PROPOSED WEIGHT AND HEIGHT STANDARDS FOR 0-19 YEAR OLD FILIPINO CHILDREN

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ABSTRACT

This is a collaborative study between the Food and Nutrition Research Institute and the Philippine Pediatric Society with the objective of developing anthropometric standards for nutritional and clinical evaluation of 0-19 year old Filipino children. A three-stage cluster sampling was utilized in defining the study population. The sample totalled 26,961 children from all regions of the country except Region IX and XII. Of these 23,660 children adjudged clinically and physically healthy with an ethnic background of less than 1/4 foreign blood were included in the construction of the proposed standards. Descriptive analysis was used to characterize the data. Using the cubic spline technique to smooth out the observed data, centile tables and curves from birth to 19 years for weight-forage, height-for-age, and weight-for-height were derived. These tables and curves representing the distribution of the current crop of apparently healthy Filipino children would be useful in assessing the growth of a given child. On a community basis, these reference data may be used to define the extent and severity of over- or under-nutrition. The data, however, will need to be validated in the field to define cut-off points for defining malnutrition before they can be used for the latter purpose.

Introduction

Standards for growth provide a means by which to check whether a child's body size is increasing, entering a period of stability, or declining⁽¹⁾ In the clinic, the pediatrician utilizes growth standards to assess nutritional status or monitor growth of individual children. Deviations from normal standards, curves and channels of growth may indicate pathological conditions. Thus, failure to gain weight in children may indicate malnutrition or some other disease.

In the community, standards are used to define the extent and severity of under- or over-nutrition. Such information will, in turn, provide basis for nutrition program planning and screening for intervention programs. A good example is Operation Timbang where all children in the community are weighed and the proportion of children belonging to various categories of weights compared with standards are used for community diagnosis. Even more recently, the National Nutrition Council has adopted growth monitoring of individual children in the community as a preventive measure against growth faltering of children and as an entry point for nutrition and health interventions.

Review of Literature

International standards

For many years, the so-called Boston and Iowa standards were used in many parts of the world including the Philippines to assess growth of children. The Boston or Stuart standards were taken from data collected in 1930-39 on a small sample of relatively well-nourished Caucasian children in the United States⁽²⁾. These data are often combined with the Iowa or Meredith reference population data compiled from a survey done in 1923 on a small population of Caucasian school age children.

In 1974, the National Center for Health Statistics (NCHS) came out with standards derived from a large sample of healthy children in the U.S. from all ethnic and socio-economic groups.⁽³⁾ The data were made available in percentile and SD scores using the least squares cubic spline technique of DeBoor and Rice⁽⁴⁾ to smooth the data. These values, together with additional values from birth to three years from the Fels Research Institute, were then recommended by the World Health Organization for international use for infants and young children irrespective of ethnic group.⁽⁵⁾ This was based on the finding that the variability arising from ethnicity in the early years of life were much less significant than the variability arising from socio-economic and nutritional factors. Thus, it was averred that infants and young children from developing countries could reasonably use such standards as reference values especially in the absence of good local standards. For older age groups, however, the effect of genetic potential becomes increasingly apparent thereby making local standards necessary.

Local standards

The weight-for-age and height-for-age standards for Filipino children recommended by Bulatao-Jayme *et al.* in 1971⁽⁶⁾ were based on nationwide nutrition survey data collected in 1958-1968 on more than 9,000 individuals of all ages. Since the data included undernourished children, the values recommended as reference standards for Filipino children were the 90th percentile of the data except for ages 0-6 months where sliding percentiles from P_{50} to P_{90} were used. The decision to use the 90th percentile was based on comparisons with limited data from high income children as well as with some weight-for-height indices of nutritional status. The standards were recommended as temporary pending collection of data on healthy children. Nevertheless, these standards have been used extensively since they came out in 1971. It should be borne in mind, however, that these standards conform to the growth pattern of high income children with which the data set was compared and not necessarily to the growth pattern of healthy Filipino children irrespective of socio-economic status and geographic location. At best they represent the potential that Filipino children can reasonably achieve given the conditions of children of high socio-economic status.

More recent studies in FNRI confirmed the position of the 1971 standards particularly with respect to boys. Data from high income children collected by Magbitang *et al.*⁽⁷⁾ on 4-18 year olds and Baltazar *et al.*^(8, 9) on 0-18 month olds and 4-12 year olds showed that growth curves of young boys from high income families more or less coincided with the 1971 recommended Philippine standards. However, for girls especially at the older age groups, the curves were lower than the standards by as much as 6 cm for height and 3 kg for weight. Comparison of these data with NCHS curves showed that even high income children could only come up to the 25th percentile of the international standards.

Briones et al.⁽¹⁰⁾ did a longitudinal study from 1969 to 1981 covering the age group birth to 12 years. There were 490 subjects initially, but this number went down to less than a hundred towards the end due to missing observations. Only healthy, well nourished children with no genetic or developmental aberrations were included in the study. The parameters collected were weight, height and head circumference.

Santos-Ocampo *et al.* have recommended the use of data they collected from Filipino infants and children belonging to middle socio-economic classes as a useful guide in the assessment of a child's development from birth to 14 years of $age^{(11)}$. The data on infants were collected from well-babies followed up from birth at monthly intervals up to 2 years. The data on older children were taken at half year interval in a group of boys and girls from 2 to 14 years of age. About 100 per sex and age group were included in the derivation of standards.

