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Trabajo Original

Valoración nutricional

Intra-observer reliability of the anthropometric measurements in South American children and adolescents: the SAYCARE Study

Confiabilidad intraobservador de mediciones antropométricas en niños y adolescentes sudamericanos: Estudio SAYCARE

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Abstract

Introduction: the South American Youth/Child Cardiovascular and Environmental (SAYCARE) feasibility study aims to develop valid and reliable indicators to investigate health-related behavior and nutritional status in children and adolescents. Anthropometric measurements are one of the evaluated indicators in the study. The accuracy of the anthropometric data is very important and relies in the quality of the measurements.

Objective: to describe the intra-observer reliability of ten anthropometric measurements: weight, height, circumferences (neck, arm, waist, hip) and skinfolds (triceps, subscapular, biceps and suprailiac) of children and adolescents from six South American cities: Lima, Medellin, Montevideo, Santiago, San Pablo and Teresina.

Methods: prior to the study, fieldworkers from the seven centers participated in central training to ensure the application of standardized procedures in the anthropometric measurements. Intra-observer precision, technical error of measurement (TEM) and coefficient of reliability (R) were estimated for each measurement.

Results: reliability of weight and height was above 99% in almost all cities. TEM for skinfold thickness was below 1.4 mm in children and 2.13 mm in adolescents, while reliability was above 95% in most of the skinfold measurements. TEM for circumferences was below 1.8 cm in children and 0.64 cm in adolescents, while reliability was above 99% in almost all circumferences.

Conclusions: reliability of the anthropometric measurements in this study was high. In comparison with similar European or American studies, the reliability of the measurements taken in our study was, in most cases, similar or even higher.

Key words:

Reliability. Anthropometric measurements. Children and adolescents.

Resumen

Introducción: el estudio piloto South American Youth/Child cARdiovascular and Environmental (SAYCARE) tiene como objetivo desarrollar indicadores válidos y confiables para investigar el estado nutricional y las conductas vinculadas a la salud en niños y adolescentes. Uno de estos indicadores son las mediciones antropométricas. La precisión de los datos antropométricos es muy importante y se basa en la calidad con que se toman las mediciones.

Objetivos: describir la confiabilidad intraobservador de diez mediciones antropométricas: peso, talla, circunferencias (cuello, brazo, cintura, cadera) y pliegues (trÍceps, subscapular, bÍceps y supraillaco) de niños y adolescentes de seis ciudades de Sudamérica: Lima, Medellín, Montevideo, Santiago, San Pablo and Teresina.

Métodos: previo al estudio, los trabajadores de campo de los seis centros participaron de un entrenamiento centralizado, para asegurar la aplicación de procedimientos estandarizados en la toma de las mediciones antropométricas. Para determinar la precisión intraobservador, se estimó el error técnico de medición (TEM) y el coeficiente de confiabilidad (R) para cada medición.

Resultados: la confiabilidad de las medidas de peso y la talla estuvo por encima del 99% en casi todas las ciudades. El TEM para el grosor de los pliegues estuvo debajo de 1,4 mm en los niños y de 2,13 mm en los adolescentes, mientras que la confiabilidad fue superior al 95% en la mayoría de las mediciones de los pliegues. El TEM para las circunferencias estuvo por debajo de 1,8 cm en los niños y de 0,64 cm en los adolescentes, mientras que la confiabilidad fue superior al 99% en casi todas las circunferencias.

Conclusiones: la confiabilidad de las mediciones antropométricas en este estudio fue alta. Comparada con estudios similares realizados en Europa y Estados Unidos, la confiabilidad de las medidas tomadas en nuestro estudio es, en la mayoría de los casos, similar o aún más elevada.

Palabras clave:

Confiabilidad. Medidas antropométricas. Niños y adolescentes.

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INTRODUCTION

Obesity is defined as an excess of total body fat and is a risk factor for chronic diseases like type-2 diabetes, cancer and cardiovascular diseases, which are the leading causes of death in adults worldwide (1). Childhood obesity is one of the most relevant problems of public health in this century, growing at alarming rates, especially in low and middle-income countries (2). Mean body mass index (BMI) and the prevalence of obesity have increased worldwide in children and adolescents from 1975 to 2016, with a global increase of 0.32 kg/m^2 per decade in girls and 0.40 kg/m^2 in boys, from an age-standardized mean BMI of 17.2 kg/m^2 in girls and 16.8 kg/m^2 in boys to 18.6 kg/m^2 and 18.5 kg/m^2 in 2016, respectively (3). Obesity rates in children and adolescents increased from less than 1% in 1975 to almost 6% in girls and 8% in boys in 2016 (3).

