HEIGHTS AND WEIGHTS OF CHILDREN IN THREE COMMUNITIES OF PORTO RICO [1]

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The increasing interest in positive measures for promoting health has resulted in widespread discussion of the measurements of children as an indication of their physical condition. In Europe and Continental America this interest has been growing for thirty years or more, until the examination and health diagnosis of school children has become a medical specialty. The disadvantage to the child of a poor state of nutrition, as revealed by clinical examination and measurements has been demonstrated too often to require discussion here.

In Porto Rico there has long been interest shown in the state of nutrition of the population in general and especially in that of the school children. Even during the nineteenth century articles on the subject were not uncommon, and recently the discussion of the subject has been more active than ever. There have been thousands of measurements of school children and of clinic patients but relatively few of them have been analyzed and published so that they could be compared with results obtained elsewhere.

For the purpose of making a preliminary contribution to the knowledge of this subject we present here an analysis of the following data:

a. Measurements of school children and clinic patients made by the Yabucoa Health Unit in 1927 and 1928.

b. Measurements of school children made by the Río Piedras Health Unit in 1926, 1927 and 1928.

c. Measurements of children and adults made in the homes of rural residents of Bayamón in 1926.

PREVIOUS INVESTIGATIONS IN THIS FIELD

There have come to our attention only the following reports which give the results of similar work in Porto Rico.

[1] This report is a contribution from the Municipal Health Units of Yabucoa and Río Piedras, Porto Rico. The work which is reported was supported jointly by the Insular Department of Health, the respective Municipal Governments, and by the International Health Division of the Rockefeller Foundation.

1. In 1916 Saliva reported the results of measuring and weighing 514 students of the University of Porto Rico. Four hundred and ninety-nine of these students were sixteen years of age or more; age groups which are not included among our measurements.

2. Miss Helen V. Bary (1923) published the results of the measurements of 7,632 children by teachers in six different communities. We have included her data for comparison with our own.

3. Two years ago one of us (Martínez, 1928) presented before the Porto Rico Medical Association, an analysis of certain measurements which had been made in some of the schools of Río Piedras.

METHODS USED IN THE COLLECTION OF DATA

In the groups studied there were minor differences as to the measurement but it is believed that they were not such as to invalidate the results. The methods were as follows:

a. Yabucoa school children were measured and weighed by one of us (M.B.B.). The scale used was the portable nurse's scale with measuring rod which is made for the purpose by the Continental Scale Works. It was always levelled in both directions and under these conditions gave accurate results. The children were weighed and measured in the clothing which they wore in the schoolroom except that the boys removed their coats. Age was recorded at the nearest birthday when the information was obtainable. Weight was recorded to the nearest pound, and height to the nearest inch.

The clinic children were of two classes, babies and pre-school children. The former were weighed nude on a small beam scale with basket, the latter were weighed and measured on standard clinic scales. Lengths of babies were obtained with a measuring board improvised for the purpose.

b. Río Piedras school children were weighed and measured by one of us (E.M.R.) in the school year 1926–27, but subsequently all measurements were made by nurses. The equipment and methods were the same as in Yabucoa.

c. Measurements in Bayamón were made by a sanitary inspector who was given special training for the purpose. His equipment was a spring bath-room scale and a "metallic" tape measure.

The scale was frequently tested for accuracy and was set at zero before each reading. Height was measured by having the person

stand with his back to the wall and marking his height upon it. The distance of the mark from the floor was then measured. Persons in this group were measured without shoes.

The school children are not representative of all grades. They include nearly all of the children of the first and second grades in the respective municipalities but much smaller numbers of the higher grades were examined. The general population group measured in Bayamón, includes all persons found at home at the time of the inspector's visit. It is a selected group in the sense that it does not include those who were away from home at work or in school.

DISCUSSION OF METHODS

The omission of the removal of shoes was one of many measures adopted to simplify the examination in order to reduce the interference with schoolroom routine. Observation of the shoes worn by the children showed that many children, particularly in the rural schools, wore no shoes, more than half of the remainder wore shoes of the rubber soled, "sneaker" type which caused no appreciable error in measuring height, and nearly all of the leather heels which were worn were low. In cases where high heels were worn, the shoes were removed. Weighing and measuring with shoes tends to increase the number of children who appear to be underweight. This error is slightly aggravated in the case of judging children of Porto Rico by the Wood-Baldwin tables because the weights in these tables are based on children wearing the indoor winter clothing of the northern states. The weight of the clothing worn here is much lighter in weight. In this connection it is interesting to note that the new tables of Emerson and Manny (1929) are based upon weights and measurements with shoes and indoor clothing.