Construction of local standards

In 1972 the International Union of Nutritional Sciences (IUNS) proposed several criteria that should be followed in the construction of local and international reference standards.⁽¹²⁾ The task force recommended that the data set from which the standards are to be derived should be large with a minimum of 100-200 children per age group and representative of the healthy children population. The data should be cross-sectional. The sampling procedure should be defined and reproducible. Measurements should be carefully taken and recorded by trained observers, using equipment of well-tested design and calibrated frequent intervals. Furthermore, local reference standards should be representative of the ethnic and genetic mix of the population being studied. In addition, local standards should be monitored every few years to detect secular changes.

None of the present standards and data sets available in the Philippines today satisfy the above criteria. The 1971 FNRI standards were arbitrarily set at the 90th percentile of the general population distribution which included non-healthy children. As mentioned above, the 90th percentile at best represents the growth pattern of high income children and not of healthy children from all socio-economic strata. As a matter of fact, studies on high income children showed that the standards seem to be too high especially among girls and older children. The data of Magbitang *et al.* and Baltazar *et al.* were again from high income children in the Metro Manila area. The data of Briones *et al.* and Santos, Ocampo *et al.* were based on longitudinal observations in the Metro Manila area on inadequate number of subjects.

Thus the present study, a collaborative effort between the Food and Nutrition Research Institute and the Philippine Pediatric Society, was conceived to develop new anthropometric standards of Filipino infants, children and adolescents based on a sufficiently large cross-sectional sample of healthy children from as wide a geographic distribution as possible and irrespective of socio-economic class. Specifically, the objective was to derive reference tables and curves for length/ height-for-age, weight-for-age, weight-for-height, crown-rump length/sitting heightfor-age, skinfold thickness and circumferences of mid-upper arm, chest and head, that might serve as standards for clinical and nutritional evaluation. The standards are intended to serve as reference with which to compare children with the distribution of the current crop of apparently healthy Filipino children. This paper describes briefly the methods that were followed in the derivation of the proposed standards and the results for the first three parameters. Those for the other parameters will be presented in a subsequent report.

Methods

Sampling design and selection

For the preschoolers, a stratified three-stage cluster sampling design was used, with the province as the primary sampling unit, the municipality and the city as the secondary sampling unit and the barangay as the tertiary unit. Using a complete list of preschoolers in the sample barangay, all households with preschoolers were notified to bring their 0-6 year old children at the barangay center or health unit. All children were examined and measured for the study. When necessary, several rounds of collection were made in order to include all children in the community.

In the case of the school age group (i.e., those aged 7-19 years), the same procedure was followed for the first three stages of selection, but some modifications were adopted after the tertiary level. Instead of gathering children from the households, it was deemed more convenient and practical to locate children in these age groups in schools. Since, in almost all cases, a barangay had either only one school in it or none at all, the rule followed in sample selection was to take the school located in the sample barangay, or the school nearest to it in the case of barangays without schools. The same rule was followed in the selection of high schools and colleges or universities where adolescents could be located. After the school had been selected, a random sample of classes were selected from each grade. A list of students from the selected classes were then requested from the teachers, from which a systematic random sample was drawn for inclusion in the study. The target population for the survey were those aged 0-19 years in all provinces nationwide, except for those in Samar Island and the provinces in Regions IX and XII. The provinces in these areas were excluded due to peace and order problems which made it risky for data collection. The stratification variable for the survey was the region. The survey covered 11 strata corresponding to 11 out of 13 regions in the country including Metro-Manila.

Estimation of sample size

The sample included two sample provinces per region, two municipalities or cities per province, and two barangays as well as two schools per municipality or city. In Metro-Manila, two municipalities or cities were randomly selected. The decision to take a sample size 2 per sampling unit was a compromise between the need to contain the geographic areas covered by the survey in order to meet budgetary and time constraints, and the need to include more than one primary sampling unit per stratum to enable the estimation of standard errors for the corresponding estimates derived from the survey. In the case of Region VIII, however, only one province (Leyte) was included since Samar Island was earlier excluded due to peace and order problems.

Since the ultimate end of the survey was to derive standards for each age and sex group, these were considered as the domains of analysis and were regarded as such in estimating sample size requirements. This means that a separate sample size was computed for each age-sex category. All in all, the survey dealt with 62-sub-groups which included 31 age categories (0-11 months by single months and 1-19 years by single years) for each sex. For each of the 62 sub-groups, sample sizes were computed using the standard deviations of the estimates or weight-for-height by age and sex derived from the Nationwide Nutrition Survey conducted by FNRI in 1982⁽¹³⁾. For purposes of sample size commutations, the maximum permissible error was set at 5% of the corresponding estimates derived in the 1982 survey, with reliability coefficients also set at 5%. After the sample size requirements were determined using purely statistical considerations, further modifications were made to fit budgetary and logistic constraints. The actual sample size covered varied slightly as a natural outcome of cluster sampling as well as other factors.

