HEALTH AND SOCIO-ECONOMIC STUDIES IN PUERTO RICO

III. PHYSICAL MEASUREMENTS OF AGRICULTURAL WORKERS*†

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IT HAS been common practice in the past to weigh and measure people for health and medical purposes and to determine physical growth. In general terms, the main object of such measurements seems to be to diagnose ill-health and malnutrition in children, to give health advice and to institute adequate programs of physical activity in young adults, and to determine the physical fitness of men drafted for military service. In addition to these purposes measurements of human beings are taken for anthropometric studies.

Because there are so many factors which may influence growth, the comparison of measurements between single individuals is absolutely unreliable. The usual procedure has been, therefore, to obtain average measurements of groups of individuals in the various ages as a sort of standard to compare individual cases. By this method several age-height-weight tables have been worked out, of which the most extensively used are those prepared by Baldwin[1] and Wood[2] for school age children; the medico-actuarial tables of 1912[3] for adults; and those prepared by Diehl[4, 5] for American college men and women. The tables of average weight for various ages and heights prepared by Davenport and Love[6] for men of military age have also been widely used.

In Puerto Rico a few studies on heights and weights of children and adult persons have been published. Salivia[7, 8] seems to have made the first contribution in this field in a report on the medical examination of students attending the University of Puerto Rico. This author continued taking measurements of University students and school children, and we have been able to examine the tables of height and weight for men and women prepared by him and Martínez Rivera with data up to 1934. In 1923 Bary[9] published the results of measurements of children of the

* The authors wish to acknowledge the very valuable assistance given to them by Messrs. Mario Marrero and F. Rodrigues Vélez in all mathematical computations and in the preparation of the graphical material presented in this paper.

† Received for publication October 10, 1938.

public schools in six communities of the Island; in 1928 Martínez Rivera[10] published the results of measurements taken by him of children of the schools in Río Piedras, and in 1930 Payne, Berríos and Martínez Rivera[11] analyzed the heights and weights of children in three communities of Puerto Rico. In the measurements taken by Salivia, persons of both sexes from 5 to 21 years of age were measured. The study of Payne, Berríos and Martínez Rivera includes measurements of 281 adult persons living in the rural zone of the municipality of Bayamón, and the results of all their measurements are compared with the Wood-Baldwin tables, and with Bardeen's curve in which the element of age is not involved.

These studies, however, are rather incomplete and hardly representative of any group of the population of Puerto Rico. Moreover, all of them are based on the comparison of groups of different individuals with different groups at different ages, a method which has been considered unsatisfactory by competent workers for the analysis of age changes during the growing period of life. The work of Boas,[12, 13, 14, 15] Merrell,[16] Palmer and Reed,[17] and others, has shown that this method of analysis fails to give an appropriate picture of the variable periods of growth during adolescence. Again, in child hygiene, as pointed out by Palmer and Reed, the method of comparing groups of individuals with other groups of the same ages has been subject to criticism. A child's actual size does not indicate the state of his health nearly as well as does his progress in height and weight and if a child's gain during a given period of time deviates widely from the average gain made by children of the same age, that child is potentially unwell. Many workers maintain that satisfactory knowledge of age changes can be obtained only by observing groups of the same individuals in successive years within their growing period. Through this method, which has been called the "individual" method to differentiate it from the "group" method, valuable information has been accrued on the variability of growth in either sex, and on the influence of hereditary and environmental factors upon growth itself.

Boas, who has made fundamental contributions in the study of individual growth, has shown that considerable variability occurs in the rate of growth, with periods of acceleration and deceleration; that the variability is greater among girls; and that the environmental factors have probably a greater influence upon growth than heredity. From measures analyzed by him, for instance, it has been shown that the children born of immigrants into the United States are taller than their parents; that children of the same racial stock increase in height with

improved environmental changes; and that among children of the same age, those of accelerated growth will have a lesser total growth than those of retarded growth. Merrell has found that the average of a series of individual growth curves may differ in certain fundamental characteristics from the separate curves, and that when observations on any biological form are taken on different individuals of varying age and the description of growth is given in terms of the average of these observations, the form of the growth of these averages cannot be assumed to be characteristic of the growth of the individual organism. To interpret the resulting variations

> as epochs in the growth of individual organisms associating them with physiological age changes would be fallacious, since such changes are a result of the mathematical process of averaging and have nothing to do with the biology of growth.

Palmer and Reed, working with material collected by U. S. Public Health Service, found that the mean annual rates of growth decrease regularly from the sixth through the tenth years of age, during which period growth in height is largely independent of height itself. The adolescent acceleration in growth begins quite abruptly regardless of age, when boys reach a height of 52-53 inches, and continues up to a height of at least 60-61 inches. During this period there is a positive correlation between the average rate of growth and height itself, and thus, the greater the stature between 53 and 61 inches the more rapid the rate of growth. They conclude that the adolescent acceleration and deceleration of growth in height is synchronized closely with actual height, and that both acceleration and deceleration tend to occur more particularly at certain points on the scale of height than on the scale of chronological age.

On the other hand, Davenport (quoted by Wheeler[18]) believes that the specific growth factor will eventually work itself out in spite of unfavorable environmental factors which apparently might retard it, and that temporary lack of food which might retard growth has little or no effect on the end point of growth, which is materially set by heredity. However, the possible effect upon human growth of a faulty diet extending throughout the life period of large groups of individuals, as occurs in Puerto Rico, is yet to be studied.

With reference to weight, it is well to mention that the Committee in charge of the medico-actuarial investigation, after examining some German, Austrian and Japanese data, concluded that the average weight in one country may not be applicable in other countries, especially when there is a difference in race.

Reference to the foregoing studies is relevant, because the knowledge of these findings will be helpful for a better interpretation of the data and certain comparisons offered in the present study, and to point out the desirability of undertaking studies in individual growth in Puerto Rico for the possibility that peculiar conditions in the process of growth might exist here as a result of the influence of climate, interbreeding, intestinal parasitism, the endurance of malnutrition through generations, etc.

Sufficient indication in this respect is offered by the findings of a study carried out in 1930 by Mitchell[19] of the American Child Health Association on the factors associated with the growth and nutrition of Puerto Rican children. In this study the author proceeds on the hypothesis that the diet of a large proportion of Puerto Rican children is deficient, and that disease in the form of intestinal parasitic infestation as well as possibly other forms of tropical disease is sufficiently prevalent to cause definite manifestations of deficiency in growth and development. In the absence of an adequate standard as to what measure of growth attainment should be expected of a Puerto Rican child of a given age and sex, certain measurable factors which are likely to be associated with marked difference in dietary and disease conditions were selected, and the relationship of these factors to manifestations of growth and development were studied.

Mitchell concluded that there is no tendency for Puerto Rican children to be more slender in build than continental children of the same height, age and sex. This judgment was based on researches of the American Child Health Association for continental children, which show that the differences in weight within an age group of school children in the United States are so closely associated with differences in bony dimensions other than height, that weight for a given height is regarded as more representative of body build than of nutritional status. Weight, it is added, is clearly a measurement of over-all size, and its relation to nutrition must be the result of those nutritional factors that are associated with bony growth differences rather than with differences in musculature or adipose tissue. Therefore, since skeletal size may be affected by genetic influences, the manifestations of nutritional disease were studied considering separately the bony dimensions and indices of musculature and adipose tissue rather than an index of size or body build such as weight.

This investigation showed that Puerto Rican children are smaller in all anthropometric traits, have less than the average arm girth and less than the average measurements of subcutaneous tissue over the biceps

than the continental children of the same bony dimensions and the same age and sex. There are differences in measurements between urban and rural Puerto Rican children: urban children are taller, have greater hip width, larger arm girth and greater amount of subcutaneous tissue over the biceps than rural children. There are differences, too, between urban children of different social groups, those of a higher social strata showing the highest dimensions, but there is no appreciable difference among the various groups of rural children, who show no consistent tendency for larger physical development to be associated with the more privileged socio-economic groups. These findings are particularly relevant since they show the remarkable homogeneity of the Puerto Rican rural classes, as we have been able to corroborate through this and other studies of this series.