The generally accepted procedure in classifying children as to nutrition is to determine the age, height, and weight of each child and to compare the results with standards in tables which take all of these factors into consideration. We made an effort to obtain these three items of information in regard to each child but internal evidence in our records shows that in many cases we obtained erroneous statements of age. We are of the opinion that, while most ages are reasonably accurate, there is a sufficient number of errors to give rise to doubt of the value of the comparison of our results with the standard age-height-weight tables. Our observations in-

dicate that there is a tendency to overstate the age in the early years of school-life and the error would therefore be in the direction of causing an apparent increase in the number of underweight children.

COMPARISON OF RESULTS WITH WOOD-BALDWIN TABLES

The first tabulation of the results obtained is a comparison with the standards given in the Wood-Baldwin age-height-weight tables, which are in general use in the continental United States. Clark and Sydenstrecker (1923) and Turner (1929) have recently pointed out the error of placing too much stress on the results of such a comparison when applied to the individual case without supplementary clinical evidence. Turner has shown that in individual cases the methods of recording and computation permit an error as great as seven per cent. Dublin and Gebbart (1923) indicate that for the Italian chilrden of New York City the use of the standard tables fails to identify a sufficiently large proportion of the children who are classified on clinical grounds as undernourished. We recognize that these measurements show only a part of the picture but we present them because they can be readily compared with similar measurements which have been made elsewhere.

TABLE I

SCHOOL CHILDREN OF EACH AGE AND SEX FOUND UNDERWEIGHT IN YABUCOA AND RIO PIEDRAS
(Wood-Baldwin Tables)

(a) YABUCOA.

Age	Total children examined		7 per cent and more underweight				More than 10 per cent underweight				More than 15 per cent underweight			
	Boys	Girls	Boys		Girls		Boys		Girls		Boys		Girls	
			No.	P.C.	No.	P.C.	No.	P.C.	No.	P.C.	No.	P.C.	No.	P.C.
All Ages	587	570	218	37.1	272	47.7	102	17.4	142	24.9	27	4.6	50	8.8
6	37	64	21	56.8	27	42.2	6	16.2	14	21.9	1	2.7	3	4.7
7	102	95	41	40.2	44	46.3	19	18.6	15	15.8	1	1.0	4	4.2
8	82	72	30	36.7	35	48.6	9	11.0	16	22.2	4	3.9	5	6.9
9	69	62	25	36.2	21	33.8	11	15.9	11	17.7	1	1.4	3	4.8
10	54	67	13	24.1	35	52.2	6	11.1	19	28.4	1	1.9	6	9.0
11	47	58	13	27.7	31	53.4	6	12.8	15	25.9	.....	.....	4	6.9
12	81	57	27	33.3	29	50.9	11	13.6	16	28.1	5	6.2	5	8.8
13	54	60	21	38.9	31	51.7	14	26.0	19	31.7	5	9.3	9	15.
14	37	18	18	48.6	11	61.1	14	37.8	9	50.0	6	16.2	5	27.
15	17	14	6	.....	6	.....	4	.....	6	.....	2	.....	4	.....
16	7	3	3	.....	2	.....	2	.....	2	.....	1	.....	2	.....

(b) RIO PIEDRAS.

All Ages	1,479	1,541	564	38.1	743	48.2	263	17.9	400	26.0	72	4.9	164	10.6
6	52	59	17	32.7	23	39.0	5	9.6	6	10.2	0	.....	3	5.1
7	309	356	107	34.6	165	46.3	53	17.2	72	20.2	10	3.2	24	6.7
8	294	352	90	30.6	136	38.6	32	10.9	66	18.8	6	2.0	26	7.4
9	209	196	74	35.4	93	47.4	26	12.4	48	24.5	9	4.3	23	11.7
10	195	207	75	38.5	106	51.2	39	20.0	62	30.0	9	4.6	22	10.6
11	139	117	61	43.9	67	57.3	27	19.4	42	35.9	8	5.8	21	17.9
12	120	144	58	48.3	88	61.1	25	20.8	61	42.4	9	7.5	22	16.0
13	81	66	42	51.9	39	59.1	27	33.3	23	34.8	10	12.4	11	16.7
14	48	31	26	54.2	19	61.3	18	37.5	16	51.6	8	16.7	9	29.0
15	26	9	11	42.3	6	62.5	9	34.6	4	37.5	3	11.5	2	.....
16	6	4	3	.....	1	.....	2	.....	.....	.....	.....	.....	.....	.....