Initial sample size estimates using 95% precision are shown in columns 2 and 3 of Table 1. These were rounded off to the nearest tens (col. 4 and 5) resulting in a grand total of 19,120. Percent of total for each sex-age group was computed (for less than one year, for example, $150/19120 \times 100 = 0.785\%$). These percentages were then used to compute the targeted sample size with 28,000 as the total target (0.785% x 28,000 = 220). These sample sizes were later proportionally allocated to the different provinces/schools based on actual population in the area.*

^{*}The target sample size of 28,000 was arrived at because of the need to come up with a weight-for-height table where a minimum of 500 subjects by age and sex group was deemed necessary. In addition, allowance was made for the inclusion of "non-healthy" children.

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Age	Initital sa 95% pr	Modifi S	ed sample ize ¹	Targeted sample size ²		
	Male	Female	Male	Female	Male	Female
Less than 1	142.42392	164.061559	150	170	28603	32374
1	74.608708	167.031852	100	175	146	256
2	120.29085	79.78631207	130	100	190	143
3	320.2316744	124.5542482	310	130	454	188
4	160.9410398	159.298171	165	165	242	244
5	173.621432	197.5327681	175	205	256	299
6	129.8601949	341.7764462	135	350	198	513
7	192.2286725	301.7764462	200	310	293	454
8	355.5327541	384 6040913	350	400	513	586
9	324.283951	486.8854225	350	500	513	732
10	372.2657325	704.7478499	400	710	586	1040
11	220.8583621	612.3766259	230	620	337	908
12	582.1888427	546.2780	600	560	879	820
13	474.05333	873.987167	500	900	732	1318
14	527.05333	524.35578	530	535	776	783
15	441.10396	546.48341	450	555	659	813
16	560.40412	593.48072	570	600	835	879
17	419.77244	838.85235	425	845	622	1237
18	406.45988	553.16843	410	560	600	820
19	509.73764	508.85006	515	515	754	754

Table 1. Sample size estimation

¹Initial sample size rounded-off

²Based on percent of total target (28,000) by age and sex

³Sample size of 220/month for 0-11 months.

⁴Sample size of 249/month for 0-11 months.

Field data collection

A. Teams

A total of eight survey teams spread out in all regions of the country except Regions IX and XII to examine the subjects and do measurements. Each team was composed of an FNRI physician, two researchers and another physician provided by the Philippine Pediatric Society (PPS). The latter physician who was either a PPS member or a pediatric resident joined the survey either on a part-time or fulltime basis and did the physical examination of the subjects independently and declared the health status of the children separately from the FNRI physician in the team. Before the actual field data collection, the physicians and researchers were trained for two weeks including a field practicum on conducting physical examination and taking of anthropo-metric measurements.

Two teams were assigned in a province, and each team in turn covered one municipality or city as the case may be. In all, 131 physicians were provided by the PPS from all over the survey areas in the Philippines.

B. Mechanics and activity sequence

The weighing scales were first calibrated in the Test and Standards Laboratory of NSTA before field data collection and were again calibrated in the field before each weighing session using a 2 kg weight. The weighing scales were recalibrated by the Test and Standard Laboratories of NSTA in Cebu City.

The collection of data was generally done in fairly the same systematic way by each team in all the survey areas covered.

The equipment and instruments were first set up before the parent or subjects were interviewed to facilitate systematic flow of data collection. General information (name, birthday, sex, school or home address, ancestry, etc.) was first obtained for each subject. Using standard methods of Jelliffee⁽¹⁴⁾ described in the manual of instructions, anthropometric measurements (weight, length/height, arm length, crown-rump length/sitting height, and mid-upper arm, chest and head circumferences) were carefully taken and recorded successively by the FNRI technicians. Weight was taken in light clothing without shoes with a platform weighing scale and read to the nearest 0.02 kg. Recumbent length was taken of children less than 2 years of age with a portable measuring board, while standing height was taken of children 2 years and over using a steel tape attached to a smooth wall. Readings of length and height were made without shoes to the nearest 0.1 cm. Afterwards, the FNRI physician took the skinfold measurements and proceeded to a physical examination of each child using a standard form. The physician evaluated each subject's general appearance and body build and if normal in these respects, proceeds to do a complete physical examination (including assessment of sexual maturation) to detect any pathological condition or abnormality. History of recent illness was also obtained, and finally the physician assessed whether the findings could likely affect the child's growth and development. The PPS counterpart did an independent examination of all subjects. Any disagreement between them with regards to the health status of the child would disqualify the child in the data analysis for construction of standards. However, as per experience of some teams, cross examination could not always be possible due to the limited time that the PPS doctors could stay with the team in the collection of data. However, for subjects who were examined by both PPS and FNRI physicians the percent agreement in terms of whether the child was healthy or not was 95%.

Clinical examination and description of subject population

The subjects who were included in the creation of the standards were only those who were apparently healthy as judged by the physicians. They were those considered mesomorphic* neither asthenic (+ or ++) nor endomorphic, neither

^{*}Mesomorphic – individuals with an average or good muscular development and of the athletic type characterized by strong robust, active body with good agility. Asthenic (+) – individuals with slight or slender body build, fragile but active, Asthenic (++) – individuals who are markedly thin, with slight muscular development, weak, debilitated and wasted. Endomorphic – individuals with pyknic type of body build characterized by shortness of stature, broadness of girth and with powerful musculature.

pathologically short nor tall, and without debilitating illness like heart, lung and kidney diseases or physical deformity that can affect height and weight. The child in the previous two weeks should not have experienced any diarrheal episodes or other illness that may have an impact on his weight. Their foreign blood if any should be less than one-fourth.