PURPOSE OF STUDY

The purpose of this study is to analyze through established methods the so-called standard measurements—height, weight, thoracic expansion—of a representative part of the rural male population of Puerto Rico, in an effort to obtain a trustworthy idea of the physique of the Puerto Rican peasant which may add to our knowedge of the health and socio-economic conditions in the rural areas of the Island. It is hoped, moreover, that the tables worked out by us may serve as a sort of standard for measurements that may be taken of other groups in Puerto Rico.

DATA OF STUDY

The data for this study have been extracted from the medical physical examination records of 15,493 of the agricultural workers employed by the P.R.R.A. during the years 1936 and 1937; the rest of the information in such records will be used for a subsequent study on the physical impairments of adult life among the rural male population.

Two-fifths of the workers (6,087 or 39.3%) were camp workers and were measured by the camp physicians; the remaining three-fifths (9,406 or 60.7%) were workers employed in various other agricultural projects and were measured by the physicians of the rural medical dispensaries. The camp workers were clearly a selected group: they were younger, taller and heavier than the rest of the workers included in the sample. This is what might be expected, since the passing of a physical examination was a pre-requisite for admission to the camps and though only very serious impairment or the suffering from certain transmissible diseases were causes for rejection, it is safe to assume that only those feeling reasonably well appeared for examination.

Since most of the camps and dispensaries were located in the central part of the Island where the population is mostly white, it is probable that the colored population is inadequately represented in the sample. Though no attempt has been made to analyze the material separately, a tabulation of the workers by race, as given in the physical examination records, reveals that 16% of them are classified as colored, which compares with 22% of colored males in the total rural male population 15 years of age and over in Puerto Rico.

A great majority (92%) of the workers measured were *bona fide* residents of the rural areas; only 8% resided in the urban areas. Yet, it is probable that many of these "urban" workers were actually rural workers who had moved to the towns in search of work, and took advantage of the opening of the camps to return to the country.

COLLECTION OF DATA

The measurements were taken by or under the supervision of qualified physicians and therefore are supposed to be sufficiently accurate. Precise instructions as to the method of performing the examinations were prepared and sent to the physicians in charge. According to such instructions, the age of the examinees was to be recorded in years and months, the date of the birth to be given also as a check; the height and weight was to be taken, the candidate without shoes or clothing. Chest measurements were to be taken at nipple, the candidate stripped.

METHOD OF TABULATION

Since it may be safely assumed that the persons measured had in the main attained their full growth, we have chosen the "group" method to analyze our material in the belief that through such method an adequate picture of the size and build of the Puerto Rican peasant may be gained.

The data on age, height, weight and chest circumference were transferred to punch cards for mechanical tabulation. In making the calculations heights were computed to the nearest inch and weights to the nearest pound; halves in years, inches or pounds were thrown alternately to the values above or below the half. From these data scattergrams and tables of heights and weights and tables of chest measurements were prepared, from all of which various statistical constants were computed.

AGE

The age of the workers ranged from 16 to 70 years. However, almost half of them (49.2%) are of ages ranging from 16 to 29 years, and

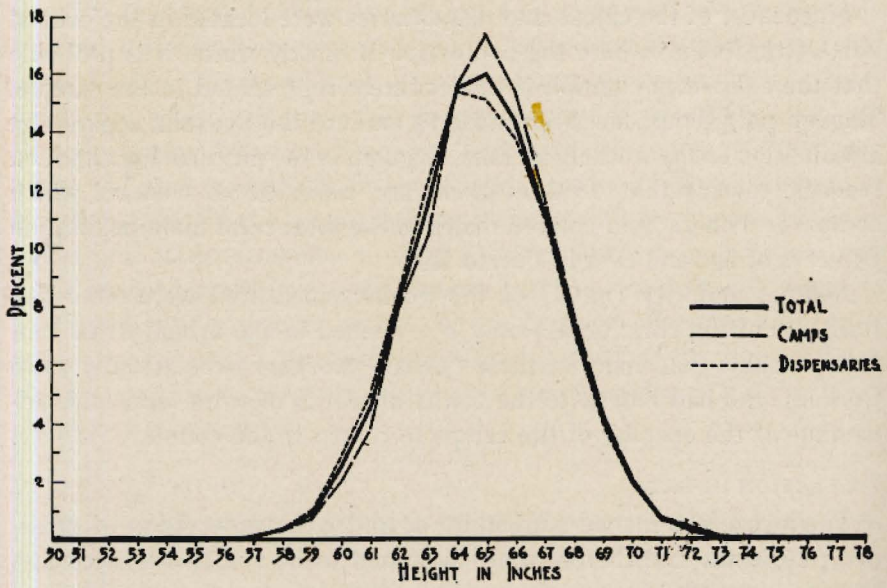

Fig. 1. Frequency distribution of heights of Puerto Rican agricultural workers. By location.

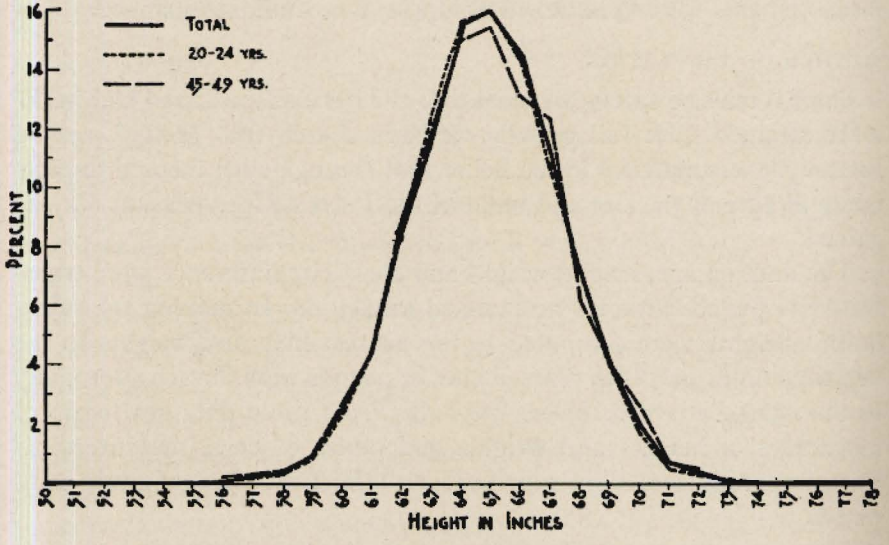

Fig. 1A. Frequency distribution of heights by age.

four-fifths (80.2%) are comprised in ages from 20 to 45 years. If specific ages are considered, the highest number of workers are found in ages 21, 22, 23, 24 and 25 years with 7.3%, 8.8%, 6.1%, 5.1% and 4.7% respectively of the total. The mean age of all the workers is 32.56 years. If the groups are considered separately we find that the camp workers are, on the average, six years younger than the dispensary workers. Their mean ages are 28.9 and 34.9 years respectively. With respect to age the sample as a whole is representative of the rural male population of Puerto Rico, except in the age-groups 15-19 years and 55 years and over (table 1).

TABLE I

Age distribution of the rural male population 15 years of age and over in Puerto Rico, and age distribution of the workers measured

Age Group	*Puerto Rico (Rural Male Population)*		*Workers Measured*	
	Number	*Per cent*	*Number*	*Per cent*
All ages	341,196	100.0	15,493	100.0
15–19 years	60,429	17.7	393	2.5
20–24 years	69,016	20.2	4,661	30.1
25–34 years	69,554	20.4	4,292	27.7
35–44 years	60,305	17.7	3,470	22.4
45–54 years	41,847	12.3	1,903	12.3
55 years and over	40,045	11.7	774	5.0

HEIGHT AND WEIGHT

Frequency distribution curves of height and of weight for the total number of workers and for the various groups studied are given in figs 1 and 2. The curves showing the percentage distribution of height do not vary greatly, those for the total and for the 20-24 years group being almost identical. Ninety-two per cent of the total number of cases fall within heights from 61 to 69 inches; in the 20-24 and in the 45-49 years age groups 93% and 91% of the cases respectively fall within the same heights. The mean height of the camp workers is 65.0 inches while the mean height of the dispensary workers is 64.7 inches. As may be observed, the curve for the camp workers is above the average in all heights from 64 inches up and below the average in all heights below 64 inches.