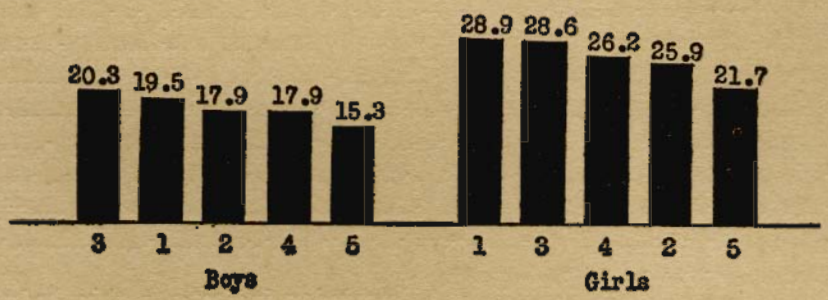
TABLE II

PERCENTAGE OF SCHOOL CHILDREN OF EACH AGE AND SEX MORE THAN TEN PER CENT UNDERWEIGHT IN YABUCOA AND RIO PIEDRAS (WOOD-BALDWIN TABLES) AND IN THE SERIES REPORTED BY CLARK AND SYDENSTRACKER FROM THE CONTINENTAL UNITED STATES (WOOD TABLES).

Age	Number of children examined						Percentage found more than ten per cent underweight					
	Clark and Sydenstrecker		Yabucoa		Río Piedras		Clark and Sydenstrecker		Yabucoa		Río Piedras	
	Boys	Girls	Boys	Girls	Boys	Girls	Boys	Girls	Boys	Girls	Boys	Girls
All Ages	5,073	4,936	587	570	1,479	1,541	19.5	28.9	17.4	24.9	17.9	26.0
6	231	223	37	64	52	59	14.3	13.9	16.2	21.9	9.6	10.2
7	503	489	102	95	309	356	13.8	16.8	18.6	15.8	17.2	20.2
8	603	572	82	72	294	352	20.3	21.5	11.0	22.2	10.9	18.8
9	634	637	69	62	209	196	18.6	29.1	15.9	17.7	12.4	24.5
10	691	593	54	67	195	207	20.1	27.8	11.1	28.4	20.0	30.0
11	610	567	47	58	139	117	18.0	35.9	12.8	25.9	19.4	35.9
12	573	569	81	57	120	144	21.3	36.6	13.6	28.1	20.8	42.4
13	489	512	54	60	81	66	20.4	35.7	26.0	31.7	33.3	34.8
14	369	400	37	18	48	31	22.2	36.1	37.8	50.0	37.5	51.6
15	227	229	17	14	26	9	23.9	30.5	16.7	33.3	34.6	37.5
16	107	145	7	3	6	4	31.4	21.7	.....	.....	.....	.....

FIGURE 1. DIAGRAM SHOWING COMPARISON OF PERCENTAGES OF SCHOOL CHILDREN FOUND MORE THAN TEN PER CENT UNDERWEIGHT IN THE FOLLOWING GROUPS:

1. Clark and Sydenstrecker series. (Wood tables.)
2. Río Piedras, urban children. (Wood-Baldwin tables.)
3. Yabucoa, urban children. (Wood-Baldwin tables.)
4. Río Piedras, rural children. (Wood-Baldwin tables.)
5. Yabucoa, rural children. (Wood-Baldwin tables.)



Tables I *a*, I *b*, and II also Figure I show the results of this comparison together with the results obtained by Clark and Sydenstrecker in the examination of 9,973 continental American school children.

The average percentage found more than ten per cent underweight in Yabucoa, and Río Piedras were nearly the same. The underweight groups of both sexes were smaller than the correspondings groups in the continental children, but the differences are not large enough to be regarded as significant. In the groups thirteen years of age and over there is a tendency for the Porto Rican children to show a greater percentage of underweights than the continental children. The numbers of children in these Porto Rican groups are too small to justify conclusions from them.

In all groups the girls show a larger percentage of underweights than the boys and in both sexes there is a tendency for the size of the underweight group to increase with age, but again, the small size of the higher age groups prevents interpretation of the results.

