

Methodological aspects of the anthropometric assessment in the *Brazilian National Survey on Child Nutrition (ENANI-2019)*: a population-based household survey

Aspectos metodológicos da avaliação antropométrica no *Estudo Nacional de Alimentação e Nutrição Infantil (ENANI-2019)*: inquérito domiciliar de base populacional

Aspectos metodológicos de la evaluación antropométrica en el *Estudio Nacional de Alimentación y Nutrición Infantil (ENANI-2019)*: encuesta domiciliar de base poblacional

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doi: 10.1590/0102-311X00293320

Abstract

The article presents methodological aspects of anthropometric assessment of nutritional status in children under five years of age and their biological mothers. It discusses the strategies used for training and data collection in the Brazilian National Survey on Child Nutrition (ENANI-2019). ENANI-2019 is a population-based household survey conducted in 123 municipalities in Brazil's 26 states and the Federal District. The anthropometric measurements were body mass and length/stature. The equipment was purchased according to its measurement capacity and precision, portability, and cost-benefit ratio after an extensive market search. The study used internationally established procedures described in manuals, videos, and support material developed for the study by a group of experts. The interviewers were trained to perform the anthropometric measurements and were assessed according to technical measurement error, which was considered adequate (0.30cm) for the children's length/stature measurements. Measurement errors were identified, and the interviewers were retrained when necessary. Of the 14,558 children in the sample, body mass and length/stature measurements were taken in duplicate in 13,835 and 13,693 children, respectively. The standardized methodological aspects will be helpful in future population studies and were essential for obtaining greater reliability in the data for generating current evidence on the anthropometric assessment of the nutritional status of Brazilian children under five years of age, allowing new perspectives for public policy development.

Infant; Child; Preschool Child; Anthropometry; Body Weight

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Introduction

Health policies are established according to evidence that allows the analysis of the epidemiological relevance of diseases and other health-related events, providing support for priority-setting and preventive, monitoring, and control measures. However, the success of these policies depends on the quality of available information during the process, from the problem's identification to the assessment of the respective measurements ¹.

Various national or regional surveys have been conducted since the 1970s to assess the nutritional status of the Brazilian population, and that included children under five years of age ^{2,3,4,5,6}. Specifically for children and women, it is worth highlighting the three editions of the *Brazilian National Demographic and Health Survey on Children and Women* (PNDS). The most recent surveys with published results are the PNDS which occurred in 2006 ⁷, and the *Brazilian National Health Survey* (PNS) in 2013, which assessed the nutritional status of Brazilian adults and some aspects of health, food, and nutrition in children under five years of age (in the PNDS) and under two years (in the PNS) and in women ⁸.

Considering the nutritional, demographic, and epidemiological transition underway in Brazil ⁹ and the impact of political and socioeconomic factors on the population health ¹⁰, the population's nutritional status has probably changed substantially since the most recent surveys. Therefore, the available data on the nutritional status of Brazilian mothers and children need to be updated to back the formulation or reformulation of the Brazilian National Food and Nutrition Policy (PNAN) ¹¹. The *Brazilian National Survey on Child Nutrition* (ENANI-2019) aimed to expand and update knowledge on the nutritional status of Brazilian children under five years of age and was organized in three domains: assessment of breastfeeding practices and dietary intake; anthropometric assessment of nutritional status; and assessment of micronutrient deficiencies ¹². The current article presents the methods, procedures, and strategies for training and data collection used in the ENANI-2019 for anthropometric assessment of the nutritional status of children under five years of age and their biological mothers.

Methods

Establishment of the Expert Group in the Anthropometry Domain

The project's Executive Committee defined as its strategy the organization of expert groups for each of the three domains of the ENANI-2019. The Anthropometry Group consisted of professors from public universities in Brazil's five major geographic regions and with experience in anthropometric studies. Most were responsible for courses in nutritional assessment. The group also included undergraduate, graduate, and postdoctoral students. The Executive Committee also consisted of professors and researchers from public universities and research institutes with expertise in conducting anthropometric surveys. The Anthropometry Group met regularly and was in charge, together with the Executive Committee, for deliberating on the choice of the best equipment for the measurements, the strategies for administering the training sessions for the field interviewers on standardization of the anthropometric measurements, and the development of field protocols for data collection.

The Anthropometry Group aimed to guarantee and control the quality of the anthropometric data by establishing standardized procedures and developing tools to prevent or minimize errors during the data collection. The procedures were based on international guidelines ^{13,14,15,16}, and those of the Brazilian Ministry of Health ¹⁷ for collecting, quality control, and presentation of the anthropometric data.

