sectional study utilizing a single measurement of height and weight was

Table I

Distribution of Male School Children by Race and Age
(8 to 16 Years Old) - Official Schools
L.M. (Mozambique) 1961-1962

Age	White No.	White %	Negro No.	Negro %	Mixed No.	Mixed %	Indian No.	Indian %	Chinese No.	Chinese %	Unknown No.	Unknown %	Total No.	Total %
8	123	8.3	16	9.1	15	6.3	12	5.0	1	4.0			167	7.7
9	212	14.3	12	6.9	30	12.5	27	11.4	3	12.0			284	13.2
10	213	14.4	29	16.0	65	27.0	38	16.0	3	12.0			348	16.1
11	166	11.2	35	20.0	43	18.0	46	19.4	6	24.0			296	13.7
12	182	12.3	24	13.7	30	12.5	32	13.5	3	12.0			271	12.6
13	181	12.2	28	16.0	22	9.2	34	14.3	2	8.0			267	12.4
14	186	12.6	19	10.9	22	9.2	22	9.3	3	12.0	1	100	252	11.7
15	166	11.2	9	5.1	10	4.2	18	7.6	4	16.0			207	9.6
16	50	3.4	3	1.7	3	1.3	8	3.4					64	3.0
Total	1479	100	175	100	240	100	237	100	25	100	1	100	2157	100

Table II

Distribution of Female School Children by Race and Age
(9 to 16 Years Old) - Official Schools
L.M. (Mozambique) 1961-1962

Age	White No.	White %	Negro No.	Negro %	Mixed No.	Mixed %	Indian No.	Indian %	Chinese No.	Chinese %	Unknown No.	Unknown %	Total No.	Total %
9	229	13.3	49	20.0	80	19.6	45	16.9			5	83.3	408	15.3
10	251	14.6	39	16.0	72	17.6	37	13.9	5	15.6			404	15.1
11	326	19.0	35	14.3	46	11.3	49	18.4	5	15.6			461	14.2
12	287	16.7	40	16.3	75	18.4	45	16.9	7	21.9			454	17.0
13	220	12.9	25	10.2	44	10.8	41	15.4	5	15.6			335	12.5
14	198	11.6	21	8.6	43	10.5	28	10.5	6	18.8			296	11.0
15	139	8.1	20	8.2	28	6.9	14	5.2	3	9.4	1	16.7	205	7.4
16	66	3.8	16	6.5	20	5.0	8	3.0	1	3.1			111	4.2
Total	1716	100	245	100	408	100	267	100	32	100	6	100	2674	100

imprecise for characterizing the maturation of individual children. However, the speed, economy and simplicity encouraged us to use this method, and previous observations of Richey (1937),[16] Tanner (1955),[32] and Shuttleworth (1939)[38] gave support to our expectation that at a given chronological age the heaviest and tallest children would be the most mature.

Similar data were obtained from males during the 1961-62 school year. Because there was no physiological "marker" in the male that would be the equivalent of the menarche in the female, another index of maturity beside a single determination of height and weight was sought for boys. Therefore, height and weight were repeated on most of the boys one year later (during the 1962-63 school year). Thus, it was possible to characterize males not only by absolute values of height and weight but also by increment of growth during a period of one year. The assumption in using growth increment as a measure of maturity was that among pre-pubescent boys of the same chronological age, those growing at the most rapid rate would be the most mature. The statistic used to describe this growth increment was the mean weight (or height) growth ratio and is conventionally represented by the weight (or height) gains during a given time interval divided by the weight (or height) of the organism at the beginning of the time interval: $\frac{W_2 - W_1}{W_1}$.

Height and weight of school children were obtained by school nurses following a standardized procedure. Weight was measured on a balance scale, the child standing freely and holding the side of his legs with his hands. Height was measured against a standing pole attached to the scale. The child was instructed to "stand tall." All measures were of children in gym clothing without shoes.

3. Menarchal Age

Menarchal age in the female is an accompaniment of maturation and is an excellent point to equate physiological age. For the present study, the age was obtained by direct questioning of school girls by the school health visitor. The mean menarchal age was calculated for those girls who already had begun to menstruate. These girls were then grouped into those whose menarche occurred before the 12th year, those with menarche between 12 and 13 years, and those with menarche after the age of 13. For some analyses the proportions of girls in these categories were applied to girls not yet menstruating so that (sic) estimates of the influence of early and late maturation on visual acuity could be made.

C. Measures of Vision

1. Visual Acuity

The Monoyer Scale was used to test the distance visual acuity of the children in the study. The Monoyer Scale follows the internationally accepted principles recommended by the American Committee on Optics and Visual Physiology, Sub-committee on the Problem of an International Nomenclature for Designating Visual Acuity (Perera (1951).[38]

The scale is read at a distance of 5 meters and has 10 lines of letters which, from line to line, increase in size (Appendix 2). The first (supplementary) line should be read by the normal eye at a distance of 5 meters; the last line which contains the biggest letters, at a distance of 50 meters. Intervening lines are of a size that should be read at 10, 15, 20, etc., meters. Visual acuity that is normal, i.e., the 5 meter line is read at 5 meters, is designated 1.0. Succeedingly larger lines are designated 0.9, 0.8, 0.7, etc., which is an index of the extent of normal acuity at 5 meters. The Monoyer Scale and the Snellen Scale are constructed on the same optical principle and 1.0 Monoyer is equivalent to 20/20 Snellen.

Measurements of visual acuity were made by the school health visitors according to instructions which are given in Appendix 3 in the form of the original circular. Such measurements were made at the beginning of each school year routinely and the results recorded on individual file cards in the pupil's name. All children whose vision in either eye was not 1.0 Monoyer as well as those who use glasses were sent to the eye clinic at the Miguel Bombarda Hospital in Lourenco Marques.

Children who were found to be wearing glasses at the time of visual acuity screening were not tested but were referred to the eye clinic for evaluation. Measurements for visual acuity were made in females during the school year 1961-62. Measurements for males were made in 1961-62 and again in 1963. These later measurements were the ones used for males in all tables except those in which changes were determined in visual acuity from 1961-62 to 1963.

2. Refraction

Children referred to the hospital eye clinic had their visual acuity evaluated once more by means of the Monoyer Scale. If the child had an acuity of 1.0 in each eye, and if there were no signs or symptoms of ocular or visual disturbances, he was pronounced "normal." If the child showed any ocular or visual disturbances, even with a 1.0/1.0 acuity, cycloplegic refraction was made. (Atropine was used for children up to age 14 and thereafter homatropine with benzedrine or cycoplegil.) If the child under cycloplegia was able to read the entire Monoyer Scale, he was considered normal. If he could not read it, various lenses were tried. The lens used to enable him to read was a measure of his error of refraction which was registered in diopters.

The most commonly observed errors of refraction were: myopia, and hypermetropia, with varying degrees of astigmatism, and mixed astigmatism, i.e., with myopia and hypermetropia in different axes. For purposes of classifying students by refractive error, a single number was obtained by adding the spherical errors in both eyes together with one-half the total cylindrical errors, if any, and dividing by two. This method was devised by Gardiner (1954) to overcome the difficulty of differing refractive errors in the two eyes.

D. Children's Identification

1. Chronological Age

Age of girls was recorded according to age at last birthday. For boys, the chronological age was obtained by subtracting the year of birth from the time point of April 1961, this date being the midpoint between the two observations made in September 1961 and September 1962.

2. Determination of Race

Race was copied from school records made from birth certificates.

E. Statistical Procedures

1. Collection and Tabulation of Data

Height, weight, visual acuity and, when appropriate, menarchal age were entered on pupil's individual health cards by the school nurse. Subsequently, these observations were coded by the author and punched on IBM cards. These cards were sorted and counted using the equipment of the Department of Biostatistics of the Graduate School of Public Health. Various special computations were made from these cards also using the IBM 7070 computer at the University of Pittsburgh Computer Center.

2. Associations

Children in the study were divided into two groups on the basis of their visual acuity. Those with acuity of 1.0 in each eye were called "normal." All others were called "abnormal." When children were classified by visual acuity, the visual acuity of the poorest eye was used. The abnormal group was further divided into "myopics" and "others" on the basis of a refractive examination by an ophthalmologist.

The height, weight, and age of menarche was determined for girls in the normal and abnormal visual acuity groups. The same factors were compared in myopic and non-myopic girls.

The height, weight and increment of growth of height and weight were compared in males with normal and abnormal visual acuity and in males with and without myopia. In addition, relationship between change in visual acuity in a one-year period and growth increment during that same period was determined for males.

3. Degree and Measure of Association

Tables, graphic analysis and numerical expressions were used to measure the degrees of association of the variables. Various tests of statistical significance were tried: all, however, were biased by the heterogeneity of the population.

A "t" test for differences of means of indices of growth and maturation with visual acuity was possible only for White children. For children of other races the test could not be made because of small numbers. Besides the "t" test, chi square tests were used to study the association between menarche and visual acuity in girls and height increment and changes in visual acuity in boys.

The problem of association and testing became even more pronounced with the association of indices of growth and maturation with myopia because of the limited number of myopic cases -- only 123 out of a population of 4831. Because only small numbers of myopic children were available for analysis, the following discriminatory method was used. First, mean height was plotted at each age for all girls who were post-menarchal, and the same was repeated for those who were pre-menarchal. Two separated smooth curves were fitted through each set of means taking into account the number of observations on which each mean was based. New mean height values were then read from these smooth curves. Deviations from the curve values at each age were calculated for each myopic child within its respective menarchal group, i.e., pre- or post-menarchal. The average deviation over all age groups was then calculated for each menarchal class. Also, the standard deviation for all age groups was calculated for each menarchal class. On another analysis of the data, measures of pre- and post-menarchal girls were combined to give a single smoothed curve. Deviations from this curve were calculated for myopic girls.

The above procedure was repeated for weight.

See Addendum, page 132.

IV. RESULTS

A. Characteristics of the Study Population

1. Age, Race, Sex

The age and race of the study population, by sex, are shown in Tables I and II (pages 30 and 31). Males and females were approximately equal in numbers, racial distribution and age. White children comprised the largest group and there were more younger than older children in all racial groups because of the tendency of older children to discontinue schooling.

2. Height

a. Female. As shown in Figure 11 and Table III a, girls in the four racial groups generally showed a steady increase in mean height with age and appeared to follow similar growth curves. No sudden growth spurt was discerned in any of the racial groups and only in White girls was there an indication of growth cessation (ages 15, 16).* The White girls achieved greater heights at early ages than did girls of other races. However, by ages 15 and 16 this advantage appeared to be lost. In general, Negro girls in early age groups were shorter than those of other races. Again, at age 15 and 16 this difference disappeared. Because of the drop-out from school of children at older age levels, the number of girls 15 and 16 years old in non-White groups was small and thus means could be distorted by an atypical observation in a single child.

"T" tests of differences of means were performed to determine whether differences noted above were statistically significant. For

*See page 105.

Figure 11. Mean Height of Female School Children by Age and Race, Official Schools, Lourenco Marques, (Mozambique) 1961-62.

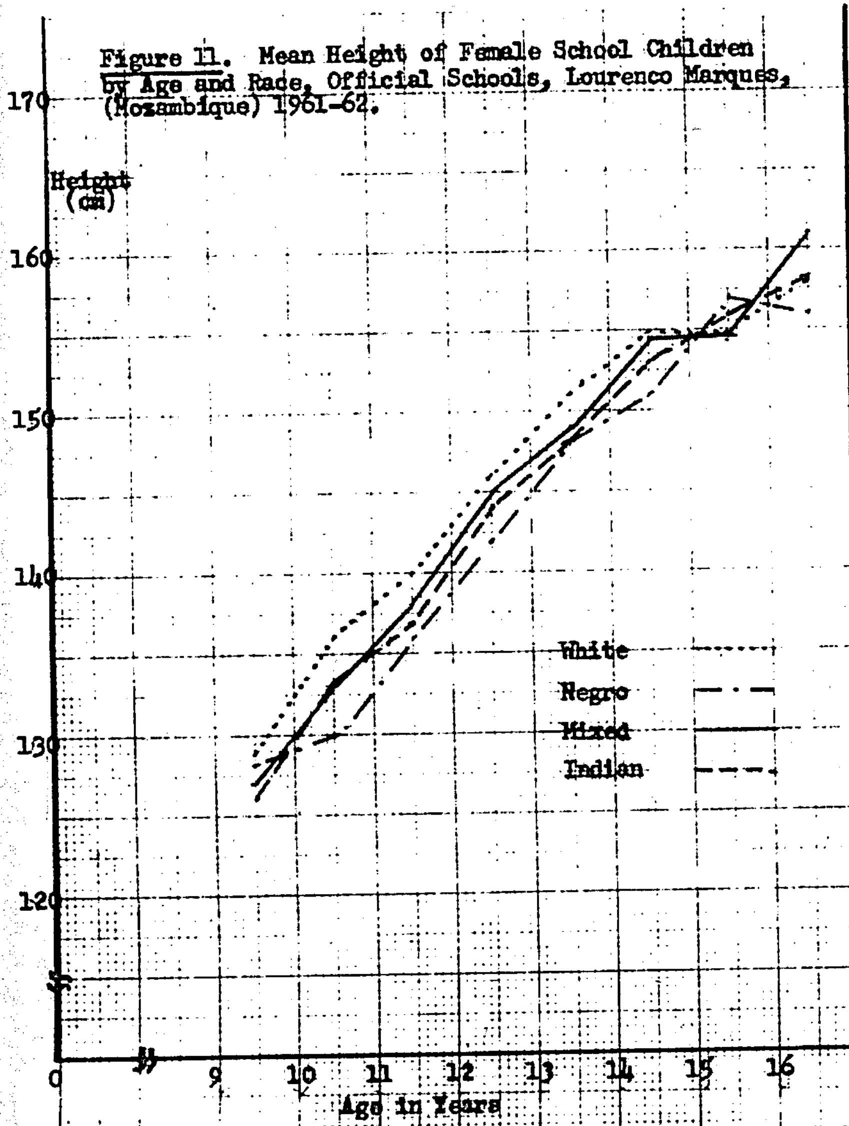


Figure 12. Mean Height of Male School Children by Age and Race, Official Schools, Lourenco Marques (Mozambique) 1961-62.

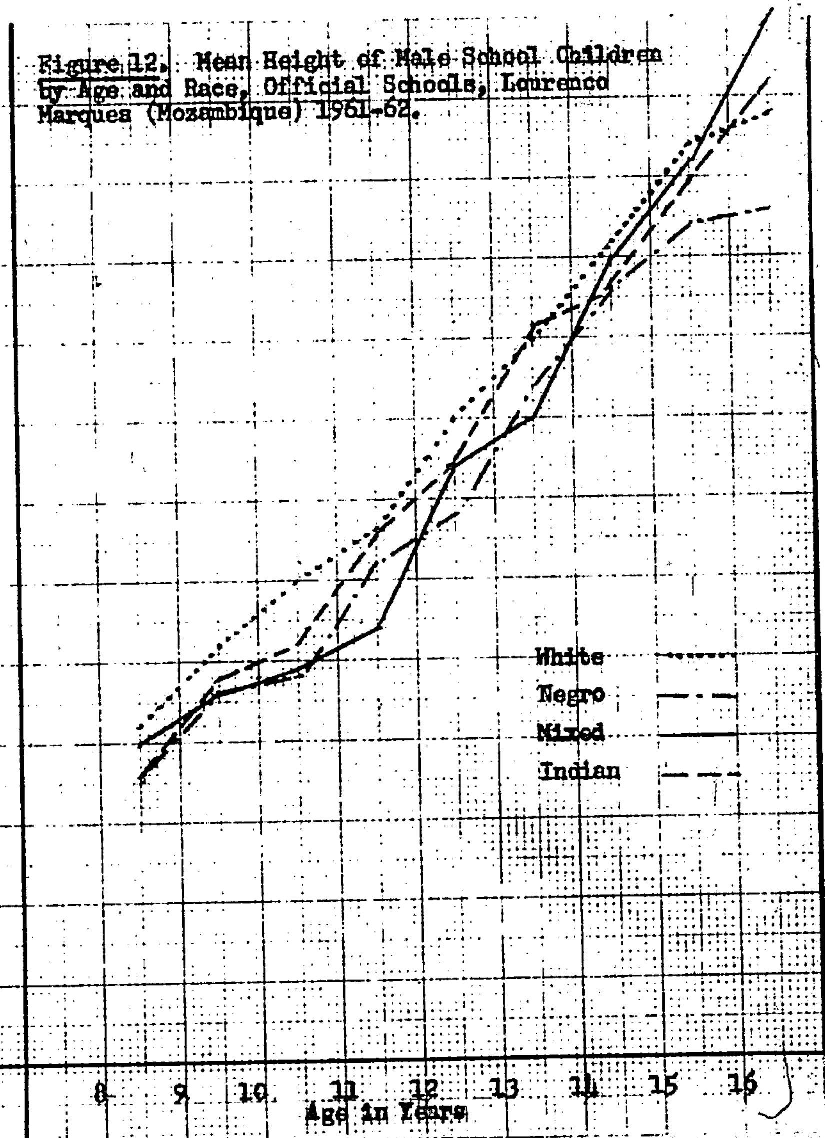


Table IIIa

Weight and Height of Female School Children by Race and Age
Official Schools - Lourenco Marques
(Mozambique) 1961-62

Race	Age	No. Weighed	Means Kilos	S.E.	No. Measured	Means (cm.)	S.E.
White	9	223	29.5	± .375	227	1.29	± .005
	10	249	33.0	± .391	249	1.36	± .004
	11	322	35.4	± .384	324	1.40	± .004
	12	281	39.9	± .462	287	1.46	± .004
	13	209	43.2	± .483	217	1.51	± .004
	14	181	45.9	± .461	196	1.55	± .004
	15	125	48.1	± .544	137	1.55	± .005
	16	51	48.7	± .682	65	1.58	± .007
Negro	9	48	26.4	± .432	48	1.28	± .080
	10	39	28.0	± .528	39	1.30	± .105
	11	35	31.7	± .936	35	1.36	± .011
	12	40	36.4	± .878	40	1.42	± .009
	13	25	40.9	±1.224	25	1.48	± .140
	14	21	45.0	±1.000	21	1.51	±1.000
	15	18	48.5	±1.209	20	1.57	±1.209
	16	15	49.5	±1.317	16	1.56	±1.317
Mixed	9	77	26.0	± .463	79	1.27	± .078
	10	72	28.7	± .520	72	1.33	± .007
	11	46	34.0	±1.050	46	1.38	± .010
	12	74	37.6	± .767	74	1.45	± .008
	13	43	41.3	±1.178	44	1.49	± .009
	14	42	46.0	± .098	43	1.55	± .008
	15	27	48.6	±1.004	27	1.55	± .120
	16	19	50.0	±1.211	20	1.61	± .009
Indian	9	42	25.2	± .619	45	1.26	± .095
	10	35	28.2	± .993	36	1.33	± .012
	11	48	30.3	± .740	48	1.37	± .010
	12	44	35.2	±1.182	44	1.44	± .017
	13	41	36.8	±1.147	41	1.48	± .011
	14	28	44.2	±1.214	28	1.53	± .010
	15	13	45.1	±1.847	14	1.56	± .012
	16	10	44.3	±2.168	8	1.58	± .042

these determinations (and also for those of female weight and male height and weight), each age-race subgroup was not compared with every other age-race subgroup. Instead, the data were examined and selected subgroups were compared -- inferences being drawn based on the relations of other subgroups to the compared subgroups. For example, if statistical significance could not be demonstrated for a difference in mean height of White girls at a given age and mean height of girls of the same age of the racial group whose mean was farthest from that of White girls, then it was considered unlikely (since numbers in non-White age-race groups were approximately equal) that a statistically significant difference would be present for the difference in mean heights of White girls of this age group and girls in other race groups the same age. Likewise, when differences appeared so great that it was considered likely that statistical significance would be present, the difference of means of race-age groups closest together were examined. If statistical significance was present for these, then it was inferred that means of groups deviating more widely also would be significant.

A "t" test of the differences between mean heights of White and Negro girls ages 10 through 14 showed these differences to be significant at the .001 level. Differences in other subgroups were not statistically significant.

b. Male. Mean height of males as shown in Figure 12 and Table IIIb follows somewhat similar patterns for all racial groups. The change in the slope of growth curves at ages 10 and 11 suggested a "growth spurt" but the indication was not strong. There was no

Table IIIb

Weight and Height of Male School Children by Race and Age
Official Schools - Lourenco Marques
(Mozambique) 1961-62

Race	Age	No. Weighed	Mean Kilos	S.E.	No. Measured	Mean (cm.)	S.E.
White	8	118	28.2	± .388	109	1.31	±.006
	9	206	31.7	± .358	206	1.36	±.004
	10	212	34.4	± .425	212	1.40	±.005
	11	165	36.2	± .519	164	1.43	±.006
	12	181	42.3	± .645	182	1.50	±.006
	13	179	46.2	± .643	178	1.55	±.006
	14	183	52.0	± .721	185	1.61	±.006
	15	165	56.6	± .714	165	1.67	±.006
	16	50	56.9	±1.126	50	1.69	±.010
Negro	8	15	26.7	±1.039	16	1.28	±.013
	9	11	28.4	±1.039	11	1.33	±.019
	10	29	28.9	±1.259	29	1.34	±.014
	11	34	33.6	± .877	34	1.41	±.014
	12	24	35.2	±1.336	24	1.44	±.012
	13	28	40.8	±1.244	28	1.52	±.015
	14	19	47.7	±2.417	19	1.58	±.018
	15	9	53.0	±2.417	9	1.62	±.022
	16	3	50.6	±2.682	3	1.63	±.034
Mixed	8	15	26.3	±5.10	13	1.30	±.019
	9	30	28.3	± .867	30	1.33	±.011
	10	65	28.8	± .635	65	1.34	±.004
	11	43	30.8	± .844	42	1.37	±.011
	12	34	36.4	±1.118	30	1.47	±.015
	13	21	39.6	±1.725	21	1.50	±.018
	14	21	47.3	±1.747	21	1.60	±.018
	15	10	50.1	±2.364	10	1.66	±.023
	16	3	64.3	±1.514	2	1.75	±.035
Indian	8	12	24.0	± .754	10	1.28	±.014
	9	26	26.9	±1.153	26	1.34	±.012
	10	36	29.6	± .953	36	1.36	±.012
	11	46	31.8	± .618	46	1.43	±.010
	12	32	35.0	±1.180	32	1.47	±.016
	13	33	42.6	±1.390	33	1.56	±.013
	14	22	45.5	±2.247	22	1.58	±.014
	15	18	49.6	±1.993	18	1.65	±.019
	16	8	53.3	±3.396	8	1.75	±.008

clear evidence of deceleration of growth at the older age levels, although the Indian boys had less increase in mean height at ages about fourteen than they did at earlier ages. As was true with girls, the number of children in the non-White groups at older ages was small and therefore means may be less accurate representations for these than for the White group. However, Negro males had lower mean heights at all ages than did White males and these differences were significant at the .01 level. Statistically significant differences in other age-race subgroups did occur but were scattered and not consistent for certain races at all or most ages.

Males of all races had greater mean heights at all ages than females.

3. Weight

a. Female. As shown in Figure 13 and Table IIIa, the mean weight of girls increased steadily by age. There was no clear evidence of a "weight spurt" nor evidence (except in the case of Indian girls) of deceleration or cessation of weight gain. As was true with height, the White girls had higher mean values in the lower age groups than did girls of other races. The Indian girls were consistently lighter in weight at all ages than were girls in the other racial groups. (p = .001 at all ages.) It appeared that weight gain in Indian girls did not increase after age 14. Negroes through age 14 also had mean weights significantly different from those of White girls (p = .01 to .001 at different ages). The other three age groups had similar mean weights at ages 15 and 16. Also, as was true for

Figure 13. Mean Weight of Female School Children by Age and Race, Official Schools, Lourenco Marques, (Mozambique) 1961-62.