A similar proportion (92%) of the total number of workers and of the camp workers weigh from 103 to 152 pounds, while in the dispensary workers, 92% weigh from 98 to 142 pounds, or 5 pounds less in the minimum weight and 10 pounds less in the maximum weight than the rest

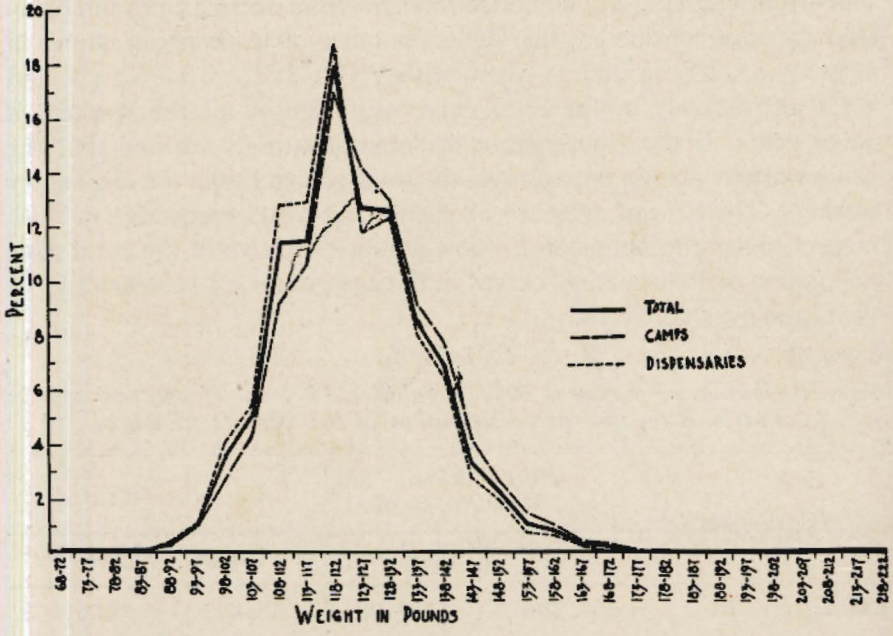

Fig. 2. Frequency distribution of weights of Puerto Rican agricultural workers. By location.

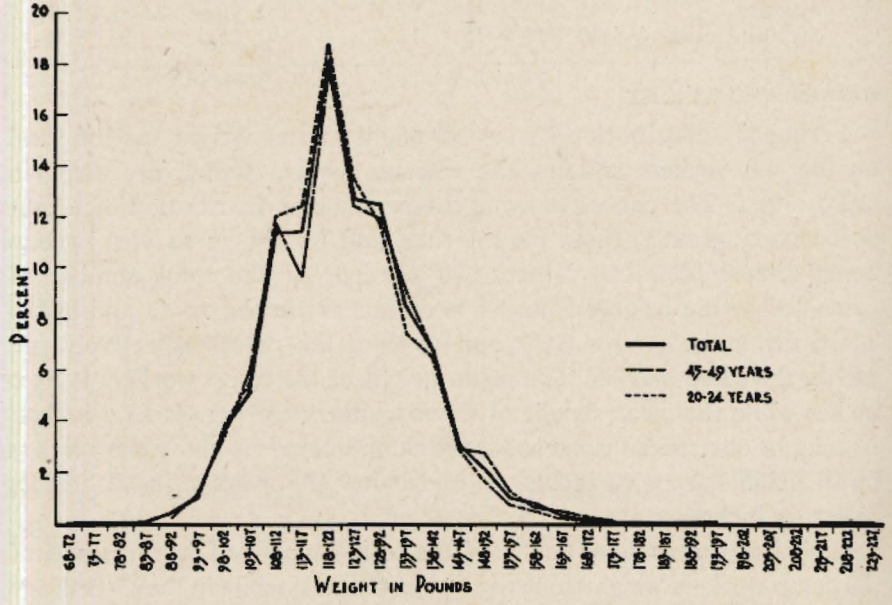

Fig. 2A. Distribution of agricultural workers by age.

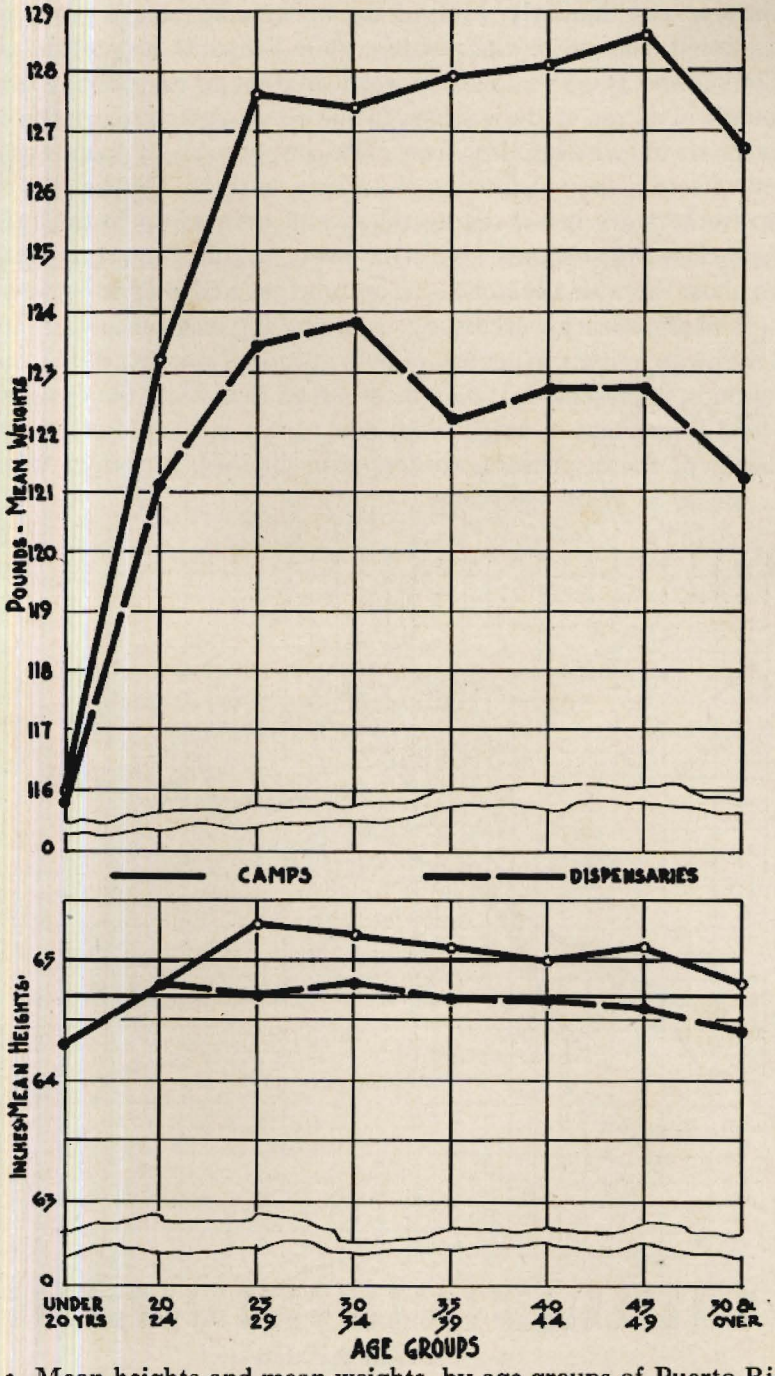

Fig. 3. Mean heights and mean weights, by age groups of Puerto Rican agricultural workers measured at camps and at dispensaries.

of the workers. Similarly, 92% of the workers in the age group 20-24 years weigh from 98 to 142 pounds, while the same proportion of the workers in the 45-49 years group weigh from 98 to 147 pounds, or only 5 pounds in excess of the workers in the 20-24 years group. The camp workers are likewise heavier: their mean weight is 125.3 pounds as compared with 122.2 pounds for the dispensary workers. The weights of the camp workers are below the average in all weights up to the 118-122 pounds class interval, and above the average after that class interval.

