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Original/*Obesidad*

Body adiposity index and associated factors in adults: method and logistics of a population-based study

Wellington Segheto[1], Danielle Cristina Guimarães da Silva[1], France Araújo Coelho[1], Vanessa Guimaraes Reis[1], Sílvia Helena Oliveira Morais[1], João Carlos Bouzas Marins[2], Andréia Queiroz Ribeiro[3] and Giana Zarbato Longo[3]

[1]Federal University of Viçosa, Minas Gerais. [2]Department of Physical Education and Sports. Federal University of Viçosa, Minas Gerais. [3]Nutrition and Health Department. Federal University of Viçosa, Minas Gerais, Brazil.

Abstract

Introduction: **obesity is a public health problem that has increased considerably. Several techniques have been developed and used to measure the amount of body fat, or a combination of excess fat with some comorbidities. The Body Adiposity Index is a new method proposed to determine body fat and its validation is still limited. Methods and logistics of a population-based study reported in the literature are few, mainly multidiciplinas team.**

Objective: **the objective was to report the proceedings of a population-based study, the denouement is the index of adiposity in adults.**

Design: **the design of this study was cross-sectional, with a sample of 1085 adults aged 20-59 years living in the city of Viçosa, MG. A questionnaire was applied at home with sociodemographic, behavioral issues, health and level of physical activity. Then anthropometric and biochemical data were collected. The training for data collection involved the calibration of evaluators, being the correlation between the measurements checked by the intraclass correlation test and was adopted as the acceptable value of 0.60.**

Results: **it is noted that, with the exception of assessors 1, the triceps and subscapular skin folds, and the evaluator 4, in the pectoral skinfolds and suprailiac, all other measures reached acceptable cutoff point for agreement among evaluators.**

Conclusions: **multidisciplinary research is important to understand the various factors that may be operating in health and disease process tool. Methodological and logistical aspects described in this study should be followed, which will lead to a steady decrease in research biases.**

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Key words: *Body adiposity index. Obesity. Method. Cross-sectional study.*

Correspondence: Wellington Segheto.
Av. Darcy Vargas, 623, CEP 36031-100, Juiz de Fora.
Minas Gerais, Brasil.
E-mail: wsegheto@gmail.com

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ÍNDICE DE ADIPOSIDAD CORPORAL Y FACTORES ASOCIADOS EN ADULTOS: MÉTODO Y LOGÍSTICA DE UN ESTUDIO POBLACIONAL

Resumen

Introducción: **la obesidad es un problema de salud pública que ha aumentado considerablemente. Se han desarrollado distintas técnicas para medir la cantidad de grasa corporal, o una combinación de exceso de grasa con ciertas comorbilidades. El Índice de Adiposidad Corporal es un nuevo método propuesto para determinar la grasa corporal y su validación es aún limitada. Solo hay algunos métodos y logísticas de estudios poblacionales recogidos en la bibliografía, la mayoría de equipos multidisciplinares.**

Objetivo: **el objetivo consistió en informar de los procedimientos de un estudio poblacional, para concluir en el índice de adiposidad en adultos.**

Diseño: **el diseño de este estudio fue transversal, con una muestra de 1.085 adultos con edades entre 20 y 59 años, que vivían en la ciudad de Viçosa, MG. Se aplicó un cuestionario para completar en casa, con aspectos sociodemográficos, conductuales, de salud y del nivel de actividad física. Después se recopilaron los valores antropométricos y bioquímicos. La formación para la recogida de datos incluyó el calibrado de los evaluadores, estableciéndose la correlación entre las mediciones a partir de una comprobación mediante una prueba de correlación intraclase, siendo 0,60 el valor definido como aceptable.**

Resultados: **se observa que, a excepción del evaluador 1, para los pliegues cutáneos subescapulares, y del evaluador 4, para los pliegues cutáneos pectorales y suprailiacos, el resto de mediciones alcanzaron un nivel aceptable de acuerdo entre los evaluadores.**

Conclusiones: **la investigación multidisciplinar es importante para comprender los distintos factores que podrían intervenir en la herramienta de evaluación de salud y enfermedad. Se deberían seguir los aspectos metodológicos y logísticos descritos en este estudio, los cuales llevan a una reducción continua de los sesgos de la investigación.**

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Palabras clave: *Índice de adiposidad corporal. Obesidad. Método. Estudio transversal.*

Abbreviations

BAI: Body Adiposity Index.

IBGE: Instituto Brasileiro de Geografia e Estatística.

SIMTEL: Monitoring System of Risk Factors for Chronic Noncommunicable Diseases for Telephonic Interviews.

IPAq: International Physical Activity Questionnair.

ISAK: International Standards for Anthropometric Assessment.

VIGITEL: Surveillance System of Risk Factors and Protection for Chronic Diseases by Telephone Survey.

ESA/Viçosa: Study on Health and Nutrition of Viçosa.

Introduction

Obesity is a public health problem that has increased considerably. In 2008, the worldwide prevalence of obesity in men was 9.8% and 13.8% in women and is almost double the values seen in 1980. The estimates are that in 2008 approximately 205 million men and 297 million women older than 20 years were obese worldwide[1]. Projections for 2030 show that 2.16 billion people will be overweight and 1.12 billion will be obese with associated comorbidities[2]. Excess weight is associated with some comorbidities such as ischemia, stroke, type 2 diabetes, some cancers and osteoarthritis[3].