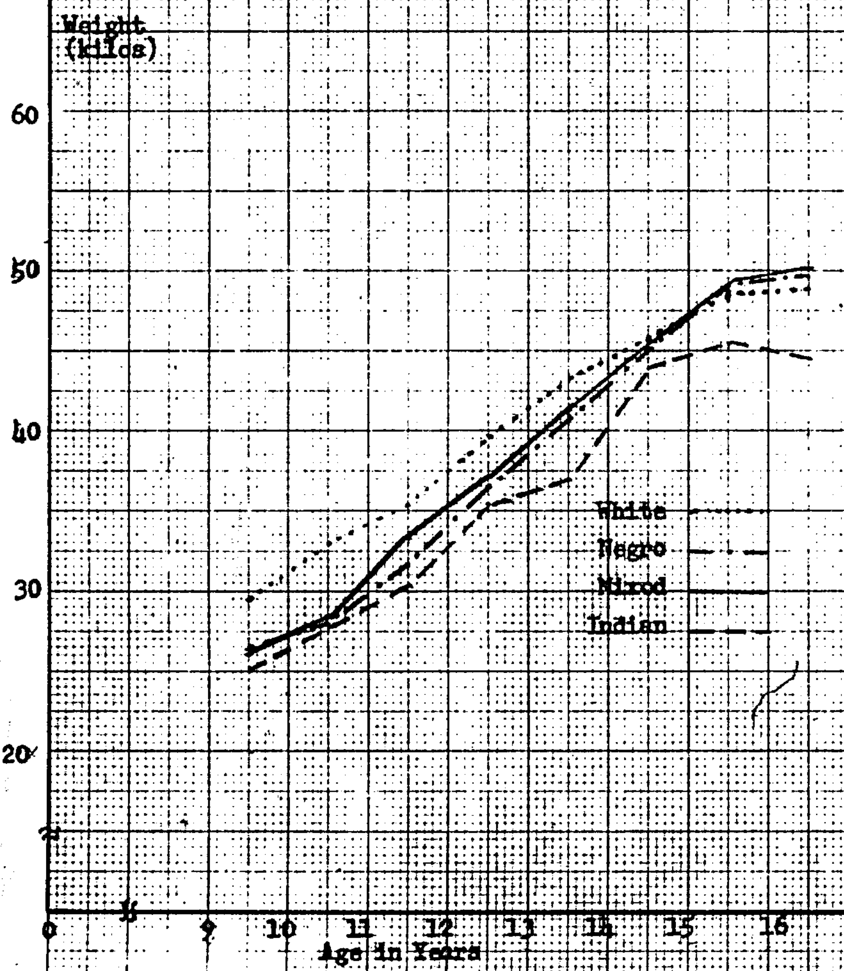
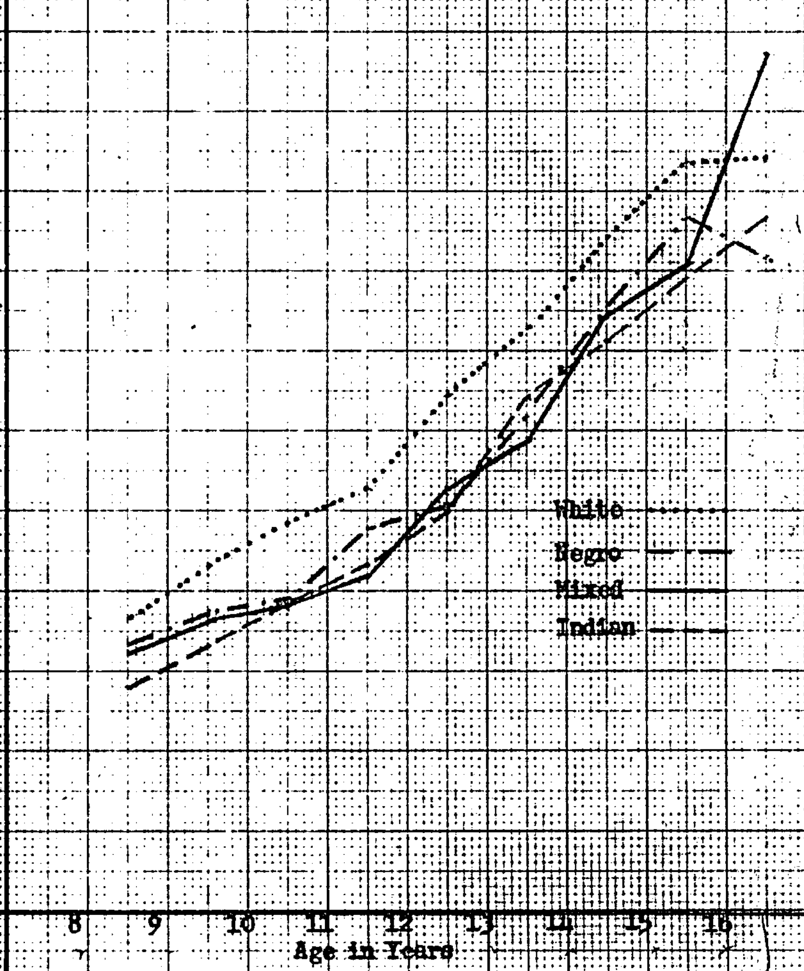


Figure 14. Mean Weight of Male School Children by Race and Age, Official Schools, Lourenco Marques, (Mozambique) 1961-62.



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10 SQUARES TO THE INCH

measurements of height, small numbers in non-White children at older age levels limited the interpretation one could make from the data.

b. Male. As shown in Figure 14 and Table IIIb, mean weight in all race groups for males increased with age. The weights of White boys were considerably higher at all age levels, except 16, than those of other groups. (p = .01 at all ages.) There was no clear evidence of a "weight spurt" in any race group. The numbers of observations made at age 16 for non-White groups were small (e.g., Negro - 3, Mixed - 3, Indian - 8) and therefore the means are not reliable. The number of observations for White boys was adequate and there was evidence of deceleration in weight gain occurring between age 15 and 16.

4. Menarche

In Figure 15 and Table IV are shown the percentage of girls by race in each age group who have passed the menarche. Below the age of 11, less than 10 per cent of the girls in any race group have passed the menarche and by age 15 almost all are post-menarchal. In the White, Indian and Mixed racial groups, the per cent of post-menarchal girls at given ages rises sharply between 12 and 14 whereas not until age 14 in the Negro group are an appreciable number of girls post-menarchal.

5. Relationship between Menarche and Height and Weight

Tables V and VI and Figures 16, 17, 18 and 19 show that post-menarchal girls of all races and at all ages are taller and heavier than their pre-menarchal counterparts.

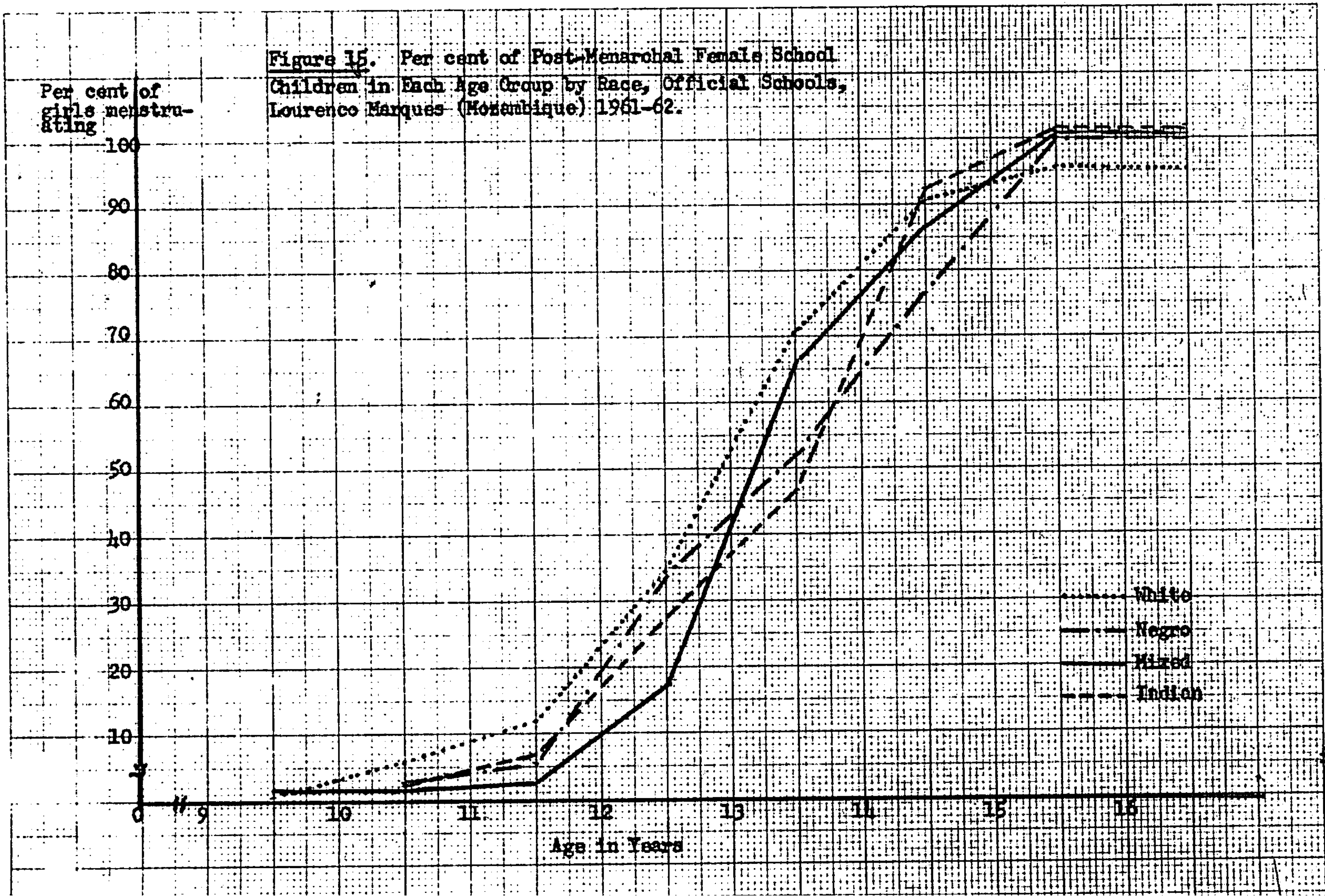


Figure 15. Per cent of Post-Menarchal Female School Children in Each Age Group by Race, Official Schools, Lourenco Marques (Mozambique) 1961-62.

Table IV

Per Cent of Post Menarchal Female School Children in Each Age Group by Race, Official Schools, Lourenco Marques (Mozambique) 1961-62

Age in Years	RACE											
	White			Negro			Mixed			Indian		
	No.	M*	%	No.	M*	%	No.	M*	%	No.	M*	%
9	227	1	.4	49	-	-	79	1	1.2	45	-	-
10	249	14	5.6	39	1	2.5	72	1	1.3	37	1	2.7
11	324	38	11.7	35	2	5.7	46	1	2.1	48	3	6.2
12	287	105	34.5	40	4	33.3	74	13	17.5	44	12	27.2
13	217	153	70.5	25	13	52.0	44	29	65.9	41	19	46.3
14	196	177	90.3	21	16	76.1	43	37	86.0	27	25	92.5
15	137	131	95.6	20	20	100	27	27	100	14	14	100
16	65	62	95.3	16	16	100	20	20	100	8	8	100

*M = number post menarchal

Table IVa

Onset of Menarche of School Children by Race and Age
Official Schools - Lourenco Marques
(Mozambique) 1961-62

Race	Age	Number	Means (in months)	S.E.
White	9	1	108.0	-
	10	14	121.3	± .160
	11	38	136.2	±1.937
	12	104	139.7	± .770
	13	150	146.2	± .835
	14	176	151.5	± .756
	15	129	150.9	±1.006
	16	62	153.2	±1.783
Negro	9	0	-	-
	10	1	121.0	-
	11	2	138.0	±2.836
	12	4	141.5	±4.030
	13	12	153.5	±2.433
	14	16	156.8	±1.925
	15	20	162.2	± .268
	16	16	159.6	± .342
Mixed	9	1	117.0	-
	10	1	118.0	-
	11	1	139.0	-
	12	13	142.8	±1.844
	13	29	149.9	±1.685
	14	37	157.8	±1.929
	15	27	157.6	±2.480
	16	20	161.2	±3.378
Indian	9	0	-	-
	10	1	126.0	-
	11	3	136.7	±1.098
	12	12	139.9	±2.054
	13	19	148.0	±1.846
	14	26	153.0	±2.200
	15	14	156.0	±3.274
	16	8	160.0	±3.286

Table V

Mean Heights in Meters of Female School Children by Age, Menarchal Status and Race, Official Schools, Lourenco Marques (Mozambique) 1961-62

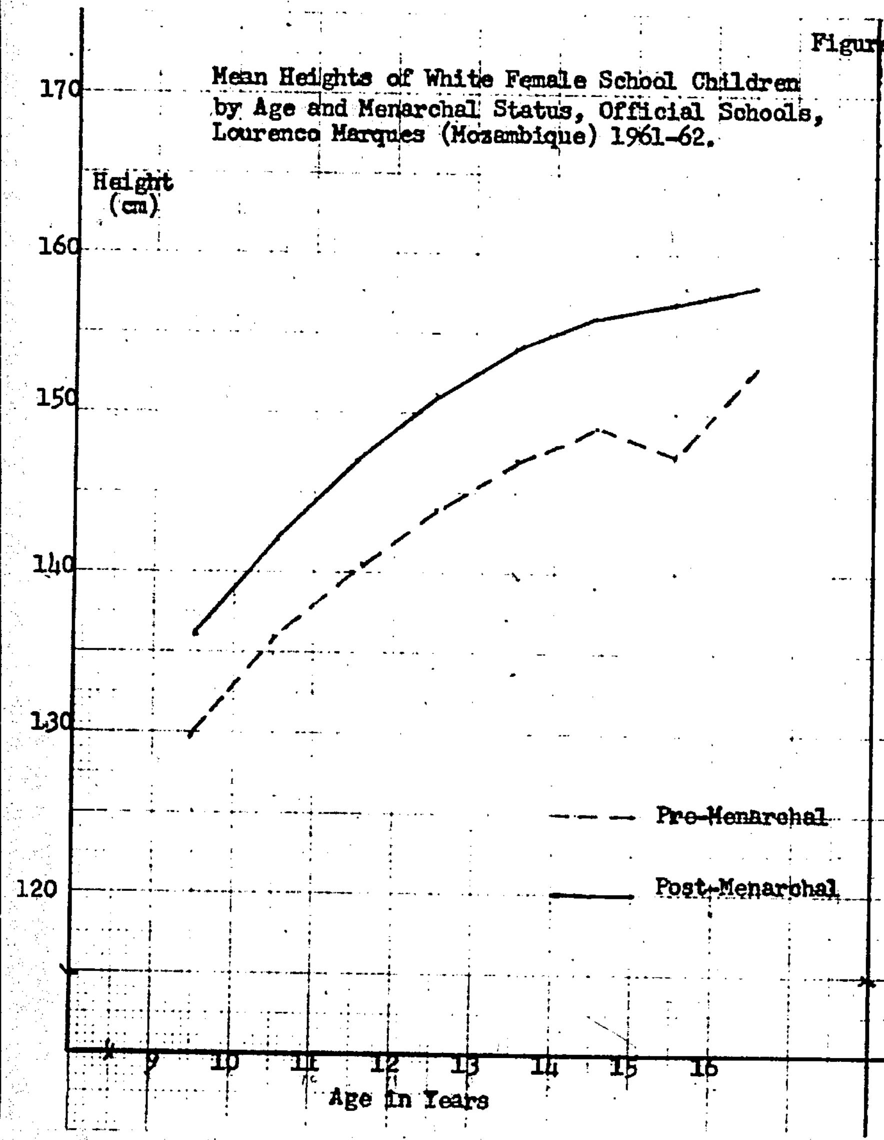
Age in Years	RACE															
	White				Negro				Mixed				Indian			
	Pre-Menarchal		Post-Menarchal		Pre-Menarchal		Post-Menarchal		Pre-Menarchal		Post-Menarchal		Pre-Menarchal		Post Menarchal	
	No.	$\bar{X}$	No.	$\bar{X}$	No.	$\bar{X}$	No.	$\bar{X}$	No.	$\bar{X}$	No.	$\bar{X}$	No.	$\bar{X}$	No.	$\bar{X}$
9	226	1.30	1	1.36	49	1.28	-	-	78	1.28	1	1.32	45	1.27	-	-
10	235	1.36	14	1.42	38	1.30	1	1.43	71	1.34	1	1.37	36	1.39	1	1.38
11	286	1.40	38	1.47	33	1.36	2	1.47	45	1.39	1	1.41	45	1.37	3	1.46
12	182	1.44	105	1.51	36	1.44	4	1.46	61	1.45	13	1.52	32	1.42	12	1.49
13	64	1.47	153	1.54	12	1.44	13	1.53	15	1.46	29	1.51	22	1.45	19	1.53
14	19	1.49	177	1.56	5	1.48	16	1.53	6	1.54	37	1.56	2	1.50	25	1.53
15	6	1.45	131	1.57	-	-	20	1.57	-	-	27	1.56	-	-	14	1.56
16	3	1.53	62	1.58	-	-	16	1.56	-	-	20	1.61	-	-	8	1.58

Table VI

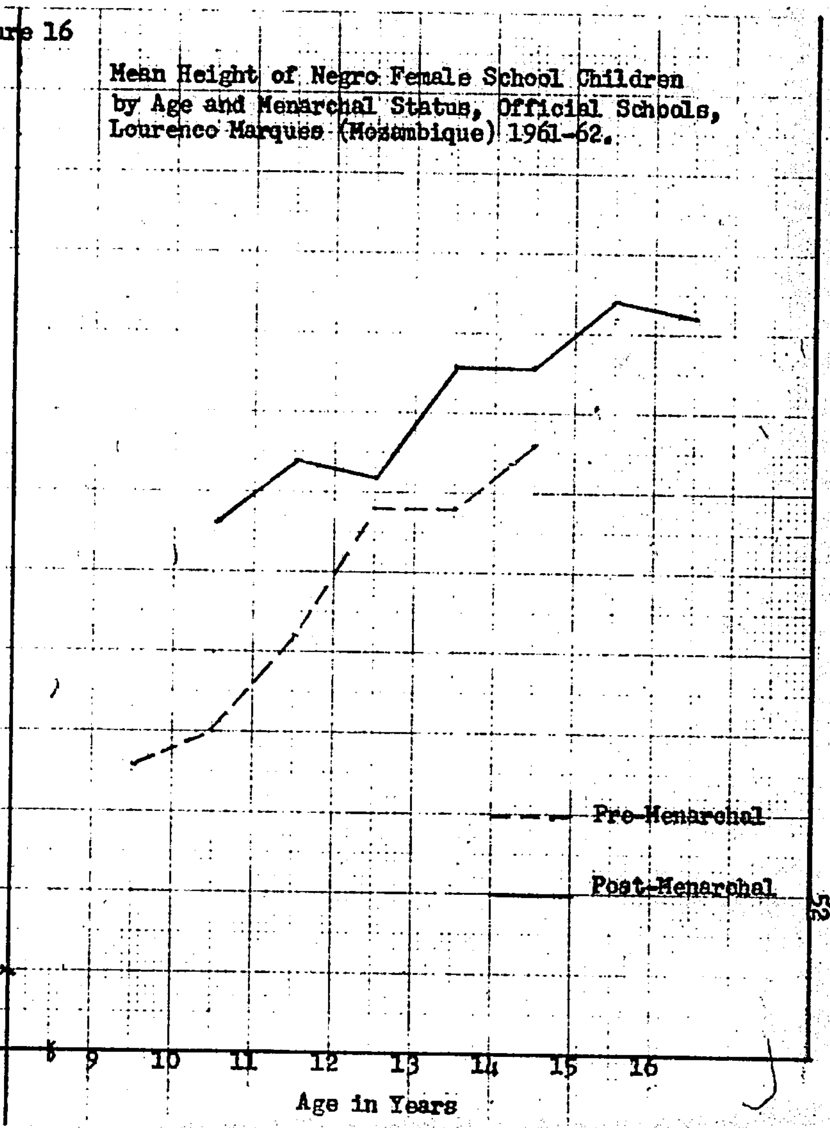
Mean Weights in Kilograms of Female School Children by Age, Menarchal Status and Race, Official Schools, Lourenco Marques (Mozambique) 1961-62

Age In Years	RACE															
	White				Negro				Mixed				Indian			
	Pre-Menarchal		Post-Menarchal		Pre-Menarchal		Post-Menarchal		Pre-Menarchal		Post-Menarchal		Pre-Menarchal		Post-Menarchal	
	No.	X̄	No.	X̄	No.	X̄	No.	X̄	No.	X̄	No.	X̄	No.	X̄	No.	X̄
9	226	29.0	1	34.5	49	26.3	-	-	78	25.8	1	35.9	45	24.7	-	-
10	235	32.8	11	37.0	38	27.9	1	34.0	71	28.7	1	31.9	36	27.8	1	29.7
11	286	35.2	38	39.9	33	31.1	2	42.2	45	33.8	1	43.8	45	29.8	3	39.0
12	182	37.3	105	46.1	36	35.6	4	43.6	61	36.3	13	44.0	32	32.2	12	43.5
13	64	39.0	153	45.8	12	36.4	13	45.2	15	36.1	29	45.1	22	34.6	19	39.0
14	19	40.0	177	48.6	5	42.2	16	45.9	6	44.2	37	47.0	2	40.4	25	44.5
15	6	41.3	131	50.2	-	-	20	50.8	-	-	27	48.6	-	-	14	45.0
16	3	46.7	62	51.2	-	-	16	50.8	-	-	20	50.7	-	-	8	44.3

Figure 16



Mean Heights of White Female School Children by Age and Menarchal Status, Official Schools, Lourenco Marques (Mozambique) 1961-62.
Height (cm)
170
160
150
140
130
120
9
10
11
12
13
14
15
16
Age in Years
Pre-Menarchal
Post-Menarchal



Mean Height of Negro Female School Children by Age and Menarchal Status, Official Schools, Lourenco Marques (Mozambique) 1961-62.
9
10
11
12
13
14
15
16
Age in Years
Pre-Menarchal
Post-Menarchal

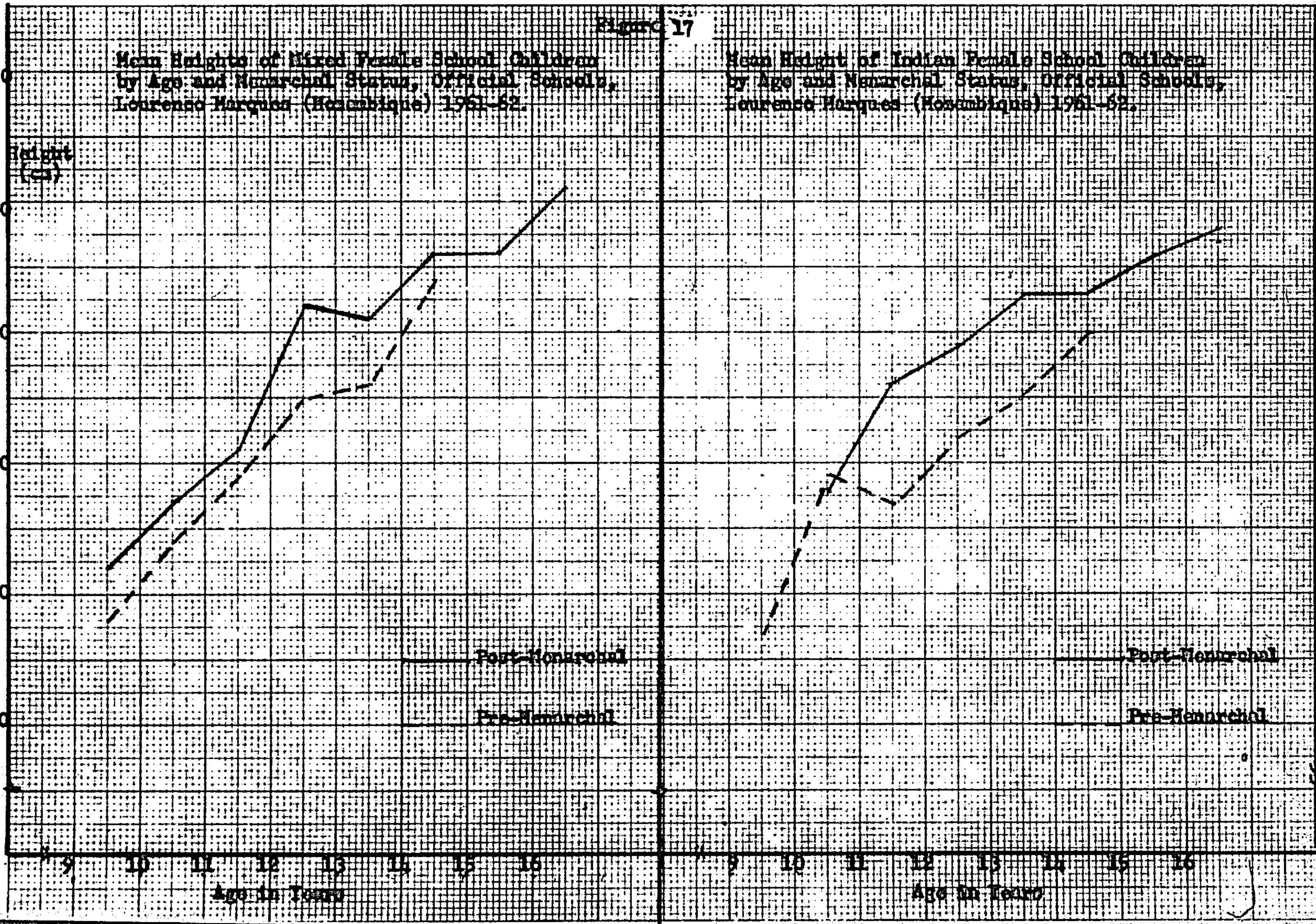
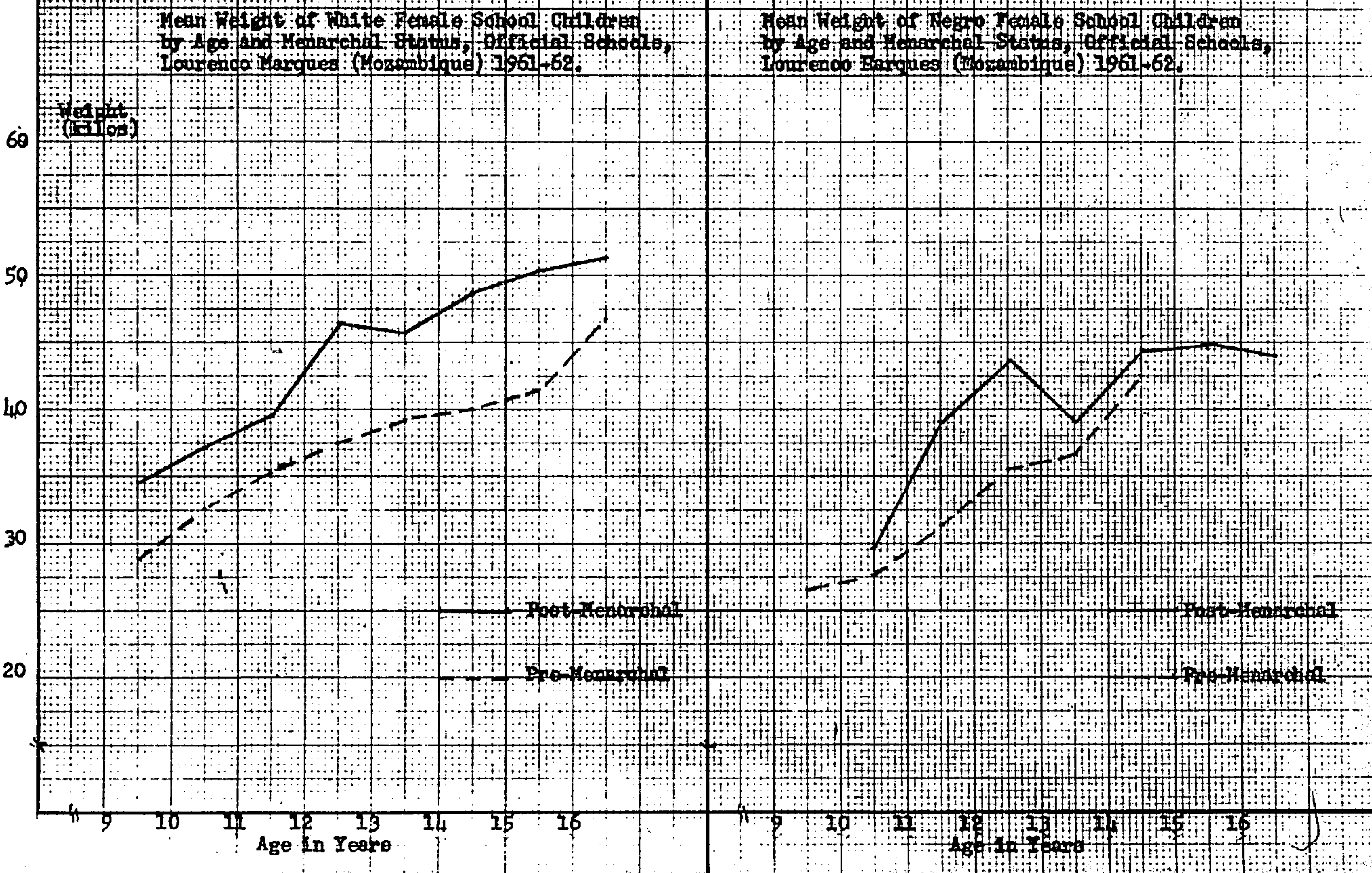