More than 20% (approximately 42.5 million) of Latin American children aged 0 to 19 years are overweight or obese. Among children under five years old, excess weight and obesity are widespread, particularly in the Southern Cone and in Mexico, reaching figures of around 10%. In older children, the prevalence of excess weight and obesity exceed 25% of the population in some countries, like Chile, Ecuador and Mexico (4). It is important to consider that children with obesity are prone to obesity in adulthood and more likely to develop non-communicable diseases at younger ages (5).

There are many techniques to determine excess body fat (dual-energy X-ray absorptiometry, underwater weighing, air displacement plethysmography, magnetic resonance imaging and computed tomography) (6). Anthropometry is a relatively quick, simple, and inexpensive method of nutritional assessment that can provide information about fat mass and fat free mass composition (7).

Body weight and height are used to calculate BMI, the most common index used to identify obesity in children (8). Both weight and height are easy measurable parameters. However, in growing children, age and sex need to be considered along with BMI (9). BMI provides information about total body mass; however, it does not give information about body compartments. To overcome the limitations of BMI in clinical practice, other measurements could be taken (11)**.** Waist circumference (WC) is a good indicator to assess abdominal obesity (12) and it is an important measurement to be taken, as cardio-metabolic risk factors are more prevalent in children and adolescents with abdominal obesity than those with excess weight or general obesity (13). The WC measurement has been difficult to standardize worldwide because there is no consensus on the location of the measurement. There are different protocols to measure WC: the World Health Organization (WHO) recommends to measure it in the midpoint between the top of the iliac crest and the lower margin of the last palpable rib in the mid axillary line (14), the Centers for Disease Control and prevention (CDC) recommend to measure it at the uppermost lateral border of the hip crest (ilium) (15) and certain studies have measured it at the umbilical level (16). In subjects with excess abdominal fat, this measurement becomes difficult at any location and can lead to errors. Skinfold thickness provides information about subcutaneous fat. The measurements are difficult to standardize because the size of skinfolds may vary according to the duration and level of compression during the measurement, and the level of tissue hydration (17). Obesity may influence the reliability of skinfold measurements, especially in cases in which skinfold size approaches the upper limit of the measurement range of the caliper (18). In their review of anthropometric measurement error, Ulijaszek and Kerr found that skinfold measurements were the most imprecise (10).

The accuracy and usefulness of the anthropometric method greatly rely on the quality of the measurements. Reliability assessment is a direct indicator of data quality (19). When anthropometric mesurements are taken, the measurements may vary due to different personal skills or inconsistencies in adherence to study protocols among fieldworkers (20). However, variations due to measurement error, technical error or personal error can be controlled to some extent at the time anthropometrical studies are performed (21).

The most common method to estimate error when taking anthropometric measurements is through the technical error of measurement (TEM), which is an accurate index that estimates the quality of the measurements taken. From an evaluation viewpoint, a low variability between repeated measurements on the same subject by one (intra-observer differences) or by two or more (inter-observer differences) observers is considered as high reliability (20).

There is information on anthropometric measurement error in epidemiological studies in children and adolescents, but mainly in North America and Europe. However, this information is not usually reported in studies from South America.

Therefore, the aim of this study was to describe the intra-observer reliability of ten anthropometric measurements (weight, height; neck, arm, waist and hip circumferences; and triceps, subscapular, bicep and suprailiac skinfolds) in the South American Youth/Child Cardiovascular and Environmental (SAYCARE) feasibility study, in children and adolescents.

MATERIAL AND METHODS

SAYCARE is an observational multicenter, feasibility study that has been designed to develop valid and reliable indicators to investigate health-related behavior and nutritional status in children and adolescents. The study was carried out in seven centers from six countries of South America: Buenos Aires (Argentina), Lima (Peru), Medellin (Colombia), Montevideo (Uruguay), Santiago (Chile), and São Paulo and Teresina (Brazil). The first goal of the SAYCARE study was to assess the feasibility and reliability of the questionnaires and the anthropometric measurements. The fieldwork was carried out during the academic years of 2015 and 2016, and different number of anthropometrists participated in each center (Medellin 2, Santiago 2, Lima 3, Montevideo 4, Buenos Aires 4, Teresina 4 and San Pablo 5)

The subjects were selected in each city, stratified by age into two groups: children (3-10 years) and adolescents (11-18 years), and by type of school into two groups: public and private. Each sex was represented by 50% of participants. The sample size was calculated based on the experience of other multicenter studies in which feasibility pilot studies were previously conducted as well as the reliability and validity of the methods were evaluated (11,12,19). This sample size was increased by 20% in order to take potential drop-outs into account. The target sample size was 240 children and 240 adolescents from each city (22). Data from Buenos Aires was not included in this anthropometric analysis because only a single measurement was available.