Choice of equipment

The anthropometric equipment purchase considered an extensive search on the market, considering the manufacturer's experience and credibility and the equipment's model, availability in Brazil, measurement capacity and precision, weight, size, power source (battery, electricity, solar), and experience

with its use in previous national household surveys. Since this was a household survey, one of the relevant factors was that the equipment should be portable, reliable, and sturdy. Therefore, the decision was made to use digital platform scales (for children over two years and mothers) and pediatric scales (for children under two years), both battery-fed. Furthermore, considering the cost-benefit ratio in the options on the domestic and international markets, the choice was made for the SECA brand equipment (https://www.seca.com/pt_br.html), organized in two anthropometric measurement kits (Box 1): (1) pediatric scale and anthropometer (infantometer) for children up to two years of age and (2) platform scale and stadiometer for children over two years and mothers. Both were carried in SECA protective backpacks with straps to facilitate transportation. Each complete kit, including the backpack, weighed approximately 8kg, so each interviewer received a foldable tote cart for holding and pulling the kit.

The number of kits to be purchased was planned according to the number of field interviewers and supervisors for the data collection in the states in each of the seven waves of the ENANI-2019 survey¹² and the possibility of redeploying the equipment for use in the subsequent waves. Due to the lack of information on the equipment's durability and allowing for potential losses, thefts, or accidental damage, an extra 10% of scales and 20% of infantometers were purchased as a reserve margin. Thus, the purchases totaled 298 units of each scale, 359 units of each infantometer/stadiometer, and 657 backpacks.

Details of measurements

The Anthropometry Group prepared a manual with the procedures for anthropometric data collection of the children and their biological mothers, with strict step-by-step instructions to standardize the procedures. The manual consisted of reading and permanent reference material for everyone involved in the survey. The group also produced video demos, slides, and a quick reference guide and script for use during training and in the collection of anthropometric measurements. These materials are available on the ENANI-2019 website (<https://enani.nutricao.ufrj.br/>) and uploaded onto the interviewers' mobile data collection devices (MDCs) in the data collection. The measurements were taken in duplicate, read aloud by the interviewer according to international guidelines¹⁴, and keyed into the MDC immediately after collection. The data stored in the MDC were sent daily to the central server in encrypted form.

The anthropometric measurements were body mass, i.e., weight, obtained in kg, directly for the children and biological mothers. Alternatively, this measurement could also be indirectly obtained for children of any age who were unable to remain steady on the scales for any reason or for those under 24 months of age that weighed over 15kg. In this case, the value was calculated by the difference in measurement of an adult standing on the digital scale with and without the child in his or her arms.

Box 1

Technical description and number of units of equipment used. *Brazilian National Survey on Child Nutrition (ENANI-2019)*.

Kit	Equipment	SECA model	Weight (kg)	Capacity	Precision	Amount purchased (units)
Child (< 2 years)	Pediatric scale	336	3.4	Up to 15kg	5g (< 5kg) 10g (5-15kg)	298
	Infantometer	417	1.6	10-100cm	0.1cm	359
Adult and child (≥ 2 years)	Digital scale (sturdy)	813	2.9	Up to 200kg	100g	298
	Stadiometer	213	2.4	40-205cm	0.1cm	359

Measurements were taken with the children wearing as little clothing as possible. Children under two years were placed on the previously stabilized and zeroed pediatric scale. The weight was measured, and the child was removed from the scale before performing the second measurement. Older children were positioned barefoot in the middle of the platform to distribute their weight evenly on the equipment, with their body straight and arms hanging by their sides, head in the anatomical position, and back to the display. After the weight was measured, the child was removed from the scale, which was zeroed to repeat the procedure. Biological mothers were weighed barefoot, wearing light clothing and without any accessories (costume jewelry, hairpins, eyeglasses, and similar items) and anything in their pockets, following the same protocol for children over two years.