Figure 17

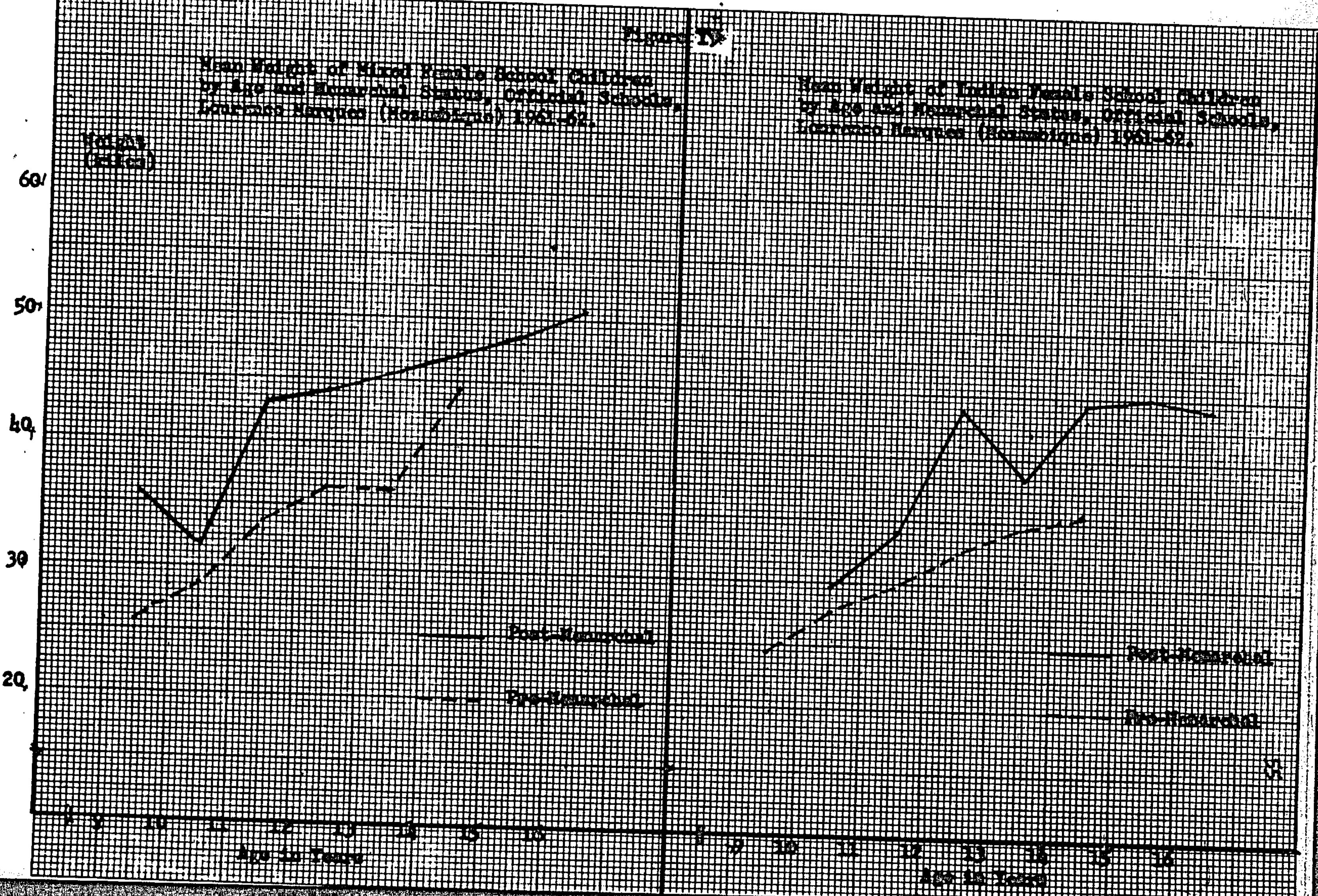
Mean Heights of Mixed Female School Children by Age and Menarchal Status, Official Schools, Lourenco Marques (Mocambique) 1961-62.

Mean Height of Indian Female School Children by Age and Menarchal Status, Official Schools, Lourenco Marques (Mocambique) 1961-62.

Figure 18


Mean Weight of White Female School Children
by Age and Menarchal Status, Official Schools,
Lourenco Marques (Mozambique) 1961-62.
Weight
(Kilos)
60
50
40
30
20
9
10
11
12
13
14
15
16
Age in Years
Post-Menarchal
Pre-Menarchal
Mean Weight of Negro Female School Children
by Age and Menarchal Status, Official Schools,
Lourenco Marques (Mozambique) 1961-62.
9
10
11
12
13
14
15
16
Age in Years
Post-Menarchal
Pre-Menarchal

12-282
20 SQUARES TO THE INCH



6. Height Increment Ratio

With the exception of the 10 Indian males in the eight-year age group, the mean height increment ratio for the Indian, White and Mixed racial groups showed a general increase between ages 11 and 14 and a decline after that. (Table VII and Figure 20.) The Negro males appeared to follow a pattern different from that of other racial groups. At most ages they had a lower mean height increment ratio than other races and the peak increment in Negroes was the lowest of all races.

7. Increment of Weight

Increment of weight determinations gave unanticipated results which made the data difficult to interpret meaningfully. A relatively large number of boys in each race group showed lower weights at the time of their second weighing than they did at the first. This is understandable in light of the adolescent "fat-spurt" which heralds puberty in some males and which disappears later. However, for many boys, adolescence is marked by steady weight gain. Thus two characteristics of somatic maturation may result in increments of weight going in different directions, i.e., negative and positive. Because the result was unanticipated, additional data were not available to interpret better the positive and negative increments of weight in the boys in this study. Therefore, increment of weight was not used as a measure of maturation.

8. Visual Acuity

The lowest visual acuity in either eye by the Monoyer Scale was used to classify the children (Tables VIII and IX). The

Table VII

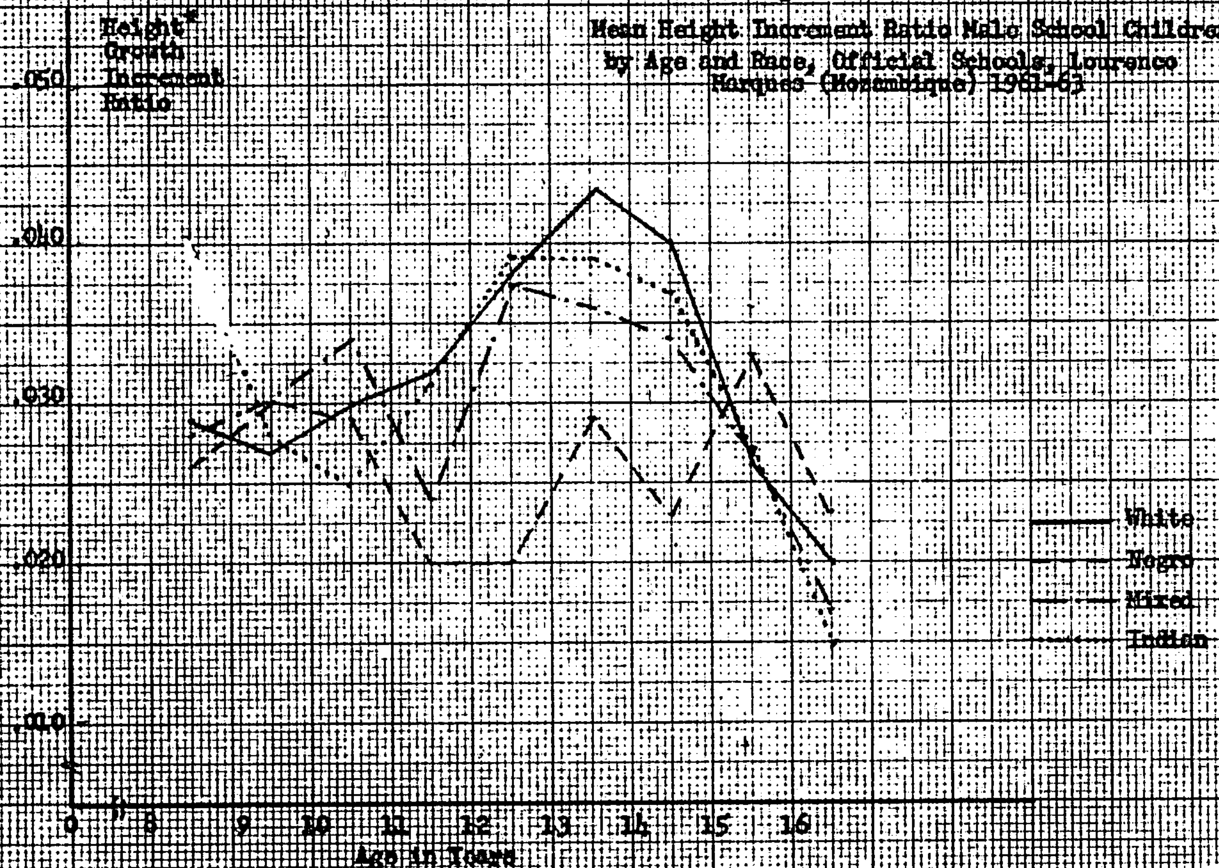
Mean Height Increment Ratio* Male School Children by Age and Race, Official Schools, Lourenco Marques (Mozambique) 1961-63

Age	White		Negro		Mixed		Indian	
	Height Increment	Number	Height Increment	Number	Height Increment	Number	Height Increment	Number
8	.029	123	.026	16	.028	15	.032	10
9	.027	211	.030	12	.030	30	.028	26
10	.030	213	.029	29	.034	65	.025	38
11	.032	166	.020	35	.024	43	.031	46
12	.038	182	.020	24	.037	30	.039	32
13	.044	181	.029	28	.036	22	.038	34
14	.040	186	.023	19	.034	22	.037	22
15	.026	166	.033	9	.027	10	.026	18
16	.020	50	.023	3	.017	3	.015	8

* $\frac{H_2 - H_1}{H_1}$ where H_1 = height 1961-62 and H_2 = height 1963

Figure 20

Mean Height Increment Ratio Male School Children by Age and Race, Official Schools, Lourenco Marques (Mozambique) 1961-63



$^{*}\frac{H_2 - H_1}{H_1}$ H_1 = height 1962 (during 1961-62 school year)
H_2 = height 1963 (during 1962-63 school year)

Table VIII

Visual Acuity of Female School Children by Race and Age - Official Schools - Lourenco Marques (Mozambique) 1961-62

Race	Age	Total No.	Glasses**	Visual Acuity (Monoyer) "Worst Eye"* .0 No.	.1 No.	.2 No.	.3 No.	.4 No.	.5 No.	.6 No.	.7 No.	.8 No.	.9 No.	10 No.	10 %
White	9	225	8	1	-	2	-	-	-	2	4	1	4	203	90
	10	245	11	1	-	-	-	1	-	3	4	1	2	222	91
	11	322	7	-	-	-	3	5	4	3	11	10	20	259	80
	12	286	4	-	-	-	2	4	3	3	8	11	14	237	83
	13	261	8	-	1	4	1	3	3	5	9	4	17	161	62
	14	194	9	-	-	2	3	1	3	-	5	9	18	144	74
	15	135	5	-	1	-	-	2	1	3	6	5	6	106	79
	16	65	5	-	-	2	-	4	1	2	1	5	4	41	63
Negro	9	49	-	-	-	-	-	-	-	-	-	1	3	45	92
	10	39	-	-	-	-	-	-	-	-	-	-	2	37	95
	11	34	-	-	-	-	-	-	1	-	1	1	2	29	85
	12	40	2	-	-	-	-	-	-	1	-	-	5	32	80
	13	25	-	-	-	-	-	-	-	-	2	1	1	21	84
	14	21	-	-	-	-	-	-	-	-	2	-	3	16	76
	15	20	-	-	-	-	-	-	-	-	2	-	2	16	80
	16	16	-	-	-	-	-	-	1	1	2	-	-	12	75
Mixed	9	79	-	-	-	-	-	-	1	1	-	2	2	73	92
	10	71	2	-	-	-	-	-	-	-	2	1	2	64	80
	11	46	-	-	-	-	-	-	-	-	3	-	6	37	80
	12	73	1	-	-	-	-	-	-	1	-	-	8	63	86
	13	44	1	-	-	-	-	-	-	2	-	-	7	34	77
	14	42	3	-	-	1	-	-	-	-	1	-	2	35	83
	15	27	-	-	-	-	-	-	-	2	-	1	-	24	89
	16	20	-	-	-	1	-	-	-	1	2	1	1	14	70
Indian	9	44	-	-	-	-	-	-	-	-	2	-	3	39	89
	10	38	1	-	1	-	-	-	1	-	-	1	5	29	76
	11	48	-	-	-	-	-	-	-	1	-	2	1	44	92
	12	43	-	-	-	-	-	1	-	-	-	-	1	41	95
	13	41	-	-	-	1	-	-	-	1	1	-	2	36	88
	14	27	1	-	-	-	-	-	-	-	1	1	1	23	85
	15	12	-	-	-	-	1	1	-	-	-	-	-	10	83
	16	8	1	-	-	-	-	-	-	-	-	-	-	7	88

*Visual acuity in "worst eye" as described in text of children not already wearing glasses.

**Children wearing glasses.

Table IX

Visual Acuity of Male School Children by Race and Age
Official Schools - Lourenco Marques
(Mozambique) 1961-62

Race	Age	Total No.	Glasses**	Monoyer Scale Acuity in "Worst" Eye* .0 No.	.1 No.	.2 No.	.3 No.	.4 No.	.5 No.	.6 No.	.7 No.	.8 No.	.9 No.	1.0 No.	1.0 %
White	8	123	4	3	-	-	-	-	1	-	2	2	1	110	89
	9	206	7	2	1	1	1	1	1	-	1	1	1	189	92
	10	215	5	-	2	1	2	-	-	3	1	1	1	199	93
	11	167	4	-	-	2	-	1	-	4	3	6	1	146	87
	12	184	4	-	-	1	2	1	1	-	2	3	5	165	90
	13	179	3	-	2	4	2	5	1	-	5	2	2	153	85
	14	184	6	-	1	5	-	-	1	3	1	1	2	164	89
	15	167	4	-	2	4	-	1	1	-	7	3	-	145	87
	16	51	5	-	-	-	-	1	-	-	3	5	-	37	73
Negro	8	16	-	-	-	-	-	-	1	-	1	-	-	14	88
	9	11	-	-	-	-	-	-	-	-	-	-	-	11	100
	10	30	1	-	-	-	-	1	-	-	-	-	-	28	93
	11	34	-	-	1	-	-	-	-	-	-	1	1	31	91
	12	23	-	-	-	1	-	-	-	-	2	-	-	20	87
	13	28	-	-	-	-	-	-	-	-	1	-	-	27	96
	14	18	-	-	-	-	-	-	-	-	-	-	1	17	94
	15	9	-	-	-	-	-	-	-	-	-	1	1	7	78
	16	3	-	-	-	-	-	-	-	-	-	-	-	3	100
Mixed	8	15	-	-	-	-	-	-	-	-	-	-	-	15	100
	9	30	1	-	-	1	-	-	-	1	2	-	-	25	83
	10	47	-	-	-	1	-	1	1	-	2	-	1	41	87
	11	33	-	1	1	-	1	-	-	-	-	-	-	30	91
	12	20	1	-	-	1	3	-	-	-	-	-	-	15	75
	13	21	1	-	-	-	-	-	1	-	-	-	-	19	90
	14	20	-	-	-	-	-	-	1	-	-	-	-	19	95
	15	9	-	-	-	-	-	-	1	-	-	-	-	8	89
	16	4	1	-	-	-	-	-	-	-	-	-	-	3	75
Indian	8	12	-	-	-	-	-	-	-	-	-	-	-	12	100
	9	26	-	-	-	-	-	-	-	-	-	-	-	26	100
	10	36	-	-	-	-	-	1	-	-	-	1	-	34	94
	11	44	-	-	-	-	-	1	-	-	-	3	-	42	95
	12	32	-	-	-	-	2	-	-	-	-	-	-	29	91
	13	35	2	-	-	-	-	-	-	-	1	-	1	31	89
	14	22	-	-	-	-	-	1	-	-	-	1	-	20	91
	15	18	-	-	-	-	-	-	-	-	-	2	-	14	78
	16	8	-	-	-	-	-	-	-	-	-	1	-	7	88

*Visual acuity in "worst eye" as described in text, children not already wearing glasses.

**Children wearing glasses.

children were grouped by race and age for each sex. There were no striking or consistent differences in the percentage of race-age subgroups with normal (1.0) visual acuity. There was, however, a difference in sexes. With only one exception, males in all race and age groups had higher percentages with normal visual acuity than did females.

The omission from testing of children already wearing glasses makes it impossible to determine rates for different levels of visual acuity. Although the number of these children was not large and they were scattered rather evenly throughout the age, sex and race subgroups, they did, in White children, constitute a relatively large proportion of children with abnormal visual acuity.

9. Consecutive Determination of Visual Acuity (Males)

In Table X are shown two visual acuity determinations taken a year apart for 2176 males. Approximately two per cent converted from normal to abnormal during this period. Of the approximately nine per cent abnormal on first testing, one per cent converted to normal, one per cent showed improvement but were still abnormal, two and a half per cent remained unchanged in their abnormality, and about four per cent were worse. The category "missing" refers to children not examined a second time.

10. Attendance at Eye Clinic

Table XI shows the percentage of females and males, by visual acuity group ("worst" eye) referred to the eye clinic and subsequently visiting the eye clinic. All children who were wearing glasses at the

Table X

Visual Acuity on Two Consecutive Annual Determinations, Male School Children, Official Schools, Lourenco Marques (Mozambique) 1961-63

First Visual Acuity	Second Visual Acuity		Number	%
Normal	Normal		1760	81.6
	Abnormal		41	1.9
	Missing		174	8.1
Abnormal	Normal		22	1.0
	Abnormal	(Better 25 (1.2%) (Same 53 (2.5%) (Worse 83 (3.8%)	161	7.2
	Missing		18	.2
Total			2176	100

Table XI

Number of School Children Referred* to Eye Clinic Actually Attending Eye Clinic (by Sex and Visual Acuity) Official Schools, Lourenco Marques (Mozambique) 1961-62

Visual Acuity of Poorest Eye on Referral	Seen at Clinic		Not Seen at Clinic	
	Female	Male	Female	Male
0.9	83 (44%)	11 (17%)	103 (55%)	52 (82%)
0.8	20 (27%)	21 (48%)	53 (72%)	22 (51%)
0.7 and 0.6	62 (56%)	27 (64%)	47 (43%)	15 (35%)
0.5 or less	42 (63%)	57 (60%)	24 (36%)	37 (39%)

*Does not include children wearing glasses at time of visual acuity examination.

time of visual acuity testing were not tested but referred directly to the eye clinic. About 85 per cent of girls and 15 per cent of boys in this category subsequently attended eye clinic. However, they are not included in these tabulations because they could not be classified by visual acuity at the time of screening examination.

Approximately half of the children (Table XI) referred actually visited the clinic for diagnostic studies. Males and females whose loss of visual acuity was of lesser degree visited the eye clinic less frequently than those with losses measured at 0.7 (Monoyer) or worse. However, differences between sexes in the 0.9 and 0.8 visual acuity groups were marked and not readily explainable. Approximately half or more of the referred White, Mixed and Indian children of both sexes attended clinic while only one-third of Negro boys and girls did so.

Attendance ratio for males of all races was slightly higher than that for females.

11. Confirmation of Screening Evaluation

In Table XII children of both sexes who received refractions are grouped according to their visual acuity on screening and their diagnosis as normal or abnormal after refraction. As would be expected, children with low levels of visual acuity on screening had the highest percentage judged abnormal after refraction. It is worth noting, however, that 11 of the 86 children in the 0.9 visual acuity group at screening subsequently were judged to have a refractive error meriting correction.

Numbers were too small to determine whether there were different patterns in the four racial groups.

Table XII

Number of School Children* Attending Eye Clinic and Diagnosed as Having Errors of Refraction (by Sex and Visual Acuity), Official Schools, Lourenco Marques, (Mozambique) 1961-62

Visual Acuity of Poorest Eye on Referral	Evaluation after Refraction			
	Normal		Abnormal	
	Female	Male	Female	Male
0.9	72 (86%)	4 (36%)	11 (13%)	7 (63%)
0.8	3 (15%)	8 (38%)	17 (85%)	13 (61%)
0.7 and 0.6	14 (22%)	7 (25%)	48 (77%)	20 (74%)
0.5 or less	0 (0%)	1 (2%)	42 (100%)	56 (98%)

*Does not include children wearing glasses at time of visual acuity examination.

12. Refractive Diagnosis

Children wearing glasses at the time of visual acuity screening and sent directly to the eye clinic without a test of visual acuity were refracted as were children with low visual acuity who attended the eye clinic. These two groups are combined in Tables XIII and XIV, and the total numbers, therefore, in these tables are greater than those in Tables XI and XII.

As shown in Tables XIII and XIV, children were grouped by age and race (separately for both sexes) according to the diagnosis made by the ophthalmologist after refraction. Because of the small number in the subgroups, only two age groups were used, 9-12 and 13-16 years. In White children of both sexes hypermetropia predominated in younger children and myopia in older. Total number of children with refractive errors was approximately equal in the younger and older age groups. The same relationships were noted also in Indian children, but numbers of observations were small. In both Negro and Mixed race groups total numbers of refractive errors were greater in older than in younger children and hypermetropia was more common than myopia in both age groups. These relationships were more pronounced in females than males and especially striking in Negro females.

Because not all children referred to the clinic actually attended, it is difficult to determine a reliable denominator from which rates of various refractive errors can be calculated for different racial groups. One can not assume that the refractive diagnoses of the group not attending would be the same as that of the group attending, even if classified by screening visual acuity status.

Table XIII

Refractive Diagnosis by Race and Age, Female School Children, Official Schools, Lourenco Marques (Mozambique) 1961-62

Diagnosis	White 9-12 yrs.	White 13-16 yrs.	Negro 9-12 yrs.	Negro 13-16 yrs.	Mixed 9-12 yrs.	Mixed 13-16 yrs.	Indian 9-12 yrs.	Indian 13-16 yrs.
Myopia	17	33	1	0	1	3	1	6
Hyper-metropia	45	23	4	10	6	8	5	1
Mixed Astigmatism	1	1	-	-	1	-	-	-
Other*	4	5	-	1	1	-	-	-

Table XIIIa

Refractive Diagnosis by Race and Age, Male School Children, Official Schools, Lourenco Marques (Mozambique) 1961-62

Diagnosis	White 9-12 yrs.	White 13-16 yrs.	Negro 9-12 yrs.	Negro 13-16 yrs.	Mixed 9-12 yrs.	Mixed 13-16 yrs.	Indian 9-12 yrs.	Indian 13-16 yrs.
Myopia	11	29	2	0	4	2	1	2
Hyper-metropia	32	14	2	2	4	6	5	1
Mixed Astigmatism	-	-	-	-	-	-	-	-
Other*	-	1	3	-	2	-	-	1

*Blepharitis, conjunctivitis, corneal scar, strabismus, optic atrophy and epicanthal folds.