The project followed the ethical standards of the Declaration of Helsinki and Good Clinical Practice recommendations. The study was approved by the Ethics Committee of each participating center. The volunteer and/or guardian provided fully-informed written consent to participate.

STANDARDIZATION PROCESS

Prior to the study, fieldworkers from the seven centers participated in central training that took place in March 2015 at the Federal University of Piauí in Teresina (Brazil). The aim of the training was to ensure the application of standardized procedures to measure weight, height, circumferences (neck, arm, waist and hip) and skinfolds (triceps, subscapular, biceps and suprailiac). Theoretical and practical training was implemented, and thereafter an assessment of intra- and inter-observer reliability was performed. As described below, intra-observer (twice) and inter-observer (once) reliability was assessed.

ANTHROPOMETRIC MEASUREMENTS

The guidelines for each measurement (according to the reference manual of anthropometric standardization of the WHO) (22) were laid down in the standard operation procedures manual and were available to all staff members. Anthropometric measurements were taken at the right side of the body two times, non-consecutively. In case of an error of 5% or higher between the first and the second measurement, a third measurement was taken. All measurements were taken in underwear or with as few clothes as possible and without shoes, as follows (14,23,24).

Weight was measured to the nearest 0.1 kg by using a digital scale (WISO W801, Barreiro, Brazil). *Height* was measured by using a portable stadiometer (Cardiomed WSC, Paraná, Brazil) to the nearest 0.1 cm, with the subject barefoot and head in the Frankfort plane.

The *arm circumference* was measured with the subject standing relaxed with his or her side to the observer, and the arm hanging freely to the side; the tape was passed around the arm at the level of the midpoint of the upper arm (the midpoint between the posterior border of the acromion process to the tip of the olecranon process). The *waist circumference* was measured midway between the lowest rib margin and the iliac crest, feet positioned close together, at the end of a gentle expiration. The *hip circumference* measurement was taken at the point yielding the maximum circumference over the buttocks, feet positioned close together, with the tape held on a horizontal plane. The *neck circumference* measurement was taken with the tape placed around the neck above the larynx and perpendicular to the axis of the neck. All the circumferences were measured to the nearest 0.1 cm using a flexible, non-elastic tape (Cardiomed WSC, Paraná, Brazil). The subject was in a standing position. Skinfold thicknesses were measured to the nearest 1mm by using a caliper (Lange, CA, USA) at the following sites: *triceps,* halfway between the acromion process and the olecranon process; *biceps,* at the same level as the triceps skinfold and directly above the center of the cubital fossa; *subscapular,* about 20 mm below the tip of the scapula and 45 degrees to the lateral side of the body; *suprailiac,* about 20 mm above the iliac crest and 20 mm toward the medial line.

The WHO cut-off points were used to characterize the population according to their nutritional status (25,26).

STATISTICAL ANALYSIS

The technical error of measurement (TEM) was calculated as the square root of the measurement error variance. TEM is the most commonly-used measure of precision and was calculated with the following formula:

$$TEM = \frac{\sqrt{\sum d^2}}{2N}$$

where “d” is the difference between measurements and “N” is the number of individuals measured. The lower the TEM obtained, the better the precision of the appraiser to take the measurement (10).

The coefficient of reliability (R) is another approach to obtain comparability of anthropometric measurement error in population studies. It shows the proportion of between-subject variance free from measurement error. In this case, we used R as a percentage (R%), which was calculated by the following formula:

$$R = 1 - \left(\frac{TEM^2}{SD^2}\right)$$

where SD^2 is the total intra-subject variance for the study, including measurement error. An R% value of 100% means that there was no measurement error. The higher the R% values, the greater the measurement precision. An R% above 95% means that the variance was due to factors not related to measurement error. Where R is around 99%, such error is unlikely (10).