In general, children suffering from conditions that may clinically affect the nutritional status of the child were excluded in the creation of standard. However, physicians proceeded with the physical examination even if the child was diagnosed in physical appearance as asthenic or endomorphic, and all anthropometric measurements were still taken.

Hence the subjects that were finally included in the creation of the standards were clinically and physically healthy at the time of examination, with an ethnic background of less that 1/4 foreign blood.

Mode of data analysis

Estimation of Parameters:

Age was computed by taking the difference between the date of collection and birthdate and expressing it in completed years and months.

For each type of anthropometric measure considered in the survey, the following computations were done:

A. Computation of percentiles

The specific percentiles computed for each anthropometric measure were P_3 , P_{10} , P_{25} , P_{50} , P_{75} , P_{90} , P_{97} . The observed figures for each of these were then smoothed (see below) and compared with corresponding values in the existing standards (e.g., NCHS).

B. Computation of the mean of each parameter

In addition to the percentiles, the mean and standard deviation of each anthropometric measure considered were also computed. Since the sampling design used did not result in equal probabilities of selection for the different sampling units, it was necessary to compute and apply sampling weights in order to come up with unbiased estimates of the sample mean. Unfortunately, the computation of sampling weights was possible only for the estimates for the pre-school age groups but not for the school age groups because for the latter, not all the necessary data were available or were recorded.

C. Computation of the standard errors of the mean

In addition to the computation of the means of the different parameters, it was necessary to compute for the corresponding standard errors in order to assess the precision of the derived estimates. Moreover, such standard errors were needed in order to construct confidence interval estimates for the parameters or do tests of significance.

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Since the survey used a complex sampling design, the standard errors were computed by applying Taylor's linearization procedure and the concept of "ultimate clusters" as defined by Hansen, Hurwitz and Madow (1953).

D. Curve fitting

The cubic spline technique was used to fit smooth curves to the data collected.⁽¹⁶⁾ This procedure was used because it was observed that data on anthropometric measures vary in such a way that a single polynomial equation may not to able to describe it. The equation was applied on three successive portions of the curve, 0-3.25 yrs. 3.25-10.25 yrs, and 10.25-19.75 yrs. Since this resulted in discontinuities at the junctions of the curves, these junctions were smoothed out by visual inspection and arithmetic interpolation.

E. Assessment of the precision of the estimates

One way of evaluating the usefulness of the estimates derived from this survey is to determine their precision. The more precise they are, the more confident one will be in applying the results to similar or comparable groups.

To measure the precision of the estimates derived from this survey as an index of the statistical quality of the estimates, the coefficient of variation of the estimate of the mean of each parameter for each age and sex group was computed.

Results and Discussion

Of the 26,961 subjects examined, 23,660 were included in the analysis for the construction of standards, of which 44.9% were boys and 55.1% were girls. Excluded were the asthenic (+) children (9.33%); asthenic (++) (0.96%); endomorphic or obese (0.59%); those who were not healthy due to organic pathology (0.98%); those who had more than 1/4 foreign blood (0.04%).

The distribution of subjects by age and sex is shown in Table 2.

Observed values

Tables 3 and 4 give the observed values of weight and height by age at for both sexes. It can be noted that the mean of the observations were very close to the median, indicating general absence of skewness in the data. Tests of normality at each age also indicated normal distributions, again pointing to the homogeneity of the data. Except for the first month, the coefficients of variation were way below 30% (range, 1% to 17% for the various age groups indicated), indicating reasonably good precision of the estimates. The NCHS data show coefficients of variation of about 9% to 16%. Incidentally, the coefficients of variation at early infancy and during the pubertal period are higher than at other periods of childhood, indicating greater variability of data during the former periods.

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AGE*	Males	Females	AGE	Males	Females
Months			7.0	267	348
0	56	42	7.5	204	207
1	27	31	8.0	350	432
2	31	58	8.5	234	280
3	55	39	9.0	307	430
4	67	35	9.5	266	320
5	52	39	10.0	364	548
6	36	51	10.5	277	377
7	62	44	11.0	303	529
8	37	45	11.5	245	387
9	43	40	12.0	404	531
10	59	35	12.5	383	414
11	61	35	13.0	433	625
Years			13.5	321	510
1.0	195	191	14.0	360	471
1.5	178	207	14.5	341	411
2.0	193	180	15.0	321	429
2.5	194	208	15.5	351	477
3.0	178	184	16.0	430	532
3.5	196	191	16.5	309	402
4.0	156	157	17.0	334	468
4.5	190	214	17.5	264	363
5.0	170	171	18.0	244	252
5.5	177	221	18.5	198	186
6.0	185	227	19.0	201	307
6.5	191	238	19.5		