Table XIV

Degree of Refractive Error by Diagnosis, Race and Age of Female School Children, Official Schools, Lourenco Marques (Mozambique) 1961-62

Age in Years	RACE															
	White				Negro				Mixed				Indian			
	Amt. of Myopia		Amt. of Hypermetropia		Amt. of Myopia		Amt. of Hypermetropia		Amt. of Myopia		Amt. of Hypermetropia		Amt. of Myopia		Amt. of Hypermetropia	
	*	**	#	##	*	**	#	##	*	**	#	##	*	**	#	##
9	0	0	7	2	0	0	0	0	0	0	1	0	0	0	1	1
10	2	0	15	1	0	0	0	0	0	0	3	0	1	0	0	0
11	5	2	11	1	1	0	1	0	0	0	1	0	0	0	2	0
12	4	4	8	0	0	0	3	1	1	0	1	0	0	0	0	0
13	7	4	6	1	0	0	6	0	0	1	2	0	0	2	0	0
14	5	5	5	1	0	0	2	0	2	0	3	0	2	0	0	0
15	4	2	6	1	0	0	0	0	1	0	2	0	1	0	0	0
16	4	2	3	0	0	0	0	0	0	0	1	0	1	0	0	0

* -.10 D to - 2.9 D

** -3 D and over

+ .10 D to + 2.9 D

+ 3 D and over

B. Associations

1. Height, Weight and Visual Acuity

a. Females. Heights and weights were tabulated separately for females according to the Monoyer vision test. At school screening the means by age and race for these two groups, normal and abnormal, are shown in Table XV and Figures 21, 22, 23 and 24. Only in the White females were numbers large enough so that differences in means of weight and height for girls of a given age with normal and abnormal vision could be tested for statistical significance. Only in 15 year old White girls were mean heights and weights significantly different in the normal and abnormal visual acuity groups at the .05 level or better.

b. Males. Heights and weights were tabulated separately for males according to results of the Monoyer vision test. The means by age and race for these groups are shown in Table XVI and Figures 25, 26, 27 and 28. Only in White males were numbers large enough for statistical testing. Of the numerous subgroups only 12 year old White boys showed a difference at the .05 level in mean weights of males with normal and abnormal visual acuity.

2. Height Increment Ratio (Males) and Visual Acuity

As shown in Table XVII, height increment ratios were determined by race and age for males having normal visual acuity and for males having abnormal visual acuity. Numbers in non-White race-age subgroups were too small for further analysis. Height increment ratios for White males with normal and abnormal visual acuity are displayed in

Table XV

Mean Weight and Height of Females with Normal and Abnormal Visual Acuity by Race and Age
Official Schools - Lourenco Marques (Mozambique) 1961-62

Race	Age	No. Weighed		Mean Weight (kilos)		S.D. from Mean		No. Measured		Mean Height (cm.)		S.D. from Mean	
		N.	Ab.	N.	Ab.	N.	Ab.	N.	Ab.	N.	Ab.	N.	Ab.
Whites	9	198	24	29.3	28.7	5.74	4.90	202	24	1.30	1.30	.07	.07
	10	222	27	32.9	32.0	6.20	6.07	222	27	1.37	1.36	.07	.07
	11	258	64	35.2	35.2	6.90	6.58	259	65	1.40	1.40	.07	.07
	12	233	49	39.3	41.4	7.90	7.52	237	50	1.46	1.48	.07	.07
	13	155	55	43.0	43.2	6.90	7.70	161	56	1.51	1.50	.06	.07
	14	133	49	45.7	45.8	6.00	7.00	144	52	1.55	1.53	.06	.07
	15	97	28	47.6	48.7	5.90	6.79	106	31	1.56	1.57	.06	.06
	16	37	21	48.1	49.6	5.50	5.07	41	24	1.58	1.57	.06	.05
Negroes	9	44	4	26.0	27.3	3.00	4.27	44	4	1.28	1.34	.05	.05
	10	37	2	27.8	26.0	3.40	2.00	37	2	1.30	1.29	.07	.06
	11	29	6	32.0	28.7	5.60	4.60	29	6	1.37	1.32	.06	.08
	12	32	8	37.3	37.9	5.80	7.15	32	8	1.42	1.45	.06	.07
	13	21	4	40.7	42.3	6.30	9.44	21	4	1.48	1.47	.07	.10
	14	16	5	44.7	44.8	5.00	2.14	16	5	1.52	1.49	.05	.05
	15	14	4	48.3	48.3	5.40	5.72	16	4	1.56	1.60	.04	.07
	16	11	4	49.0	50.5	5.30	4.15	12	4	1.56	1.60	.06	.06

Table XV (continued)

Race	Age	No. Weighed		Mean Weight (kilos)		S.D. from Mean		No. Measured		Mean Height (cm.)		S.D. from Mean	
		N.	Ab.	N.	Ab.	N.	Ab.	N.	Ab.	N.	Ab.	N.	Ab.
Mixed	9	71	6	25.9	22.7	4.07	3.25	73	6	1.28	1.24	.07	.06
	10	64	8	27.8	32.9	4.00	6.50	64	8	1.33	1.37	.06	.06
	11	37	9	32.7	37.6	7.00	9.40	37	9	1.38	1.40	.08	.05
	12	63	11	37.3	37.5	6.61	7.08	63	11	1.46	1.48	.07	.06
	13	33	5	40.7	42.5	8.20	6.25	34	10	1.49	1.51	.06	.06
	14	35	7	45.4	47.0	6.80	6.33	35	8	1.55	1.56	.05	.04
	15	24	3	48.0	49.7	5.07	6.80	24	3	1.56	1.55	.05	.01
	16	13	6	48.8	51.7	4.90	5.90	14	6	1.61	1.60	.04	.04
Indian	9	36	6	25.3	23.3	4.20	2.63	39	6	1.27	1.26	.07	.06
	10	28	7	28.3	26.7	5.04	8.53	29	7	1.34	1.31	.07	.09
	11	44	4	30.1	29.8	5.32	3.56	44	4	1.37	1.36	.07	.08
	12	41	3	34.6	41.7	7.20	11.59	41	3	1.44	1.47	.06	.06
	13	36	5	36.0	40.0	7.60	5.62	36	5	1.48	1.50	.08	.08
	14	23	4	44.6	39.3	6.80	2.59	23	4	1.53	1.53	.05	.05
	15	10	4	46.1	41.5	6.75	10.50	10	4	1.57	1.55	.05	.04
	16	7	1	44.1	43.0	3.76	0.00	7	1	1.57	1.62	.01	.00

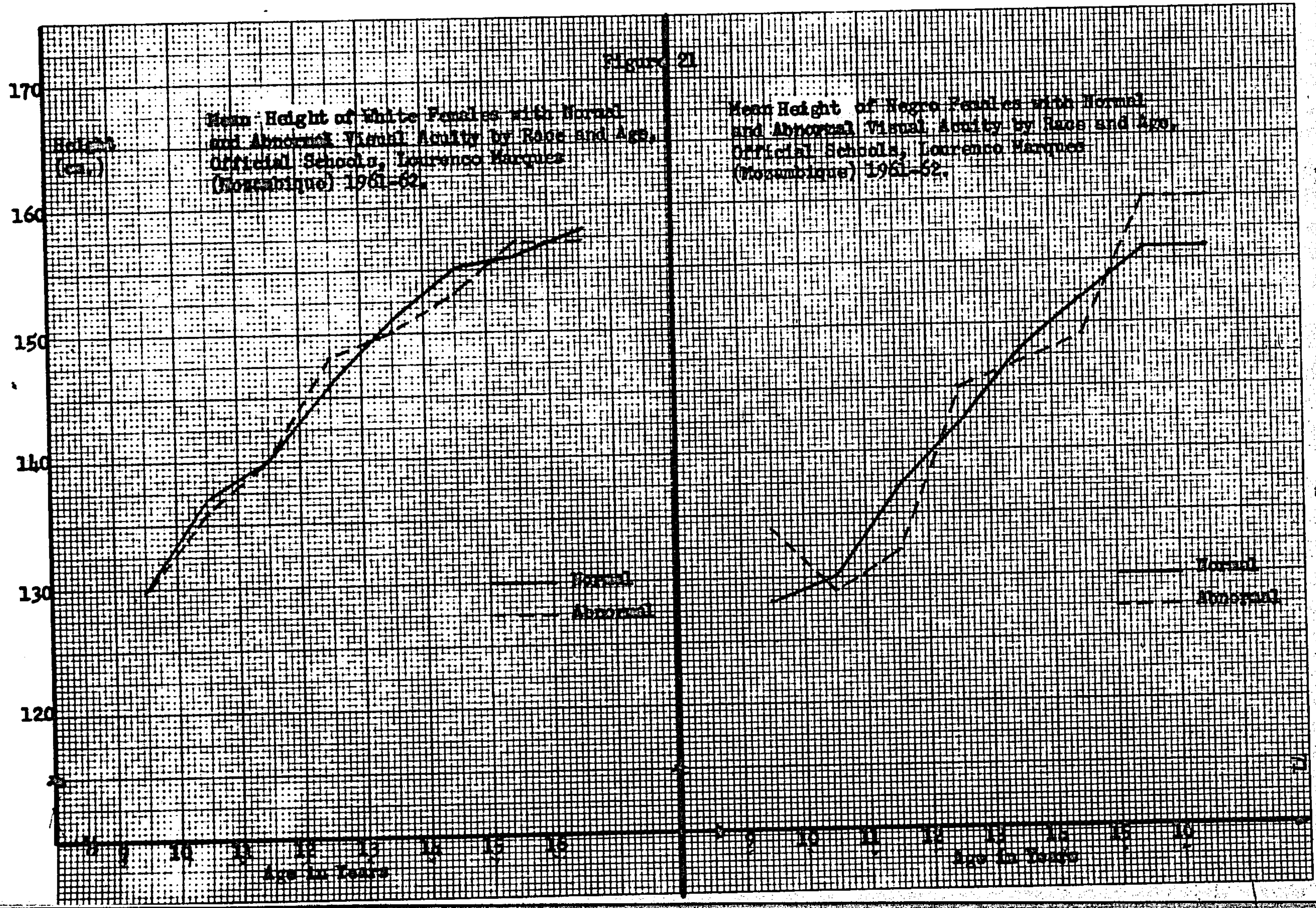


Figure 21
Mean Height of White Females with Normal and Abnormal Visual Acuity by Race and Age, Official Schools, Lourenco Marques (Mozambique) 1961-62.
Mean Height of Negro Females with Normal and Abnormal Visual Acuity by Race and Age, Official Schools, Lourenco Marques (Mozambique) 1961-62.
Height (cm.)
170
160
150
140
130
120
Normal
Abnormal
8 9 10 11 12 13 14 15 16
Age in Years
Normal
Abnormal
9 10 11 12 13 14 15 16
Age in Years

12-282
20 SQUARES TO THE INCH

Figure 72

Mean Height of Mixed Females with Normal and Abnormal Visual Acuity by Race and Age, Official Schools, Lourenco Marques (Mozambique) 1961-62.

Mean Height of Indian Females with Normal and Abnormal Visual Acuity by Race and Age, Official Schools, Lourenco Marques (Mozambique) 1961-62.

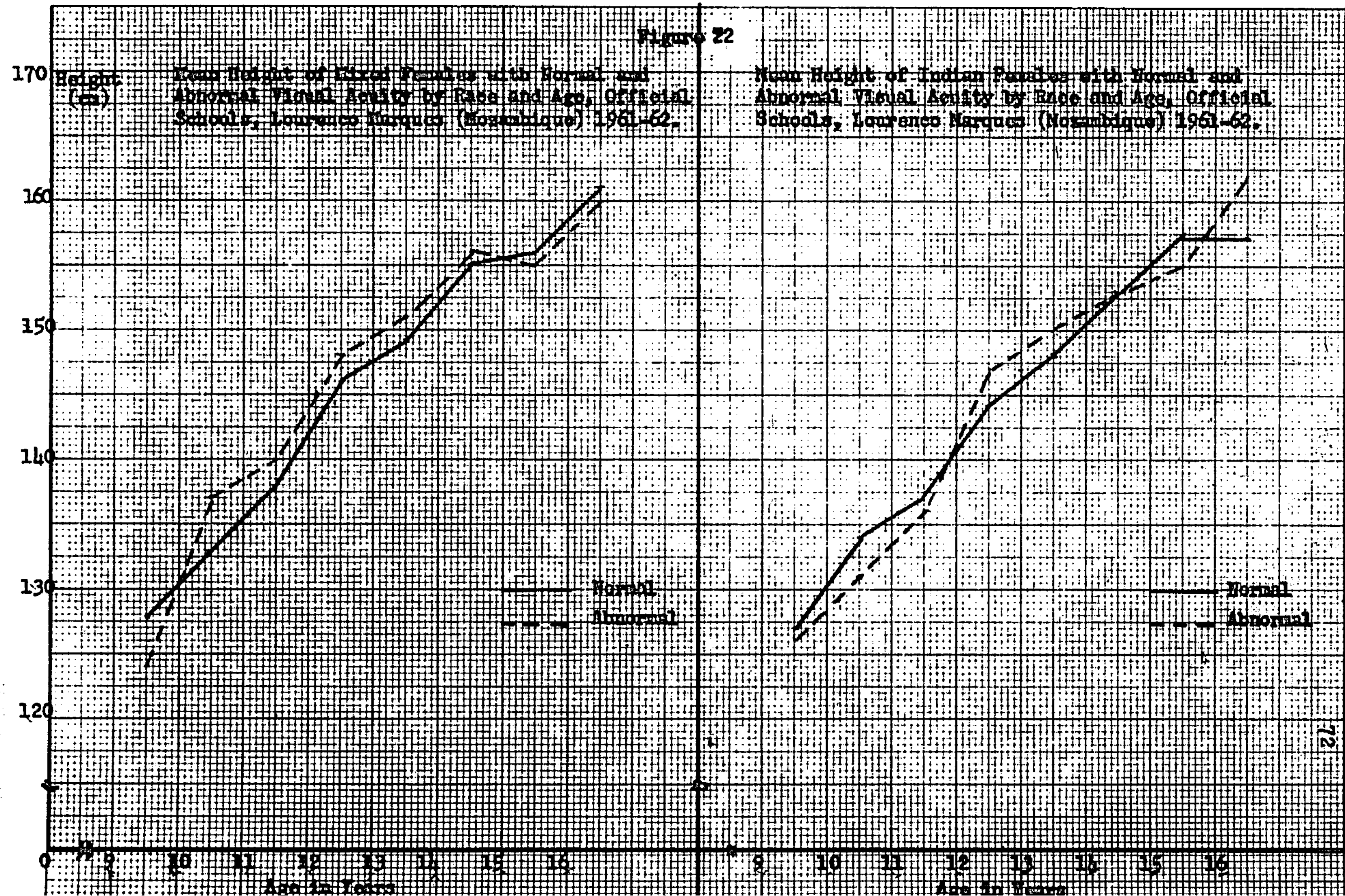
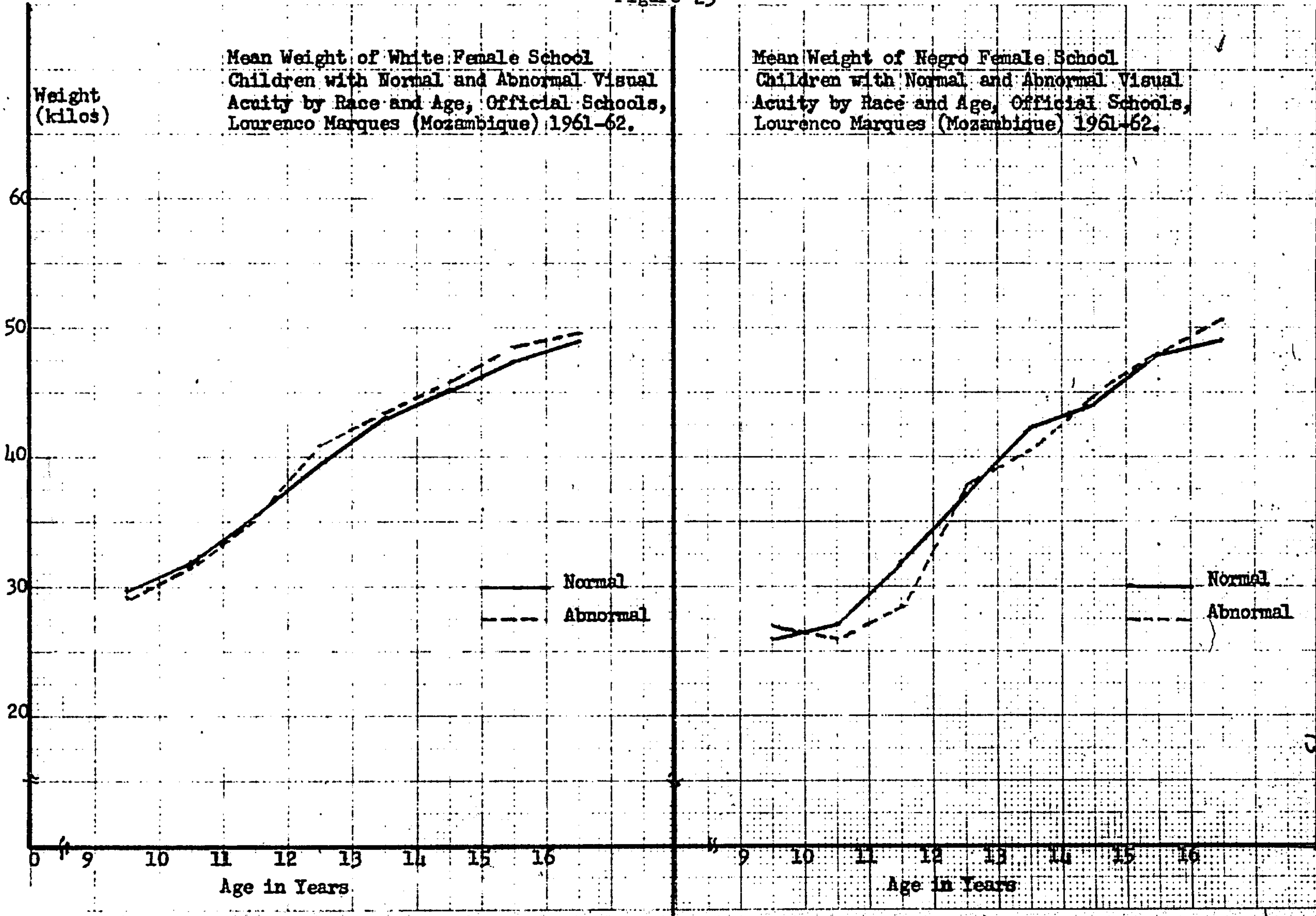


Figure 23


Mean Weight of White Female School Children with Normal and Abnormal Visual Acuity by Race and Age, Official Schools, Lourenco Marques (Mozambique) 1961-62.
Weight (kilos)
60
50
40
30
20
0
9
10
11
12
13
14
15
16
Age in Years
Normal
Abnormal
Mean Weight of Negro Female School Children with Normal and Abnormal Visual Acuity by Race and Age, Official Schools, Lourenco Marques (Mozambique) 1961-62.
9
10
11
12
13
14
15
16
Age in Years
Normal
Abnormal

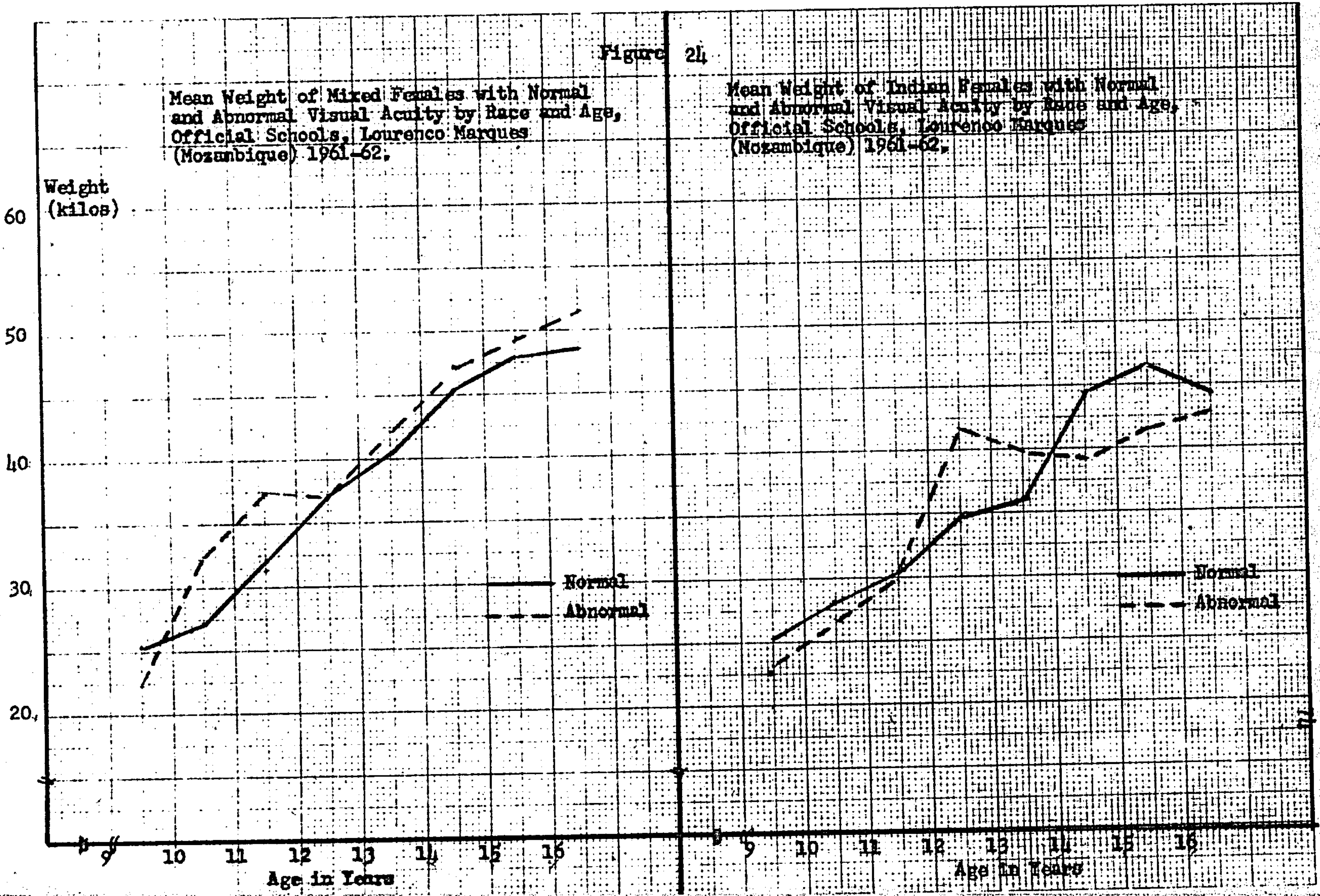


Figure 24
Mean Weight of Mixed Females with Normal and Abnormal Visual Acuity by Race and Age, Official Schools, Lourenco Marques (Mozambique) 1961-62.
Weight (kilos)
60
50
40
30
20
9
10
11
12
13
14
15
16
Age in Years
Normal
Abnormal
Mean Weight of Indian Females with Normal and Abnormal Visual Acuity by Race and Age, Official Schools, Lourenco Marques (Mozambique) 1961-62.
9
10
11
12
13
14
15
16
Age in Years
Normal
Abnormal

Table XVI

Mean Weight and Height of Males with Normal and Abnormal Visual Acuity by Race and Age
Official Schools - Lourenco Marques (Mozambique) 1961-62

Race	Age	No. Weighed		Mean Weight (kilos)		S.D. from Mean		No. Measured		Mean Height (cm.)		S.D. from Mean	
		N.	Ab.	N.	Ab.	N.	Ab.	N.	Ab.	N.	Ab.	N.	Ab.
Whites	8	109	9	28.2	27.6	4.07	5.75	109	-	1.31	-	.07	-
	9	188	18	31.7	32.1	5.19	4.64	187	19	1.36	1.37	.06	.05
	10	198	14	34.5	33.1	6.23	4.73	198	14	1.40	1.38	.07	.06
	11	146	19	36.4	34.4	6.60	7.21	145	19	1.43	1.41	.07	.08
	12	164	17	42.6	39.6	9.00	4.62	165	17	1.50	1.49	.08	.07
	13	153	26	46.0	47.6	8.80	7.37	152	26	1.55	1.56	.08	.06
	14	162	21	51.7	54.3	9.74	9.90	163	22	1.61	1.62	.08	.08
	15	144	21	56.6	56.7	9.14	9.30	144	21	1.67	1.67	.08	.06
	16	37	13	57.5	55.1	7.80	8.42	37	13	1.69	1.69	.07	.07
Negroes	8	13	2	26.5	29.0	3.00	8.00	14	2	1.28	1.30	.04	.10
	9	11	0	28.4	-	4.20	-	11	0	1.33	-	.06	-
	10	28	1	28.8	32.0	4.72	0.00	28	1	1.34	1.45	.07	.00
	11	31	3	33.3	36.6	8.07	3.85	31	3	1.40	1.47	.08	.03
	12	20	4	34.1	40.5	5.80	10.30	20	4	1.44	1.47	.06	.03
	13	27	1	41.1	33.0	6.58	0.00	27	1	1.52	1.42	.07	.00
	14	17	2	49.6	32.5	11.08	3.50	17	2	1.60	1.46	.08	.03
	15	7	2	54.4	48.0	7.51	6.00	7	2	1.63	1.56	.06	.07
	16	3	0	50.6	-	4.64	-	3	0	1.63	-	.06	-