WEIGHT-HEIGHT RATIOS

It has been mentioned that we are not satisfied with the records of ages of school children as they were collected for our records and we have sought for some method of analyzing the data by which the consideration of age could be eliminated. Emerson and Manny (1929) from their unusual experience in health diagnosis, conclude that, "In the children's tables now in use, age complicates the problem without offering any real assistance or advantage to those using them". They have prepared a table of average and optimum weights for height by modifying the Wood-Baldwin tables and the medico-actuarial tables to form a continuous unit. Bardeen (1920) and Jackson (1925) emphasize the need of a height-weight ratio independent of age and both summarize the efforts of previous workers to devise such an index. Because the volume and weight of the body must vary according to the cube of its linear dimensions they recommend an index which will express this ratio. The most convenient form is the relation of the weight to the cube of the height. This has been previously tried in various forms but Bardeen adopts a modification of Rohrer's "Körperfülle-index" which may be expressed as $1000 \frac{(Weight\ in\ Pounds)}{(Height\ in\ inches)^3}$. A low index indicates a thin body, a high index a stocky or fat body. Because the relation of the weight of the body to the cube of the height changes with the dif-

ferent stages of the growth of the body this index is not constant. Bardeen has used data which are available from measurements of children made by many observers and from them has computed a curve for each sex which shows approximately the changes in the index during the period of growth. This curve shows the high index of the fatter bodies of babyhood, the rapidly decreasing index of childhood, a period in which the boy becomes more slender, and the relatively more constant index during the later years of growth.

For practical use of Bardeen's curve we depend upon the fact that one of the first effects of inanition is to reduce the fat and to cause the body to have more slender proportions so that a lower index results. Jackson (1929, pp. 86 and 88) has applied the index to two series of such cases and has demonstrated graphically that famine cases and many hospital cases show results far below the values represented in Bardeen's curve. We have applied the same test to our measurements of school children and to other data, using the average weight found for each inch of height, instead of charting the index for each individual, as was done by Jackson. We have also computed the indexes for the results published by Miss Bary (1923, pp. 43) and those for the average weights for each inch of height given in the Wood-Baldwin tables. With the results from the Wood-Baldwin tables we have included the changes suggested by Emerson in the higher groups to bring the values into line with his experience and to articulate the table with the medico-actuarial tables. The graphic representations of the results of these computations are shown on Figures II, III, IV and V.

COMPARISON OF PORTO RICAN DATA WITH BARDEEN'S CURVE

Figures II and III show Bardeen's curve as a heavy line making a smooth curve, the values calculated from the average weights for each inch of height as given in the Woodbury and the Wood-Baldwin Tables as a light continuous line and similar values obtained from the results of measurements of children in Yabucoa and Río Piedras as a dotted line. Figure II represents the data from males and Figure III those from females. The line representing the data from the Woodbury and the Wood-Baldwin tables bifurcates near its termination. The upper division represents values obtained by the use of averages suggested by Emerson instead of those given in the standard table.

We have included results obtained from measurements of children from twenty inches to sixty-seven inches. The school children

are represented in each sex by those portions of the line from thirty-six inches in height upwards, although there was a slight overlapping with the pre-school group between thirty-six inches and forty-three inches.

TABLE III

CHILDREN MEASURED IN YABUCOA AND RIO PIEDRAS CLASSIFIED BY HEIGHT IN INCHES WITH HEIGHT INDEX

$1000 \frac{\text{weight in pounds}}{(\text{height in inches})^3}$ **for mean weight for each inch of height**