Table 2. Distribution of subjects by age and sex

*Completed month or year

Table 3. Observed values of weight-for-age, boys and girls

	BOYS				GIRLS					
AGE*	Median	X	SD	CV	Median	x	SD	CV		
Months										
0	3.38	3.41	0.55	30.69	3.10	3.23	0.65	24.50		
1	4.90	4.88	0.84	4.11	4.45	4.40	0.52	2.45		
2	5.62	5.68	0.85	1.28	5.00	5.15	0.79	5.73		
3	6.00	6.05	0.84	7.40	5.40	5.61	0.67	14.19		
4	6.60	6.63	0.89	10.20	6.05	6.13	0.77	6.15		
5	7.05	7.18	0.84	5.17	6.60	6.61	0.96	8.78		
6	7.10	7.12	0.99	7.00	6.90	6.82	0.86	6.13		
7	7.60	7.56	0.80	9.74	7.02	6.91	0.66	3.84		

		BOYS					GIRLS	
AGE*	Median	x	SD	CV	Median	x	SD	CV
8	7.75	7.83	0.83	4.91	7.10	7.20	0.86	6.79
9	8.10	8.10	1.07	6.22	7.40	7.47	0.98	6.60
10	7.90	8.04	1.16	7.67	8.00	7.80	1.07	10.90
11	8.20	8.14	1.08	5.41	7.60	7.82	1.46	5.33
Years								
1.0	8.90	8.33	1.16	13.10	8.10	8.24	1.07	12.97
1.5	9.70	9.88	1.28	12.95	9.00	9.13	1.20	13.14
2.0	10.60	10.70	1.31	12.28	10.15	10.28	1.32	12.82
25	11.50	11.59	1.61	13.86	11.00	11.14	1.48	13.31
3.0	12.50	12.55	1.48	11.79	11.70	11.90	1.65	13.87
3.5	13.25	13.30	1.59	11.96	12.60	12.92	1.78	13.77
4.0	13.70	13.89	1.84	13.24	13.65	13.72	1.69	12.30
4.5	14.55	14.84	2.05	13.78	14.10	14.24	1.81	12.70
5.0	15.10	15.33	1.92	12.53	14.80	14.97	1.88	12.52
5.5	16.10	16.12	1.71	10.64	15.70	15.85	1.87	11.78
6.0	16.78	16.94	1.84	10.88	16.50	16.60	1.90	11.45
6.5	17.80	17.96	2.10	11.72	17.50	17.66	2.23	12.63
7.0	18.60	18.63	1.88	10.06	17.90	18.08	2.32	12.82
7.5	19.40	19.41	1.89	9.72	18.60	18.73	2.39	12.63
8.0	20.30	20.40	2.31	11.32	20.00	20.13	2.37	11.84
8.5	20.62	21.06	2.52	11.95	20.80	21.06	2.49	11.73
9.0	22.30	22.53	2.89	12.82	22.20	22.50	2.64	11.88
9.5	23.00	23.32	2.76	11.85	22.50	22.99	3.25	13.94
10.0	24.00	24.31	2.70	11.10	24.40	24.72	3.62	14.69
10.5	25.88	25.33	2.90	11.45	25.50	26.22	4.42	16.76
11.0	26.80	27.31	3.73	13.67	27.60	28.24	4.70	16.69
11.5	27.30	27.36	3.16	11.56	29.20	30.05	5.22	17.32
12.0	29.20	29.92	4.64	15.50	31.70	32.27	5.68	17.65
12.5	30.25	31.78	5.28	16.60	34.05	34.20	5.47	15.94
13.0	34.05	34.96	6.10	17.43	36.30	36.61	5.44	14.95
13.5	35.90	36.56	6.45	17.65	38.18	38.24	5.83	15.20
14.0	39.50	39.50	6.27	15.87	40.00	40.33	5.52	13.76
14.5	41.10	41.49	6.23	15.01	41.10	41.51	5.49	13.22
15.0	43.90	44.43	6.18	13.90	42.70	42.78	5.16	12.10
15.5	46.00	46.16	6.08	13.17	43.22	43.52	4.89	11.23
16.0	47.78	48.14	5.98	12.42	44.00	44.26	5.10	11.51
16.5	49.12	49.23	6.11	12.41	44.90	45.15	5.34	11.86
17.0	50.00	50.02	5.77	11.53	45.40	45.54	5.06	11.13
17.5	50.40	50'88	6.11	12.01	45.20	45.73	5.23	11.62
18.0	52.00	52.33	5.99	11.45	45.90	45.11	5.67	12.31
18.5	51.15	51.67	6.06	11.74	45.55	46.23	5.19	11.24
19.0	53.35	53.29	6.13	11.51	46.30	46.24	5.46	11.87
19.5	52.92	53.41	7.44	13.93	45.20	45.25	4.86	10.75