Table XVI (continued)

Race	Age	No. Weighed		Mean Weight (kilos)		S.D. from Mean		No. Measured		Mean Height (cm.)		S.D. from Mean	
		N.	Ab.	N.	Ab.	N.	Ab.	N.	Ab.	N.	Ab.	N.	Ab.
Mixed	8	15	0	26.3	-	5.10	-	13	0	1.30	-	.07	-
	9	25	5	28.4	27.8	4.80	3.48	25	5	1.33	1.35	.06	.03
	10	59	6	28.4	33.3	5.13	5.08	59	6	1.34	1.38	.07	.09
	11	41	2	30.7	32.0	5.52	6.00	40	2	1.37	1.44	.07	.09
	12	30	0	36.0	-	5.83	-	30	0	1.47	-	.08	-
	13	15	6	38.6	42.1	8.61	5.72	15	6	1.49	1.53	.08	.08
	14	19	2	48.9	47.0	8.33	3.00	19	2	1.60	1.62	.08	.02
	15	8	2	49.8	51.5	8.26	2.50	8	2	1.60	1.68	.08	.01
	16	3	0	64.3	-	2.62	-	2	0	1.75	-	.03	-
Indian	8	12	0	24.0	-	2.61	-	10	0	1.28	-	.04	-
	9	26	0	26.9	-	5.88	-	26	0	1.34	-	.06	-
	10	33	3	29.1	35.6	5.38	8.65	33	3	1.35	1.42	.07	.06
	11	42	4	31.4	36.5	4.14	4.71	42	4	1.42	1.50	.06	.04
	12	29	3	35.1	34.0	6.70	6.48	29	3	1.47	1.45	.09	.11
	13	31	2	43.2	33.5	8.23	.50	31	2	1.57	1.46	.07	.03
	14	20	2	46.4	36.5	11.06	.50	20	2	1.58	1.53	.06	.01
	15	14	4	47.1	58.2	7.76	10.52	14	4	1.64	1.68	.09	.06
	16	7	1	54.8	43.0	9.61	0.00	7	1	1.71	1.68	.02	.00

T-test

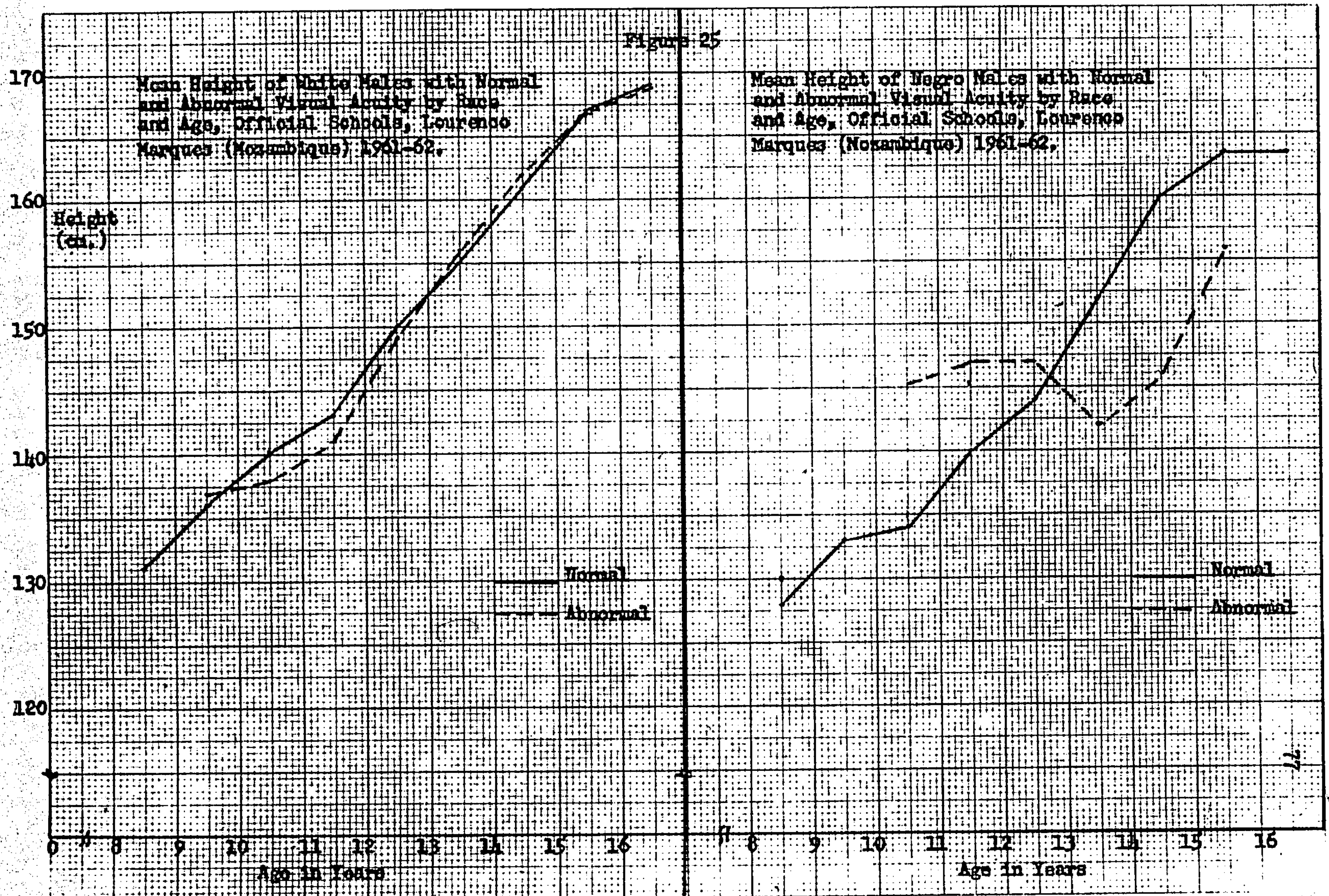


Figure 25
Mean Height of White Males with Normal and Abnormal Visual Acuity by Race and Age, Official Schools, Lourenco Marques (Mozambique) 1961-62.
Mean Height of Negro Males with Normal and Abnormal Visual Acuity by Race and Age, Official Schools, Lourenco Marques (Mozambique) 1961-62.
Height (cm.)
170
160
150
140
130
120
Normal
Abnormal
0
8
9
10
11
12
13
14
15
16
Age in Years
Age in Years

Figure 23 6

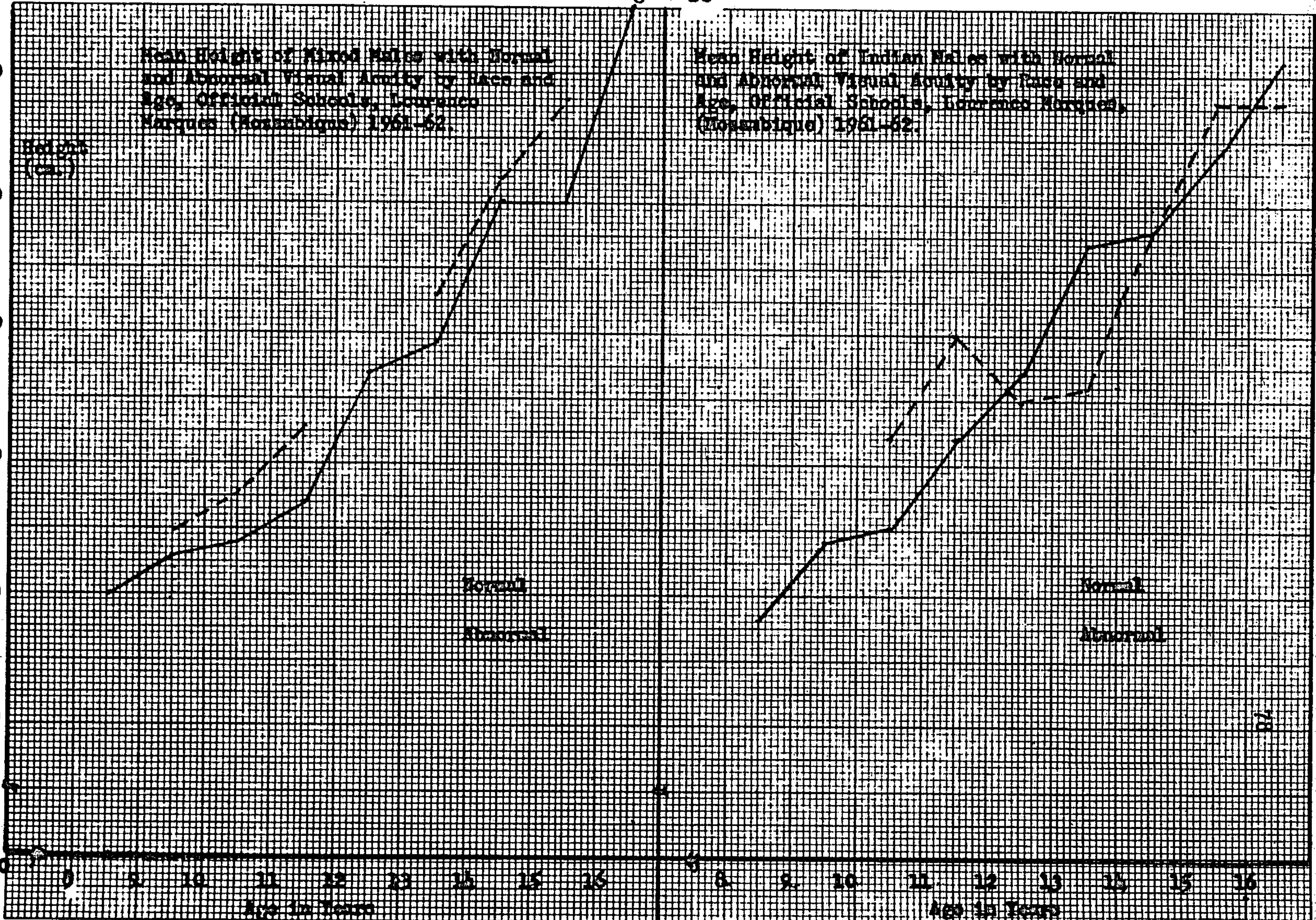
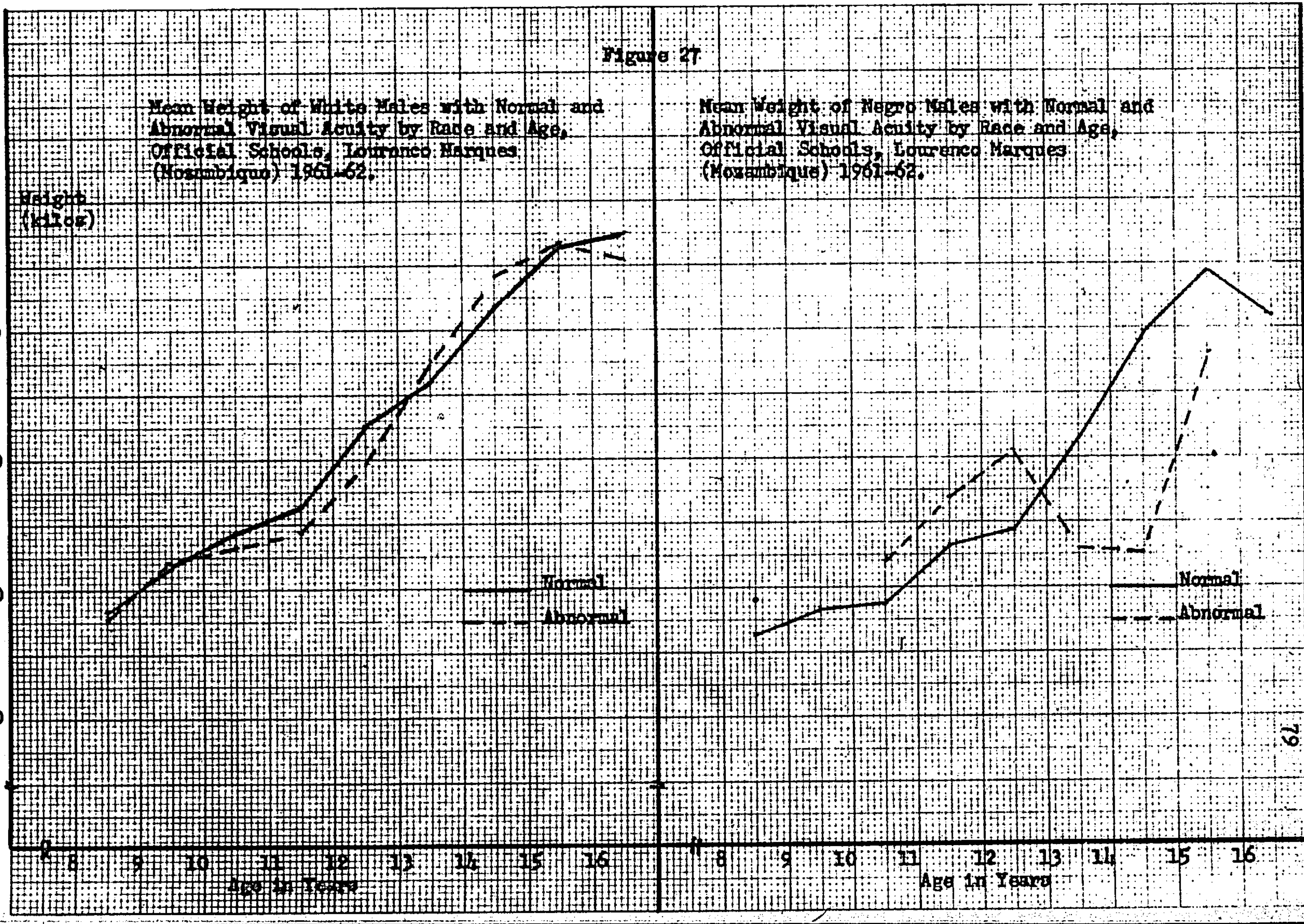

Mean Height of Mixed Males with Normal and Abnormal Visual Acuity by Race and Age, Official Schools, Lourenco Marques (Mozambique) 1961-62.
Height (cm.)
170
160
150
140
130
120
Normal
Abnormal
8
9
10
11
12
13
14
15
16
Age in Years
Mean Height of Indian Males with Normal and Abnormal Visual Acuity by Race and Age, Official Schools, Lourenco Marques, (Mozambique) 1961-62.
Normal
Abnormal
8
9
10
11
12
13
14
15
16
Age in Years

Figure 27



Mean Weight of White Males with Normal and Abnormal Visual Acuity by Race and Age, Official Schools, Lourenco Marques (Mozambique) 1961-62.

Mean Weight of Negro Males with Normal and Abnormal Visual Acuity by Race and Age, Official Schools, Lourenco Marques (Mozambique) 1961-62.

12-282
20 SQUARES TO THE INCH

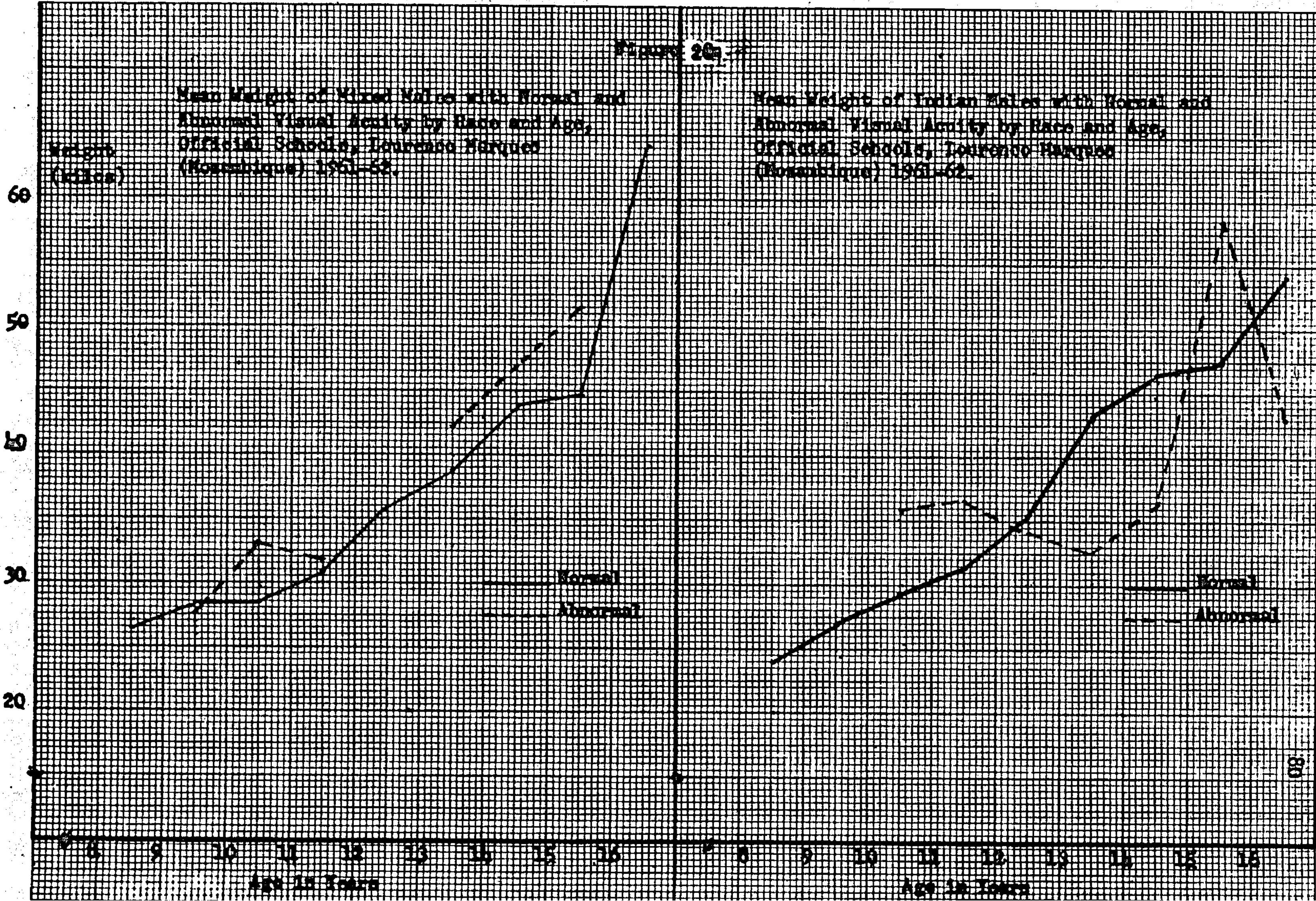


Table XVII

Mean Height Increment Ratio* of Male School Children by Visual Acuity, Race and Age. Official Schools, Lourenco Marques (Mozambique) 1961-62

Race	Age in Yrs.	Normal Visual Acuity			Abnormal Visual Acuity		
		Number	Mean Height Increment	S.D.	Number	Mean Height Increment	S.D.
White	8	110	.032	.024	13	.016	.019
	9	189	.027	.025	22	.024	.023
	10	199	.030	.028	14	.023	.018
	11	146	.033	.037	20	.023	.019
	12	165	.038	.023	17	.033	.033
	13	153	.046	.027	28	.034	.020
	14	164	.040	.024	22	.041	.033
	15	145	.025	.020	21	.029	.020
	16	37	.017	.013	13	.029	.025
Negro	8	14	.026	.020	2	.030	.000
	9	11	.030	.015	1	.000	.000
	10	28	.029	.017	1	.040	.000
	11	31	.020	.017	4	.017	.011
	12	20	.022	.016	4	.010	.012
	13	27	.029	.016	1	.030	.000
	14	17	.024	.009	2	.015	.005
	15	7	.027	.027	2	.055	.015
	16	3	.023	.012	0	-	-
Mixed	8	15	.028	.016	0	-	-
	9	25	.029	.028	5	.036	.050
	10	59	.034	.025	6	.038	.026
	11	41	.024	.012	2	.015	.015
	12	30	.037	.029	0	-	-
	13	15	.030	.016	7	.050	.033
	14	19	.034	.016	3	.033	.029
	15	8	.031	.016	2	.010	.010
	16	3	.017	.012	0	-	-
Indian	8	10	.032	.028	0	-	-
	9	26	.028	.017	0	-	-
	10	34	.024	.019	4	.035	.026
	11	42	.030	.015	4	.038	.015
	12	29	.040	.026	3	.033	.047
	13	31	.040	.026	3	.017	.012
	14	20	.037	.014	2	.040	.020
	15	14	.028	.016	4	.018	.025
	16	7	.013	.008	1	.030	.000

* $\frac{H_2 - H_1}{H_1}$ H_1 = height 1961-62 H_2 = height 1963

Figures 29 and 30. It will be seen that in every age up to 14, males with normal visual acuity had greater height increment ratio than did those with abnormal visual acuity. After age 14 this relationship was reversed. Viewed longitudinally, it appears that males with normal visual acuity antedate males with abnormal visual acuity in their height spurt. The mean height increment ratios for White males with normal and abnormal visual acuity differed at a significance level of .01 at ages 8 and 13 years and at a level of .05 at age 11 years. At all other ages, $p > .05$.

In this analysis, it must be noted that children wearing glasses at the time visual acuity was determined were placed in the abnormal group. Thus, the entire White male population is represented in these tabulations.

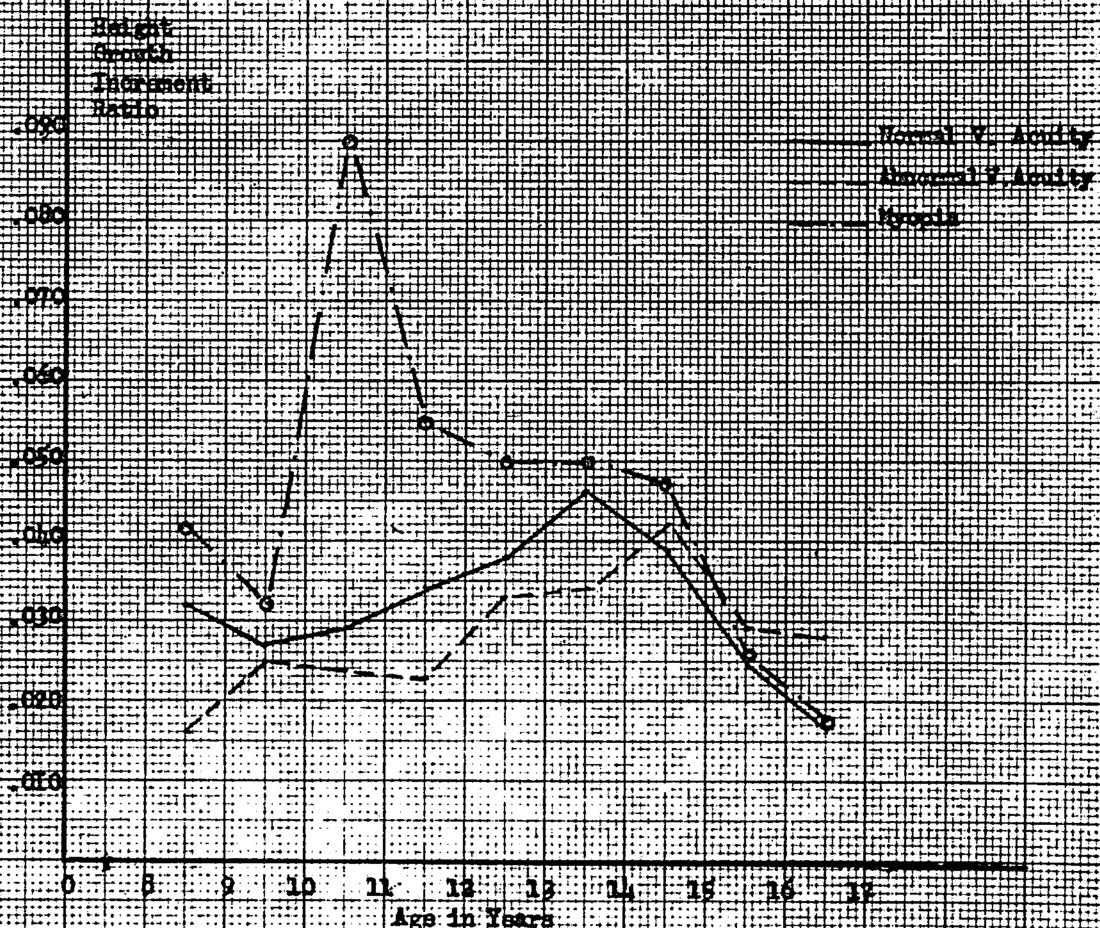
3. Visual Acuity and Height Increment

The relationship of height increment and changes in visual acuity (Table XVIII) for boys was compared over all ages and races using the median test. The resulting chi-square value of 0.099 is extremely low and indicates that height increment and changes in visual acuity over a one-year period are not related.