To show the wide differences in both height and weight between the camp and dispensary workers, fig. 3, giving the mean heights in inches and the mean weights in pounds of both groups of workers in the various age groups, is presented. It may be observed that while the camp workers tend to increase in weight with age, except in the oldest group, the tendency of the dispensary workers is to diminish in weight with age after the 30-34 years age group.

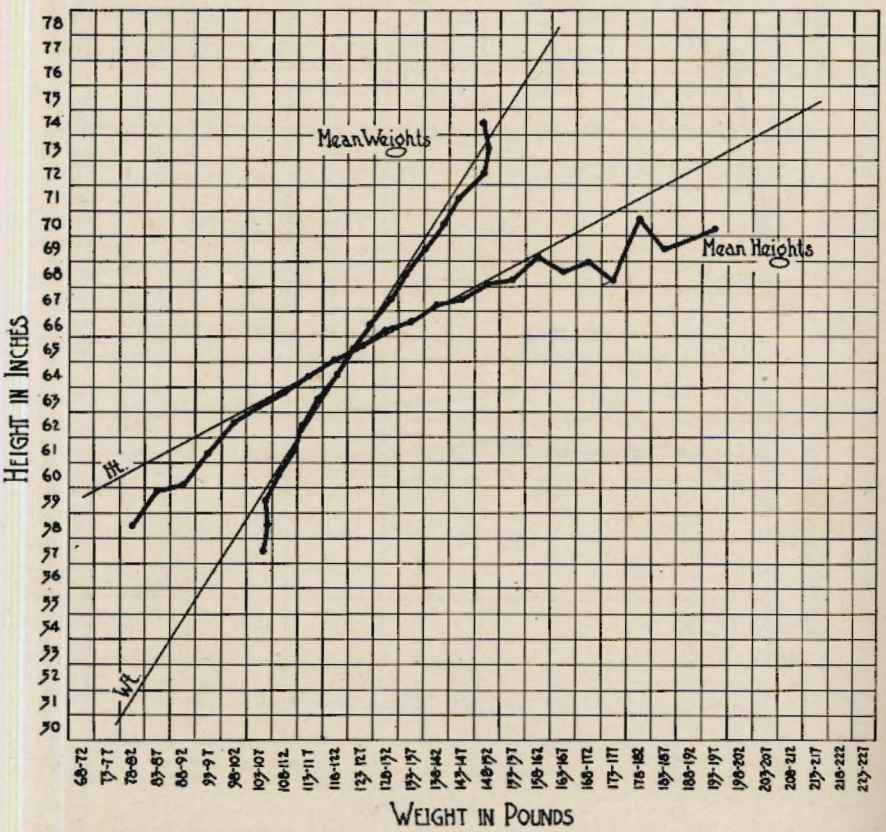

Fig. 4. Actual and linear regression lines of height and of weight for Puerto Rican agricultural workers, all ages.

Since the presentation of tables and scattergrams by specific ages would take too much space, only tables and scattergrams for the total number of workers and for the groups showing the minimum (20-24 years) and the maximum (45-49 years) dispersion are presented here. The tables and scattergrams for the other age groups which would represent intermediate values are kept on file in the office of the Research and Statistics Section, Rural Rehabilitation Division of the P.R.R.A.

In table 2 the height in inches, the mean weights per inch in height and their probable errors, the standard deviations for the various weights according to height, and the coefficients of variability for each

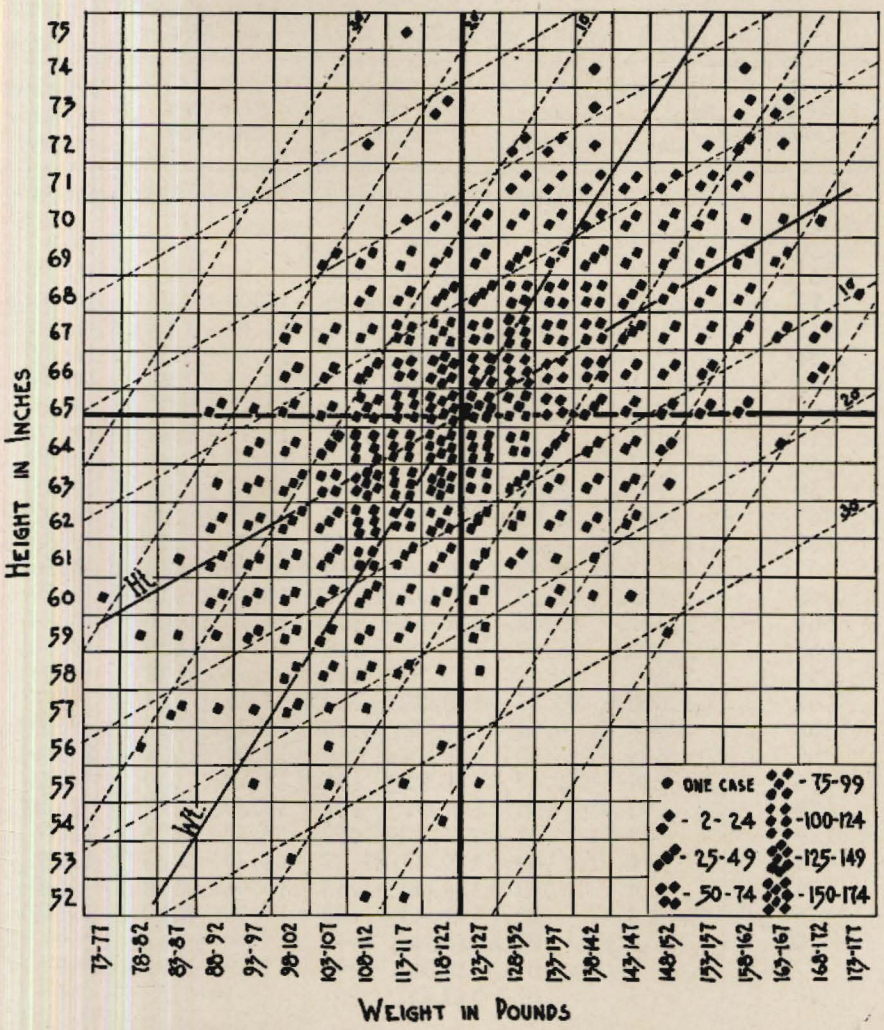

Fig. 5. Scattergram of heights and weights of Puerto Rican agricultural workers, ages 20-24 years.

inch in height are given for all workers in all ages. The mean height of all workers is 64.8±.014 inches; the mean weight 123.45±.075 pounds; the standard deviation 13.87±.053; and the coefficient of variability 11.24%. The table includes also the number of men for each inch in height and the percentage of workers in each height.