Table 3	(conti	inuation

*Completed month or year

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		BOYS				GIRLS				
AGE*	Median	X	SD	CV	Median	X	SD	CV		
Months										
0	51.60	51.09	2.57	4.68	49.40	49.41	3.12	11.50		
1	55.20	56.07	3.33	4.47	54 60	54.70	2.42	0.64		
2	59.00	59.09	3.09	2 70	57 50	57.72	3.12	2 30		
3	60.50	60.62	3.06	6 49	59.60	59.80	2 39	2.10		
4	63.20	63 37	2.85	3 45	61.00	60.68	3 38	2.20		
5	65.00	64.57	3 20	2.75	62.00	62.88	3.06	2.22		
5	65.50	65.02	3.20	1.62	64.50	64.25	3.00	2.12		
0	63.50	03.93	2.74	1.02	66.15	04.33	2.49	2.10		
/	67.50	07.40	3.00	3.78	00.15	00.19	3.40	1./3		
8	69.00	69.86	3.72	1.59	67.80	67.55	2.39	2.13		
9	70.60	70.96	3.22	1.93	68.90	69.16	4.00	3.13		
10	69.75	70.33	3.39	1.73	70.60	70.05	3.67	3.65		
11	70.20	70.52	3.50	2.10	70.00	69.69	3.88	1.17		
Years										
1.0	73.90	73.99	3.72	5.03	72.80	72.81	3.76	5.17		
1.5	78.00	78.25	3.89	4.97	77.20	77.43	4.09	5.28		
2.0	81.85	82.39	4.50	5.46	81.50	81.69	5.04	6.17		
2.5	86.10	85.74	5.34	6.23	85.15	85.09	4.89	5.74		
3.0	89.80	89.80	5.01	5.57	88.20	88.28	4.96	5.62		
3.5	92.25	92.54	4.48	4.84	92.20	92.10	4.93	5.35		
4.0	95.60	95.35	4.95	5.20	95.00	95.13	4.66	4.89		
4.5	99.50	99.32	5.75	5.79	97.70	98.15	5.42	5.52		
5.0	101.50	101.35	5.00	4.93	101.05	100.86	4.97	4.93		
5.5	104.10	104.51	5.32	5.09	104.10	104.09	4.77	4.58		
6.0	107.50	107.39	4./8	4.45	107.00	107.01	5.22	4.88		
0.5	110.00	112.65	5.37	4.8/	110.25	110.33	5.14	4.00		
7.0	114 20	114.26	4.19	3.75	113.15	113.06	5 22	4.00		
8.0	117.50	117 43	5 29	451	117.00	117 23	5 20	4.55		
8.5	118 10	118 48	5.06	4 27	119.15	119.23	5 16	4 31		
9.0	122.70	122.69	5.50	4.48	122.70	122.82	5.03	4.12		
9.5	123.65	123.85	4.98	4.02	122.90	123.66	5.88	4.73		
10.0	126.95	126.98	5.02	3.95	127.00	127.44	5.96	4.69		
10.5	127.90	128.40	5.36	4.17	129.80	130.15	6.66	5.11		
11.0	131.95	132.10	5.95	4.50	133.80	134.08	6.57	4.91		
11.5	132.20	132.32	5.71	4.31	136.35	136.88	7.24	5.29		
12.0	135.80	135.90	6.92	5.07	139.60	139.58	7.12	5.11		
12.5	138.85	139.53	7.55	5.41	141.70	141.80	6.43	4.53		
13.0	144.10	144.28	8.08	5.60	145.05	144.77	6.03	4.18		
13.5	146.50	146.61	8.43	5.75	146.40	146.09	5.79	3.95		
14.0	152.00	151.14	8.07	5.34	148.50	148.61	5.66	3.82		
14.5	154.00	153.05	7.54	4.91	148.95	149.00	5.44	3.00		
15.0	158.00	150.37	6.96	4.0/	150.00	150.10	5.10	3.44		
16.0	160.60	160.59	6.12	3.91	150.40	151.06	5.43	3.01		
16.5	161.00	161.26	6.08	3.77	151.00	150.74	4.87	3.40		
17.0	161.00	161 36	6.21	3.85	151.00	151.26	5 21	3.45		
17.5	161.90	161.76	6.04	3.73	151.30	151.28	5.56	3.67		
18.0	162.50	162.85	5.79	3.56	152.00	151.71	5.28	3.48		
18.5	163.30	163.11	6.01	3.68	151.55	151.71	5.10	3.36		
19.0	163.40	163.37	5.60	3.43	151.68	151.59	4.93	3.25		
19.5	162.85	163.11	6.58	4.03	151.40	151.24	4.45	2.94		

Table 4. Observed values of height-for-age, boys and girls

*Completed month or year

Smoothed values-weight- and height-for-age

Figs. 1 and 2 give the smoothed median values for weight and height by age for both sexes. These figures clearly show the rapid growth in infancy, followed by a rather linear growth until the pubertal spurt which occurs at abut 10 - 10 1/2years in girls and about 12 years in boys. Growth then levels off at about 16 1/2 years for girls, while the boys are still increasing in weight by 19 years of age.

Boys are heavier than girls from birth to 9 years by about 1% to 10%, at which point girls get heavier. The girls, however, are overtaken by the boys at 14 1/2 years. Thus at birth the boys are heavier than girls by about 1/3 kg., and at 19 years, they are heavier by 6.3 kg.

Birth length of boys is greater by 0.7 cm than for girls. Boys double their length before the age of 5 years, while girls do so earlier at age 4 1/2 years.

As in the case of weight, boys are taller than girls from birth to about 10 years (but only by less than 1%), and then again from 14 years on. By 19 years of age, boys are taller than girls by 11 cm.

The smoothed percentiles of weight-for-age (Figs. 3 and 3a) show that the 3rd and 97th percentiles are, on the average, 21% and 27% below and above the median, respectively; the 10th and 90th percentiles are 15% and 17% below and above the median; and the 25th and 75th percentiles are both 8% below and above the median.