Height in inches	Males			Females		
	Number measured	Average weight	Index	Number measured	Average weight	Index
20	5	9	1.125	2	9	1.125
21	4	8.5	.918	7	8.9	.961
22	10	13.9	1.31	10	11.6	1.09
23	9	12.4	1.02	15	12.6	1.04
24	6	13.2	.955	8	13.4	.970
25	17	15.4	.985	19	15.8	1.01
26	13	15.4	.876	9	17.3	.984
27	16	17.8	.904	15	16.9	.859
28	11	19.1	.870	11	16.5	.752
29	13	19.6	.804	15	19.3	.791
30	16	19.8	.733	16	21.0	.778
31	10	21.4	.718	22	21.5	.722
32	17	22.0	.671	15	22.9	.699
33	12	25.0	.696	21	23.4	.651
34	13	27.3	.695	17	26.2	.667
35	29	28.1	.655	11	28.0	.653
36	17	28.94	.620	20	31.45	.674
37	14	32.50	.642	20	33.25	.656
38	16	32.38	.590	25	32.76	.597
39	27	34.81	.587	39	33.97	.573
40	45	38 29	.598	60	36.45	.570
41	56	40.38	.586	64	38.61	.560
42	72	40.72	.550	109	38.16	.515
43	107	41.62	.523	105	40.92	.515
44	140	43.11	.506	139	41.76	.490
45	160	44.99	.494	161	43.98	.483
46	184	46.16	.474	173	45.90	.472
47	159	49.18	.474	159	47.75	.460
48	133	51.20	.463	121	48.85	.442
49	135	53.70	.457	137	52.26	.444
50	132	55.70	.446	116	54.87	.439
51	108	58.59	.442	130	57.43	.433
52	126	61.16	.435	113	59.65	.424
53	105	62.26	.418	90	63.23	.425
54	83	66 05	419	73	65.18	.414
55	71	69.23	.416	75	69.07	.415
56	60	71.53	.407	58	74.77	.426
57	56	76.21	.411	62	77.44	.418
58	41	80.68	.414	45	81.98	.420
59	33	83.12	.405	43	88.70	.432
60	16	87.38	.405	28	91.18	.422
61	23	91.87	.405	25	95.64	.421
62	9	97.89	.411	13	98.23	.412
63	19	103.32	.413	7	103.43	.414
64	16	103.81	.396	6	96.67	.369
65	2	119.5	.435	1	104.	.379
66	2	109.	.379	1	103.	.358
67	5	118.8	.395			
68	3	116.	.369			
	2,375			2,431		

The number of babies measured was too small to justify an attempt to interpret the results shown, even were the standards for

this period of development sufficiently well established for the purpose. In the group from the pre-school clinic the numbers examined were small but the results are sufficiently consistent to raise the suspicion that the children in this period of development are not kept up to the physical standard shown by those in later years.

It is striking how closely the results obtained in the measurement of school children follow the Bardeen curve in both sexes. It must be recalled here, however, that the Bardeen standard was computed on the basis of measurement without clothing while the Porto Rican children were measured with clothing. The correction for this difference might have a tendency to depress the curve for Porto Rican school children, but it is not known how much influence was exercised on the averages by those children who wore shoes which increased their height. Correction of the height would have a tendency to raise the weight-height index. In either case there is no likelihood that corrections would produce a significant difference between the values obtained for the Porto Rican children and those given by Bardeen.

Among the children with heights from thirty-six to forty-five inches there was also a close correspondence with the values obtained from the Wood-Baldwin averages. Children with heights greater than forty-five inches had averages which were consistently lower than the averages given by the tables and those given by Emerson. It is doubtful whether the differences shown between the curves for the boys can be regarded as of serious significance. The curves for girls are farther apart, but judgment must be withheld until a larger number of children, especially those in the older age groups, are measured. Reference to Table I will show that only seventy-nine of the girls measured were more than thirteen years of age and only thirty were of more than fourteen years. Many of the taller girls had reached the difficult period of pubescence but few had passed it.

Figure IV presents the Bardeen curves for males and females together with the results obtained from measurement of persons found in their homes in rural communities near Bayamón. On this figure it was necessary to indicate by broken lines those portions of the curves for which we obtained no data. The chief observation to be made from the examination of these curves is that the measurement of the general population of this community, when compared with the Bardeen standard, gives results not unlike those obtained by the measurement of the school children.

TABLE IV

GENERAL POPULATION MEASURED IN RURAL AREA OF BAYAMON, CLASSIFIED BY HEIGHT IN INCHES, HEIGHT-WEIGHT INDEX FOR MEAN, WEIGHT FOR EACH INCH OF HEIGHT.