All statistical analyses were performed by using the Predictive Analytic Software (PASW 18.0 for Windows; PASW Chicago, IL).

RESULTS

Anthropometry was the part of the SAYCARE study that presented the highest compliance (728 children and 391 adolescents had double anthropometry *versus* 237 and 258, respectively, who completed all the questionnaires twice). Table I summarizes the characteristics of the population with anthropometric data.

Table I. Main characteristics of the SAYCARE population

	Children	Adolescents
Number	732	392
Sex (female, %)	51	51
Weight (kg) (95% CI)	27.3 (26.6-28)	54.8 (53.7-55.6)
Height (cm) (95% CI)	120.6 (119.7-121.4)	158.3 (157.5-159.1)
BMI (kg/m^2) (95% CI)	18.7 (18.5-19)	21.8 (21.6-21.9)
WC (cm) (95% CI)	59.3 (58.9-59.9)	73.3 (72.7-74)
% Growth retardation*	4.03 (2.5-5.5)	5.7 (3.3-8.1)
% Overweight/Obesity†	40.6 (36.9-44.2)	34.8 (30.1-39.6)

*BMI: body mass index; WC: waist circumference. *Height/age < -2 SD (95% CI). †BMI/Age > +2 SD up to five years old and BMI/age > +1 SD above five years old (95% CI).*

The intra-observer TEM and reliability for each anthropometric measurement, both in children and adolescents from the six cities of South America, are shown in tables II and III, respectively.

The TEM for weight ranged between 0 kg (Medellin) and 0.2 kg (San Pablo) in children and from a minimum of 0.03 kg (Santiago) and a maximum of 0.89 (Lima) in adolescents. The TEM for height ranged between 0.03 cm (Lima) and 0.93 cm (San Pablo) in children and 0.05 cm (Santiago) and 1.25 cm (Lima) in adolescents. Reliability was above 99% in both measurements, except for adolescent's height from Lima, which was 98.6%.

The error in circumferences ranged between 0.03 cm (neck, waist, hip) and 1.8 cm (hip) in children and between 0.05 cm (neck) and 0.64 cm (waist) in adolescents. Reliability in children´s circumferences was above 99% for all measurements, except for the arm circumference, which was 98.4% and 98.8% in Teresina and Montevideo respectively, and for the neck circumference, which was 96.6% in Montevideo, 96.8% in Teresina and 98.5% in Santiago. In adolescents' circumference measurements, reliability was above 99% for almost all of them. The exceptions were the arm circumference, which was 97.9% in Teresina, 98.3% in Montevideo and 98.7% in Medellin, and the neck circumference, which was 98.8% in Montevideo.

TEM in skinfold measurement in children ranged between 0.07 mm (subscapular) and 1.40 mm (triceps) and in adolescents between 0.08 mm (triceps and suprailiac) and 2.13 mm (triceps). Reliability for skinfolds was above 95% in all skinfolds,

Table II. Intra-observer TEM and %R of anthropometric measurements in children by city

	São Paulo			Teresina			Medellin			Lima		
	n	TEM	R%	n	TEM	R%	n	TEM	R%	n	TEM	R%
Weight (kg)	107	0.21	99.96	174	0.05	99.99	134	0.00	100.00	100	0.03	99.99
Height (cm)	106	0.93	99.62	173	0.14	99.99	134	0.53	99.91	100	0.03	99.99
Circumferences												
Neck (cm)	107	0.09	99.88	175	0.46	96.80	135	0.03	99.99	100	0.08	99.92
Arm (cm)	107	0.20	99.58	175	0.46	98.43	135	0.29	99.37	100	0.08	99.96
Waist (cm)	107	0.17	99.97	175	0.40	99.84	135	0.03	100.00	100	0.08	99.99
Hip (cm)	107	0.20	99.97	175	1.84	96.87	132	0.41	99.88	100	0.03	99.99
Skinfolds												
Triceps (mm)	107	0.31	99.62	175	0.37	99.52	135	1.40	93.05	100	0.10	99.96
Subscapular (mm)	107	0.38	99.56	175	0.49	99.44	135	0.36	99.33	100	0.07	99.99
Biceps (mm)	107	1.29	88.52	175	0.58	98.00	135	0.91	88.97	100	0.30	99.72
Suprailiac (mm)	107	0.27	99.94	175	0.64	99.50	135	0.61	99.32	100	0.14	99.98
	Montevideo			**Santiago**						**All**		
	n	TEM	R%	n	TEM	R%				n	TEM	R%
Weight (kg)	68	0.03	99.99	149	0.04	99.99				732	0.12	99.99
Height (cm)	68	0.25	99.96	149	0.24	99.97				732	0.32	99.94
Circumferences												
Neck (cm)	68	0.51	96.66	149	0.29	98.51				734	0.88	99.27
Arm (cm)	68	0.34	98.87	149	0.21	99.60				734	2.39	98.33
Waist (cm)	68	0.22	99.92	149	0.58	99.64				734	0.62	99.86
Hip (cm)	68	0.03	100.00	149	0.33	99.89				734	1.50	99.18
Skinfolds												
Triceps (mm)	68	0.26	99.71	143	0.64	98.54				733	8.87	95.68
Subscapular (mm)	68	0.39	98.81	143	0.22	99.84				733	4.57	99.47
Biceps (mm)	68	0.30	99.15	143	0.27	99.07				733	1.67	99.91
Suprailiac (mm)	68	0.88	96.68	143	0.21	99.92				733	3.06	99.83