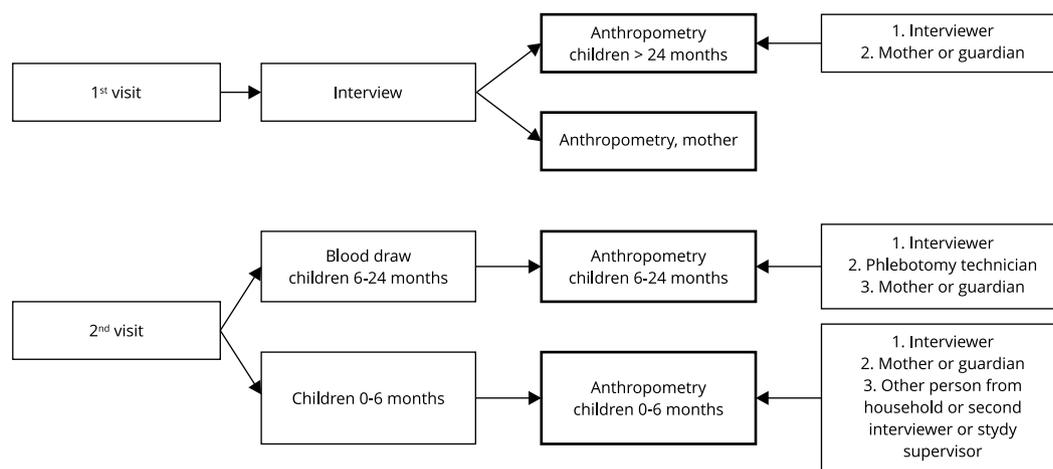
The height was obtained in centimeters (cm), with a precision of 0.1cm. This term encompasses measurement of length (performed with the infantometer in children under two years, in the supine position) and stature (obtained from the mothers and children at least two years old who could stand on the stadiometer). Some situations required measuring the length of children over two years (< 100cm) or the stature of children under two years. The interviewer recorded whether the measurement had been taken with the child standing or lying down, as recommended by the World Health Organization (WHO) ¹⁸.

The data collection stages in the ENANI-2019 are described in Alves-Santos et al. ¹². Specifically, concerning anthropometry, the established protocol recommended the participation of two persons to measure stature in children and three persons to measure length. Since the survey planned the presence of a single interviewer per household, the strategy was to rely on the help of the mother or guardian to measure length. For children from 6 to 24 months of age, the interviewer scheduled the anthropometric measurement for the second visit, when blood samples were also drawn. The technician who drew the samples participated as the third person for the measurement. For children at least six months of age, the interviewer requested the participation of another resident in the household or scheduled for another interviewer or the supervisor to be present on the day of the expected measurement (Figure 1).

For the measurement of length, the mother or guardian was asked to lay the child on the infantometer, previously positioned on a smooth surface. The child was measured undressed, barefoot, and without any object on the head, placed against the infantometer's fixed plate, with eyes positioned at a 90° angle with the equipment (Frankfurt plane ¹⁴), neck straight, and chin away from the chest.

Figure 1

Flowchart of anthropometric measurements in the *Brazilian National Survey on Child Nutrition* (ENANI-2019).



The child's shoulders and back were maintained in contact with the horizontal surface and the arms positioned along the body or held over the abdomen by the mother or guardian. The interviewer held the child's legs, placing the index finger on the legs at the level of the knees and pressing carefully with the other fingers so that the knees remained extended. The interviewer moved the infantometer's footplate to the soles of the child's feet to form a right angle with the legs and then performed the reading. The mother or guardian removed the child from the infantometer, and the entire procedure was repeated.

To measure the child's stature, the mother or guardian was asked to remove the child's footwear (including stockings) and any object from the child's head. Next, the child was asked to stand with their feet firmly placed on the stadiometer platform (Figure 2), heels together, and feet open at an angle of about 60°¹⁵. Next, the child was positioned with back and buttocks touching the stadiometer's vertical shaft, with arms hanging loosely alongside the body and palms turned to the thighs and eyes at a 90° angle (Frankfurt plane). The interviewers positioned themselves on the side of the stadiometer to verify whether the child's position was correct and to perform the measurement by sliding the head plate down to the top of the head with sufficient pressure to hold the hair down. The reading was performed at the level of the interviewer's eyes. To maintain the child in the proper position, the mother was asked to squat and place light pressure on the child's knees and heels against the stadiometer's vertical shaft. After the recording, the child stepped down off the stadiometer, and the entire procedure was repeated.

To measure the biological mother's stature, she was asked to step onto the stadiometer barefoot, with heels together and resting against the equipment's vertical base, placing her feet to coincide with the figure attached to the horizontal platform and positioning herself as described for measuring the children. The measurement was taken with the mother holding her breath after inspiration, recorded immediately in the MDC, and repeated according to the previous procedures.

