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Original

Normative values for anthropometric, adiposity, and handgrip strength in Costa Rican adults aged 60 to 110 years old

Valores normativos de antropometría, adiposidad y fuerza de prensión manual en adultos Costarricenses entre 60 y 100 años de edad

Cinthya Campos Salazar[1], Yamileth Chacón Araya[2], Luis Solano Mora[3], Gilbert Brenes Camacho[4], and José Moncada Jiménez[5]

1. Master of Science in Physical Education, School of Physical Education and Sports, University of Costa Rica cinthia.campos@ucr.ac.cr
2. Doctor in Physical Activity and Sports Sciences, Human Movement Sciences Research Center, University of Costa Rica, yamileth.chacon@ucr.ac.cr
3. Master of Science in Human Movement Sciences, School of Human Movement Sciences and Quality of Life, National University, lsolano@una.cr
4. Doctor in Demography, School of Statistics and Central American Population Center, University of Costa Rica, gilbert.brenes@ucr.ac.cr
5. Doctor in Biomedical Sciences, Human Movement Sciences Research Center, University of Costa Rica, jose.moncada@ucr.ac.cr P.O. Box 239-1200 Pavas, San José, Costa Rica. Tel. +506 2511-2909

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ABSTRACT

Objective: The purpose of the study was to develop normative data for anthropometric, adiposity and upper body strength in Costa Rican adults 60 to 110 years old.
Method: A representative sample of Costa Rican male and female older adults (n= 2 711) were assessed for body weight and height, knee height, waist, hip and arm circumferences, adiposity, and upper-body strength. The 10th, 25th, 50th, 75th, and 90th percentiles were selected as the normative reference points for each 10-year age groups (60-69, 70-79, 80-89, 90-99, and ≥100).

Results: Men and women experience age-related increased adiposity and reductions in upper body strength; however, men increased their upper-body strength at older ages.

Conclusion: The normative values allow health professionals to monitor anthropometric, adiposity, and upper-body strength in older adults, and to design comprehensive fitness interventions that promote a healthy lifestyle in the population.

Key Words: norms, aging, fitness, adiposity, Latin America.

RESUMEN

Objetivo: El propósito del estudio fue desarrollar datos normativos para antropometría, adiposidad y fuerza de la parte superior del cuerpo en adultos costarricenses de 60 a 110 años de edad.

Método: Se evaluó una muestra representativa de adultos mayores costarricenses varones y mujeres (n = 2 711) para determinar el peso y la talla corporal, la altura de la rodilla, la cintura, las circunferencias de la cadera y el brazo, la adiposidad y la fuerza de la parte superior del cuerpo. Los percentiles 10, 25, 50, 75 y 90 se seleccionaron como puntos de referencia normativos para cada grupo de edad de 10 años (60-69, 70-79, 80-89, 90-99 y ≥100).

Resultados: Los hombres y las mujeres experimentan una mayor adiposidad relacionada con la edad y reducciones en la fuerza de la parte superior del cuerpo; sin embargo, los hombres aumentaron la fuerza de la parte superior del cuerpo a edades más avanzadas.

Conclusión: Los valores normativos permiten a los profesionales de la salud monitorear antropometría, adiposidad y fuerza de la parte superior del cuerpo en adultos mayores, y diseñar intervenciones integrales de acondicionamiento físico que promuevan un estilo de vida saludable en la población.

Palabras clave: normas, envejecimiento, estado físico, adiposidad, América Latina.

There is an undeniable process of demographics transformation worldwide, in which older adult figures are rising and children and adolescent figures are decreasing. Costa Rica, a middle-income country has a high life expectancy, with more people reaching 100 years of age. Costa Rican nonagenarians have an extraordinarily high life expectancy compared to elderly from developed countries (1). Furthermore, Costa Rican older adults at the age of 90 show a mortality rate 14% lower than the average older adult from 13 high-income countries. In addition, at an older age this advantage increases by 1% and is greater for men by 12% compared to women.

Data from a comparative study conducted in 2016 revealed that the United States showed a higher mortality rate than Costa Rica for men (18%) and women (10%) (2). These findings might be partially explained by a lower mortality attributed to cardiovascular and lung diseases in the Costa Rican population. Given the growth in the aging population in developed and developing countries, it is necessary to characterize their physical and functional health parameters and pursue actions that allow them to improve their quality of life.