In Brazil, studies have found that obesity reached 11% of the population over the period 2002-2003, which amounted to 10.5 million people[4]. Data collected in the capitals of Brazilian states showed that the prevalence of obesity in Belo Horizonte, Minas Gerais[5] was 9.3%. In 2012, the prevalence of obesity in Brazil[6] was 15.8%, indicating a rapid increase of this condition in approximately 10 years.

Techniques were developed and used to measure the amount of body fat or the association of excess fat with few comorbidities, including the body mass index, waist circumference, waist-hip ratio, the skinfolds, bioimpedance, dual-energy X-ray absorptiometry and hydrostatic weighing[7], but some of them are complex and expensive to be routinely used. Anthropometry has then been referenced as a good alternative to assess the collective nutritional status because of the ease of obtaining the measurements that can be both reliable and valid, provided there is proper training and the measurements are standardized[8].

Considering these factors, Bergman et al.[9] suggested a new method, the Body Adiposity Index (BAI), for determining body fat. BAI is calculated from the measurements of height and hip circumference, allowing its determination without the need of measuring a person's body fat as to calculate the Body mass index[9].

The BAI validation in different populations and with different patterns of body fat distribution has been recommended in the literature[10]. These different patterns can be found in population-based studies that evaluate representative samples of the population, allowing the evaluation of individuals with distinct sociodemographic, behavioral, anthropometric and biochemical characteristics through the methodology.

Knowledge of body fat based on representative samples of the population is still limited, especially in the Zona da Mata region of Minas Gerais State, although such research may contribute to a broad knowledge of individuals and reduce costs, especially when working with a multidisciplinary team and seeking to meet several objectives. Studies based on cross-sectional methodologies, as well as their challenges and solutions, are scarcely reported in the literature[11].

Seeking to contribute to the discussion on the methodological aspects and logistics of a population-based study conducted by a multidisciplinary team and reduce the gap in the literature concerning the description of these aspects, the aim of this study is to describe the procedures for a population-based study in Viçosa, Minas Gerais, Brazil, with the focus on the body adiposity index in adults.

Methods

The study used a population-based cross-sectional design. It was conducted in Viçosa – MG, in the State of Minas Gerais, located in the Zona da Mata region. The reference population consisted of 20-59 year-old individuals. Individuals of both sexes living in the urban area of the municipality of Viçosa were eligible. Data from the 2010 Census indicated that this age group is composed of 52% of the total population, the equivalent to 43,431 people[12].

Population sample size

The sample size was calculated using the Epi-Info software, considering the following parameters: reference population of 43,431 individuals; outcome prevalence of 23.4%[13], expected sampling error of 3.5%; effect of study design, estimated at 1.5, to which was added 20% relating to losses or refusals and 10% for the control of confounding factors, yielding a final sample of 1,085 individuals.

The process of sampling was used, with the first-stage units being the census tracts, IBGE census units and then households.

Number of households visited

To determine the number of sectors[14], 30 census tracts were selected by draw among the 99 existing tracts in the urban area of Viçosa, maintaining the non-replacement policy. After obtaining the census

tract maps, each had the blocks identified and numbered. A block number was selected by draw and then a corner was also drawn, starting fieldwork clockwise from the drawn corner.

The number of individuals per sector was estimated considering that each household had an average of 4 dwellers. Each census tract has 300 households that multiplied by the number of people per household equals approximately 1,200 individuals. Because the required sample number was calculated at 1,085, which divided by 30 census tracts selected, gives the number of people needed in each of the selected tracts equal to 36. It was estimated that 15 households should be visited in each census tract to meet the required number of subjects for research.

Criteria for loss, refusals and exclusion

Individuals who were not found in their homes after at least four visits, including a visit on weekends and one at night, were considered as losses. If the house was uninhabited, interviewers were directed to move to the nearest house on the right. The reason for the loss was described for that residence and/or individual and a note was added to the spreadsheet.

Individuals who refused to participate in the study were contacted again by the research supervisors. Those who maintained no agreement to participate were recorded as refusals.

Other exclusion criteria included pregnant women, individuals that were bedridden or unable to stand for measurements and those with a mental disability that prevented them from answering the survey questions.

Logistics of the study

The research team of this study consisted of the following members: General Coordination (researcher responsible for the study, coordination, guidance and supervision); coordinators (faculty advisors responsible for coordinating, training and guidance of the actions of supervisors and other team members); supervisors (students of the Postgraduate Program, responsible for the supervision of interviewers); evaluators (graduate students, nurse and biochemist, responsible for applying and evaluating the protocols for determination of adiposity and biochemical tests); secretary (delivery and receipt of questionnaires, scheduling laboratory tests and quality control of questionnaire completion); interviewers (undergraduates in