Training of interviewers

Two types of training were performed for interviewers and supervisors: central and anthropometric. Central training was conducted in seven state capitals and included content on data collection procedures, except anthropometry. Participation included the team from each data collection wave. A

Figure 2

Sticker developed with figures of feet for children and biological mothers and attached to stadiometer base. *Brazilian National Survey on Child Nutrition (ENANI-2019).*



total of 27 training courses were performed in anthropometry, conducted in all the state capitals and Federal District and targeted to interviewers and supervisors in each state. The anthropometry training was undertaken generally immediately after the study's central training. The goal was to certify the interviewers and supervisors for the anthropometric measurements according to the procedures established by the Anthropometry Group and the Executive Committee. The training was conducted by the members of the Anthropometry Group or by a guest instructor with the collaboration of professors and researchers from local institutions. Details on the central training are available in Alves-Santos et al. ¹².

For the anthropometry training, a professor from a university located in each state capital and the Federal District identified a site to perform the theoretical component of the training, schools or daycare centers that agreed to have the anthropometric measurements performed in the children enrolled there, distributed the Free and Informed Consent Form to the parents, and recruited undergraduate and graduate students with experience in anthropometric measurements of children and adults to participate as monitors. The study and the specific informed consent form for training in anthropometry were approved by the Institutional Review Board of the Clementino Fraga Filho University Hospital of the Federal University of Rio de Janeiro (UFRJ) and registered under number CAAE 89798718.7.0000.5257. Details on the study's ethical aspects are available in Alves-Santos et al. ¹².

The training was planned to take place full-time for two or three days, depending on the number of interviewers to be trained. The three-day structure was used when the number was at least eight interviewers and included: 1st day – theoretical and practical training on anthropometric measurement of adults; 2nd day – training on measurement of children under two years; and 3rd day – training on measurement of children over two years. When fewer interviewers were trained, the measurement activities in children were concentrated in one day.

During the practical training, each interviewer had to measure at least 10 adults and 10 children, as recommended in international guidelines ¹⁴. Interviewers followed the described protocols for measurements, except for reading the values out loud, which was completed in an individual form to avoid influencing the results of the other interviewers since more than one interviewer measured the same individual.

The practical training in measuring mothers in the ENANI-2019 survey was conducted among the interviewers themselves. The training to measure children was conducted by those associated with the selected daycare centers and schools and in children whose parents had signed and returned the informed consent. In both types of practical training, the plan was for each interviewer and instructor in charge of the training to measure the stature/length twice in each child/adult. When it was not possible for the instructor and interviewers to measure the same children, the instructor reinforced the details of the measurement technique with the interviewers. The procedure was only used to measure height since it is considered unnecessary for weight measurements ¹⁴, mainly when using a digital scale, which was the case in ENANI-2019.

Considering that measurement of length is relatively tricky, requiring greater attention when training the interviewer, besides the fact that there are usually not enough children under 24 months of age to conduct the practical activity, the attempt was made to optimize the training by using a doll (described in <https://www.cotiplas.com.br/boneca-nino's-com-a-boca-aberta/p>) with similar characteristics to those of an infant and with sufficient flexibility for the trainees to handle it, mimicking the procedure to be performed for measuring a real child's length.

After all the participants had concluded the height measurements, the data were keyed into an electronic spreadsheet ¹⁴ for computation of the technical error of measurement (TEM). TEM is used to calculate intra-evaluator variability, the variation in the measurements repeated in the same individual performed by the evaluator, and inter-evaluator variability, which is the variation of measurements performed by different evaluators. Intra-evaluator TEM was calculated for interviewers and instructors. Inter-evaluator TEM was calculated by the difference between the interviewer's and instructor's measurements.

In the end, the assessment of the interviewers' performance was conducted by the team that administered the training, considering the TEMs and the measurement observations. Thus, the individuals in charge of the training sessions identified the possible errors that led to inadequate TEM

values and oriented the interviewers to review the measurement protocols and repeat the measurements to correct the errors.

Based on the ethical commitment and acknowledging the teaching institutions' collaboration in the training process, the children's nutritional diagnosis was performed. An individual copy was provided to the parents with the values for each measurement, plus a description of the nutritional diagnosis and plotting of the weight and height values on the growth curves recommended by the WHO¹⁸ and provided in the Child's Health and Growth Card used in the Brazilian Unified National Health System (SUS)¹⁷. Children with nutritional risk received a referral for care in a health unit.

Procedures for assessment of the training

Intra-evaluator and inter-evaluator TEMs were used as estimates of precision and accuracy¹⁹. Interviewers had good precision when the intra-evaluator TEM was less than twice the instructor's intra-evaluator TEM. Intra-evaluator TEM values of height were considered adequate when they were $\leq 0.30\text{cm}$, the reference value suggested by the United Nations Children's Fund (UNICEF)¹⁴ based on data from the *WHO Multicenter Growth Reference Study*²⁰. In addition, interviewers had good accuracy when the intra-evaluator TEM was less than 2.8 times the instructor's intra-evaluator TEM.