There is evidence regarding physical and functional health in elderly mostly from European and Asian countries, and few in America. A study conducted in Portugal on 4 712 adults over 65 yr. of age, assessed functional fitness variables (3). The main finding was that both, women and men, experience age-related losses in all functional fitness variables; only about 50% achieved the Senior Fitness Test (SFT) standards (4) for upper and lower body strength, and less than 50% of the population the standards for aerobic capacity, agility and balance. Body mass index (BMI = body weight (kg)/body height (m^2)), abdominal obesity, and hip circumference were also assessed in the study, showing that almost 50% of the sample were overweight (women = 44%, men = 48%), a higher percentage of women (69%) had abdominal obesity than men (33.9%), and a similar between-gender waist circumference. In another European study conducted on 6 449 older adults between 60-99 years of age from Extremadura, Spain (5), the results showed that when compared to similar cohorts from other countries, this cohort had more elderly participants physically inactive and with higher body fat percentages. In addition, differences were observed between men and women in the age-related reduction in body mass (5).

A multi-ethnic study conducted in Singapore on adults between 60 and 105 years of age, compared hand grip strength (HGS) and anthropometric and socio-demographic variables (6). The results showed a significant decrease in HGS at older age regardless of the ethnic group and socio-demographic situation. Descendants from Malaysia and India had lower strength values. When comparing to other countries, the HGS of the older Singaporeans was relatively lower than the older adults of Western countries (US and UK) and some Asian countries (Japan, Malaysia, and Hong Kong), except Taiwan. Finally, a multivariate analysis showed a positive association between HGS and body height ($\beta = 0,12$, $p = 0,001$), body weight ($\beta = 0,09$, $p = 0,019$), and an

inverse association with waist circumference (β = −0,08, p = 0,018).

These associations confirmed previous results (7), where for all muscle groups, in all age groups, there is a significant association between body height and strength, muscle mass and hip circumference.

A study conducted with Costa Rican and US populations compared cardiovascular risk factors adjusted by educational level (8). Anthropometric measurements were included as part of the biomarkers studied. Results showed that US men and women were more likely to be obese, severely obese, and have a larger waist circumference than the Costa Rican sample. Costa Ricans also showed a substantially lower BMI than the US sample, and interestingly, cardiovascular risk factors in both populations did not behave uniformly after adjusting by educational level. In general, risk biomarkers increased at higher levels of education for the Costa Ricans than for the US sample.

It is evident that the aging process is associated with a loss of physical function, fitness, and changes associated to anthropometric parameters. The elaboration of physical and anthropometric norms is important, since it is known that in men, but especially in women, some physical variables are related to their quality of life (9). It is also important to compare these variables in older adult populations from different countries, and thus offer health strategies according to the physical status of the population.

Therefore, the purpose of the study was to elaborate norms of anthropometric variables, adiposity and HGS in Costa Rican adults 60 to 110 years of age. The relevance of the study is that the norms obtained in this study will allow us to identify the anthropometric health and upper-body strength status of a person relative to people of the same age and gender. It will also allow us study trends over time and compare with normative values obtained in other countries.

METHODOLOGY

Participants

We examined data from a representative sample of Costa Rican residents who were born before 1946, with an over-sample of the oldest-old (i.e., ≥ 95 yrs.), pertaining to the Costa Rican Longevity and Healthy Aging Study (CRELES, for its acronym in Spanish) (10). A random selection was obtained from the database of the Population Census of the year 2000, totaling 9 600 individuals 55 years of age or older, after a stratification by five-year age groups that assured a sufficiently large number of participants of advanced ages (the oldest olds). The sampling fraction in this selection varied between 1% for those who were born between 1941 and 1945, and 100% for those who were born before 1905. The final sample size for this study consisted of 2 711 older adults. The de-identified CRELES database is publicly available at the National Archive of Computerized Data on Aging (NACDA) of the University of Michigan: http://www.icpsr.umich.edu/icpsrweb/NACDA/studies/26681.The Scientific Ethics Committee of the University of Costa Rica approved the study and all participants provided written informed consent.

Materials and procedures

All the data were gathered in the homes of the participants, generally in two visits; during the first visit, participants read and signed an informed consent to participate in the study. In the second visit, the anthropometric and handgrip strength measures were recorded. All the data were registered using handheld personal digital assistants (PDAs). The anthropometric measurements (body weight, body height, knee height, abdominal, hip, calf, and arm circumferences, triceps and subscapular skin-fold measurements), and HGS were collected by trained personnel.

Participant's body weight was measured on a scale (Life Source®, A&D medical, model UC-321,

Brooklyn, NY), placed on an even floor without carpets. Body height was measured on a stadiometer (Seca®, Hamburg, Germany). Those participants with major spine problems were not measured. The knee height was recorded with a caliper (Shorr USES Knee-Height Caliper®, Olney, MD) in the right leg unless an injury was present.