Height in inches	Males			Females		
	Number measured	Average weight	Index	Number measured	Average weight	Index
26	2	15	.853	3	15.6	.887
28	.....	.....	.....	2	18.5	.843
29	1	20.	.821	2	20.5	.846
30	2	24.5	.907	.....	.....	.....
31	2	27.	.906	.....	.....	.....
32	2	22.5	.687	1	23.	.702
33	3	34.	.945	3	23.6	.656
34	6	28.3	.720	1	26.	.661
35	5	29.	.676	4	34.5	.804
36	4	29.5	.632	4	26.2	.562
37	6	30.5	.602	5	33.6	.664
38	6	35.6	.648	5	32.2	.586
39	5	33.4	.563	5	32.6	.549
40	6	33.2	.519	9	33.2	.519
41	6	36.5	.530	1	32.	.464
42	4	37.	.499	5	37.	.499
43	5	40.6	.510	6	41.6	.522
44	5	42.8	.503	5	42.4	.497
45	7	46.1	.506	2	44.5	.489
46	3	45.	.463	1	48.	.493
47	3	53.7	.517	2	47.5	.457
48	6	49.8	.451	4	60.7	.549
49	2	50.5	.429	13	54.2	.461
50	9	51.7	.414	3	51.6	.412
51	2	57.5	.433	8	66.1	.498
52	4	59.	.420	2	59.	.420
53	4	61.7	.415	2	57.	.383
54	3	66.7	.423	4	66.8	.424
55	2	67.5	.405	6	77.8	.467
56	3	73.3	.417	2	72.	.409
57	1	60.	.373	9	92.7	.500
58	.....	.....	.....	15	93.1	.477
59	.....	.....	.....	17	97.6	.476
60	.....	.....	.....	29	108.7	.503
61	5	114.4	.504	29	98.9	.436
62	7	112.9	.473	18	105.	.441
63	7	106.7	.427	9	116.4	.466
64	14	118.2	.451	9	126.9	.484
65	6	122.	.444	9	127.9	.466
66	12	129.2	.449			
67	8	128.3	.427	254		
68	3	145.6	.463			
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Figure V illustrates the comparison of the results obtained by Miss Bary in the measurement of 7,632 school children in Porto Rico. Her results give consistently higher indexes than those obtained by us. Whether or not the differences are significant must remain for determination through future study. The very high values obtained for heights less than forty inches are no doubt due to the small number (seven) of children included in those groups.

DISCUSSION OF RESULTS

Averages of measurements of large groups obscure the variations

which should be seen in order to have a complete understanding of the nutrition of the individual members of the groups. Our records show the presence in these groups of persons with undoubted nutritional defects. Considered as individuals some of these cases were striking but when their measurements are included in the averages of the groups and the results are compared with those of similar work in other countries the differences are not striking. One important conclusion to be drawn is that the average parent of the school child in the communities where these measurements were made was getting surprisingly good results from such facilities as were available to him for feeding his children. It is generally believed that in some respects the food supplies are incomplete and that food habits could be improved so that better results would be obtained from the available supplies. Since our results do not show a gross difference in physique between the children measured and those in the continental United States, it is suggested that such important defects of nutrition as exist may be, not in the lack of a sufficient quantity of food, but may be qualitative, due to deficient amounts of specific elements.

We suggest that the search for defects in nutrition and the study of their nature should be continued and that it should be intensified, with the use of more refined methods. While the height-weight ratio is regarded as the best single index by which to judge nutrition, it is not the only standard. Continued study with more complete clinical examinations will probably yield the information which must be obtained before successful education of the people in food habits can be carried out.

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FIGURE II. HEIGHT-WEIGHT INDEXES OF BOYS MEASURED IN YABUCOA AND RIO PIEDRAS COMPARED WITH BARDEEN'S CURVES AND WITH HEIGHT-WEIGHT INDEXES CALCULATED FROM THE AVERAGES IN THE WOOD-BALDWIN TABLES.