The reliability coefficient (R) was calculated to estimate the proportion of variation between individuals that is not due to measurement error. The formula used to calculate the R was: $1 - [(TEM(\text{inter-evaluator}))^2 / (\text{standard deviation}^2)]$. For example, an R of 0.80 means that 80% of the total variability is true variation, while the remaining proportion is attributable to measurement error, called imprecision or lack of reliability²⁰.

Data quality was also assessed by estimating its "heaping", or tendency for a preference in the final digit, in the anthropometric measurements performed by the interviewers. The dissimilarity index was calculated for this purpose: calculating the sum of the differences (without the positive/negative sign) between the observed percentage and the predicted percentage (10%) for each of the last 10 possible digits divided by 2¹⁶. The value indicates the number of new measurements needed to achieve perfection, i.e., zero, the situation in which each of the last digits occurs in 10% of the measurements¹⁴, a rare outcome in studies involving many interviewers.

Quality assurance and quality control

In quality assurance and quality control, three possible sources of error should be considered: the instrument, the interviewee, and the interviewer. In the current study, all the instruments acquired were new since reutilization of equipment from other studies is not recommended¹⁴, and larger than the number of interviewers. The equipment could be replaced in case of malfunctioning. Pieces of equipment transferred between states for the study had their conditions of use verified during the anthropometry training. In relation to the interviewees, the interviewers' training emphasized the need to provide peace of mind for the mothers or guardians through good measurement practices documented in the manual. The training sessions were scheduled and carried out to provide the entire structure for interviewers to acquire the appropriate techniques for obtaining reliable data. Interviewers who displayed any difficulty in measurement or large measurement errors compared to the instructor were identified and retrained.

During the collection, the quality control procedures for the anthropometric data included: verification of the equipment's proper functioning; regular verification of the scales using objects with a known mass, and instant identification of extreme values (implausible, as described below) for the children's weight and height and the measurement's repetition. In addition, weekly revisions were performed in the collected data, such as date of birth and date of the interview for calculating age; and recording in the MDC, by the interviewer, of any alteration observed during the measurement (agitated child, anatomical alteration, or procedure performed off-protocol).

To identify implausible values or outliers in the anthropometric measurements of children, interviewers were oriented to key the measurements into the MDC immediately after they were taken. The data capture system calculated the height-for-age (H/A) and weight-for-age (W/A) indices for each of

the two measurements and indicated whether the information was implausible. The cutoff points for this identification were: $H/A < -6$ or $> +6$ and $W/A < -6$ or $> +5$ Z-scores in the reference curve¹⁸. Before recommending repetition of the measurement, the system asked the interviewer to confirm the child's date of birth. When the date was altered, it verified whether the anthropometric measurement was still implausible. In the affirmative case, the system asked to repeat the measurement. If the new measurement remained implausible, the system opened a procedure to take a photograph (only with the parent or guardian's authorization) and a field for a mandatory recording of observations, for example, children that were unusually small or large, overweight, or premature. Follow-up of the data collection by all the interviewers was performed by the supervisors, who monitored the collected data daily. In some cases, when errors were identified, the supervisors returned to the households and performed new measurements. These procedures were implemented to guarantee that the percentage of potentially implausible cases remained within the internationally recommended levels ($< 1\%$)¹⁴.

Results

The training included 353 interviewers and supervisors in the state capitals and Federal District. Forty-nine schools, daycare centers, and philanthropic institutions supported the training activities. In total, 386 adults and 3,815 children were measured by the interviewers during the training, totaling 7,100 measurements. Of all the children, 3,267 were measured at least once by both the interviewer and the instructor, 2,023 were measured in duplicate by the interviewers, and 1,542 were measured twice by the interviewers and the instructor (Table 1). Each interviewer measured on average 15.1 adults and 11.2 children (6.3 children over two years and 4.9 children under two years).

As expected, the instructors' intra-evaluator TEMs were lower than those of the interviewers. However, the interviewers' intra-evaluator TEMs for the measurement of adults and stature and length of children were considered adequate for the set of measurements taken in duplicate by the interviewers and the instructor. Intra-evaluator TEM was also within this reference for the set of

Table 1

Assessment of reliability of stature or length measurements performed by interviewers during anthropometry training in adults and children. *Brazilian National Survey on Child Nutrition (ENANI-2019)*.