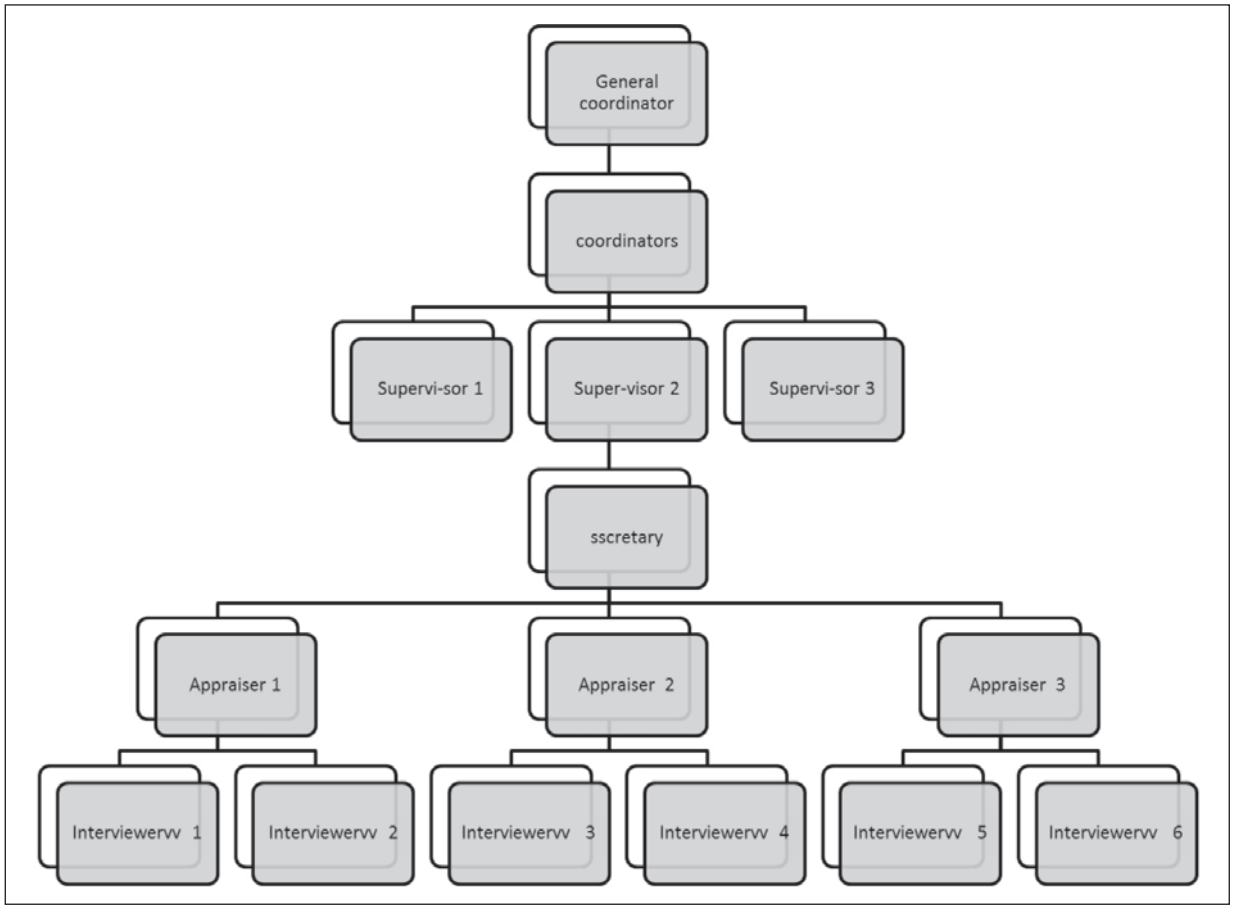

Fig. 1.—Introduction of staff working for the development of research ESA / Viçosa group.

Nutrition, Nursing and Physical Education, responsible for applying the questionnaires) and typists (undergraduates responsible for collected data entry typing). Figure 1 shows the organization chart of the team involved in the study.

Training and Calibration

In order to achieve standardization in using the criteria of objective anthropometric measurements, it was essential that the evaluators involved in the study participated in a training and calibration process. This process in this study consisted of four steps.

In the first step the interviewers received information on the study objectives, criteria and methods of measuring all variables. The questionnaire and the study instruction manual were read out loud and an exercise of questionnaire application was performed to clarify the first doubts. This training was carried out to make clear to the interviewers the importance of keeping the diagnosis concordance rate at a good level.

The evaluators, in the second stage, practiced anthropometric measurements in a group of 6-8 adults selected in the age range of the study, which were sufficient for all the evaluators participate in the exercise, aiming at a greater apprehension of the criteria.

All evaluators assessed the same individuals. If differences occurred in the anthropometric measurements, these observations were noted and discussed in the group. The group coordinator was the mediator of the discussion, which was based on the objective criteria that were previously studied by the team and recommended by the literature[15]. At this step, a standard evaluator was selected, someone with previous experience in anthropometric measurements for calibration of the other evaluators.

After training the team members participated in the calibration. Anthropometric measurements were taken in 19 individuals. During this phase of the process, each of the evaluators and the standard evaluator performed the measurements and recorded on forms, no contact was allowed between them. At the end, the concordance obtained between the different evaluators and the standard evaluator were analyzed by the intraclass correlation coefficient.

In the last stage, the questionnaire pre-test was performed with 20 individuals randomly selected and with the same age range of the research. The pre-test aimed to adapt the questionnaire for field work. The interviews were monitored by the supervisors that analyzed the procedure and the conduct of interviewers.

Pilot Study

A pilot study was conducted in a census tract drawn from the tracts considered non eligible for the study. The pilot study aimed to identify possible errors in the preparation and application of the questionnaire, determination of adiposity and biochemical protocols. It also aimed to train all the research team and verify the operational aspects for the development of the study.

Dependent variable

The dependent variable BAI[9] was determined based on the height (m) and hip circumference (cm) measured at the level of the maximum extension of the buttocks posteriorly in a horizontal plane and without compressing the skin, in a minimum of clothing that could interfere with measurement. The BAI calculation was performed using the equation BAI (%fat) = (Hip circumference (cm)/height (m)$^{1.5}$)– 18.