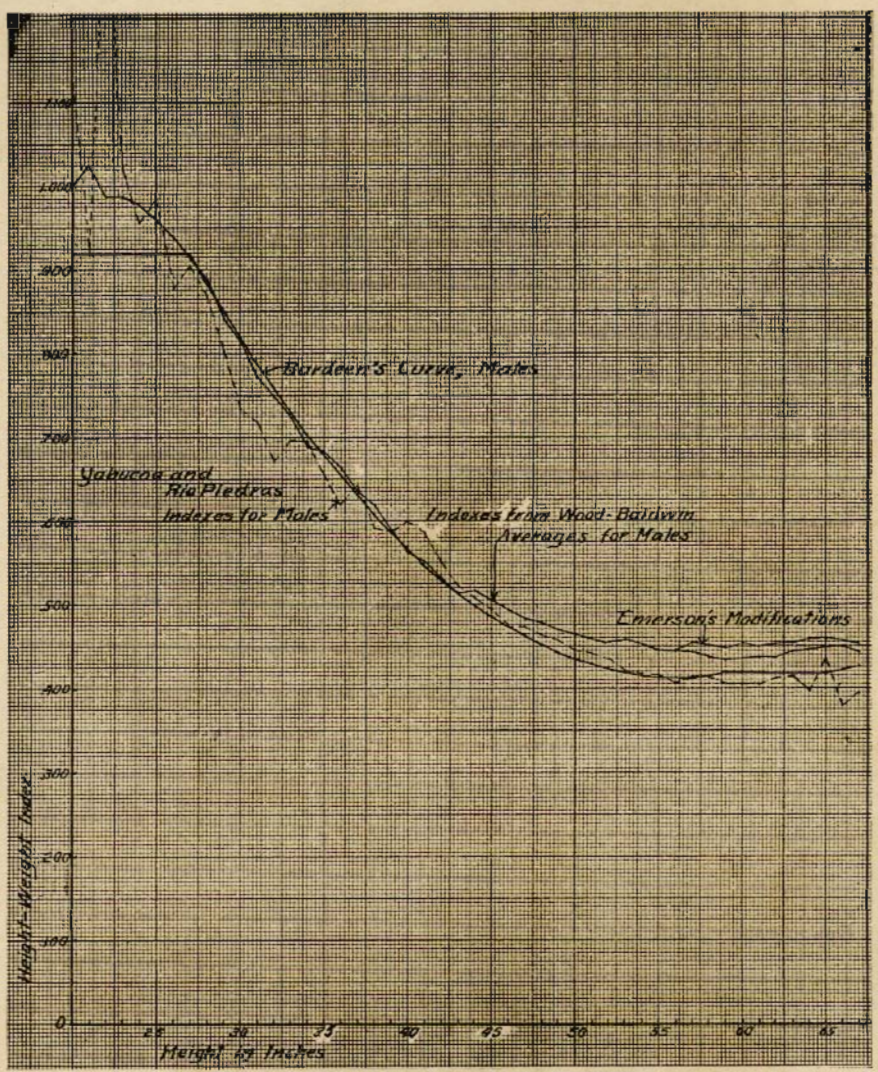

FIGURE III. HEIGHT-WEIGHT INDEXES OF GIRLS MEASURED IN YABUCOA AND RIO PIEDRAS COMPARED WITH BARDEEN'S CURVES AND WITH HEIGHT-WEIGHT INDEXES CALCULATED FROM THE AVERAGES IN THE WOOD-BALDWIN TABLES.