	Adults Stature	Children Height	Children Stature	Children Length
Using two height measurements by interviewers and instructors				
Number of observations	3,143	1,542	983	559
Intra-evaluator TEM (cm)				
Interviewer *	0.301	0.282	0.299	0.250
Instructor	0.212	0.174	0.150	0.211
Inter-evaluator TEM (cm) **	0.273	0.363	0.365	0.360
Reliability coefficient (R)	0.999	0.999	0.995	0.999
Using the first measurement by the interviewers and instructors				
Number of observations	3,178	3,267	1,762	1,505
Inter-evaluator TEM (cm)	0.367	0.381	0.352	0.413
Reliability coefficient (R)	0.998	0.991	0.993	0.975
Using two measurements by the interviewer				
Number of observations	3,157	2,023	1,214	809
Intra-evaluator TEM (cm)	0.301	0.271	0.286	0.247

TEM: technical error of measurement.

* Good precision when intra-evaluator TEM is < 2 times instructor's intra-evaluator TEM;

** Good accuracy when inter-evaluator TEM is < 2.8 times instructor's intra-evaluator TEM.

interviewers that measured children in duplicate. The estimated reliability coefficient was greater than 99% for the measurements in duplicate and analysis, with only one measurement taken by the interviewer and instructor in the same child, except for length (97.5%). In half of the states, the percentage of interviewers with good precision was 77.3% for adults and 75% for children. In comparison, the percentages of interviewers with good accuracy were 96% and 75%, respectively. These results indicate that the set of interviewers in the country displayed good precision and accuracy in obtaining measurements of height in children and adults.

The estimated heaping showed that except for the measurement of length with the last digit 0, there was no major heaping in the percentage distribution of the final digits (Table 2). Analysis of the dissimilarity index revealed the need for new measurements in 5.3%, 7.4%, and 12.3% for the distribution of the final digits to be equal to the measurement of stature in the biological mothers and children and length, respectively. Measurement of weight did not show any tendency in preference for the final digit.

Presentation of the data

The variables sex, age, weight, and height of the children will be analyzed in the WHO software programs Anthro and AnthroPlus (<https://www.who.int/toolkits/child-growth-standards/software>). For the anthropometric indices W/A, H/A, W/H (weight for height), and body mass index (BMI) for age (BMI/A), the Z-scores will be obtained in relation to the WHO reference ¹⁸. The interpretations of the nutritional significance will be performed according to the cutoff points applied to the anthropometric indices and the respective nomenclature for nutritional diagnosis adopted by the Brazilian Food and Nutritional Surveillance System (SISVAN) ¹⁷ and by the WHO to diagnose the severity of malnutrition ¹⁹.

The Z-score distribution for all these indices will be recorded to allow various other definitions ^{21,22}, such as nutritional risk condition ($Z < -1$) and process severity ($Z < -3$ or > 3 , for all deficiencies or in the case of indicators of obesity, respectively).

The nutritional status of mothers 20 years or older will be assessed with the WHO classification ²³, based on BMI and recommended by the Brazilian Ministry of Health ¹⁷. For mothers under 20 years of age, BMI/A will be used in relation to the reference population ²⁴.

Table 2

Assessment of last-digit preference in height measurements (stature or length) by interviewers during anthropometry training in adults and children. *Brazilian National Survey on Child Nutrition (ENANI-2019)*.

Final digit	Adults		Children			
	Stature		Stature		Length	
	Observed	Difference *	Observed	Difference *	Observed	Difference *
0	12.10	2.10	12.49	2.49	18.41	8.41
1	9.94	-0.06	9.02	-0.98	9.04	-0.96
2	10.45	0.45	9.14	-0.86	7.91	-2.09
3	9.30	-0.70	7.55	-2.45	7.91	-2.09
4	10.12	0.12	12.32	2.32	9.30	-0.70
5	10.72	0.72	12.20	2.20	13.55	3.55
6	10.54	0.54	10.39	0.39	7.11	-2.89
7	6.26	-3.74	8.12	-1.88	7.77	-2.23
8	9.25	-0.75	9.14	-0.86	8.70	-1.30
9	11.32	1.32	9.65	0.35	10.30	0.30
Dissimilarity index **		5.3		7.4		12.3

* Difference: the difference between observed and predicted values (10%) for each of the last 10 possible final digits;

** Dissimilarity index = Sum of differences (without positive/negative sign)/2.

Z-scores for the anthropometric measurements of premature children and those with gestational age from 189 to 454 days will be calculated with the growth curves generated by the Intergrowth study²⁵.