In the scattergram for all workers (fig. 4) only the regression lines showing the theoretical mean weight for each height and the lines showing the actual mean weights for each height are given. The actual mean values are satisfactory for all heights from 59 to 71 inches and for all

TABLE 2

Mean weights—agricultural workers—all ages

Height (Inches)	*Cases*		*Mean weight*	*Standard deviation*	*Coefficient of Variability*
	Number	*Per cent*			
Total	15,493	100.00	123.45±.075	13.87±.053	11.24
50	2	.01	104.00 —	—	—
51	3	.02	106.00±2.54	6.55±1.80	6.18
52	6	.04	110.83±4.96	18.03±3.51	16.27
53	6	.04	97.17±4.31	15.64±3.04	16.10
54	13	.08	107.08±3.33	17.80±3.35	16.62
55	11	.07	111.73±3.71	18.25±2.62	16.33
56	16	.10	110.19±2.44	14.45±1.72	13.11
57	23	.15	106.52±2.22	15.75±1.57	14.70
58	63	.41	104.76± .93	11.00± .66	10.50
59	162	1.04	105.96± .58	10.97± .41	10.35
60	454	2.93	109.35± .35	10.95± .24	10.02
61	739	4.77	111.49± .26	10.40± .18	9.33
62	1,433	9.25	114.26± .19	10.92± .14	9.56
63	1,899	12.26	117.62± .16	10.46± .11	8.89
64	2,427	15.66	121.22± .15	10.70± .10	8.83
65	2,466	15.92	123.79± .14	10.48± .10	8.46
66	2,197	14.18	127.79± .17	11.55± .12	9.04
67	1,600	10.33	130.84± .20	12.10± .14	9.25
68	998	6.44	134.82± .26	12.25± .18	9.09
69	558	3.60	138.44± .40	13.97± .28	10.09
70	252	1.63	141.91± .56	13.10± .39	9.23
71	92	.59	144.91± .94	13.39± .67	9.24
72	48	.31	147.77±1.70	17.52±1.21	11.86
73	14	.09	149.07±3.32	18.43±2.35	12.36
74	4	.02	154.00±3.53	10.48±2.50	6.80
75	3	.02	142.33±7.48	19.20±5.29	13.49
76	1	.01	155.00 —	—	—
77	2	.01	119.00 —	—	—
78	1	.01	145.00 —	—	—
Mean height 64.8±.014					

weights from 100 to 160 pounds; beyond these points the observed values deviate somewhat from the calculated values; probably due to the small number of cases falling within these heights and weights. The extremely short and the extremely tall cases (below 57 inches and above 74 inches respectively) are not shown in the graph.

There are 4,659 workers in the age group 20-24 years (see table 3 and fig. 5). This age group is the most numerous of all and hence the results obtained from the mathematical treatment of the data pertaining to it are the most stable. This group offers the lowest standard deviation and the lowest coefficient of variability of all groups, in both heights and weights. The mean height of the workers in this group is $64.81 \pm .024$ inches, and the mean weight $122.8 \pm .127$ pounds; the standard deviation is $12.94 \pm .090$, and the coefficient of variability 10.53%.

TABLE 3

Mean weights—agricultural workers—20–24 years

Height (Inches)	*Cases*		*Mean weight*	*Standard deviation*	*Coefficient of Variability*
	Number	*Per cent*			
Total	4,659	100.00	122.8± .127	12.94± .090	10.53
52	2	.03	113.0 —	—	—
53	1	.02	100.5 —	—	—
54	1	.02	120.5 —	—	—
55	4	.08	110.5±3.77	11.18±2.67	10.12
56	3	.06	102.2 —	—	—
57	8	.17	96.8±2.04	8.57±1.44	8.85
58	13	.27	110.5±1.74	9.30±1.23	8.42
59	40	.86	105.8±1.29	12.14± .92	11.47
60	109	2.33	108.5± .70	10.82± .49	9.97
61	207	4.44	110.8± .43	9.20± .30	8.30
62	406	8.71	113.9± .32	9.52± .23	8.36
63	584	12.53	116.2± .26	9.35± .18	8.05
64	729	15.64	119.9± .25	9.86± .17	8.22
65	745	15.99	123.2± .26	10.38± .18	8.43
66	666	14.29	126.7± .28	10.68± .20	8.43
67	496	10.64	130.1± .34	11.07± .24	8.51
68	337	7.23	133.4± .39	10.67± .28	8.00
69	182	3.90	135.8± .56	11.28± .40	8.31
70	79	1.69	139.4± .80	10.51± .56	7.54
71	23	.49	147.0±1.08	7.65± .76	5.20
72	14	.30	141.6±2.81	15.61±1.99	11.02
73	7	.15	147.6±4.81	18.87±3.40	12.78
74	2	.04	150.6 —	—	—
75	1	.02	115.5 —	—	—
Mean height 64.81± .024					

The workers in the 45-49 years age group are 1,170 and they offer the highest dispersion both in height and in weight, though the standard deviation and coefficient of variability for height is almost equal to that

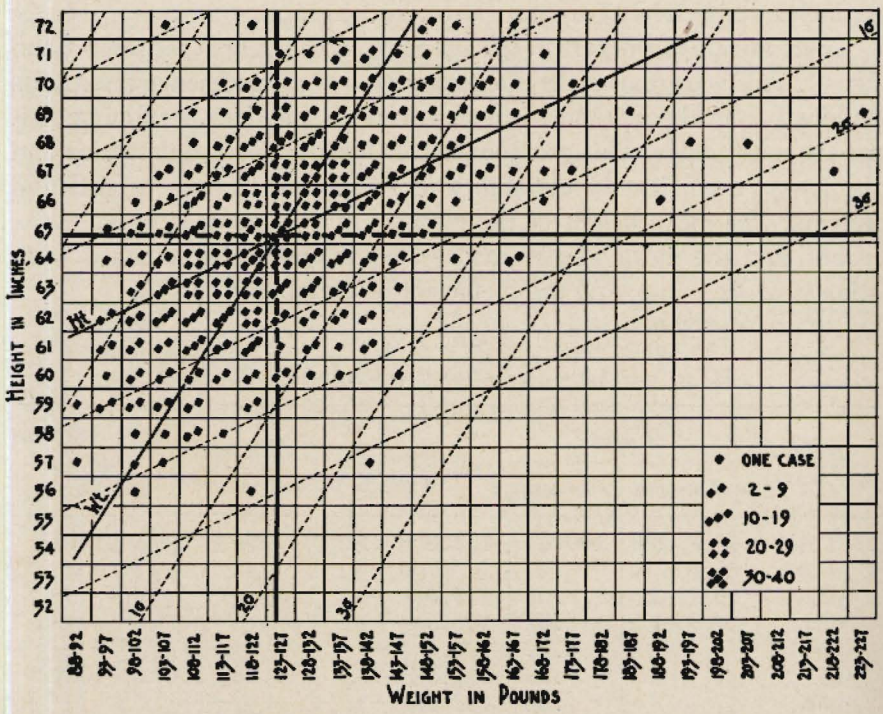

Fig. 6. Scattergram of heights and weights of Puerto Rican agricultural workers, ages 45-49 years.

given by the workers in the age group 50 years and over. The mean height for this group of workers is 64.79±.052 inches, and the mean weight 124.7±.299 pounds; the standard deviation 15.19±.212, and the coefficient of variability 12.17% (see table 4 and fig. 6).

Table 5 is a summary table giving the means of height and of weight, the standard deviations from these means, the coefficients of variability of height and weight, and the coefficients of correlation between the two variables for each five-year age group. The standard deviation of height for the whole number of workers is 2.58±.010 and the coefficient of variability 3.97%. The deviations of individual age groups do not vary greatly, ranging from 2.50±.017 inches in the age group 20-24 years to 2.67±.033 inches in the age group 50 years and over. The standard

deviation of height for the camp workers' group is 2.47±.015, or slightly less than the standard deviation of the 20-24 years age group.