TEM: technical error of measurement; R: coefficient of reliability.

Table III. Intra-observer TEM and %R of anthropometric measurements in adolescents by city

	São Paulo			Teresina			Medellin			Lima		
	n	**TEM**	**R%**	**n**	**TEM**	**R%**	**n**	**TEM**	**R%**	**n**	**TEM**	**R%**
Weight (kg)	70	0.21	99.98	56	0.53	99.80	69	0.42	99.89	104	0.89	99.52
Height (cm)	70	0.43	99.85	56	0.24	99.96	69	0.07	99.90	104	1.25	98.65
Circumferences												
Neck (cm)	70	0.10	99.93	56	0.05	99.97	69	0.14	99.74	104	0.11	99.85
Arm (cm)	70	0.30	99.55	56	0.53	97.96	69	0.40	98.73	104	0.14	99.79
Waist (cm)	70	0.19	99.96	56	0.18	99.96	69	0.64	99.40	104	0.10	99.98
Hip (cm)	70	0.30	99.93	56	0.17	99.96	69	0.26	99.91	104	0.25	99.90
Skinfolds												
Triceps (mm)	70	0.08	99.98	56	0.47	99.29	69	2.13	89.06	104	0.62	98.66
Subscapular (mm)	70	1.09	97.96	56	0.47	99.15	69	0.94	97.51	104	0.45	99.41
Biceps (mm)	70	0.15	99.94	56	0.47	98.27	69	0.74	96.37	104	1.42	95.84
Suprailiac (mm)	70	0.13	99.98	56	0.19	99.96	69	0.08	99.99	103	0.83	99.20
	Montevideo			**Santiago**						**All**		
	n	**TEM**	**R%**	**n**	**TEM**	**R%**				**n**	**TEM**	**R%**
Weight (kg)	35	0.13	99.99	58	0.03	99.90				392	0.60	99.78
Height (cm)	35	0.18	99.99	58	0.05	99.90				392	0.84	99.51
Circumferences												
Neck (cm)	35	0.35	98.86	57	0.23	99.18				391	0.21	99.55
Arm (cm)	35	0.47	98.37	57	0.18	99.57				391	0.16	99.80
Waist (cm)	35	0.12	99.98	57	0.23	99.92				391	0.33	99.87
Hip (cm)	35	0.21	99.96	57	0.35	99.72				391	0.24	99.93
Skinfolds												
Triceps (mm)	35	0.42	99.30	57	0.26	99.82				391	0.85	97.99
Subscapular (mm)	35	0.66	98.55	57	0.09	99.98				391	0.68	98.84
Biceps (mm)	35	0.24	99.47	57	0.10	99.91				391	0.73	98.95
Suprailiac (mm)	35	0.12	99.94	57	0.39	99.74				391	0.45	99.76

TEM: technical error of measurement; R: coefficient of reliability.

except for the biceps in children from San Pablo (88.5%) and Medellin (88.9%) and triceps in children (93%) and adolescents (89%) from Medellin.

DISCUSSION

The SAYCARE feasibility study was carried out to determine the reliability of several indicators that will be used in the final complete study to investigate risk factors for cardiovascular diseases in children and adolescents from seven cities of South America. Anthropometric measurements are among these indicators and they are very useful in population studies to determine the presence of obesity or body composition abnormalities. As excess weight and obesity are risk factors for cardiovascular diseases (12), it is very important to establish (17) the reliability of body fat and fat distribution measurements. The most important result of our study is that the field work researchers obtained a very good intra-observer agreement.