On the other hand, the smoothed percentiles of height-for-age (Figs. 4 and 4a) show that the 3rd and 97th percentiles are both, on the average, only 8.5% above and below the median, respectively; the 10th and 90th percentiles both 6% above and below the median; and the 25th and 75th percentiles are both 3% above and below the median.

It can also be noted that during puberty, there is an "expansion" in the curves (increase in difference between P_3 and P_{97}), a reflection of the increase in standard deviation during this period as mentioned earlier. This is because of the differences in the age at which puberty starts and in the rates of growth at this time among individual children.

Smoothed values-weight-for-length/height

Weight increases more or less linearly with length from 0 to 23 months (Fig. 5). Median weight-for-length for both sexes closely approximate each other with a maximum difference of only half a kilogram at 70 cm. On the other hand, the increase in weight with height from 2 to 10 years is somewhat curvilinear (Fig. 6) with a more rapid increase at higher heights than at lower values. Again the curves for both sexes approximate each other except at tall heights. The latter effect is probably due to the inclusion of early maturers among girls beyond 8 or 9 years of age.

For ages greater than 10 years, weight-for-height is no longer age independent because of large differences in pubertal spurt among children. Separate tables for these ages will be presented in a subsequent report.









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Fig. 4a Height, females (01-9 yrs old).



Fig. 6 Median weight for height - male vs female (2-10 yrs old).

Comparison with the 1971 FNRI standards

Comparison of the median weight-for-age values of the present study with the 1971 FNRI standards⁽⁶⁾ showed that the two sets are comparable only from birth to 6 months (Figs. 7 and 7a). Beyond that, the present values are definitely lower by about 14%, on the average, for both sexes. At the middle of the seventh month (6.5 months of age), the difference is 0.06 kg in boys and 0.57 kg in girls. At the middle of the seventh year (6.5 years of age), the difference is 2.13 kg in boys and 2.47 kg in girls, and at 18.5 years, the difference is 6.82 kg in boys and 8.26 kg in girls.

The 1971 weight standards (which, except in infancy, was the 90th percentile of the population during the 60's), is seen to lie between the 75th and 90th percentiles of the present data. Similarly the median of the population from which the 1971 standards were derived is found to lie between the 25th and 50th percentiles of the present data. The differences may of course be due to the inclusion of only apparently healthy subjects in the present study, but it may also indicate a positive secular trend from the 60's to the present.

In terms of height, the deviations of P_{50} values of the present study from the 1971 standards are lesser for both sexes compared to those in the case of weight, but the values are still lower than the standards at all ages (Figs. 8 and 8a). The differences are about 6% for both sexes.

Again, the 1971 FNRI height standard is seen to lie between the 75th and 90th percentiles of the present data. Also, the median height of the population from which the 1971 standards were derived lies between the 25th and 50th percentiles of the present data. The same conclusion may be reached as in the case of weight differences between the 1971 standards and the present data.

Comparison with international standards

Except for the first half of infancy where the differences are slight, the present median values of weight are much lower than the NCHS standards (Figs. 9 and 9a). Percentage deviations from 1 year to 18 years ranged from 17% to 28% in both sexes (average, 22%). On the whole, the differences are slightly lower for girls than for boys. It should also be noted that the NCHS median curve lie between the 90th and 97th percentiles curves of the present data.

Differences of median height-for-age in the present study from international standards are lower than in the case of weights, although again the present values are lower than NCHS standards except in early infancy (Figs. 10 and 10a). After the first year, the present values are about 7% to 10% lower (average 8%). Again, the NCHS median curve lie between the 90th and 97th percentile curves of the present data.

As a whole the present values of weight-for-length and weight-for-height are much closer to the NCHS standards than the two parameters just discussed (Figs. 11 and 11a and 12 and 12a). In fact for shorter recumbent lengths, weight-for-length values in the present study are slightly higher than the NCHS standard for both



Fig. 7a. Present median vs FNRI STD weight - females (0-19 yrs old).







Fig. 9a. Present median vs NCHS STD weight - females (0-19 yrs old).



Fig. 10a. Present median vs NCHS STD height - females (0-19 yrs old).



Fig. 11a. Present median vs. NCHS STD weight for length - females (0-23 months old).

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Fig. 12a. Present median vs NCHS STD weight for height - females (2-10 yrs old).

sexes. For taller lengths/heights, the NCHS standards are higher than the present values by only about 2 to 4%. It is apparent that as far as weight-for-height measurements for 2-10 year old children are concerned the values in the present study closely approximate the international standards.

Comparison with other local studies

In general, median values of weight and height in present study are higher than the average measurements of Filipino children of corresponding ages found in the 1982 national nutrition surveys (13). The median weight measurements of boys in the present study at age 6 months are higher by 9.5%, at 3.5 years by 2.5%, and at 17.5 years by 1.3%. In girls, the differences in median weight between the two sets of data are much smaller than in boys, with 0.75% difference at 2 years and 0.18% at 6.5 years.

The deviations between the two sets of data in terms of height are much lower than in the case of weight. Nevertheless, the mean heights for both sexes in the present study are also higher than the average heights at corresponding ages in the 1982 survey.