Independent variable

The demographic variables were age in years, sex, marital status, and skin color[12] and socioeconomic variables were number of school years completed, number of children and current activity. Alcohol consumption was measured by the number drinks consumed per drinking occasion[6]. Cigarette smoking was categorized into smokers, ex-smokers and nonsmokers[6].

Dietary habits were assessed based on the structured questionnaire and tested through phone interviews, the SIMTEL (Monitoring System of Risk Factors for Chronic Noncommunicable Diseases for Telephonic Interviews)[16-17]. The analysis of dietary habits considered the following criteria: protection factor (consuming five or more times per week of fruits and vegetables, raw salads and beans) and risk factors (consuming soft drinks more than three times per week, consuming whole milk and meat with visible fat).

The long version of the International Physical Activity Questionnaire (IPAq), validated for the Brasilian population[18] was used to measure the level of physical activity. Data analysis followed the criteria by Haskell et al.[19] those with scores < 150 minutes of physical activity in a week were classified as irregularly active and those with scores ≥ 150 minutes physical activities were classified as physically active. The level of physical activity was calculated in each domain and overall; the latter was obtained by adding the time spent on physical activities in all domains evaluated (domain 1 + domain 2 + domain 3 + domain 4).

Body image (dis)satisfaction was assessed using the Adult Silhouette Scale[20] validated for Brazilian adults. The participant was asked to indicate the silhouette closest to their own body image at the current time (Actual Silhouette) and the one closest to the body they would like to have (Ideal Silhouette)[21]. Body image (dis)satisfaction was calculated by the equation: body (dis)satisfaction = current silhouette – ideal silhouette[21-22]. The categorization proposed by Quadros et al.[23] was chosen for the study.

Anthropometric measurements were based on International Standards for Anthropometric Assessment (ISAK)[15]. The anthropometric data were recorded at the on laboratory Studies on Health and Nutrition, Nutrition and Health Department,of the Federal University of Viçosa.

Body weight was measured by a TANITA BC-554 Ironmam® digital scale, with 200 kg capacity and 100 g precision, with the participant wearing minimum of clothing and no shoes. Height in meters was measured directly, using a stadiometer attached to the wall, with the participant in straight position, barefoot or with socks only, heels together, arms straight down along the sides of the body, on a smooth, flat and rigid surface.

Body mass index was measured using body mass and height in the ratio (body mass (Kg)/height(m)^2). The cutoff points were according to the World Health Organization[24]: participants were classified as underweight (<18.5 kg/m^2), normal weight (≥ 18.5 kg/m^2 and ≤ 25.0 kg/m^2), overweight (≥ 25.0 kg/m^2 and ≤ 30.0 kg/≥ m^2) and obese (≥ 30 kg/m^2).

The perimeters waist were measured with participantsin the standing position, using an inelastic tape (Sanny®) to the nearest 0.1 cm, at three different points and without compressing the skin: 1) the lesser curvature between the last rib and the iliac crest at the end of a forced expiration; 2) at the midpoint between the last rib and the iliac; and 3) at the umbilicus. The cutoff points were according to the World Health Organization[24]. Hip circumference was measured at the level of the maximum posterior extension of the buttocks in a horizontal plane using an inelastic tape (Sanny®) to the nearest 0.1 cm.

Skinfolds were measured according to techniques described in the literature[25-26]. The authors divided the sites by gender: triceps, abdomen and iliac crest for females[25] and triceps, pectoral and subscapular region for males. Skinfold data were used in the equation specific for each sex to calculate the body density. Then, the percentage of body fat was calculated using the Siri's equation[27]. The skinfolds were measured using a Lange Skinfold caliper (*Cambridge Scientific Industries, Inc, Cambridge, MD*) accurate to 1mm.

Body composition was determined by using a quadrupole BIA 310 Bioimpedance Analyzer with an operating frequency of 50 kHz at 800 μA, following the manufacturer's recommendations. All study participants were assessed once and instructed previously to remove all metal objects, abstain from alcohol drinking and caffeinated beverages within 24 hours of testing, not to do strenuous physical activity within 24 hours of testing, urinate thirty minutes before the assessment and rest for five minutes before the assessment. All assessments were performed in the morning and before breakfast.

Dual-energy X-ray absorptiometry was used as the criterion standard for determination of body adiposity. Data were acquired using a GE Healthcare Lunar Prodigy densitometer with the EnCORE™ software version 13.31. Tests were performed by a professional experienced in radiological measurements. All measurements were taken at the Health Division of the Federal University of Viçosa, depending on participants' availability. The densitometer was calibrated daily according to the manufacturer's recommendations.

Blood pressure was measured 2 times: first, at five minutes after the beginning of the interview and, then, at the end of the interview, using an automatic wrist sphygmomanometer (Omron HEM 629), properly calibrated. At both times of measurement, the individual was in the sitting position, feet flat on the floor, right arm relaxed, leaning on the table or on the shoulder of the evaluator at the level of the heart and palm of hand facing upward[28]. Individuals with systolic blood pressure greater than > 140 mmHg and/or diastolic blood pressure > 90 mmHg or were known to be hypertensive, were classified as high blood pressure[28].