4. Menarche and Visual Acuity

The population of White girls was divided into those with normal and with abnormal visual acuity. In each vision group, the members who were post-menarchal were arranged both by chronological age and by menarchal age. Three menarchal age groups were considered:

Figure 29. Male Height Growth Increment Ratio* by Age for White Male School Children with Normal and Abnormal Visual Acuity and with Myopia, Official Schools, Lourenco Marques (Mozambique) 1961-63.



$$* \ \frac{H_2 - H_1}{H_1}$$

H_1 = Height 1962 (During 1961-62 School Year)
H_2 = Height 1963 (During 1962-63 School Year)

Figure 30

Height Increment Ratio* of White Male School Children by Visual Acuity and Age, Official Schools, Lourenco Marques (Mozambique) 1961-63

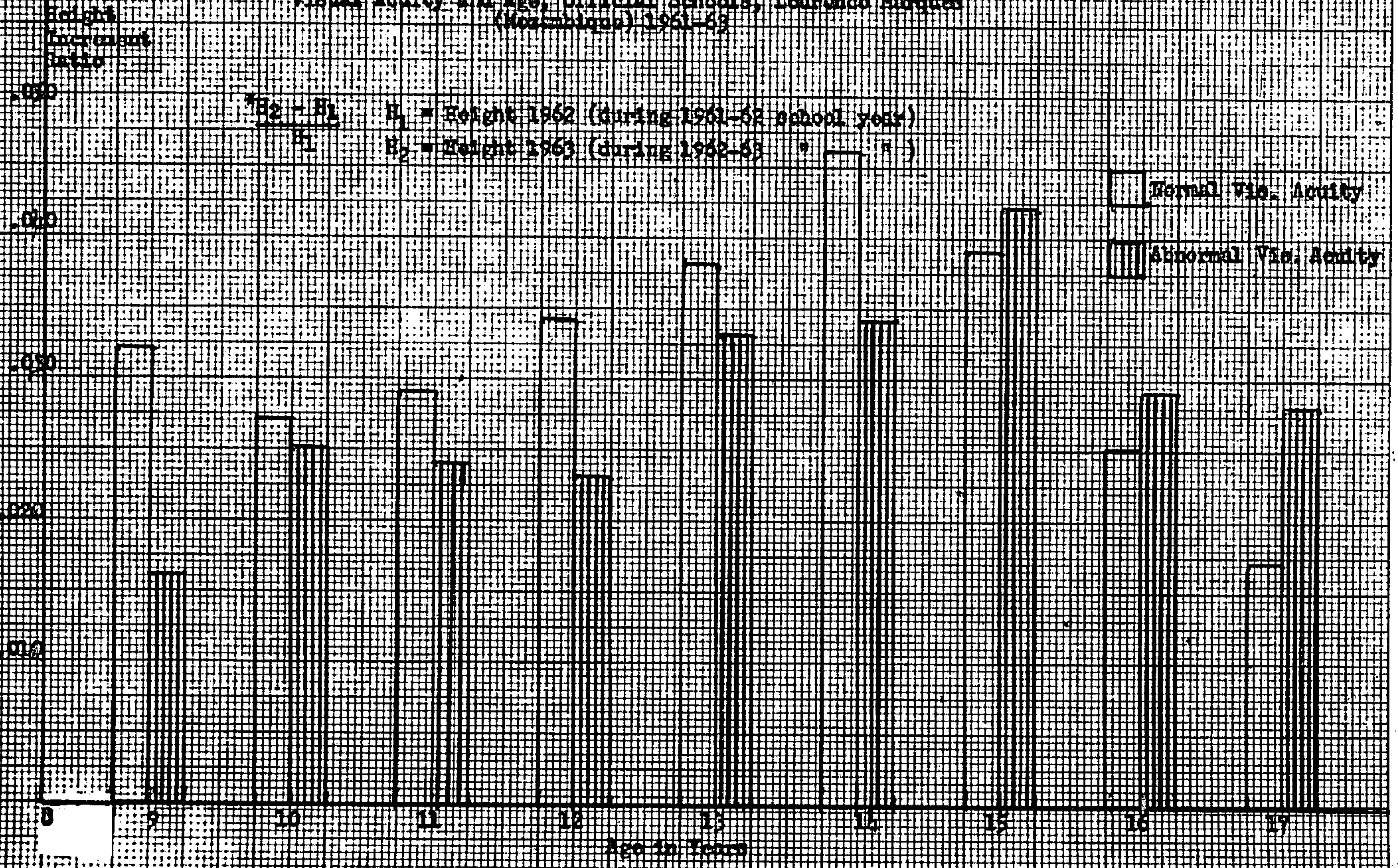


Table XVIII

Change in Visual Acuity on Two Consecutive Annual Determinations, by Height Increment for the Same Period, Male School Children, Official Schools, Lourenco Marques (Mozambique) 1961-63

	Visual Acuity on First and Second Determinations		
	Normal 1st Normal 2nd	Abnormal 1st Abnormal 2nd	Normal 1st Abnormal 2nd
Below or Equal to the Median Height Increment	866	67	16
Above the Median Height Increment	822	61	15

$X^2 = .099$ df = 2 x 1 = 2

X^2 = is not significant

Early (9-11), Middle (12-13) and Late (14-16). The percentage of girls in each menarchal group was determined separately for each vision group (Table XIX). These were:

	Normal Vision	Abnormal Vision
Early	36.7%	36.0%
Middle	59.2%	55.2%
Late	4.6%	8.7%

The pre-menarchal girls with normal and abnormal vision were then placed on the basis of chronological age in early, middle, and late maturing groups according to the above distributions. For example: There were 669 pre-menarchal girls 9 to 11 years old with normal vision. It was assumed that their future experience re. menarchal age would follow that of the girls who already had menstruated. Therefore, 36.7 per cent of them were considered to be early; 59.2 per cent middle; and 4.6 per cent late. Of the 226 pre-menarchal girls 12-13 with normal vision it was assumed that 92.8 per cent would menstruate between 12 and 13 and 7.2 per cent from 14 to 16. These percentages also were derived from the foregoing distribution. However, because girls 12-13 obviously could not be counted in the "early" group, they were divided in the same proportion as the middle and late groups of post-menarchal girls, e.g., 59.2/63.8 = 92.8 per cent and 4.6/63.8 = 7.2 per cent. All of the pre-menarchal girls 14-16 were included in the late maturing group. These tabulations are displayed in Tables XX and XXa.

As is shown in Table XX, the estimated and the real numbers of girls in each menarchal group were compared for normal and abnormal

Table XIX

Per cent of Menstruating Female School Children with Normal and Abnormal Visual Acuity by Age, Race and Age of Menarche, Official Schools, Lourenco Marques (Mozambique) 1961-62

Race	Age of Onset of Menarche	Normal Visual Acuity		Abnormal Visual Acuity	
		No.	%	No.	%
White	$9 - 9^{11}$	7	1.4	1	.5
	$10 - 10^{11}$	41	8.2	11	6.2
	$11 - 11^{11}$	132	26.4	50	28.2
	$12 - 12^{11}$	184	36.8	49	27.6
	$13 - 13^{11}$	111	22.2	50	28.2
	$14 - 14^{11}$	20	4.0	14	7.9
	$15 - 15^{11}$	2	.4	1	.5
	$16 - 16^{11}$	1	.2	0	0
Negro	$9 - 9^{11}$	2	3.5	0	0
	$10 - 10^{11}$	1	1.7	0	0
	$11 - 11^{11}$	6	10.5	1	5.8
	$12 - 12^{11}$	14	25.0	6	35.2
	$13 - 13^{11}$	20	35.0	5	29.4
	$14 - 14^{11}$	12	21.0	3	17.6
	$15 - 15^{11}$	1	1.7	1	5.8
	$16 - 16^{11}$	0	0	0	0
Mixed	$9 - 9^{11}$	2	1.8	1	3.7
	$10 - 10^{11}$	1	.9	1	3.7
	$11 - 11^{11}$	15	14.1	2	7.4
	$12 - 12^{11}$	33	31.1	8	29.6
	$13 - 13^{11}$	32	30.1	7	25.9
	$14 - 14^{11}$	16	15.0	5	18.5
	$15 - 15^{11}$	5	4.7	1	3.7
	$16 - 16^{11}$	1	.9	1	3.7
Indian	$9 - 9^{11}$	0	0	0	0
	$10 - 10^{11}$	2	2.8	0	0
	$11 - 11^{11}$	14	20.2	4	26.6
	$12 - 12^{11}$	29	42.0	3	20.0
	$13 - 13^{11}$	16	23.1	7	46.6
	$14 - 14^{11}$	6	8.6	0	0
	$15 - 15^{11}$	1	1.4	0	0
	$16 - 16^{11}$	0	0	0	0

Table XX

Estimated (M.E.)* and Actual (M) Menarchal Age of School Children, Official Schools, Lourenco Marques (Mozambique) 1961-62

Normal Visual Acuity

Age at Observation	Age of Menarche						Total	
	9-11		12-13		14-16			
	M.	M.E.	M.	M.E.	M.	M.E.	M.	M.E.
9-11	42	(242)	-	(396)	-	(31)	42	(669)
12-13	83	-	105	(210)	-	(16)	188	(226)
14+	54	-	190	-	23	(26)	267	(26)

Table XXa

Abnormal Visual Acuity

Age at Observation	Age of Menarche						Total	
	9-11		12-13		14-16			
	M.	M.E.	M.	M.E.	M.	M.E.	M.	M.E.
9-11	10	(25)	-	(39)	-	(6)	10	(70)
12-13	31	-	34	(16)	-	(2)	65	(18)
14+	20	-	65	-	15	(2)	100	(2)

*Note: These numbers do NOT represent observations but are estimates based on assumptions stated in text.

Table XX a

Visual Acuity by Hypothetical Menarchal Age,*
School Children, Official Schools,
Lourenco Marques (Mozambique) 1961-62

I. Under 12 years of age at observation

	Menarchal Status			
	Early	Middle	Late	
Normal Acuity	284	396	31	711
Abnormal Acuity	35	39	6	80
	319	435	37	791

$X^2 = 2.4718$, df = 2
$P(X^2 \geqslant X^2_o) \doteq .30$

II. 12-13 years of age at observation

	Menarchal Status			
	Early	Middle	Late	
Normal Acuity	83	315	16	414
Abnormal Acuity	31	50	2	83
	114	365	18	497

$X^2 = 11.87636$, df=2
$P(X^2 \geqslant X^2_o) < .01$

III. Over 14 years of age at observation

	Menarchal Status			
	Early	Middle	Late	
Normal Acuity	54	190	46	293
Abnormal Acuity	20	65	17	102
	74	255	63	395

$X^2 = .11081$, df = 2
$P(X^2 \geqslant X^2_o) \doteq .95$

*NOTE: These numbers do NOT represent observations but are estimates based on assumptions stated in text.

visual acuity in three chronological age groups. Chi square tests of significance were performed. In the chronological age group 12 to 13, the difference in distribution of girls with normal and abnormal visual acuity into the three menarchal groups was significant at $< .01$. In the other two age groups, no significant differences were observed between menarchal status of girls with normal and abnormal vision.

It is impossible to interpret the foregoing observations because of the invalidity of the assumption, that pre-menarchal girls (as defined in this study) will follow the menarchal age experience of post-menarchal girls (as defined in this study). A test of statistical significance under this circumstance has no meaning.

Another and more valid tabulation of data was made using only post-menarchal girls in the 12-13 age group at time of observation. The number of girls with normal vision who had menarche before 12 and after 12 was not statistically different (chi square test) from that in the corresponding girls with abnormal vision.

It must be concluded that no meaningful association was shown between menarchal age and visual acuity.

5. Association of Myopia and Height in Girls by Age, Menarchal Status and Race

As described in Section III of Methods (page 37), height weight values for each myopic girl were placed in relation to smoothed curves representing mean height and weight values for pre- and post-menarchal girls (Figures 31 and 32) and for these groups combined (Figures 33 and 34).

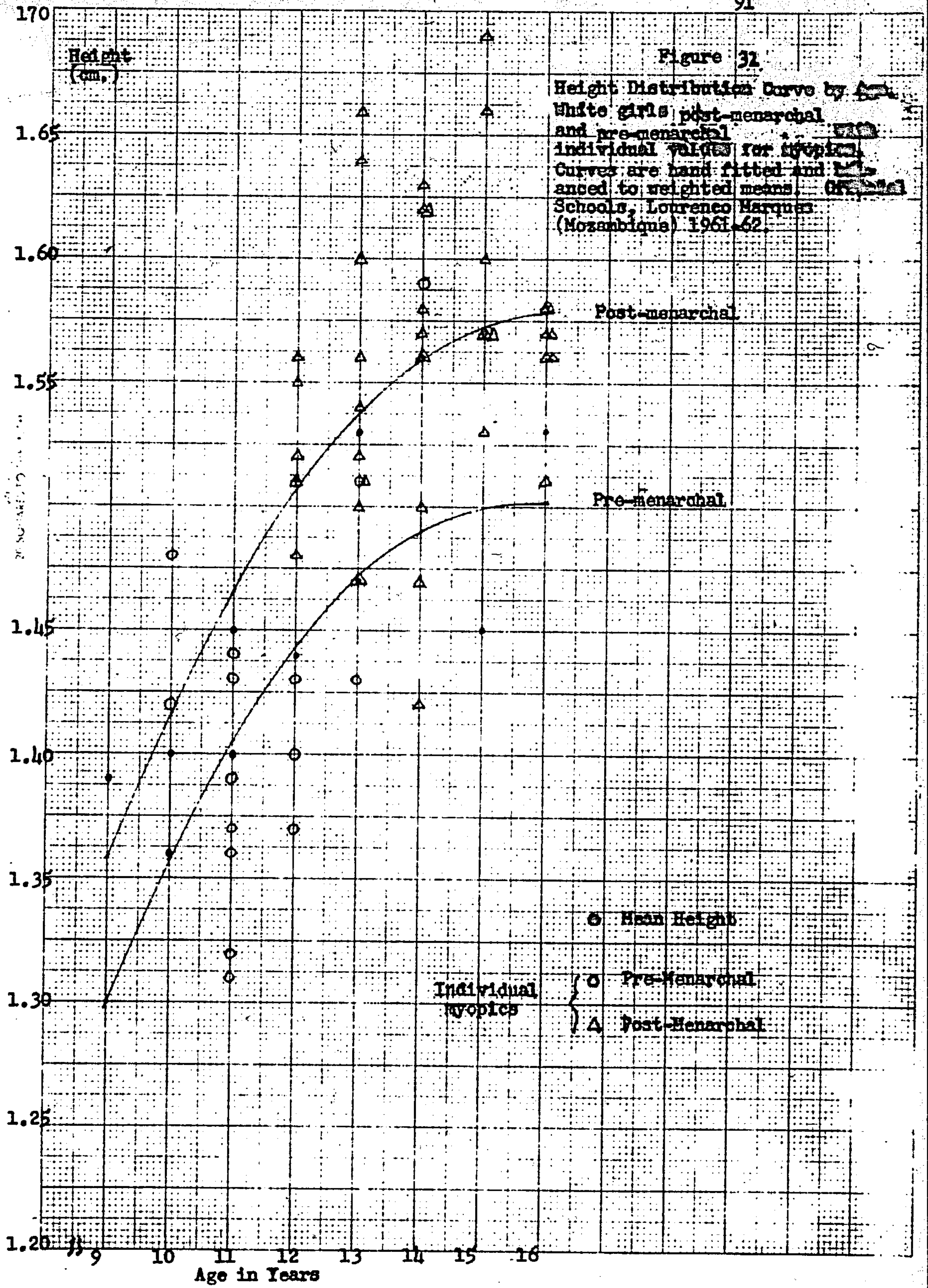


Figure 31. Height Distribution Curve by [illegible] White girls post-menarchal and pre-menarchal [illegible] individual val[illegible] for myopi[illegible] Curves are hand fitted and [illegible]anced to weighted means. [illegible] Schools, Lourenco Marques (Mozambique) 1961-62.

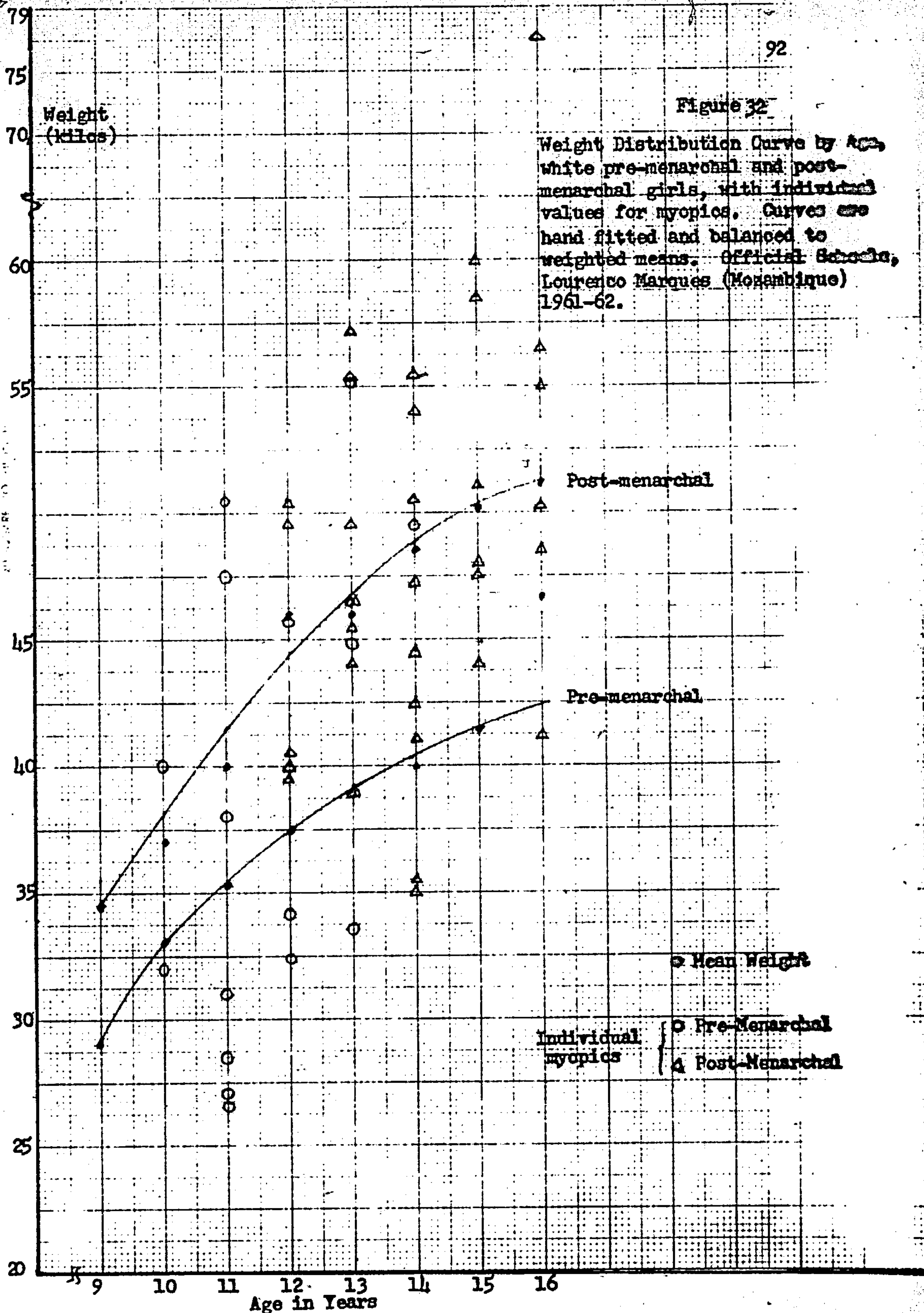


Figure 32

Weight Distribution Curve by Age, white pre-menarchal and post-menarchal girls, with individual values for myopics. Curves are hand fitted and balanced to weighted means. Official Schools, Lourenco Marques (Mozambique) 1961-62.

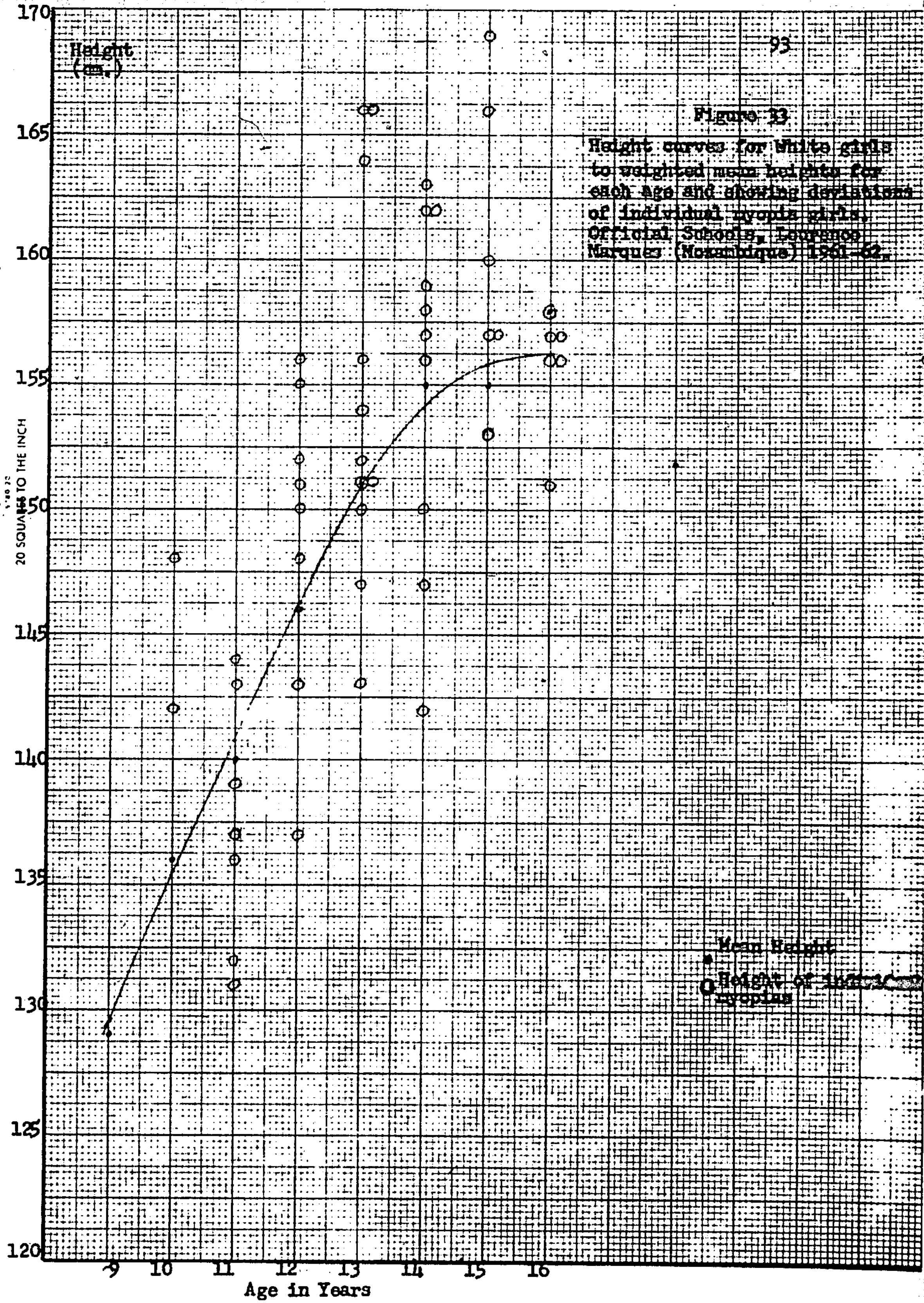


Figure 33

Height curves for White girls to weighted mean heights for each age and showing deviations of individual myopia girls. Official Schools, Lourenço Marques (Moçambique) 1961-62.