The standard deviation of weight for the whole number of workers is 13.87±.053; for individual age groups it ranges from 12.94±.090

TABLE 4

Mean weights—agricultural workers—45–49 years

Height (Inches)	*Cases*		*Mean weight*	*Standard deviation*	*Coefficient of Variability*
	Number	*Per cent*			
Total	1,170	100.00	124.7± .299	15.19± .212	12.18
52	1	.08	95.5 —	—	—
53	1	.08	90.5 —	—	—
54	—	—	—	—	—
55	—	—	—	—	—
56	2	.17	110.5 —	—	—
57	4	.34	109.2±6.35	18.83±4.49	17.24
58	5	.42	108.5±3.66	12.15±2.59	11.20
59	16	1.36	104.9±1.42	8.45±1.01	8.06
60	30	2.56	113.5±1.35	11.00± .96	9.69
61	53	4.52	112.9±1.02	11.05± .72	9.79
62	103	8.80	115.1± .64	9.66± .45	8.39
63	139	11.88	118.1± .58	10.22± .41	8.65
64	175	14.95	122.2± .58	11.44± .41	9.36
65	180	15.38	123.6± .53	10.57± .38	8.55
66	153	13.07	129.0± .66	12.40± .48	9.61
67	144	12.30	132.8± .86	15.38± .61	11.58
68	71	6.06	134.9±1.17	14.66± .83	10.87
69	48	4.10	142.1±1.86	19.15±1.32	13.48
70	30	2.56	140.5±2.07	16.83±1.46	11.98
71	9	.76	141.6±2.79	12.42±1.97	8.77
72	6	.51	141.3±5.81	21.10±4.11	14.93
Mean height 64.79±.052					

pounds in the age group 20-24 years to 15.19±.212 pounds in the age group 45-49 years. The coefficient of variability is 11.18% for the entire group of workers, fluctuating from 10.53% in the age group 20-24 years to 12.17% in the age group 45-49 years. For the group of camp workers separately the standard deviation of weight is 14.52±.089, and the coefficient of variability 11.54%.

CORRELATION BETWEEN HEIGHT AND WEIGHT

A rather high correlation is found between height and weight in the entire group of workers and in the various age groups as well. The co-

TABLE 5

Mean heights, mean weights and coefficients of correlation between height and weight by age groups

Age group	*Number of cases*	*Height*			*Weight*			$r_{wt.\,ht.}$
		Mean	*S.D.*	*C.V.*	*Mean*	*S.D.*	*C.V.*	
All ages	15,493	64.85±.014	2.58±.010	3.98	123.45±.075	13.87±.053	11.24	+.583±.004
Under 20 years	391	64.27±.086	2.53±.061	3.94	116.33±.461	13.53±.326	11.63	+.622±.021
20–24 years	4,659	64.81±.024	2.50±.017	3.86	122.80±.127	12.94±.090	10.53	+.599±.006
25–29 years	2,578	65.07±.034	2.53±.024	3.89	125.62±.176	13.25±.124	10.55	+.582±.009
30–34 years	1,714	64.99±.043	2.62±.030	4.03	125.66±.231	14.17±.163	11.28	+.598±.011
35–39 years	2,109	64.86±.037	2.55±.026	3.93	124.42±.205	13.99±.145	11.24	+.588±.010
40–44 years	1,360	64.91±.046	2.54±.033	3.91	124.72±.261	14.25±.184	11.42	+.548±.013
45–49 years	1,170	64.79±.052	2.66±.037	4.10	124.72±.299	15.19±.212	12.18	+.549±.014
50 years and over	1,507	64.52±.046	2.67±.033	4.14	122.85±.254	14.62±.180	11.90	+.550±.012

efficient of correlation between height and weight for all the workers is $+.583\pm.004$; for the various age groups it fluctuates from $+.55\pm.014$ in all groups from 40 years and over to $+.622\pm.021$ in the age group under 20 years of age. The coefficient of correlation for the camp workers is $+.587\pm.006$.

In table 6 the correlation and variability between height and weight in adults as found in our sample are compared with similar values for American adults. On the whole, the Puerto Rican workers are more than 2½ inches or 4% shorter and, as measured by the standard deviations, 5% less variable in height than the Army recruits; they are similarly more than 3¼ inches or nearly 5% shorter though 5% more variable in height than the American adults whose measurements are given by Pearl.[20]

With respect to weight, the Puerto Rican workers are 18 pounds or 13% lighter and 20% less variable in weight than the American Army recruits; and they, too, are 28 pounds or 18.5% lighter and 30% less variable in weight than the American adults. The similar variability of the samples may be seen, too, by the respective coefficients of variability.

COMPARISON WITH MEDICO-ACTUARIAL DATA

A word of warning is necessary before comparing the medico-actuarial data with ours, for there exists very wide differences in race, culture, economic condition, etc., of the individuals measured in both sets of data. The material of the medico-actuarial tables was drawn from data pertaining to policyholders of the United States covering a fair cross-section of the middle and upper classes of the nation, while the Puerto Rican data is made up exclusively of rural workers pertaining to the underprivileged groups. Therefore differences, and even wide differences, are to be expected. Yet, in comparing our data with the medico-actuarial, consistent and striking deviations are observed.

TABLE 6

Correlation and variability of height and weight as found in Puerto Rican workers and in American adults

Statistical constant	*American adults 20–49 years**	*P. R. workers*	*U. S. army recruits***
No. of cases	272	15,493	868,445
Height:			
Standard deviation	2.45 ± .07	2.58 ± .010	2.71
Mean	68.13 ± .10	64.85 ± .014	67.49
C. of variability	3.60	3.99	4.02
Weight:			
Standard deviation	19.95 ± .58	13.87 ± .053	17.42 ± .0089
Mean	151.56 ± .82	123.45 ± .126	141.54
C. of variability	13.16	11.24	12.31
Correlation ($r_{wt.ht.}$)	+ .486 ± .016	+ .583 ± .004	+ .4810 ± .0006

* Taken from Pearl[20] table 58, pg. 350, for all values except coefficient of correlation which has been taken from table 77, pg. 385.

** Taken from Davenport and Love[6] table I, pg. 417.

In table 7 and fig. 7 we compare the mean weights for each inch in height in the various age groups of both the Puerto Rican workers and the American adults of the medico-actuarial investigation. The medico-actuarial data start with the 25-29 years age group, because there are very few cases below 25 years in that study.

We have graded our data on weights by using the theoretical mean weights obtained from the regression lines for all those weights to which the actual mean weights are sufficiently near; for weights in both extremes of the line which deviate too much from the calculated values we have used intermediate points chosen by inspection between the theoretical and observed lines.

The mean heights and the mean weights of the medico-actuarial investigation have been corrected by subtracting one inch in each height and 4.46 pounds in each weight, for the reason that heights and weights in that investigation were taken with the individuals wearing shoes and ordinary clothing. In making these corrections we have employed the factors used by Diehl[4], although we have deducted an entire inch in each height instead of .9 of an inch as he did.

Inspection of this table and graph will show that while the American adults increase in weight with age in all specific heights, as appears to be the normal law, the Puerto Rican workers *of the same age and height* remain stationary with a tendency to diminish in weight as age advances.

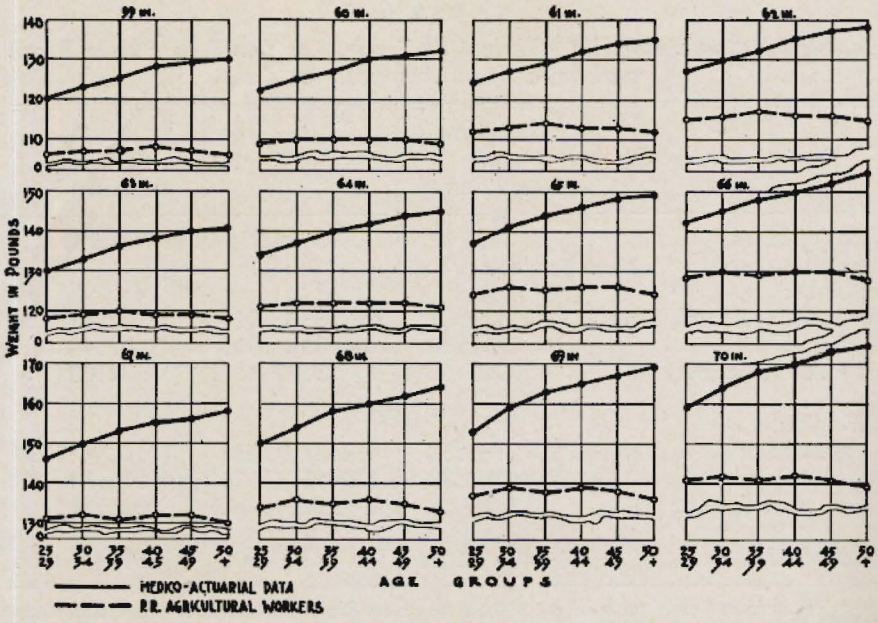

Fig. 7. Mean weights in each height, by age groups, of Puerto Rican agricultural workers as compared with Medico-Actuarial data.