Database cleaning and organization

Until the data collection in the field was interrupted in March 2020 due to the COVID-19 pandemic, 14,558 children had been studied in 12,524 households¹². Of this total, duplicate measurements of body mass and length/stature were obtained in 13,835 and 13,693 children, respectively. The percentage of implausible data was below the maximum allowable level recommended by international agencies both for measurement of weight (0.48 and 0.61% for the first and second measurements, respectively) and height (0.76 and 0.71%). Of all the children examined, 1,588 were premature. Among those within the possible gestational age group for evaluation according to the *Intergrowth Study*, no implausible weight or length values were identified. Of the total of 12,169 biological mothers, 11,150 and 11,218, respectively, had their body mass and stature measured in duplicate. Of the total, 52 biological mothers were pregnant, and 1,011 were adolescents (14 to 19 years old). The main reasons reported for non-measurement were absence or illness (40% and 41% of the children and mothers, respectively); refusal (35% and 35%); or other reasons (25% and 24%). Missing, inconsistent, or implausible anthropometric data will be imputed.

Discussion

Many procedures implemented in the ENANI-2019 survey are unprecedented in national household surveys. Traditionally, in household surveys, the study's coordination trains the field coordinators to perform the anthropometric measurements for operational and budget reasons. Then, the field coordinators replicate the training of the interviewers without performing detailed practical training in anthropometric measurements in children. In the ENANI-2019 survey, members of the study's Executive Committee and members of the Anthropometry Group trained the interviewers directly. The training protocol ensured that they also practiced the measurements in children.

Specifically, concerning anthropometry, the authors are unaware of detailed documentation on the assessment of field interviewers in national household surveys. Nevertheless, the results presented here indicate that it is possible to guarantee the interviewers' good and accurate data production capacity, so long as appropriate training and quality control procedures are performed.

The data collection procedures in ENANI-2019 allowed consistency between the work by the interviewer and the phlebotomist for the measurement of children from 6 to 24 months of age. In addition, the development of a data capture system, which immediately checked the plausibility of the anthropometric measurement in children in their household, allowed generating reliable data on the anthropometric nutritional status of Brazilian children under five years of age.

The infantometers' resistance and durability were highly satisfactory. Since the stadiometer has a base that allows placing the feet at 90° from the vertical shaft and with a support stabilizer on the wall, it allowed measuring stature on walls with baseboards. Despite the stabilizer, the equipment did not touch some highly uneven walls, thus requiring extra care in their use. The digital platform scale levelers displayed insufficient resistance and durability. The pins fitting into the levelers broke fairly frequently so that some scales lost their stability and reliability and had to be replaced. Although the pediatric scales were delivered with a seal and stamp of approval from INMETRO (the Brazilian National Metrology Institute), eight scales had to be replaced during data collection due to inconsistency in the readouts.

Although the equipment was chosen with the lightest possible weight, carrying the kit placed an overload on the interviewers. In neighborhoods with irregular streets and sidewalks, steep stairways or byways, the tote carts for transporting the equipment could not be used. However, they were intended to facilitate the fieldwork.

Final remarks

ENANI-2019 is the first nationwide survey in Brazil that conducted an anthropometric assessment of nutritional status and the assessment of breastfeeding and feeding practices using a 24-hour dietary recall and 12 biomarkers of micronutrients in children under five years of age. Specific decentralized training in anthropometry in each state of Brazil by qualified instructors, real-time electronic monitoring of children's anthropometric measurements in the household, teamwork combining interviewers and phlebotomy technicians in obtaining the anthropometric measurements, and weekly data monitoring were successful experiences in the study. They can be considered strengths in the ENANI-2019. Implementing these standardized methodological procedures lends greater reliability both to the data and to the final results. It is thus expected that the care in obtaining anthropometric data in the ENANI-2019 survey will encourage this practice in future national household surveys.

The anthropometric results of ENANI-2019 will update the information on magnitude, distribution, and inequalities of nutritional problems (whether deficiencies or excesses) in children under five years of age. Furthermore, knowledge of anthropometric nutritional status, associated with under-five health outcomes, socioeconomic conditions, and quality of life, can reinforce public policy proposals according to current data, aimed at reducing nutritional disorders and increasing strategies for promotion, prevention, and care with adequate and healthy feeding practices starting in childhood, thus modifying the nutritional, epidemiological, and mortality profile of the Brazilian population.

Contributors

L. A. Anjos and M. B. Freitas contributed to the study conception and design, data analysis and processing, and article's writing and review. H. S. Ferreira, N. H. Alves-Santos, C. S. Boccolini, E. M. A. Lacerda, I. R. R. Castro, V. G. Mariz, B. M. Tavares, D. P. Gigante, and G. Kac contributed to the study conception and design and article's writing and review. All authors approved the final version of the article.