In this study, for the vast majority of measurements and cities, R values were higher than 95%, in most measurements reaching values above 98%. The lowest R values were obtained for the triceps skinfold, both in children (95.6%) and adolescents (97.9%), although they are above the optimal values in both cases. Skinfold thicknesses are particularly difficult to measure, as this involves separating the subcutaneous adipose tissue from the underlying muscle, something that becomes even more difficult in overweight individuals (27). Skinfold thicknesses can be affected by compression during measurement but also by the biological characteristics of the individual being measured and anatomical differences in compressibility that vary with age, gender and recent weight loss (17).

Reliability was higher for circumferences than for skinfolds, both in children and adolescents. Analyzing the reliability of both measurements in children and adolescents, for circumferences, reliability was higher in adolescents than in children, and for skinfolds, the opposite occurs. The TEM for the circumferences measured was below 0.5 cm (except for children's hip that was 0.99 cm). The TEM for the skinfolds was below 1 mm, except for children's tricipital skinfold, which was 1.09 mm.

The measurement of error in anthropometry is not always analyzed in epidemiological studies. In a review by Ulijaszek and

Kerr (10), results were compiled on intra-observer reliability; for circumferences it ranged from 85 to 95% and for the skinfolds from 89 to 97%. Weight and height had a reliability of 98%.

There are few studies measuring anthropometry and involving several countries in Latin America, and even less that have studied the reliability of the measurements taken. One of them is the Hispanic Health and Nutrition Examination Survey (HHANES 1982-1984) (28), which collected data to determine growth patterns for Hispanic children living in the United States. They determined the intra-observer reliability of some anthropometric measurements in a sample of children aged above 12 years. Considering the reliability of the common measurements taken in both studies (in the case of SAYCARE, taking into account the reliability of adolescents): height, arm circumference, and tricipital, subscapular and suprailiac skinfolds, the reliability was higher in most of the SAYCARE measurements: in arm circumference, it was 1.9% higher (99.7% *vs* 97.8%), in the subscapular skinfold it was 3.4% higher (98.8% *vs* 95.4%), and in the suprailiac skinfold it was 10.5% higher (99.7% *vs* 89.2%). The tricipital skinfold reliability was the same in both cases (97.9%) and for height the SAYCARE study reliability was 0.5% lower (99.5% *vs* 100%).

In Europe, there have been more recent epidemiological studies that analyzed the measurement errors in anthropometry in children and adolescents: Toybox (infants, six countries) (20), IDEFICS (infants and children, six countries) (18) and HELENA (adolescents, ten cities) (17). Height and weight reliability in SAYCARE children were very similar to Toybox and IDEFICS studies (above 99%), but for waist circumference, the reliability was better in SAYCARE children (99.8%) than in Toybox (96.7%). Toybox had a second training session for waist circumference measurement due to low reliability in the first. In the second training session, reliability was better but still lower than our study or the IDEFICS study. On comparing reliability of the other circumference measurements, we found that, for SAYCARE children, it was better than for IDEFICS children, except for arm circumference, which was lower (98.3% *vs* 99.3%). Something similar occurs with skinfolds reliability, which was better in SAYCARE children than in IDEFICS children, except for the tricipital skinfold that was lower in our study (95.6% *vs* 99.4%). Reliability in adolescent measurements was better in our study than in the HELENA study, both for circumferences (> 99% *vs* > 97%) and for skinfold thicknesses (> 97% *vs* > 95%). In all the previous studies, reliability results were optimal or at least acceptable (> 90%) for epidemiological studies in children and adolescents.

In summary, the intra-observer reliability of the anthropometric measurements of our study can be considered as very good. However, due to involuntary difficulties, we could not determine the margin of inter-observer error in this feasibility study, but it will be determined prior to the complete final study.

CONCLUSIONS

We can conclude that the training workshop carried out with the fieldworkers before taking the measurements in the respective countries gave good results in the subsequent feasibility study. The reliability of the measurements taken in our study was in most cases the same or higher than the reliability shown in European or American studies.

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ES, TRU, AER, CAD, KAM and JCA were involved in data collection. ES, TRU, PME, JACA and LM were involved in the conducting, analysis and writing of the manuscript. All authors were involved in writing the paper and gave final approval of the submitted and published versions.

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