The biochemical variables evaluated were: levels of fasting glucose, total cholesterol, High Density Lipoproteins cholesterol, Low Density Lipoproteins cholesterol, triglycerides and ultrasensitive C-reactive protein. Low Density Lipoproteins cholesterol concentration was calculated using the Friedewald equation. Total cholesterol, triglycerides, high density lipoprotein cholesterol and fasting glucose were measured with enzymatic reagents and quantified photometrically using a COBAS Mira Plus auto-analyzer (Roche Diagnostics Systems). The following reference values were used: fasting glucose < 100 mg/dL; Total cholesterol < 200 mg/dL; high density lipoprotein > 50 mg/dL; Low Density Lipoproteins cholesterol < 130 mg/dL, triglycerides < 150 mg/dL[28].

Immunoturbidimetric assays were used for quantifying C-reactive protein in very low concentrations, with sensitivity of 0.0313 mg/L (Bioclin - C-reactive protein ultrasensitive K079). Reference values were: low risk (< 1.0 mg/L), moderate risk (1.0 to 3.0 mg/L) and high risk (> 3.0 mg/L)[29].

Data collection

The first phase consisted of questionnaire applications. Interviewers, following the home visit criteria, invited all participants that fulfilled the inclusion criteria to participate in the research. Before beginning with the interviews, the participants were informed about the objectives, procedures for participation and evaluation, the voluntary character and possible risks and benefits of participation in the research.

After the consent and reading, the participants were requested to signing the Consent Form and the interview proceeded. At the end, participants were informed that there would be a contact from the research secretary to schedule the laboratory data collection.

At the appointed date and with 12-hour fasting, the study participants were directed to a specific room for

anthropometric and metabolic data collection. The evaluators applied the laboratory tests and blood collection was performed by a qualified professional. Blood was separated in a Twister Sislab centrifuge, at 3500 rpm for 10 minutes, and a serum sample was sent for biochemical analysis at the clinical analysis laboratory of the Federal University of Viçosa. After data collection, the participants received a snack. Figure 2 shows the flowchart for the data collection procedure.

Quality control

This procedure was performed to determine the reproducibility of results. The participants were asked to answer again some questions in the questionnaire; 10% of the sample was re-interviewed. In addition to this control, a quality control of the questionnaires was performed to identify possible errors in data collection or filling.

Tabulation of data

Data were entered into the EpiData software by two students trained by the research coordinator, in duplicate, and checked on the Data Compare Module

Ethical Issues

The project was approved by the Research Ethics Committee of the Federal University of Viçosa (Of Ref No. 02/2013/CEP/07.12.13). All the participants were informed of the research results and those who showed alterations in one of the behavioral, metabolic and/or anthropometric variables were advised to seek qualified professional or health facility closest to their residence, whose location was informed.

Statistical analysis

Data were analyzed using the Stata 13.0 software. The Shapiro-Wilk test indicated that all variables were normally distributed. The agreement between the measurements of the evaluators was verified by the intraclass correlation coefficient test. Percent agreement was classified using the guidelines proposed by Landis and Koch[30], i.e., almost perfect (0.81 to 1), strong (0.61 to 0.80), moderate (0.41 to 0.60), fair (0.21 to 0.40), slight (0 to 0.20) and poor (<0). The level significance was $\alpha = 0.05$.

Results

Since this is an article that aimed to describe the methodological aspects of a population-based study, this section describes data concerning the calibration of the evaluators in the study (Table I). It was considered the means of anthropometric measurements obtained in the calibration and the agreement between them. It was found that, except for the evaluator 1, in the triceps and subscapular skinfolds, and the evaluator 4, in the pectoral and iliac crest skinfolds, all other measures reached the acceptable cut-off point for agreement among evaluators. The evaluator 2 was in agreement with the standard evaluator for all variables.

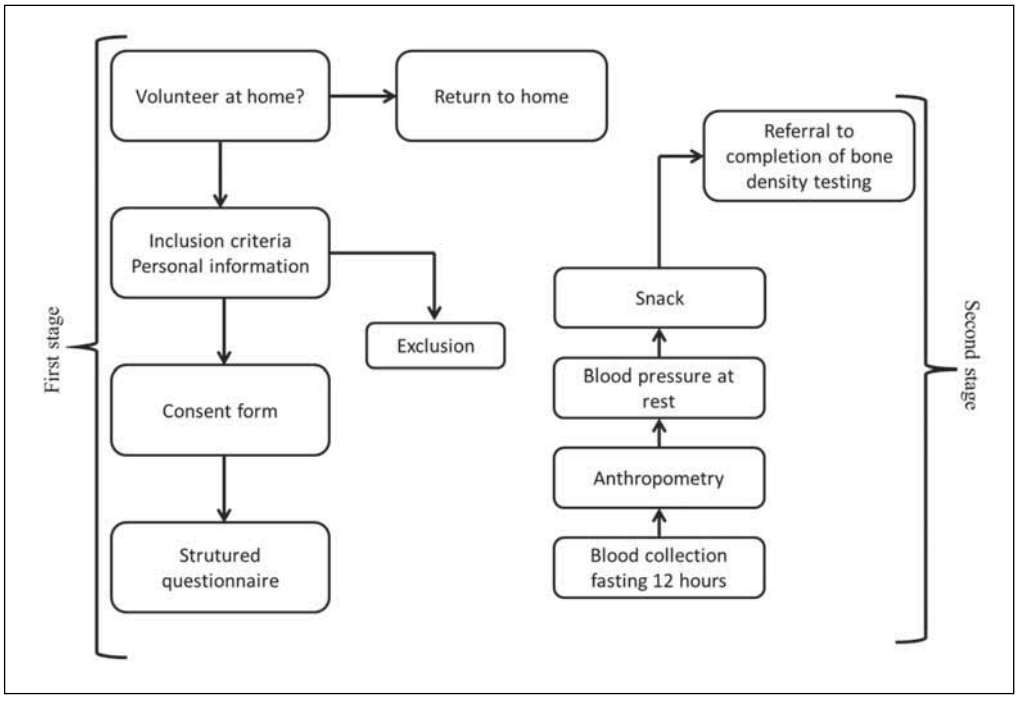

Fig. 2.—Flow diagram of the data collection process.