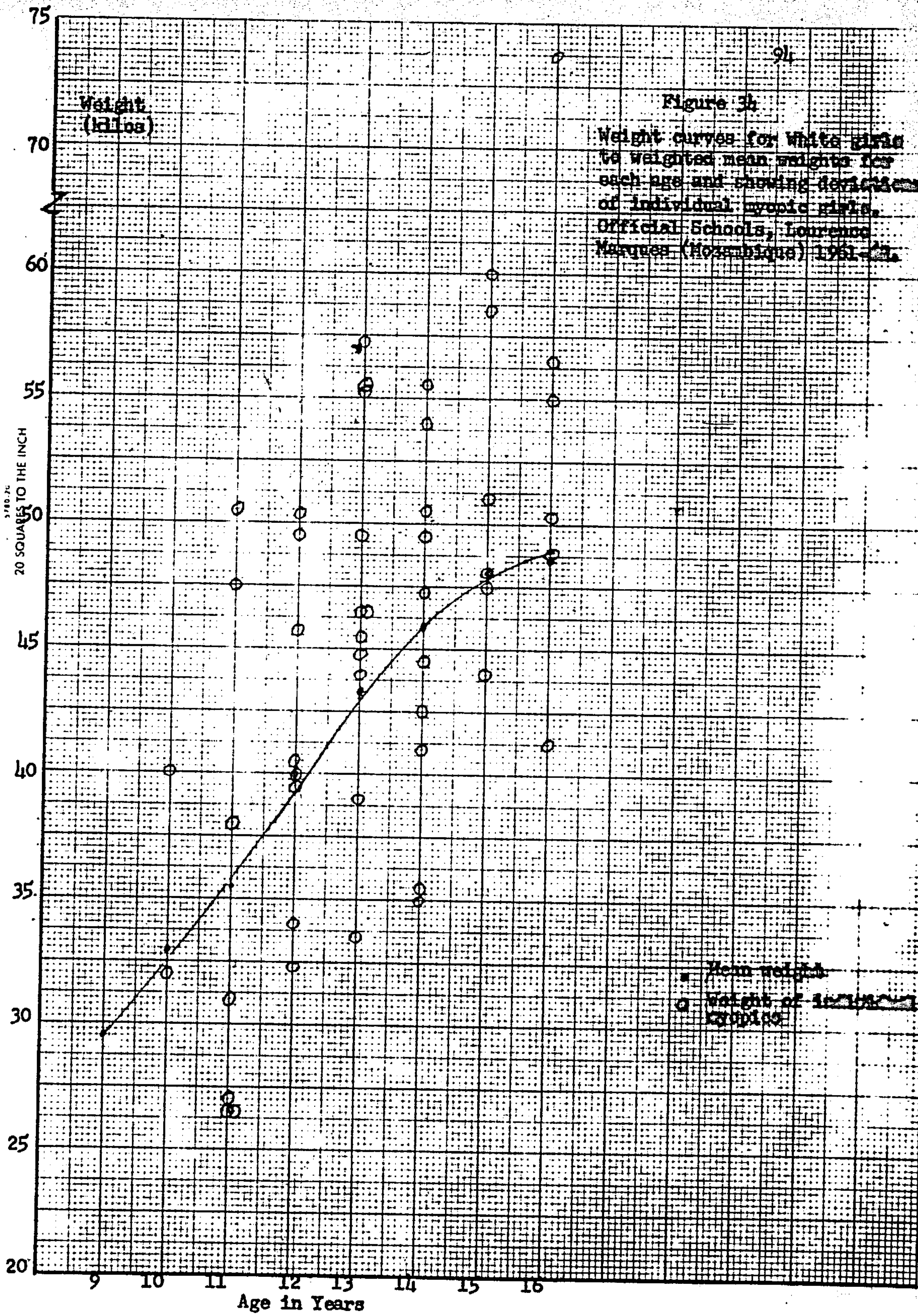


Figure 34

Weight curves for White girls to weighted mean weights for each age and showing deviations of individual myopic girls. Official Schools, Lourenco Marques (Mozambique) 1961-62.

The values used in the above figures are shown in Tables V, VI, and IIIa.

It is apparent that there was no significant difference between the pre- and post-menarchal groups of myopic and non-myopic girls in respect to height and weight. It would seem, then, that myopia was not related to height or weight when menarchal status was taken into account. When menarchal status was disregarded (Table XXIa) there still appeared to be no relation between myopia and mean height and weight.

A similar process was omitted for the non-Whites because of the small numbers of individuals in the non-White category. If one had sufficient observations for the non-White myopic individuals, a similar analysis could be made. (See Addendum, page 132.)

6. Myopia and Menarchal Age

The distribution of age at menarche of 35 White girls with myopia was compared with that of the remaining 674 White girls as follows:

Menarchal Age	Non-Myopic	Myopic
9	8 (1.7%)	0 -
10	52 (7.5%)	1 (3 %)
11	182 (26.2%)	5 (14.3%)
12	233 (33.5%)	13 (37.1%)
13	161 (22.4%)	11 (31.4%)
14	34 (6.1%)	5 (14.3%)
15	3 (1.2%)	0 -
16	1 (0.9%)	0 -

Nothing in this tabulation gives evidence to support an association between myopia and early menarche. The per cent post-menarchal

Table XXI

Average Deviations and Standard Deviations of Myopic White Girls from Curve Values of Height and Weight by Menarchal Status. Official Schools, Lourenco Marques (Mozambique) 1962

	Post-Menarchal	Pre-Menarchal
Height		
Average Deviation	+ .011	+ .0046
Standard Deviation	.0624	.0640
Weight		
Average Deviation	.323	- 1.067
Standard Deviation	7.47	8.16

Table XXI a

Average Deviations and Standard Deviations of Myopic White Girls from Curve Values of Height and Weight. Official Schools, Lourenco Marques (Mozambique) 1962

	Height	Weight
Average Deviation	4.018	+2.19
Standard Deviation	.0694	8.08

at given ages was compared for myopic and non-myopic girls. The expected number pre- and post-menarchal girls was determined for each age and race. Expected values were based on the total number of girls whether myopic or not, within each race and age group. The expected number of pre- and post-menarchal myopics and the number actually observed were summed for all ages and races. A chi square test was performed giving a value of .85 ($p = .35$), indicating no significant difference between the observed and expected values. It can then be inferred on the basis of this test that there is no relationship between the incidence of myopia and menarchal status.

7. Height Growth Increment Ratio, Myopic Males

Height growth increment ratio was calculated for each boy by dividing the two measurements of height taken in successive years by the height taken at the first year, i.e., $\frac{H_2 - H_1}{H_1}$. Means of height growth increment ratios were computed for boys with normal vision, abnormal vision and myopia in each age interval. In only the White race group were numbers adequate for analysis. The means for White boys were plotted as shown in Figure 29 and Table XVII. Although the values for myopics are based on small numbers (total number White males = 42), the mean height increment ratios of myopic children exceed those of children with normal visual acuity up to 15 years of age. Males with abnormal visual acuity, as previously noted, appear to have a later peak of height increment than either of the other groups.

The small numbers of observations in the myopic subgroups by age (e.g., the apparent peak between 10 and 11 years is based on only one observation) do not permit conclusions about differences of mean height increment ratio nor are they adequate for statistical analyses of these differences.

V. DISCUSSION

A. Limitations of Study

1. Size of Study Population

Initially, it seemed that the number of children observed (4831) would be more than adequate to test the hypotheses of this thesis. In retrospect, this was a naive assumption and was based on a belief that adequacy of subject numbers was an absolute quantity rather than a relative quantity dependent on the questions being asked. For purposes of this study it seemed essential that the study group be sub-divided by sex (2), race (4) and age (8 for female and 9 for male) since all of these variables had been demonstrated or suggested by other observers to be associated with measures of somatic growth, age of maturation and, possibly, with attributes of vision. Thus, there were 68 basic subgroups. When, then, the distribution of a particular variable, e.g., height, weight, visual acuity, etc., was determined by these subgroups, additional sub-categories were formed. The problem of small numbers was compounded by the fact that attributes such as normal and abnormal visual acuity were unequally distributed in the group — the number with abnormal vision being much smaller than that with normal vision. Thus, it became apparent readily that compromises must be made in order to obtain meaningful analyses of the data. In some instances subgroups could be combined, as was true in the instance of visual acuity where, arbitrarily, children with 1.0 (Monoyer) in each eye were considered normal and all others, abnormal. Such compromises, of course, sacrificed precision and may have obscured meaningful relationships. The alternative, however, was to maintain the subgroups and be faced with "cells" which had small or absent numbers. Combinations of subgroups were deemed unjustified in many instances, because knowledge provided by other observers indicated that these subgroups (e.g., age, sex, race) were critical to the problem being investigated. Although disregard of these variables would have enabled larger numbers to be available for analysis, the results would have been difficult to interpret. For example, at the critical period of adolescent somatic growth, it was deemed unwise to group children by age groups such as: (9, 10 and 11); (12 and 13); (14, 15 and 16).

2. Distribution by Age and Race

The numbers of children in the older age groups (above 14) available for study were considerably less than those in younger age groups. These small numbers in older age groups were a consequence of early discontinuation of school which in most cases was dictated by economic reasons. Also, distribution of children by race was quite unequal. For example, originally, five racial groups were identified, but one of these, the Chinese, had only 57 members and was eliminated from the study population. Of the remaining, White children were by far the most numerous (3195), the other races having the following distribution: Negro, 420; Mixed, 648; and Indian, 504. The race of seven children was not recorded. Since the study population represented the entire official school enrollment, this unequal distribution was not a problem of sampling nor could it be solved in any way except by bringing into the study school age children attending rudimentary schools. This latter category contained rather large numbers in the non-White race groups.

The small numbers in older children prevented, or made difficult, interpretations of late adolescent or post-adolescent changes in vision that might have been present. The small numbers of children in certain racial groups made it more difficult to make analyses of somatic growth patterns by race and of attributes of vision by race.

3. Representativeness of the Study Group

The study group is representative only of children attending the official schools of Lourenco Marques, Mozambique. As mentioned above, not all Lourenco Marques children in the different age and race categories studied attended the official schools. A few, usually of the White upper socio-economic groups, attended private schools while the remainder, usually non-White lower socio-economic groups, attended rudimentary schools. Personal knowledge of the author would suggest that the group attending and not attending official (government) schools might differ, perhaps markedly, in a number of variables including nutritional status and level of maturation by chronological age. If these attributes are in any way associated with vision, then the non-attenders of official schools might also vary in vision characteristics.

All children in the study, except those wearing glasses, received a visual acuity test by Monoyer at school. Of this group, those with vision less than 1.0 in each eye were referred to the eye clinic for further study. Not all referred children, as was reported here, attended the eye clinic. While it was possible to determine whether those children attending and those not attending differed in attributes such as race, age, sex, and visual acuity on screening examination, it was not considered justifiable to make inferences about the probable refractive status of non-attending children since refractive status was not directly associated with the foregoing attributes, including Monoyer visual acuity.

4. "Cross-sectional" Nature of Study

This study has the limitations associated with any cross-sectional study of growth and development. The time allotted to data collection did not permit any other kind; but it is recognized that if relationships between somatic growth and changes in visual acuity and refraction exist, they would have the greatest chance of being detected in a longitudinal rather than across-section study.

5. Weight Increment

As mentioned earlier in this thesis, an unforeseen finding was that of weight increments with a negative value. In retrospect, this should have been predicted and additional data collected on boys so that characteristics of the group with weight loss might be identified. As was explained previously, the coexistence of weight gain and loss required that boys with each be treated separately (in which instance the numbers of boys with weight loss were not large enough to permit analysis by the various subgroups of this study), or that boys with weight gain or loss be considered together (in which instance the effect of both would be obscured when means for the subgroups were determined). Thus, data on weight increment were considered unusable in this study.

6. Menarchal Age

The difficulties inherent in a cross-sectional study were most evident in the instance of determinations of menarchal age. Because not all girls in the study had passed the menarche, it was not possible to determine accurately a mean menarchal age for the entire group. The members of the group of girls 15 and older had in almost every instance achieved the menarche, but the number of girls in the 15-year and 16-year age groups (especially in the different race subgroups) was small and not sufficient for analyses in relation to other variables. Mean menarchal ages for all girls already menstruating were determined, but it was recognized that such a determination was biased in favor of early menstruating girls -- they being the only members of the younger age groups represented in such a statistic. The assumption that experience of post-menarchal girls could be applied to pre-menarchal girls (as defined in this study) was invalid and analyses based on this were not interpretable.

7. Children Wearing Glasses

Another limitation of the study was the failure to measure the Monoyer visual acuity of children wearing glasses at the time of examination. The routine practice in vision screening tests within the Lourenco Marques schools is not to screen children wearing glasses and this practice, because the problems which it would create were not foreseen, was not altered during the collection of data for this study.

The omission of Monoyer visual acuity of children wearing glasses was a serious one. Because of it, it was not possible to determine the distribution of degrees of reduction of visual acuity of children in the various age, race, maturation and sex categories. Fortunately, data were available on the refractive status of these children so that for certain analyses they could be included.

8. Reliability of Observations

Data were collected by health visitors in the various study schools. Although the procedures for determining visual acuity, height, weight, and menarchal status were outlined in written instructions such as those included in the Appendix of this report, in all probability there was variation among different observers and perhaps with the same observer at different times. No duplicate observations were made at any time. These should have been made. It is not possible to determine whether this omission was serious for the purposes of this study, but previous experience with collection of these data would suggest that duplicate determinations probably would have been in close agreement.

Eight ophthalmologists performed the refractions on children attending the eye clinic. There was no evidence that they differed greatly in the numbers of children they characterized as normal or abnormal, but no duplicate observations were made to determine interobserver or intraobserver reliability.

B. Interpretation of Findings

1. Measures of Growth and Development

a. Differences in Height and Weight by Sex and Age. As would have been expected from the observations of others in the field of growth and development, there were differences in the heights and weights of boys and girls at different ages. In general, in all races, there was a tendency for boys to be taller and heavier than girls in both the youngest and oldest age groups. In the age period of 11 through 13, there was a tendency for these measures either to be about equal in the two sexes or, in the case of weight, to be greater in the female than the male. This latter relationship is clearly shown for females in both Negro and Mixed race groups. The tendency of girls to equal or exceed boys in size in the 11 through 13 year age period is a reflection of the earlier adolescent growth spurt in females. After 13 the growth spurt of the boys restores the previous relationship of greater size in males than females.

Post-menarchal females at all ages were taller and heavier than their pre-menarchal age mates. These findings, also, were in agreement with those of other observers and supported the assumption that height and weight at a given chronological age were associated with level of maturity.

A sharp "spurt" in mean height or weight was not evident at any age in either sex in any of the race groups. Lack of its demonstration does not mean that it did not occur in most or all members of the study group. Instead, this finding almost certainly results from the cross-sectional technique employed in this study which, at a given age, tended to balance the "spurts" of early maturers with the slow changes of average or late maturers; and in addition the spurt of late maturers is obscured by the slowdown of the early maturers — thus giving means which, while increasing steadily from year to year, never increased sharply.

b. Racial Differences in Height, Weight, Age of Menarche, and Height Increment Ratio. As mentioned previously, interpretation of age and race differences in height and weight was limited by the small numbers of children in some subgroups. White children generally were taller and heavier at almost every age than were children of other races. When numbers were adequate for statistical tests of significance, the differences in mean height and weight between White and Negro children usually were significant at levels of .01 or less. Indian children also usually differed from White children and sometimes also from those of other races in respect to having a lower mean weight at given chronological ages.

No other consistent differences of mean heights and weights between other racial groups were noted although levels of statistical difference of .01 or less were found sometimes for differences in mean heights and/or weights of children of two races at a certain age. Because these differences did not also exist for age levels immediately above or below and because there was no ready biological explanation for differences occurring at a single age, these relationships were not considered biologically significant. The occurrence of these "unpatterned" statistical differences in mean heights and weights of different racial groups at different ages was attributed to the possible atypicality of the selected sample and the variation (or range) of these measures within given age-race subgroups which, with the sample sizes used, led either to distortions of the means (false indication of true differences) or failure to identify true existing differences. Since statistical significance is a reflection of mathematical probability, the more associations of variables that are made, the more likely that one or more of these will show "statistical significance" on the basis of chance alone. Perhaps this fact accounted for one or more of the "unpatterned" findings of statistical significance.

The difference in sizes of White children and those of other races possibly could be explained on the basis of genetic differences or variations in nutritional and health status. This study was not designed to determine the cause of these differences. However, other observations of this study such as the low height increment ratio in certain early age groups of Negro males and the low percentage of 12 and 13 year old post-menarchal Negro girls would suggest that, at least in the Negro, these differences are a reflection of slower maturation. Slow maturation often is the result of poor nutrition and/or illness, and the personal experience of the author is that Negro children in Lourenco Marques are more often (and White children less often) poorly nourished and chronically ill than those of other races. Although the study does not include observations of older children and young adults, the personal impression of the author is that adult Negroes are neither shorter nor lighter in weight than adults of other races in Mozambique. This latter observation would tend to support the suggestion that differences are on the basis of nutrition and physical health (and consequent differences in maturation rate) rather than genetic in nature. Such a hypothesis would be in agreement with the observations of Roberts (1960)[29] who noted that Southern Sudan Negroes attained their adult stature at a later age than did London school children.

In the instance of Indian children, it was noted that they did not differ significantly in height from their non-White peers but did so in respect to weight. Again, personal knowledge of the author of the slender bone structure of mature and even well-to-do Indians suggests that this difference may have a large genetic component.

When the percentage of post-menarchal girls at a given chronological age was determined, White girls had higher rates than girls in other races at ages up to 14, while Negro girls had noticeably lower rates up to age 15 than did girls in other races. This apparent later onset of menarche may also be a reflection of poor nutrition and health as previously discussed. Partial support for this suggestion may be given by observations (Michelson, 1944)[34] that the menarchal age of Negroes in certain cities of the United States (whose health and nutritional status are presumed good) is similar to that of White children.

Negro males in the younger ages had the lowest height increment ratios of any of the racial groups. This observation, as was that of their lower height and weight at all ages, again was considered explainable by their slower maturation rate which possibly was a reflection of poor nutrition and health.

2. Visual Acuity

The higher rates of normal visual acuity shown for males in this study in comparison to females is consistent with observations made by Sorsby, Brown, and Slataper. There are no ready explanations for this sex difference. Krogman, in reviewing the work of Scammon and Todd, suggested that this might be an expression of the greater relative size of the female than the male eyeball. Sorsby and coworkers demonstrated that the net refractive change with growth was greater in the eyes of females than males. However, this latter is a description of the change in visual acuity rather than an identification of the underlying cause of it.

The findings of this study in respect to age and race differences in visual acuity, while present and generally in the relationship anticipated, were not as marked as had been suggested by the observations of Slataper (1950),[10] Brown (1938),[9] Sorsby (1961),[8] and Hirsch (1954).[30] Their studies indicated that ocular refraction in the vertical meridian declined with age and that this decrease with age was orderly and pronounced. While there was a general tendency in the various racial groups (more pronounced in females than males) for older children to have lower percentages of members with normal vision, this tendency was neither orderly nor pronounced.

Studies of Karpinos (1960)[13] of the differences in distant visual acuity of Negro and White army recruits directed our attention to the visual acuity of Negro and White boys in this study. In general, visual acuity of Negro boys was superior to that of White boys but the differences were not as great as would have been suggested by the findings of Karpinos. It is possible because of the older age of the group studied by Karpinos that it is not comparable with the present study group. The findings of better visual acuity in Negroes than Whites possibly might be explained by the apparent slower maturation rate (poorer nutrition and health) of Negroes and its possible relationship to defects in visual acuity with maturation. Binning (1958),[35] in his study of Saskatoon school children, noted that malnourished children had better visual acuity and fewer refractive errors than did well nourished children. Differences in visual acuity between Negroes and Whites might also be on a genetic basis (eye structure, growth characteristics). Studies of Karpinos[34] on army inductees in the U.S.A. suggest that a genetic etiology might be responsible, at least in part, for these differences if one assumes that the Negro and White inductees were of comparable health and nutritional status.

It was hoped, originally, that this study would provide information on the annual increment of new vision defects so that a school program might be designed with optimal periodicity for the vision screening tests. Visual acuity determinations in two consecutive years were made for 2176 males. Males wearing glasses at the time of the first examination were excluded from these determinations. Of the group tested, 92 per cent were normal on the first examination and approximately two per cent (41 boys) of these converted to abnormal at the time of the second test one year later. Simultaneously, approximately half this number (22 boys) converted from abnormal to normal visual acuity. Of the previously identified children with abnormal visual acuity, half had visual acuity one year later that was equal to or better than that at the first examination, and half had a decrease in visual acuity. Because there were only about 200 boys in the abnormal visual acuity group (and only 41 newly identified on the second examination), it was not possible by age and race to determine incidence of new abnormalities. However, these observations suggest that the annual increment of new defects in visual acuity in these boys is not high but that there are considerable changes in degree of visual acuity as measured by screening test in school in the boys already identified as having abnormal visual acuity. Such observations are not sufficient for recommending that the present program of annual screening be changed. However, they do suggest that it would be profitable in devising such a screening schedule to think separately about children previously having been identified as abnormal and those not previously so identified. In the former group it might be expected that annual testing would have a high yield of patients with changed status whereas with the latter group, annual testing might not be necessary because of the small increment of new cases. Further study (i.e., larger numbers of cases) would be necessary before such a decision would be made. One important determination would have to be the nature of vision defect in the newly detected cases. If these defects were mild, it would reinforce a decision to make periodic testing at longer intervals. If they were severe, it would support a decision to test annually or more frequently.

3. Diagnosis on Refraction

As previously noted, it was not considered justifiable to make inferences about the possible refractive status of children who had received a screening examination but did not subsequently attend the eye clinic. Therefore, conclusions drawn from these data in respect to age, sex, or race differences must be guarded. The increase in refractive errors with age that observers such as Slataper and Brown have reported were not seen in either the White or the Indian racial groups but were seen in the Negro and Mixed groups. The author has no explanation of why the White did not show the anticipated increase in refractive errors with age. However, in the case of the Indian children, this may have been the result of limited numbers of observations. The White and Indian children did show the transition with age from predominantly hyperopic refractive errors to myopic ones that has been described by Slataper and Sorsby. These changes, according to Sorsby, are the result of growth in the sagittal diameter of the eyeball without corresponding compensatory changes elsewhere in the ocular system.

The virtual absence of myopia in Negro children and the preponderance of hyperopic refractive errors in the Negro and Mixed racial groups was of interest. Since both the White and Indian groups contained children with hyperopia, it was not apparent from the data of this study whether absolute rates for hyperopia were greater in Negroes or whether the predominance of this refractive error was apparent because of the absence of myopia. The previously referred to inability to arrive at a reliable denominator for refractive errors accounts for this difficulty. Post (1962)[14] noted that Orientals had higher rates of hyperopia than did Caucasians. It is presumed that racial differences in refractive errors have an important genetic component but until groups can be equated by the important factors of nutrition and rate of maturation, these latter factors can not be excluded as accounting for all or part of these findings. Gardiner (1958)[12] and Binning (1958)[35] have reported a positive relationship between myopia and nutritional status.

4. Association of Measures of Growth and Development with Attributes of Vision

a. Visual Acuity. The failure to demonstrate important differences of mean height and weight at given ages of children with Monoyer visual acuity of 1.0 in each eye and of all other children may indicate that visual acuity is not related with these variables or it may indicate that the division into "normal" and "abnormal" vision groups was not made correctly. Perhaps the definition of "normal" visual acuity should have extended to 0.9 or 0.8 (Monoyer) in the worst eye of the tested child. It is definitely possible that the "abnormal" group as constituted for this study included a number of children who should have been considered normal, e.g., had 0.9 acuity in only one eye and 1.0 in the other eye and 1.0 binocular. The inclusion of any sizeable number of children in this category into the abnormal group could have obscured differences from the normal if they existed. However, the problem here as elsewhere in the study was of adequate numbers in the subgroups. Inclusion in the normal visual acuity group of children with 0.8 and 0.9 (Monoyer) in the worst eye tested would have reduced the numbers in the abnormal group still further and made comparisons between it and the normal group in various age, race, sex categories more difficult. Even as the groups were divided, it was possible to make statistical tests of significance only for White children.

Height increment ratios of boys judged to have normal and abnormal visual acuity strongly suggested that boys with normal vision were having their height "spurts" (i.e., maximum increments of linear growth) at an earlier age than boys with abnormal visual acuity. This finding is contrary to the one expected -- that maturation and abnormalities of visual acuity are directly associated. There may be at least two explanations for the findings of this study, neither of which can be tested satisfactorily by the present data. The first, which already has been mentioned, is that the normal and abnormal groups were not defined in such a way as to truly distinguish normal and abnormal -- the 0.8 and 0.9 (Monoyer) more properly being considered normal than abnormal. The second is that deficiency of visual acuity can be accounted for by a number of refractive errors only some of which are associated with maturation. This latter possibility is discussed later in relation to the association of myopia and height increment ratio shown in this study. Another possibility is that the findings of this study represent a true relationship between onset of maturation and of visual acuity. This latter possibility is most unlikely since it would be at variance with observations of Brown, Hirsch, Slataper and others on the relationship between maturation and deficiencies in visual acuity.

There did not appear from this study to be a statistically significant relationship between menarchal age and visual acuity. The finding was in agreement with the report of Sorsby *et al.* that "there is nothing to suggest that early menarche -- and presumably early puberty -- tends to precipitate undue axial elongation."

b. Refractive Errors. The findings of this study support the hypothesis that myopia is associated with early maturation in males. The mean height increment ratios for White males who were myopic exceeded those of the remainder of White males. This would suggest that whereas boys with abnormal visual acuity had a later peak of height increment than those with normal visual acuity, a subgroup of the abnormal (the myopics) showed an opposite relationship. One would infer from the studies of Sorsby *et al.* that this relationship of myopia and maturation was an outcome of increase in the sagittal diameter of the eye without corresponding change in the other structures. These findings also agree with those of Gardiner (1954)[11] who found a positive association between growth rate and myopia.

Contrary to the observations of Gardiner and Binning and in accord with those of Sorsby *et al.*, this study did not show an association between myopia and measures of maturation in White girls (the only group with large enough numbers to study). The mean heights and weights, menarchal age, and per cent menstruating at a given chronological age did not differ between myopic and non-myopic White girls. These findings were unexpected since the author's clinical observations had led her to consider that myopia and early maturation were associated. Perhaps in studies where such associations appeared to exist, maturation and myopia rather than being directly related to one another were each related to a third factor such as nutrition. (Gardiner has documented a relationship between nutrition and myopia.) In such an instance, for example, malnutrition possibly could both/delay maturation and slow the growth of the eyeball, thereby delaying the emergence of myopia. In this study, the population of White girls was relatively homogeneous in respect to nutrition so that if such a factor was important, it did not have an opportunity to express itself.

The problem of the relation of myopia and maturation obviously needs further study. The numerous racial groups and the highly varied socio-economic status of different portions of the population of Mozambique furnish suitable subjects for further study of the relationship of myopia to race (genetic aspects), nutrition, and maturation.