The fact that these differences are consistently found in essentially the same form in all specific heights is highly illuminating. Moreover, the relative differences are greater not only in the higher ages but also in the higher statures running from 12 to 13.5% in heights from 59 to 72 inches in the 25-29 years age group and from 18.5 to 21.5% in the same heights in the 50 years and over age group.

These findings may not be surprising in view of the conditions existing in the rural areas of the Island, as we have been able to present through the various investigations carried out in the sugar cane[21] and in the tobacco, coffee and fruit[22] regions. A faulty diet, heavy parasitic infestation, inadequate housing, poor sanitary conditions, etc., coupled with the weariness resulting from a strenuous work, seem to reduce the rural Puerto Rican worker to a miserable physical condition which becomes more serious with age.

AGE AND HEIGHT SPECIFIC WEIGHTS

Hitherto we have presented our data by five-year age groups, since it is considered that the results thus obtained are more reliable, on account of the known tendency of the country people to misstate their age. A preliminary tabulation of the age of the workers by specific years demonstrated that in a rather high number of cases the ages were stated

TABLE 7

Average weights according to height by five-year age groups of Puerto Rican workers, as compared with similar weights of the Medico-Actuarial investigation

Age group	*59 inches*		*60 inches*		*61 inches*		*62 inches*	
	P.R.W.	*M.A.*	*P.R.W.*	*M.A.*	*P.R.W.*	*M.A.*	*P.R.W.*	*M.A.*
20–24 years	105	—	108	—	111	—	114	—
25–29 years	106	120	109	122	112	124	115	127
30–34 years	107	123	110	125	113	127	116	130
35–39 years	107	125	110	127	114	129	117	132
40–44 years	108	128	110	130	113	132	116	135
45–49 years	107	129	110	131	113	134	116	137
50 years and over	106	130	109	132	112	135	115	138
	63 inches		*64 inches*		*65 inches*		*66 inches*	
20–24 years	117	—	120	—	123	—	126	—
25–29 years	118	130	121	134	124	137	128	142
30–34 years	119	133	122	137	126	141	129	145
35–39 years	120	136	122	140	125	144	128	148
40–44 years	119	138	122	142	126	146	129	150
45–49 years	119	140	122	144	126	148	129	152
50 years and over	118	141	121	145	124/	149	127	154
	67 inches		*68 inches*		*69 inches*		*70 inches*	
20–24 years	130	—	133	—	136	—	139	—
25–29 years	131	146	134	150	137	153	141	159
30–34 years	132	150	136	154	139	159	142	164
35–39 years	131	153	135	158	138	163	141	168
40–44 years	132	155	136	169	139	174	142	170
45–49 years	132	156	135	161	138	167	141	173
50 years and over	130	158	133	164	136	169	139	172

P.R.W. = Puerto Rican Workers.
M.A. = Medico-Actuarial Data.

in figures ending in 0 or 5. In assembling the data by five-year age periods it is considered that most of the errors resulting from misstatements of age are done away with.

It is necessary, however, to give average weights by specific age and height in order to make the measurements of this study comparable with similar measurements that might be taken from individuals in other population groups. In table 8 the average weights for groups of workers in each height by specific years of age are given. We tried to graduate the data to take care of the errors of age stated above but, since the vari-

ability in weights from year to year in the respective heights is so small, any graduation of the data would result in an actual standardization more or less at a given value of all weights in each stature regardless of age. Therefore, it was decided to present the average weights by specific age and height as obtained from the measurements taken without any modification whatsoever. Inasmuch as the number of cases in heights below 59 and above 70 inches and under 20 years of age are not sufficiently numerous, only weights for heights from 59 to 70 inches and for ages from 20 to 50 years and over are included.

BODY BUILD

The index of body build is used to determine the physical constitution or robustness of man. The interpretation given to such index is that a low index indicates a slender build while a high index indicates a stocky build. Using Davenport's formula: $wt/ht^2 \times 1{,}000$, we have computed the indices of body build for the Puerto Rican workers included in the present study. In table 9 such indices are compared with those of the medico-actuarial investigation and with the indices of body build of

TABLE 8

Average weights by specific age and height

Age	*59"*	*60"*	*61"*	*62"*	*63"*	*64"*	*65"*	*66"*	*67"*	*"68*	*69"*	*70"*
20	94	103	109	111	114	116	119	122	127	134	132	136
21	100	107	109	112	115	118	122	127	129	132	134	139
22	108	108	113	114	117	122	123	127	130	134	136	139
23	108	111	112	115	118	122	125	128	131	135	137	144
24	115	111	114	116	115	122	126	129	131	134	136	136
25	109	106	115	114	118	122	124	128	132	136	136	143
26	110	112	110	114	122	122	125	127	134	136	141	144
27	102	114	110	117	120	124	123	129	131	136	134	150
28	100	110	110	114	122	121	125	128	132	138	134	144
29	104	110	116	113	123	124	128	128	133	136	137	136
30	113	109	112	113	118	123	125	127	130	136	141	143
31	93	112	120	118	119	125	124	128	134	137	138	137
32	115	111	115	117	118	122	125	129	132	136	147	143
33	—	105	110	116	120	123	124	129	134	140	140	146
34	114	112	111	114	117	123	124	129	128	142	141	141
35	104	111	109	114	118	123	124	128	130	133	143	145
36	112	116	119	113	120	122	124	128	131	133	136	150
37	109	103	112	116	117	121	123	130	129	131	138	146
38	—	108	109	116	118	121	124	130	128	135	142	156
39	116	109	106	114	119	121	124	130	137	138	139	152
40	108	114	111	114	118	124	124	128	131	134	137	137
41	115	116	109	113	118	126	125	132	137	133	145	148
42	99	103	110	121	121	119	126	128	134	133	149	148
43	100	108	115	117	119	120	127	127	133	139	139	125
44	109	118	114	118	123	123	122	130	130	134	133	159
45	104	112	111	115	119	121	123	130	128	136	147	134
46	98	115	113	113	118	124	128	127	133	133	138	133
47	102	112	112	118	116	120	123	133	139	134	143	145
48	106	119	109	115	116	125	124	132	131	149	137	130
49	—	115	120	110	126	122	121	127	133	131	148	138
50 and over	102	108	112	116	118	120	124	127	130	133	142	143

American Army recruits. From this table it may be observed that the Puerto Rican workers are more slender than the American adults in all statures. They are somewhat comparable with the Army recruits in statures from 66 inches up, but consideration should be given to the fact that the Army recruits are, on the average, about 7 years and 8 months younger than the Puerto Rican workers; the mean age of the Puerto Rican workers being 32.56 years, while the mean age of the Army recruits is 24.89 years. On the whole, however, the Puerto Rican workers have a much lower index than the Army recruits. The differences in body build with the medico-actuarial data are very significant.

CHEST MEASUREMENTS

In analyzing the measurements of workers it was deemed proper to tabulate their chest measurements for the known importance that such measurements have in relation to physical development and also in relation with certain diseases and pathological conditions. In table 10 the mean chest measurements in inches at expiration and at inspiration and the resulting thoracic expansion or mobility are given. The minimum mobility in the Army is set at 2 to 3 inches for men under six feet, and

TABLE 9

Body build of Puerto Rico Rican workers compared with body build of army recruits and policy-holders of the medico-actuarial investigation

Height (In inches)	*Puerto Rican workers*	*Army recruits**	*Medico-actuarial data***
All heights	29.35	31.08	33.28
59	30.44	—	32.94
60	30.38	—	37.25
61	29.96	36.54	34.55
62	29.72	33.33	34.20
63	29.63	31.44	33.57
64	29.59	30.58	33.41
65	29.30	30.17	33.25
66	29.34	29.90	33.33
67	29.15	29.65	33.13
68	29.16	29.46	33.16
69	29.08	29.29	33.10
70	28.96	29.15	33.05
71	28.75	29.01	33.30
72	28.51	28.84	33.78
73	27.97	28.76	34.00
74	28.12	28.61	33.98
75	25.30	—	34.69

* Taken from Davenport and Love[6] table 56, pg. 164.
** Computed from data of the Medico-Actuarial Investigation,[3] Vol. I.

at 3 to 4 inches for men over six feet. It may be observed that the mean mobility of the Puerto Rican workers in all heights from 59 to 70 inches is scarcely two inches, or the minimum mobility set by the Army standard. Yet, it has been reported by Davenport and Love[6] that many subjects are unable to expand the chest, not through small lung capacity, but through an inability to exercise a voluntary control of the muscles of the chest. Moreover, Hoffman[23] states that many physically fit negroes in the United States have not a chest mobility of two inches because they do not know how to expand the chest.