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Acknowledgments

To the professors of Brazilian universities who collaborated in conducting and recruiting student monitors for training. To the institutions that allowed the theoretical training to be carried out on their premises: São Lucas University Center – Rondônia State, National Supply Company (Conab) – Mato Grosso do Sul State; Social Service of Commerce (SESC) – Regional Departments in the states of Bahia, Goiás, Roraima, and Santa Catarina; Estácio Faculty – Amapá State; Oswaldo Cruz Foundation (Fiocruz) – Federal District; São Paulo Federal University (UNIFESP); Ceará State University (UECE); Rio de Janeiro State University (UERJ); Acre Federal University (UFAC); Alagoas Federal University (UFAL); Amazonas Federal University (UFAM); Espírito Santo Federal University (UFES); Maranhão Federal University (UFMA); Minas Gerais Federal University (UFMG); Paraíba Federal University (UFPB); and Pernambuco Federal University (UFPE).

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Resumo

Este artigo apresenta aspectos metodológicos da avaliação antropométrica do estado nutricional de crianças menores de cinco anos e suas mães biológicas, e as estratégias utilizadas para o treinamento e a coleta de dados do Estudo Nacional de Alimentação e Nutrição Infantil (ENANI-2019). O ENANI-2019 é um inquérito populacional de base domiciliar realizado em 123 municípios dos 26 estados da Federação e o Distrito Federal. As medidas antropométricas coletadas foram a massa corporal e o comprimento/estatura. Os equipamentos foram adquiridos segundo a sua capacidade e precisão de medida, portabilidade e custo-benefício após ampla pesquisa de mercado. Utilizaram-se procedimentos estabelecidos internacionalmente e descritos em manuais, vídeos e material de apoio desenvolvidos para o estudo por um grupo de especialistas. Os entrevistadores foram treinados para a realização das medidas antropométricas e avaliados segundo o erro técnico de medição, que foi considerado adequado (0,30cm) para as medidas de comprimento/estatura das crianças. Os erros de medição foram identificados e os entrevistadores retreinados quando necessário. Nas 14.558 crianças identificadas, foram obtidas medidas de massa corporal e o comprimento/estatura em duplicata em 13.835 e 13.693 crianças, respectivamente. Os aspectos metodológicos padronizados serão úteis para estudos populacionais futuros e foram fundamentais para se obter maior grau de confiabilidade dos dados na geração de evidências atualizadas sobre a avaliação antropométrica do estado nutricional de crianças brasileiras menores de cinco anos, possibilitando novas perspectivas para o desenvolvimento de políticas públicas.

Lactente; Criança; Pré-Escolar; Antropometria; Peso Corporal

Resumen

Este artículo presenta aspectos metodológicos de la evaluación antropométrica en el estado nutricional de niños menores de cinco años y sus madres biológicas, y las estrategias utilizadas para el entrenamiento y la recogida de datos del Estudio Nacional de Alimentación y Nutrición Infantil (ENANI-2019). El ENANI-2019 es una encuesta poblacional de base domiciliar, realizada en 123 municipios de los 26 estados de la Federación y el Distrito Federal. Las medidas antropométricas recogidas fueron la masa corporal y la longitud/estatura. Los equipos se adquirieron según su capacidad y precisión de medida, portabilidad y coste-beneficio, tras una amplia investigación de mercado. Se utilizaron los procedimientos establecidos internacionalmente y descritos en manuales, vídeos y material de apoyo, desarrollados para el estudio por un grupo de especialistas. Los entrevistadores fueron entrenados para la realización de las medidas antropométricas, y fueron evaluados según el error técnico de medición, que fue considerado adecuado (0,30cm) para las medidas de longitud/estatura en los niños. Los errores de medición fueron identificados y los entrevistadores, reentrenados cuando era necesario. En los 14.558 niños identificados, se obtuvieron medidas de masa corporal y longitud/estatura por duplicado en 13.835 y 13.693 niños, respectivamente. Los aspectos metodológicos estandarizados serán útiles para estudios poblacionales futuros y fueron fundamentales para que se obtuviera un mayor grado de confiabilidad de los datos, así como en la generación de evidencias actualizadas sobre la evaluación antropométrica del estado nutricional de niños brasileños menores de cinco años, posibilitando nuevas perspectivas para el desarrollo de políticas públicas.

Lactante; Niño; Preescolar; Antropometría; Peso Corporal

Submitted on 17/Oct/2020

Final version resubmitted on 19/Feb/2021

Approved on 11/Mar/2021