C. Other Studies Suggested

As with most studies, this one suggested more questions to be investigated than it answered. In addition, it was obvious that some of the questions which this study was supposed to answer were not answered, due to limitations in the number of subjects with certain characteristics and to faults in study design and data collection.

If this study were to be repeated, the following changes would be made. Visual acuity of children wearing glasses would be determined by the Monoyer test. An attempt would be made to obtain observation on all children in Lourenco Marques between the ages of 9 and 16 whether in official school or not. Duplicate observations would be made on a subsample of the study population to determine the reliability of the methods used. The subject of menarchal age would be investigated by questioning girls 15 through 18 in Lourenco Marques. This latter group could be expected to have passed the menarche and yet be of an age probably to reflect the current pattern.

Related studies which are suggested include a longitudinal study of somatic growth of male and female school children of different racial groups in relation to their visual acuity and refraction status. Similar studies might be made within racial groups according to body type. If differences are found by race, some of these might be due to genetic differences and might be studied with interest in the "Mixed" racial group which is comprised of hybrids of various races. Francois (1961)[36] has stated "Ocular refraction, like skin color, is an example of polymeric or plurifactorial inheritance. In Negroes black skin color is due to the additive action of two dominating genes carried by two different chromosomes whereas the white color of the Caucasian is linked to the additive action of two similar recessive pairs of genes."

If large enough numbers were available, studies might be made of family patterns of visual acuity and refraction status. (In this study there were observations on siblings, but their number was not sufficient to warrant analysis). Because children residing in Lourenco Marques and in the rural areas of Mozambique have different health problems and nutritional status, these two groups might be compared in a study of somatic growth and vision.

Finally, this study suggests that a number of characteristics such as illness (amount and kind), dental growth and development, hearing, exercise tolerance, etc., could be investigated in the different racial groups present in Lourenco Marques or elsewhere in Mozambique.

VI. CONCLUSIONS

This thesis tested the hypothesis that visual acuity in children is influenced by factors which also display themselves in the child's pattern of growth and that evidence of such can be obtained by demonstrating associative relationships between visual acuity and maturational characteristics of children.

In the main, the hypothesis was not supported when Monoyer vision test results and diagnosis of selected children on refraction were taken as indices of visual acuity and when height, weight, menarchal age, height increment, and height increment ratio were taken as measures of maturation.

When children were divided into a group with 1.0 (Monoyer) visual acuity in each eye (defined as normal) and those whose visual acuity was less (defined as abnormal):

a) There was no difference in the mean heights and weights of these two groups in any age, sex, or race category.

b) There was no significant difference in age of menarche in members of these two groups.

c) There was no significant difference in males in increases in height in a one-year period between members of these two groups.

d) There was a greater height increment ratio up to age 14 in the male normal visual acuity group than the abnormal visual acuity group; the relationships being reversed after that age.

When children with refractive diagnoses of myopia were compared to all other children:

a) The heights and weights of White myopic females did not differ significantly from mean heights and weights of their non-myopic age mates.

b) The mean menarchal age and the percentage post-menarchal at different ages of White myopic children did not differ significantly from those of White non-myopic children.

c) The height increment ratio of White male myopics was greater at all ages than for White male non-myopics.

Thus, the only growth measure associated with visual acuity in this study was the height increment ratio. It was higher in White males with normal Monoyer visual acuity and in White males with myopia than it was in White males with abnormal visual acuity but without myopia. No inferences were made from these observations.

Two additional conclusions, not related to the hypothesis tested, were:

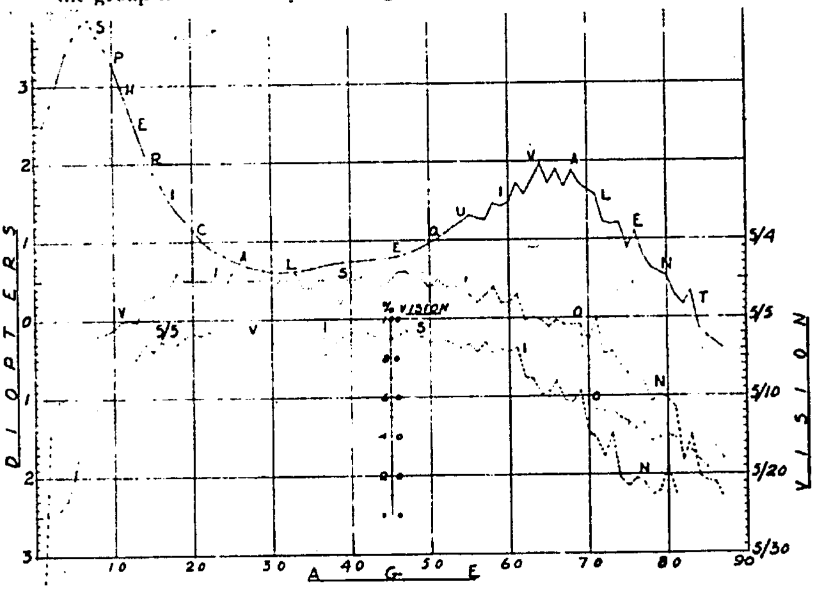
a) That testing of children previously found to have normal visual acuity may be done with less than yearly frequency because of the low yield (2 per cent) of new cases on annual testing; but that annual testing of children previously found to have abnormal visual acuity is worthwhile because it reveals changes in half the subjects.

b) That a screening level which includes 0.9 (Monoyer) as "abnormal" yields an appreciable number of children (19 per cent) with refractive errors.

- v. 43, pp. 470-471, 1950.

Brown used compilations of 8,104 eyes of patients of ages from 1 to 30 inclusive, as shown in table 1. Since he had many more patients from 1 to 6 years of age than I, I include his statistics for ages from 1 to 10 years, which give a better over-all picture of the age variations for these years.

It will be noted that his annual age variations are very close to mine, the difference being ± 0.038 D. Hence, in table 1 I have given the averages of our two figures for each of the first ten years of life. My table 2 and graph (chart) include the cases from Brown's statistics for the group from 1 to 10 years of age (table 2).



Age norms of refraction and vision.

For the years (below 11) for which my statistics were weak, Brown [3] had many more cases. For the group below 11 years of age, he had a total of 3,138 eyes and I had 1,062 eyes, the total being 4,200 eyes.

Age Norms for Spherical Equivalent Refraction.—The four types of age variations from the average of + 2.32 D. at birth are tabulated:

Hypermetropia of early childhood	Birth to 7 yr.	+ 1.617 D.
Axial myopia of the young	8 to 30 yr.	— 3.327 D.
Hypermetropia of middle age	31 to 64 yr.	+ 1.362 D.
Senile myopia	65 to 87 yr.	— 2.367 D.
These values are shown in the graph		± 8.673 D.

Table 2.—*Age Norms of Refraction and Vision*

Age	Spherical Equivalent, D.	Annual Age Variation, D.	Number of Eyes	Vision	Number	Percentage with 20/20 Vision
0	+2.320	....	...	.....	...	..
1	+2.406	+0.176	16	5/35 (estimated)	...	..
2	+2.830	+0.334	103	5/12/1	7	..
3	+3.213	+0.383	209	5/10.4	59	3
4	+3.503	+0.290	291	5/9.9	92	8
5	+3.731	+0.228	571	5/8.2	115	22
6	+3.895	+0.164	467	5/6.7	207	44
7	+3.937	+0.042	556	5/6.4	261	52
8	+3.778	—0.159	609	5/6	350	56
9	+3.610	—0.168	757	5/5.8	318	61
10	+3.355	—0.255	638	5/5.6	309	69
11	+3.088	—0.207	234	5/5.1	278	75
12	+2.789	—0.299	480	5/5	206	78
13	+2.483	—0.306	464	5/5.2	221	81
14	+2.191	—0.292	492	5/4.7	255	86
15	+1.935	—0.256	504	5/4.7	243	84
16	+1.768	—0.167	510	5/4.6	258	89
17	+1.574	—0.194	480	5/4.6	301	87
18	+1.425	—0.149	450	5/4.4	270	88
19	+1.290	—0.135	466	5/4.5	384	91
20	+1.152	—0.138	486	5/4.5	319	93
21	+1.035	—0.117	510	5/4.5	367	92
22	+0.949	—0.086	554	5/4.5	387	94
23	+0.869	—0.080	520	5/4.5	337	92
24	+0.806	—0.063	536	5/4.6	412	91
25	+0.754	—0.052	562	5/4.4	419	92
26	+0.719	—0.035	552	5/4.4	361	92
27	+0.683	—0.036	570	5/4.5	370	91
28	+0.651	—0.032	608	5/4.5	410	91
29	+0.626	—0.025	634	5/4.5	400	91
30	+0.610	—0.016	648	5/4.6	386	88
31	+0.603	—0.007	666	5/4.5	306	89
32	+0.606	+0.002	702	5/4.5	284	93
33	+0.617	+0.012	708	5/4.4	320	92
34	+0.629	+0.012	702	5/4.6	332	89
35	+0.647	+0.018	712	5/4.6	367	87
36	+0.662	+0.015	754	5/4.5	289	88
37	+0.687	+0.025	726	5/4.5	283	93
38	+0.707	+0.020	762	5/4.5	354	88
39	+0.721	+0.014	702	5/4.5	287	91
40	+0.730	+0.009	800	5/4.5	308	93
41	+0.744	+0.014	782	5/4.5	354	93
42	+0.750	+0.006	722	5/4.4	411	93
43	+0.756	+0.006	728	5/4.5	428	91
44	+0.762	+0.006	718	5/4.6	372	91
45	+0.778	+0.016	714	5/4.5	387	89
46	+0.799	+0.021	708	5/4.4	311	93
47	+0.828	+0.029	712	5/4.4	235	94
48	+0.864	+0.036	663	5/4.5	299	90
49	+0.900	+0.045	614	5/4.5	218	91
50	+0.962	+0.053	582	5/4.6	276	88
51	+1.022	+0.060	508	5/4.5	181	89
52	+1.093	+0.071	452	5/4.6	193	89
53	+1.168	+0.075	412	5/4.6	107	87
54	+1.237	+0.069	378	5/4.6	108	85
55	+1.306	+0.069	350	5/4.7	129	87
56	+1.286	—0.020	375	5/4.8	112	83
57	+1.253	—0.033	363	5/4.7	87	88
58	+1.468	+0.215	300	5/4.6	129	82
59	+1.439	—0.029	274	5/4.8	94	84
60	+1.478	+0.039	231	5/4.8	84	83
61	+1.722	+0.244	187	5/4.7	89	85
62	+1.583	—0.139	304	5/5.2	97	70
63	+1.708	+0.185	135	5/5	79	69
64	+1.972	+0.204	118	5/5.2	78	61
65	+1.720	—0.252	105	5/5.6	84	62
66	+1.896	+0.176	88	5/5.2	50	68
67	+1.683	—0.213	63	5/5.4	83	56
68	+1.879	+0.196	106	5/5.4	43	57
69	+1.715	—0.164	80	5/5.4	60	63
70	+1.632	—0.083	112	5/6.4	100	42
71	+1.574	—0.058	72	5/6	62	38
72	+1.215	—0.359	153	5/7.2	72	29.5
73	+1.201	—0.014	144	5/7.2	58	41
74	+1.211	+0.010	124	5/8.1	56	18
75	+ .899	—0.314	116	5/8.6	100	14
76	+1.105	+0.206	73	5/8.8	36	18
77	+0.789	—0.316	44	5/9.1	28	16
78	+0.639	—0.150	36	5/10.8	18	9.5
79	+0.577	—0.062	40	5/9.9	20	12
80	+0.537	—0.040	24	5/10.4	12	24
81	+0.298	—0.249	16	5/11.5	8	10
82	+0.164	—0.134	8	5/18.2	4	..
83	+0.347	+0.183	20	5/15	10	..
84	—0.125	—0.482	8	5/20.1	4	..
85	—0.230	—0.104	8	5/20.9	4	..
86	—0.311	—0.078	8	5/21	4	..
87	—0.395	—0.084	8	5/23	4	..
			34,570		17,386	

ESCALA TIPOGRÁFICA DECIMAL DO DR. MONOYER

Estabelecida para a . stância de CINCO metros
e dando a acuidade da sta V em DÉCIMOS da unidade

d = 5 metros

Δ = 5 $\frac{d}{\Delta}$ = V = 1,0

M R T V F U E N C X O Z D

5,55 0,9

D L V A T B K U E H S N

6,25 0,8

R C Y H O F M E S P A

7,14 0,7

E X A T Z H D W N

8,33 0,6

Y O E L K S F D I

10 0,5

O X P H B Z D

12,50 0,4

N L T A V R

16,66 0,3

O H S U E

25 0,2

M C F

50 0,1

Z U

APPENDIX 3

Sample Circular for the Orientation of School Personnel (School-Health Visitors and Teachers) to Determine Visual Acuity

Visual acuity is evaluated by making the testee read the optometric scale (here, the Monoyer scale) at a distance of 5 m. Before making the test, the following procedure for measuring acuities should be followed.

The acuity of each eye has to be evaluated separately. If the child is able to distinguish the smallest letters of the first line, the visual acuity of the eye examined is said to be 10/10; if he can only distinguish the last line, acuity is 1/10; if he reads the last two lines, acuity is 2/10, and so on.

If the child has an acuity of 10/10, he has a normal acuity and we can be satisfied with this result <u>unless he complains about any of the following disturbances</u>:

a) frequent headaches, especially when reading, writing or engaging in any work that requires prolonged fixation;

b) momentary clouding of vision under the same circumstances;

c) burning eyes;

d) watering eyes;

e) his eyes fatigue readily;

or if the teacher observes:

1) bloodshot or watering eyes;

2) very frequent blinking, especially when fixating;

3) that he winks his eyes while fixating;

4) that he closes one eye;

5) that he rubs his eyes often;

6) that he mistakes letters or transposes them;

7) that he reads very closely to the book or that he writes with his eyes close to the paper;

8) that he pays little attention during class-reading or during explanations made on the blackboard or on the map.

All these symptoms, we repeat, appear in children with normal visual acuity and can be symptoms of hypermetropia, which can only be diagnosed by an ophthalmologist and which requires permanent use of glasses or at least during fine work.

The fact that acuities in these cases can be normal is due to the tremendous capability of accommodation which the children display.

This examination gives us precise but limited information. For example, we can not verify the coordination and efficiency of the two eyes when they are jointly used, at a normal reading distance. However, there exist visual disturbances caused by lack of this coordination. For this reason, a visit to the ophthalmologist should be required of children who

a) have less than normal acuity (a tolerance of 8/10 for each eye and 9/10 for binocular vision is acceptable);

b) have normal acuities but display any of the described symptoms or others, related to the use of their eyes.

Reading the Optometric Chart

A room should be chosen which is sufficiently big to allow the placing of the optometric chart at one end and the child, sitting or standing, 5 m. distant at the other end.

Daylight should be eliminated as much as possible in order to employ mainly artificial light on the optometric chart. The sources of light should be shaded so that they cast light only onto the chart and not into the face of the child.

Any sources of light which could possibly interfere -- especially those which might lie within the visual horizon of the child -- should also be eliminated.

The chart must be hung so that its center is more or less level with the child's eyes.

As visual acuity tends to increase with an increase in light intensity and vice versa, it is necessary that greatest attention be paid to the lighting of the optometric chart.

A highly lighted chart makes reading easier. To obtain proper illumination of the chart that is not equipped with a special lighting frame, lights should be placed 1 m. from the plane of the chart and horizontally displaced 2 m. from the center line.

They should be level with the center of the chart. Pieces of white card (80 x 40 cm.) with the reverse side, i.e., toward the child, painted black or any other dark color, can be used as reflectors.

There should be only one child in the room where the measuring takes place.

The teacher should either stand beside the pupil or near the chart, pointing out with a rod the letters to be read by the child.

The child should be sitting or standing, with his eyes level with the center of the chart or at least not lower than the last reading rows.

If a chart for the non-literates is used, the child must point out with his hands in what direction the open ends of the "E" point, that is, downward, upward, or toward which side.

If the child has no defects regarding acuity he should be able to read all letters or to indicate the direction of all signs.

If the child reads the entire line and only fails at one or two letters, the reading of this line is considered correct.

The child must first read with one eye, then with the other, and finally with both eyes together.

The eye which is not to be tested can be covered by a thick piece of card, measuring 12 by 24 cm., which the child holds in place with one hand so that the eye is not pressed.

If the child uses glasses, visual acuity has to be evaluated first without glasses, then <u>with</u> glasses.

Before coming to the conclusion that a child is mentally retarded we have to determine if his lack of concentration and attention or his apathy (lack of excitement) are not due to bad vision or to bad hearing.

In the interest of the child's health and of the progress of the class, teachers should do their best to uncover these deficiencies by means of an examination.

The teacher should be persistent in urging parents to take the child to an ophthalmologist if this should be necessary; and if the doctor prescribes the use of glasses, the teacher should insist that the children use them while in class.

The teacher should also arrange for myopic children to sit in the places nearest to the blackboard and he should do his best to ensure that the class rooms are properly lit.

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ADDENDUM

The same discriminatory method described in Section III of Method (page 37) for the association of height and weight values for individual myopic White girls was used for White boys.

The average deviation and standard deviation of myopic White boys from curve values of height and weight are shown in Table XXII and Figures 35 and 36. There appeared to be no difference between mean height and weight of White males with and without myopia.

Table XXII

Average Deviations and Standard Deviations of Myopic White Boys from Curve Values of Height and Weight. Official Schools, Lourenco Marques (Mozambique) 1962-63

	Height	Weight
Average Deviation	.01	1.0
Standard Deviation	.0627	8.76

Figure 35
Weight Curves for White males to weighted mean weights for each age and showing deviations of individual myopic males. Official Schools, Lourenco Marques (Mozambique) 1962-63

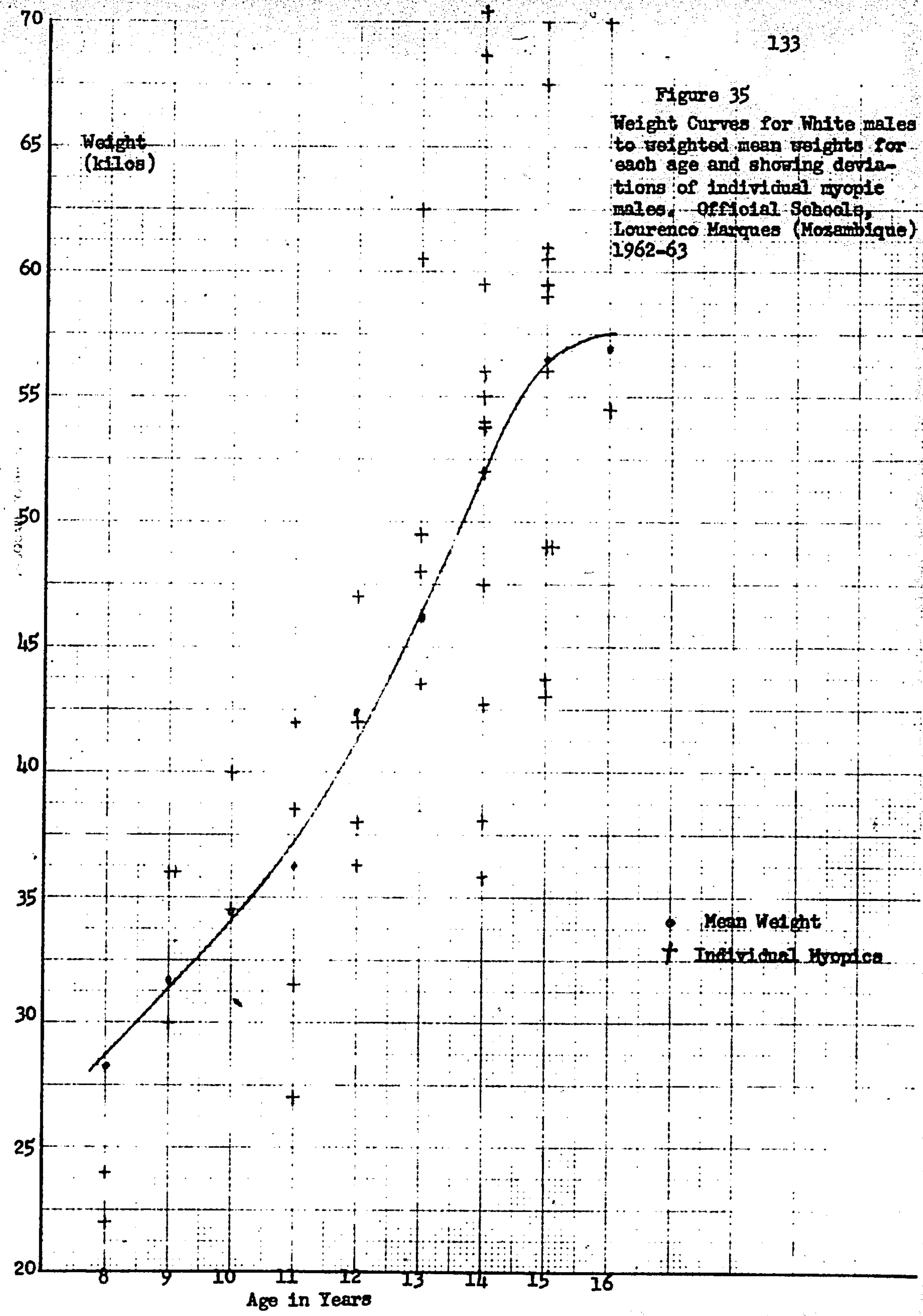
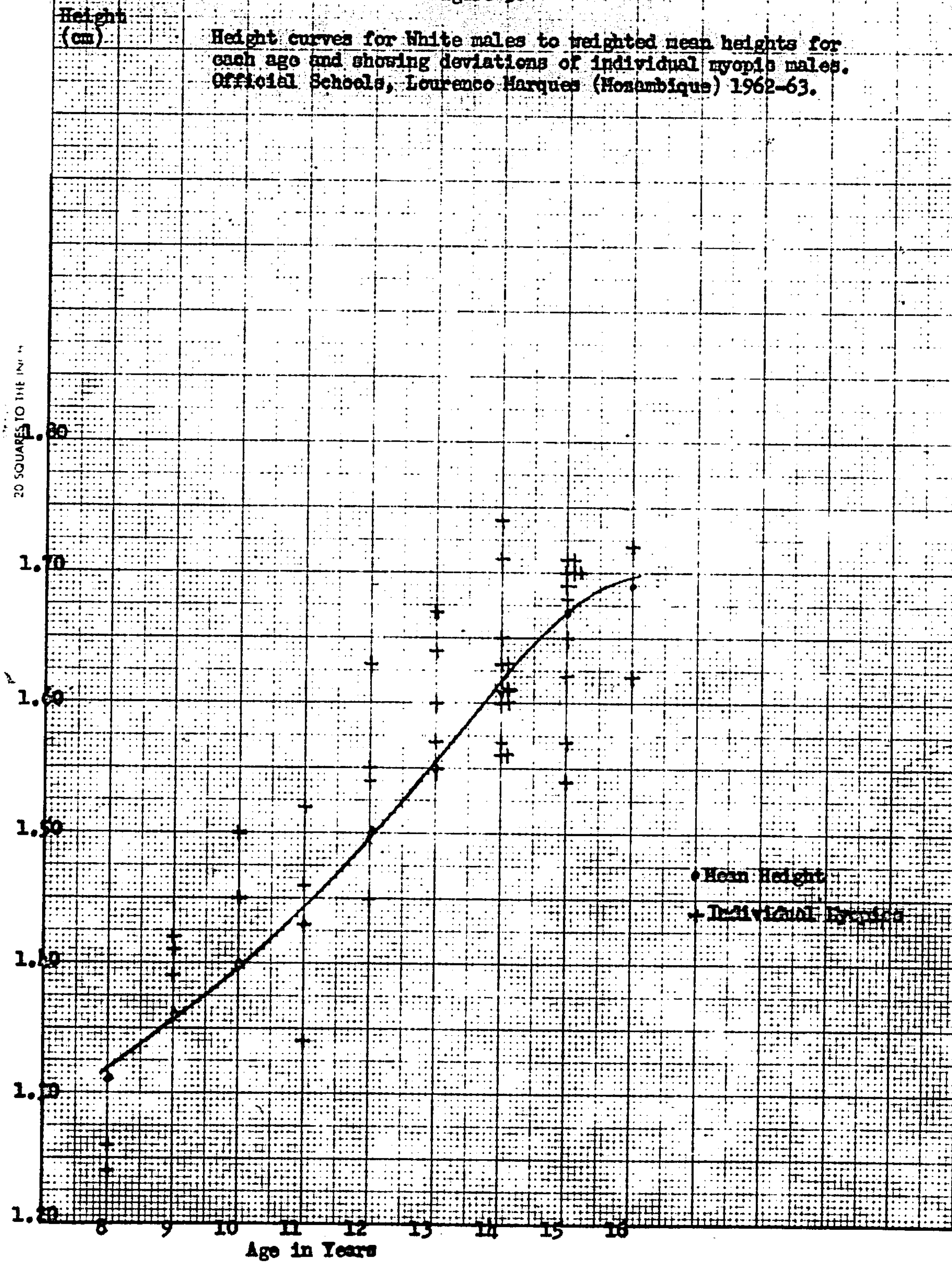


Figure 36

Height curves for White males to weighted mean heights for each age and showing deviations of individual myopic males. Official Schools, Lourenco Marques (Mosambique) 1962-63.




65
5199