The median values were also compared with selected groups of children in the 1978 FNRI nutrition surveys⁽¹⁷⁾ who belong to households with above average income and those above 90% energy adequacy intake level. Results showed that for age group 0-6 years, values in the present study are higher for both height and weight by as much as 6.65% for weight at 0.5 years, boys, and 6.3% for weight at 6.5 years, girls. Likewise, height values in the present study are higher for both sexes except at ages 6 1/2 years for boys and 4 1/2 years for girls.

Summary and Conclusion

In order to arrive at anthropometric standards for 0-19 year-old Filipino children useful for nutritional and clinical evaluation, 26,961 randomly selected children from nearly all regions of the country were clinically examined and measured for weight, height and other anthropometric parameters. A total of 23,660 healthy children of no more than 1/4 foreign blood were included for the derivation of standards. Percentile curves of weight-for-age, length/height-for-age and weight-for-length/height were constructed using the cubic spline technique to fit curves to the data. The coefficients of variation indicate very stable estimates for practically all of the age groups. Normal distribution was found for the different parameters at all ages.

As expected, the weight and height of boys are greater than those of girls for the same age up to the time the latter starts their pubertal growth spurt when the girls overtake the boys. The boys start to get taller and heavier again by 14 yrs of age.

The curves of weight-for-length/height for both sexes approximate each other except at tall heights.

Except in early infancy, the present values for weight-for-age are lower than the 1971 FNRI standards by as much as 15% for both sexes. Height-for-age values are lower than the same standards by about 6% for both sexes. On the other hand, the 1971 standards for weight and height as well as the median values of the population from which the standards were derived are seen to lie below the corresponding P_{90} and P_{50} values of the present data. While this may be due to the inclusion of only apparently healthy subjects in the present study, it may also indicate a positive secular trend from the 60's to the present.

Except in early infancy, present values were considerably lower than the NCHS standards (range of deviation, 18% to 28% for weight-for-age and 5% to 8% for height-for-age). Weight-for-length/height values, however, closely approximate the NCHS standards.

It is concluded that the present data constitute the best available data for use in the construction of new growth standards for Filipino children. It is however, recommended that these values are validated in the field among health and malnourished subjects to delineate the levels below which malnutrition is likely to be present.

References

- Neumann, C. G. 1979. Reference data in: Nutrition and Growth (D.B. Jelliffee and E.T.P. Jelliffe, eds) pp. 299-327. Human Nutrition: A Comprehensive Treatise. Plenum press, New York and London.
- 2. Griffiths, M. 1984. Defining Adequate Growth Chapter 2 in: Growth Monitoring of Pre-school Children 13-20.
- 3. Hammill, P.V.V. 1977. NCHS Growth Curves for Children Birth 18 Year. United States. DHEW Publ. Series 11, No. 165.
- 4. DeBoor C. and Rice J.R. 1968. Least Squares Cubic Spline Approximation 1 Fixed Knots. Tech. Report No. 20 Computer Service Department Purdue Univ. W. Lafayette Ind.
- 5. WHO 1985. A Growth Chart for International Use in Maternal and Child Care: Guidelines for Primary Health Care Personnel (Revised Ed) Geneva.
- 6. Bulatao-Jayme, J. D. dela Paz and C. C. Gervasio. 1971. Recommended Height and Weight Standards for Filipinos. PJN 24(3): 161-178.
- 7. Magbitang, J.A., M.T.R. Jardeleza, E.G. Flores, A.C. Baltazar. 1984. Anthropometric measurements of 4-18 year old schoolchildren from exclusive schools in Metro-Manila. Unpublished data.
- 8. A.C. Baltazar, S.M. Mendoza, A.J. Cruz, C.C. Dayco, E.G. Flores. Anthropometric measurements of apparently healthy 0-18 months old children (In Press, PJN).
- 9. Baltazar, A.C. F.C. Enriquez, S. Mendoza, M.F. Villadolid, E.G. Flores. 1982. Anthropometric measurements of apparently healthy children of good socio-economic status aged 4-12 year, PJN 35(4): 171-187.
- 10. Briones, T.K. et al. 1981. Longitudinal Study (Unpublished).
- 11. Santos-Ocampo, P. Growth and Development. Chap. 3 in Textbook of Pediatrics, P.S. Ocampo and F. del Mundo, eds.
- 12. Waterflow, J.C., R. Buzina, W. Keller and J.M. Lane, N.Z. Nichaman and J.M. Tanner. 1977. The presentation and use of height and weight data for comparing the nutritional status of groups of children under the age of 10 years. *Bull. WHO* 55: 489-498.

- 13. FNRI 1984. Second Nationwide Nutrition Survey, Philippines, 1982 FNRI-84-NS-10. Manila.
- 14. Jelliffe, B.B.: The assessment of the nutritional status of the community **WHO Mono**graph Series No. 53, WHO. Geneva. 1966.
- 15. Hansen, M.H., N. Hurwitz, and W.G. Madow, 1953. Sample survey Methods and Theory New York Wiley Publications in Statistics.
- 16. Suits D., A. Mason and L. Chan. Spline functions fitted by standard regression methods. Jour. Stat. Assoc.
- 17. FNRI 1981 First Nationwide Nutrition Survey, Philippines 1978 FNRI-81-RP-NS 3(2) 2nd Rev. Manila.