Table I
Mean, standard deviation, intraclass correlation coefficient and the confidence intervals of anthropometric in adults, Viçosa, Brazil, 2012.(n-19)

Variáble	*Pattern*	*Measurer 1*		*Measurer 2*		*Measurer 3*		*Measurer 4*	
	Mean (SD)	*Mean (SD)*	*ICC 95% CI*	*Mean (SD)*	*ICC 95% CI*	*Mean (SD)*	*ICC 95% CI*	*Mean (SD)*	*ICC 95% CI*
Triceps skinfold	16,76 (8,90)	21,27 (8,22)	0,54 0,11-0,80	19,64 (8,62)	0,86 0,68-0,94	16,51 (6,38)	0,93 0,82-0,97	17,83 (8,39)	0,95 0,87-0,98
Calf skinfold	17,24 (9,37)	17,72 (7,85)	0,77 0,50-0,90	17,16 (8,52)	0,90 0,77-0,96	17,25 (9,54)	0,66 0,31-0,85	17,68 (9,49)	0,98 0,75-0,95
Chest skinfold	11,93 (6,97)	17,42 (8,67)	0,68 0,73-0,95	13,97 (6,56)	0,83 0,61-0,93	11,10 (3,71)	0,67 0,30-0,86	15,76 (7,58)	0,42 0,55-0,92
Suprailiac skinfold	19,13 (6,76)	23,04 (7,03)	0,87 0,70-0,95	18,46 (7,86)	0,84 0,63-0,94	17,11 (5,61)	0,89 0,74-0,96	19,49 (6,61)	0,53 0,11-0,78
Subscapular skinfold	17,41 (6,79)	19,90 (7,13)	0,50 0,07-0,77	16,64 (4,81)	0,91 O,77-0,96	15,13 (4,61)	0,79 0,53-0,91	17,03 (6,06)	0,85 0,66-0,94
Abdominal skinfold	21,65 (7,05)	20,99 (5,09)	0,76 0,48-0,91	20,70 (5,91)	0,95 0,64-0,94	19,20 (5,04)	0,99 0,71-0,85	19,01 (6,51)	0,81 0,55-0,92
Thigh skinfold	23,21 (11,30)	25,38 (10,85)	0,89 0,74-0,96	24,31 (10,75)	0,91 0,79-0,97	22,01 (8,70)	0,87 0,67-0,95	22,68 (11,54)	0,95 0,88-0,98
Stature	167,68 (7,85)	167,49 (7,72)	0,99 0,97-0,99	167,20 (7,72)	0,98 0,97-0,99	167,29 (7,39)	0,99 0,96-0,99	167,32 (7,50)	0,98 0,96-0,99
CC1	72,33 (6,32)	73,40 (6,41)	0,88 0,73-0,95	73,13 (6,53)	0,91 0,80-0,97	73,31 (6,39)	0,92 0,80-0,96	73,98 (6,67)	0,94 0,85-0,97
CC2	74,42 (6,31)	75,96 (6,53)	0,79 0,51-0,90	76,86 (6,66)	0,85 0,66-0,94	76,54 (6,43)	0,82 0,58-0,92	75,88 (6,02)	0,81 0,58-0,92
CC3	78,47 (8,20)	78,82 (6,80)	0,94 0,84-0,97	78,64 (6,19)	0,90 0,77-0,96	78,51 (6,79)	0,83 0,61-0,93	78,80 (6,57)	0,88 0,72-0,95
CQ	96,43 (7,98)	95,05 (6,52)	0,91 0,77-0,96	96,66 (7,14)	0,95 0,88-0,98	97,41 (7,32)	0,91 0,78-0,96	96,34 (6,86)	0,94 0,87-0,98

Abbreviations: SD, standard deviation; CI, confidence interval; ICC, Intraclass correlation coefficient
CC1 = wzaist circumference measured circumference at the smallest visible; CC2 = waist circumference measured at the midpoint enters the last rib and the iliac crest; CC3 = waist circumference measured at the umbilicus; CQ = hip circumference.

Discussion

This type of study design with specific methodological aspects and a representative sample of the population of a city, state or even the country, is still scarce in Brazil, taking into consideration the size of the country, the number of people and the different characteristics of each region. Two studies stand out for having used a representative sample of the Brazilian population, namely, the study by the National Cancer Institute (2002-2003) was the first to address the issues of preventive practices and prevalence of behaviors related to health[5] and the Surveillance System of Risk Factors and Protection for Chronic Diseases by Telephone Survey (VIGITEL) that is in its 6th edition bringing important population information of residents of the Brazilian state capitals[6].

Some population-based studies in large cities, which take into account the demographic and cultural aspects of each region, were carried out in southern Brazil[13,31-33]. However, no studies with such characteristics was reported for the Zona da Mata region of Minas Gerais State, reinforcing the importance of the description of this logistics system and the need for conducting population surveys, particularly those with multidisciplinary approach that can meet various outcomes, such as the proposal of this study. Francis et al.[34] pointed out that with the growing number of epidemiological surveys in the last decade in Brazil, it is important to publish studies related to methodological issues involved in study design, sample size calculation, participant selection methods and analytical techniques that ensure quality and validity of data, among others, for a rigorous evaluation.