TABLE 10

Mean chest measurements at inspiration and expiration and mean mobility

Height	*Mean expiration (Inches)*	*Mean inspiration (Inches)*	*Mean mobility (Inches)*
All cases	33.1	35.1	2.0
59	31.6	33.5	1.9
60	32.0	33.8	1.8
61	32.1	34.1	1.9
62	32.4	34.4	2.0
63	32.6	34.6	2.0
64	32.9	34.9	2.0
65	33.1	35.1	2.0
66	33.4	35.5	2.0
67	33.6	35.7	2.1
68	33.9	36.0	2.1
69	34.2	36.3	2.1
70	34.2	36.4	2.2

The mean chest circumference at expiration for the 873,000 American Army recruits of the World War is given as 33.22 inches, while at demobilization it was 34.9 inches. It is thus interesting to note that the mean chest circumference at expiration obtained for the Puerto Rican workers (33.1 inches) is approximately the same as that of the Army recruits at mobilization.

SUMMARY

1. The material for this study was drawn from the physical examination records of 15,493 agricultural workers employed by the P.R.R.A. during 1936 and 1937. These workers are a fairly representative group of the rural male population.

2. The mean height of the workers is $64.8 \pm .014$ inches and their mean weight $123.45 \pm .075$ pounds. The standard deviations of height and of weight are $2.58 \pm .010$ inches and $13.87 \pm .053$ pounds respectively; the coefficient of variability between height and weight is

11.24%. The age of the workers ranges from 16 to 70 years; their mean age is 32.56 years. Yet, four-fifths of them are of ages from 20 to 45 years.

3. The Puerto Rican workers are 2½ inches or 4% shorter and, as measured by the standard deviation, 5% less variable in height than the Army recruits and 3¼ inches or 5% shorter and 5% more variable in height than other American adults of ages 20-49 years.

4. Again, the Puerto Rican workers are 18 pounds or 13% lighter and 20% less variable in weight than the American Army recruits and 28 pounds or 18.5% lighter and 30% less variable than the American adults.

5. While the American adults increase in weight with age in all specific heights, the Puerto Rican workers of the same age and height remain stationary with a tendency to diminish in weight as age advances. The relative differences in weight are greater, too, in the higher statures, running from 12 to 13.5% in heights from 59 to 72 inches in the 25-29 years age group to 18.5 to 21.5% in the same heights in the 50 years and over age group.

6. The Puerto Rican workers are quite slender; their index of body build is 29.35 as compared with 31.08 for the Army recruits and 33.28 for the American adults of the Medico-Actuarial investigation. Their thoracic expansion is two inches or less, or the minimum expected mobility for their size.

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ESTUDIOS SANITARIOS Y ECONOMICO-SOCIALES EN PUERTO RICO

III. MEDIDAS CORPORALES DE LOS TRABAJADORES AGRICOLAS*

EXTRATO

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EL PROPÓSITO de este estudio—véase el original completo en inglés—es analizar, según métodos ya establecidos, las que se consideran medidas normales—estatura, peso y expansión torácica—de un grupo humano representativo de la población rural masculina de Puerto Rico, con objeto de poder formarnos una idea veraz de la constitución física del campesino puertorriqueño, e ir completando nuestros conocimientos de las condiciones sanitarias y económicosociales de la población rural de la isla.

Los datos que figuran en este estudio han sido sacados de las tarjetas de exámenes físicos practicados, durante los años 1936 y 1937, a 15,493 obreros empleados por la Administración para la Reconstrucción de Puerto Rico (P.R.R.A.). De este número de trabajadores, dos quintas partes eran trabajadores en los campamentos, y las mediciones fueron practicadas por los médicos de dichos campamentos; las otras tres quintas partes se componían de peones empleados en distintos proyectos de reconstrucción agrícola, y las medidas físicas fueron tomadas por los médicos encargados de los dispensarios rurales.

Estos trabajadores componen un grupo suficientemente respresentativo de la población rural masculina, aunque es posible que no entre en el mismo la proporción debida de gente de color, porque la mayoría de los campamentos y dispensarios estaban ubicados en la región central de la isla donde la mayor parte de los habitantes pertenece a la raza blanca.

La estatura media de los sujetos que componen el grupo es de $64.8 \pm .014$ pulgadas; el peso medio, $123.45 \pm .075$ libras. Las desviaciones "standard" de las cifras correspondientes de estatura y peso son $2.58 \pm .010$ pulgadas y $13.87 \pm .053$ libras, respectivamente; el coeficiente de variabilidad entre peso y estatura es de 11.24%. La edad de estos trabajadores fluctúa de 16 a 70 años, siendo la edad promedio de todo el grupo 32.56 años. Cuatro quintas partes de los trabajadores, sin embargo, tienen de 20 a 45 años de edad.

Las curvas de distribución de frecuencias de pesos y estaturas en el número total de trabajadores aparecen en los grabados 1 y 2 del original inglés. En el grabado 3 (original inglés) puede verse la gran diferencia que existe tanto en peso como en estatura entre los trabajadores de los campamentos y los que acudían a los dispensarios. Hay que advertir que los primeros formaban un grupo seleccionado, habiendo sido examinados físicamente, como requisito indispensable, antes de ser admitidos al campamento.

El grabado 4 es un diagrama de dispersión mostrando la relación real y teórica existente entre el peso y la estatura de todos los trabajadores medidos. Los grabados 5 y 6 son también diagramas de dispersión construídos en forma idéntica para mostrar la relación entre el peso y la estatura en los grupos de trabajadores de 20 a 24 y de 45 a 49 años de edad, que son los dos grupos que, entre todos, ofrecen la menor y mayor dispersión.

Los campesinos de Puerto Rico tienen 2½ pulgadas menos de estatura (o sea el 4%) y, según lo demuestra la desviación "standard" calculada, sus medidas varían 5% menos que las de los reclutas del ejército americano. Son, asimismo, 3¼ pulgadas más bajos (5%), variando en estatura menos de 5% que otros adultos americanos de 20 a 49 años de edad.

Por otra parte, los campesinos puertorriqueños tienen 18 libras (13%) menos de peso, y éste varía menos del 20% que en los reclutas del ejército americano; tienen también 28 libras menos (o sea 18.5%), y la variación del peso es 30% menor que en los adultos americanos de 20 a 49 años de edad.

Los adultos norteamericanos en todas las estaturas aumentan de peso según avanzan en edad; en los campesinos puertorriqueños el peso se estaciona y más bien tienden a pesar menos en las edades mayores. Las diferencias relativas en peso son mayores en las estaturas más elevadas, oscilando de 12 a 13.5%, en las estaturas de 59 a 72 pulgadas, en el grupo de edades de 25 a 29 años y de 18.5 a 21.0%, en las mismas estaturas, en las edades de 50 años en adelante (grabado 7).

Los campesinos puertorriqueños son muy delgados; su índice de constitución física (*index of body build*) es 29.35 en comparación con 31.08 en los reclutas del ejército americano y 33.28 en los adultos americanos, según mediciones verificadas en la Investigación Medico-Actuarial de 1912. La éxpansión torácica de los trabajadores cuyas medidas analizamos es de dos pulgadas o menos, o sea la expansión mínima normal para adultos de su tamaño.