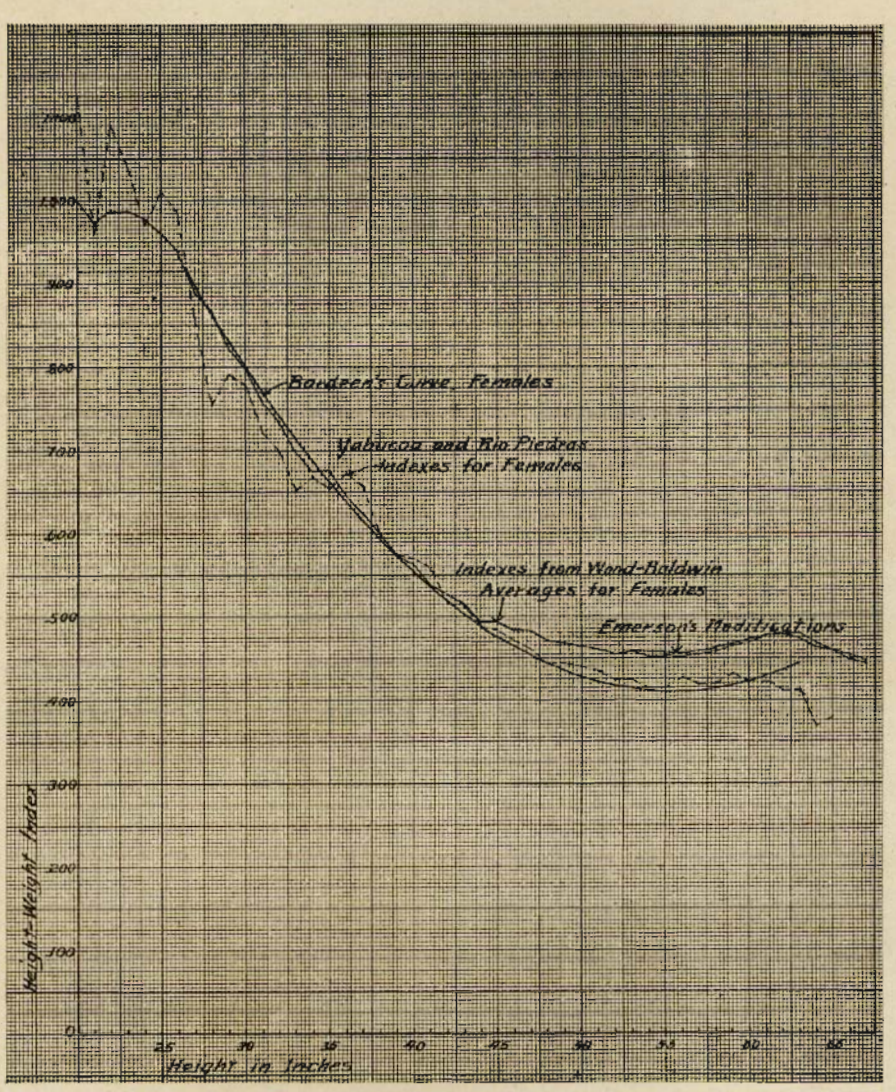

FIGURE IV. HEIGHT-WEIGHT INDEXES OF CHILDREN AND ADULTS MEASURED IN THE RURAL PORTION OF BAYAMON, COMPARED WITH BARDEEN'S CURVES.

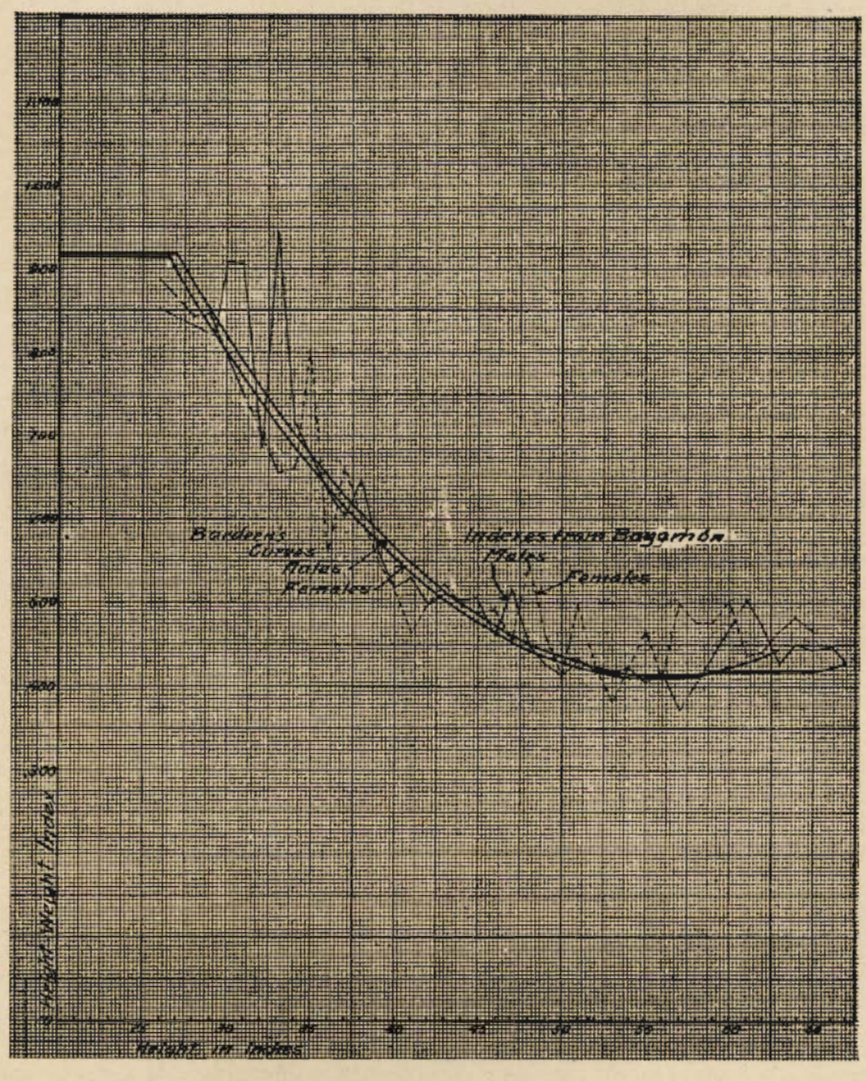

FIGURE V. HEIGHT-WEIGHT INDEXES OF SCHOOL CHILDREN WHOSE MEASUREMENTS ARE REPORTED BY MISS BARY, COMPARED WITH BARDEEN'S CURVES.