The number of refusals by eligible participants in each sector was within the expected based on the sample calculation, of approximately six individuals per sector. The main reasons for refusals were the lack of interest from eligible participants in taking laboratory tests and/or availability for the second phase of data

collection. Easy access to laboratory tests and the lack of time for the research were the main problems encountered by the interviewers. Strategies that could minimize this type of justification for refusals include emphasizing the carrying out of a test that is not routine in the clinic, such as the assessment of bone mineral density by Dual-energy X-ray absorptiometry, and the opportunity to attend the laboratory on a day off from work, on Saturdays and holidays.

One of the important aspects and that should be followed in this type of study is the calibration of the evaluators, allowing the standardization of the criteria of objective anthropometric measurements. Calibration aims to ensure uniformity of interpretation, understanding and application of the criteria of the condition to be observed and recorded; ensure that evaluators can examine consistently with the standard adopted and minimize variations between different evaluators[35]. These objectives have been met when it was found that only the evaluator 1, triceps and subscapular skinfolds, and the evaluator 4, the pectoral and iliac crest skinfolds, have not achieved the minimum value determined as reference for calibration. Thus, new training was conducted for these evaluators, so that so that they were not limited in taking these measurements. Thus, new training was conducted for these evaluators, so that they were not prevented from carrying out these measurements.

Overall, the sociodemographic and behavioral parameters analyzed in this study served to verify the need for interventions to prevent and reduce excess body fat and, consequently, the rise of non-communicable chronic diseases. This range of variables will allow associations that aim at propositions about the relationship between risk behaviors and diseases. Regarding this aspect, Barros[36] pointed out that "having a set of indices that assess different dimensions of the health and illness process provides formulations for a complete and compelling health scenario".

The cross-sectional design of the study is a limiting factor with regard to causal relationships, but methodological issues inherent in population-based studies and conglomerate sampling reduce these limitations. Population surveys allow us to obtain information on sociodemographic, cultural and economic aspects, as well as health status and health risk behaviors[36]. These aspects may allow the creation of public health policies aimed at preventing the onset of diseases as well as strategies that provide a healthy way of life.

This work is part of a larger multidisciplinary project entitled "Body adiposity index, coronary risk and associated factors in adults: *A population-based study in Viçosa, MG, 2013" developed by the ESA/Viçosa group (Study on Health and Nutrition of Viçosa). To meet the study objectives, a team was formed with nutritionists, physical educators, physical therapists and nurses. The multidisciplinarity of this study, comprising four professional health areas, has some advantages as to methodological aspects which can be applied to this research, such as: a single data collection, data collection cost reduction and comprehensive health assessment*[11].

The authors emphasize that although the use of these methodologies may be increasing, the financial resources for such studies are still limited, which justifies the assessment of different outcomes when conducting a population-based study.

Conclusion

Multidisciplinary research is an important tool to understand the many factors that may be acting in the health and disease process and allows cost reduction and work optimization. For this to hold true, the methodological aspects and logistics described in this study should be strictly followed, which will lead to a steady decrease in research biases and keep the number of losses and refusals as predicted, which was found in our work. The training of the interviewers and the calibration of the evaluators were critical to data consistency. Studies of this nature can help to develop intervention programs, seeking a better lifestyle and the reduction of harm to health.

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References

1. Finucane MM, Stevens GA, Cowan MJ, et al. National, regional, and global trends in body-mass index since 1980: *systematic analysis of health examination surveys and epidemiological studies with 960 country-years and 9-1 million participants. Lancet 2011;377(9765):557-567.*
2. Kelly T, Yang W, Chen CS, et al. Global burden of obesity in 2005 and projections to 2030. *Int J Obes* 2008;32(9):*1431-1447.*
3. World Health Organization. *Global health risks: mortality and burden of disease attributable to selected major risks. Geneva: World Health Organization; 2009.*
4. Instituto Brasileiro de Geografia e Estatística. *Pesquisa de orçamentos familiares 2002-2003: análise da disponibilidade domiciliar de alimentos e do estado nutricional no Brasil. Rio de Janeiro: Instituto Brasileiro de Geografia e Estatística; 2004.*
5. Instituto Nacional do Câncer. *Inquérito domiciliar sobre comportamentos de risco e morbidade referida de doenças e agravos não transmissíveis: Brasil, 15 capitais e Distrito Federal, 2002- 2003. Rio de Janeiro: Instituto Nacional do Câncer; 2004.*
6. Departamento de Análise de Situação de Saúde, Secretaria de Vigilância em Saúde, Ministério da Saúde. *Vigilância de Fato-*

res de Risco e Proteção para Doenças Crônicas por Inquerito Telefônico: Vigitel 2011. Brasília: Ministério da Saúde; 2012.
7. Lopez AA, Cespedes ML, Vicente T, et al. Body adiposity index utilization in a Spanish Mediterranean population: *comparison with the body mass index. PloS one 2012;7(4):e35281.*
8. Gibson RS. *Principles of nutritional assessment*. New York: *Oxford University Press; 2005*.
9. Bergman RN, Stefanovski D, Buchanan TA, et al. A Better Index of Body Adiposity. *Obesity* 2011;19(5):*1083-1089*.
10. Lemacks JL, Liu PY, Shin H, et al. Validation of body adiposity index as a measure of obesity in overweight and obese postmenopausal white women and its comparison with body mass index. *Menopause* 2012;19(11):*1277-1279*.
11. Goettems ML, Correa MB, Vargas-Ferreira F, et al. Methods and logistics of a multidisciplinary survey of schoolchildren from Pelotas, in the Southern Region of Brazil. *Cad. Saúde Pública* 2013;29(5):*867-878*.
12. Instituto Brasileiro de Geografia e Estatística. Orçamento e Gestão. *Contagem Populacional*. Instituto Brasileiro de Geografia e Estatística; 2012.
13. Longo GZ, Neves J, Castro TG, et al. Prevalência e distribuição dos fatores de risco para doenças crônicas não transmissíveis entre adultos da cidade de Lages (SC), sul do Brasil, 2007. *Rev bras epidemiol* 2011;14(4):*698-708*.
14. Barros FC, Victora CG. *Epidemiologia da Saúde Infantil*. Um manual para diagnósticos comunitários. São Paulo: *Hucitec/ UNICEF; 1998*.
15. Stewart A, Marfell-Jones M, Olds T, et al. *International standards for anthropometric assessment*. Lower Hutt, New Zealand.2011.
16. Carvalhaes MABL, Moura EC, Monteiro CA. Prevalência de fatores de risco para doenças crônicas: *inquérito populacional mediante entrevistas telefônicas em Botucatu, São Paulo, 2004. Revista bras epidemiol 2008;11(1):14-23*.
17. Monteiro CA, Moura EC, Jaime PC. Monitoramento de fatores de risco para doenças crônicas por entrevistas telefônicas. *Rev Saúde Pública* 2005;39(1):*47-57*.
18. Pardini R, Matsudo SMM, Araújo TL. Validação do questionário internacional de nível de atividade física (IPAQ - versão 6): *estudo piloto em adultos jovens brasileiros. R. Bras. Ci. e Mov 2001;9(3):45-51*.
19. Haskell WL, Lee IM, Pate RR, et al. Physical Activity and Public Health: *Updated Recommendation for Adults from the American College of Sports Medicine and the American Heart Association. Med Sci Sport Exer 2007;39(8):1423-1434*.
20. Kakeshita IS, Silva AIP, Zanatta DP, et al. Construção e fidedignidade teste-reteste de escalas de silhuetas brasileiras para adultos e crianças. *Psic.: Teor. e Pesq 2009;25(2):263-270*.
21. Campana ANNB, Tavares MCGCF. *Avaliação da Imagem Corporal*. São Paulo: *Editora Phorte; 2009*.
22. Cash TF, Pruzinsky T. *Body Image: A Handbook of Theory, Research and Clinical Practice. New York: Guilford Press; 2002*.
23. Quadros RMB, Gordia AP, Martins CR, et al. Imagem corporal em universitários: *associação com estado nutricional e sexo. Motriz: rev. educ. fis 2010;16(1):78-85*.
24. World Health Organization *Obesity: preventing and managing the global epidemic. Geneva: World Health Organization; 1998*.
25. Jackson AS, Pollock ML, Ward A. Generalized equations for predicting body density of women. *Med Sci Sports Exerc* 1980;12(3):*175-181*.
26. Jackson AS, Pollock ML. Generalized equations for predicting body density of men. *Br. J. Nut* 1978;40(3):*497-504*.
27. Siri WE. The gross composition of the body. *Adv Biol Med Phys* 1956;4:*239-280*.
28. Sociedade Brasileira de Cardiologia/Sociedade Brasileira de Hipertensão/Sociedade Brasileira de Nefrologia. *VI Diretrizes Brasileiras de Hipertensão. Arquivos Brasileiros de Cardiologia*. 2010;95-1 Suppl. 1):*1-51*.
29. Pearson TA. Markers of Inflammation and Cardiovascular Disease: *Application to Clinical and Public Health Practice: A Statement for Healthcare Professionals From the Centers for Disease Control and Prevention and the American Heart Association. Circ 2003;107(3):499-511*.
30. Landis JR, Koch GG. The measurement of observer agreement for categorical data. *Biometrics* 1977; 33(1): *159-174*.
31. Lopes JA, Longo GZ, Peres KG, et al. Fatores associados à atividade física insuficiente em adultos: *estudo de base populacional no sul do Brasil. Rev bras epidemiol 2010;13(4):689-698*.
32. Ferreira GD, Silva MC, Rombaldi AJ, et al. Prevalência de dor nas costas e fatores associados em adultos do sul do Brasil: *estudo de base populacional. Brazilian Braz. J Phys Ther 2011;15(1):31-36*.
33. Sousa CA, César CLG, Barros MBA, et al. Prevalência de atividade física no lazer e fatores associados: *estudo de base populacional em São Paulo, Brasil, 2008-2009. Cad Saúde Pública 2013;29(2):270-282*.
34. Francisco PMSB, Barros MBDA, Segri NJ, et al. Comparação de estimativas de inquéritos de base populacional. *Rev Saúde Públ* 2013;47(1):*60-68*.
35. World Health Organization. *Calibration of examiners for oral health epdemiology surveys*. Geneva: *World Health Organization; 1993*.
36. Barros MBA. A importância dos sistemas de informação e dos inquéritos de base populacional para avaliações de saúde. *Epidemiol Serv Saúde* 2004;13(4):*199-200*.