The BMI was calculated and categorized according to international cut-off criteria (11) into six groups: 1) underweight, < 18,5 kg/m^2, 2) normal, 18,5-24,9 kg/m^2, 3) pre-obesity, 25,0-29,9 kg/m^2, 4) obesity class I, 30-34,9 kg/m^2, 5) obesity class II, 35,0-39,9 kg/m^2, and 6) obesity class III, >40 kg/m^2.

The waist and hip circumferences were recorded with a measuring tape (Seca®, QuickMedical, Issaquah, WA) having the participants standing, in a semi-anatomical position, with the feet separated and the palm of the hands resting on the lateral thigh. The waist-to-hip ratio (WHR) was computed from these measures. Increased risk for metabolic complication was defined as a WHR ≥ 0,90 cm for males and ≥ 0,85 cm for females (12). Abdominal obesity in males was defined as having a waist circumference >102 cm and in females >88 cm (13). The calf circumference was recorded by having the participant seated, with the right leg exposed. For the arm circumference, the person was seated or standing, and the measurement was taken at the half point between the acromion and the olecranon anatomical sites. A Lange® skinfold caliper (Beta Technology Inc., Santa Cruz, CA) was used to measure triceps and subscapular skin folds.

Finally, HGS was measured with a T-18® hand-held dynamometer (Creative Health Products Inc., Ann Arbor, MI). Two trials were allowed and the highest value was used for analysis. The participant was instructed to complete trials using the dominant and non-dominant hand.

Statistical analysis

Statistical analyses were performed with the IBM-SPSS Statistics, version 22 (IBM Corporation, Armonk, New York). The data are presented stratified by age and gender, reported as mean (M) and standard deviation (±) for continuous variables and as frequencies and percentages for categorical variables. The Kolmogorov-Smirnov normality statistic was used within each age and gender group. The 10th, 25th, 50th, 75th, and 90th percentiles were selected as the normative reference points for each 10-year age groups (60-69, 70-79, 80-89, 90-99, and ≥100).

A mixed three-way ANOVA (2 x 5 x 2, gender by age-group categories by hands) on handgrip was computed. Two-way (2 x 5, gender by age-group categories) were used to analyze differences between gender and age subgroups on the anthropometric and handgrip strength variables. The 95% confidence intervals ($CI_{95\%}$) for the estimate are reported. Non-parametric Chi^2 was used to determine associations between WHR risk stratification by gender. The level of significance was set *a priori* at p ≤ 0,05.

RESULTS

Complete data were obtained from 2 711 participants, 1 233 males (45,5%) and 1 478 females (54,5%), with a mean age of 76,5 ± 10,3 yr. (min= 60, max= 110 yr.). Based on the WHO definitions for WHR risk values (12), a significant proportion of female (59,1%) and male (40,9%) elderly shown an increased risk for metabolic complications (χ^2 = 91,6, p ≤ 0,001). Adiposity based on WHO definitions for BMI values (11) showed that the prevalence of normal-weight was similar for males (37,6%) and women (36,4%). Males (39,8%) were more pre-obese than females (37,2%), and more obese class II (3,8%) than females (3,5%); however, males were more underweight (4,4%) than females (3,9%), less obese class I (13,4%) than females (17,5%), and less obese class III (1,0%) than females (1,5%). Abdominal obesity as measured by the waist circumference was significantly more prevalent in women (64,5%) compared with men (18,6%).

A significant interaction was found between age categories and gender on mean waist circumference (p = 0,047). Males in the 60-69 yr. old age group (Mean = 92,8 ± 13,0 cm; min = 64,0, max = 152,0) had a higher waist circumference than males on the 80-89 yr. old age group (Mean = 90,8 ± 11,7 cm; min = 56,0, max = 129,0) (p = 0,047, $CI_{95\%}$ = 0,03 a 4,00). Females in the 90-99 yr. old age group (Mean = 90,4 ± 12,7

cm; min = 25,0, max = 139,0) had a lower waist circumference than females on the 70-79 (Mean = 93,2 ± 13,1 cm; min = 23,0, max = 139,0) (p = 0,048, $CI_{95\%}$ = -5,57 a -0,27) and 80-89 (Mean = 93,2 ± 13,8 cm; min = 36,0, max = 168,0) (p = 0,049, $CI_{95\%}$ = -5,61 a -0,02) yr. old age groups. A significant age group main effect was found on mean WHR (p = 0,032). Elderly in the 70-79 yr. old age group (Mean = 0,96 ± 0,10; min = 0,26, max = 1,24) had a higher WHR than elderly in 80-89 yr. old age group (Mean = 0,94 ± 0,10; min = 0,40, max = 1,53) (p = 0,017, $CI_{95\%}$ = 0,00 a 0,02). No significant three-way and double significant interactions were found on handgrip strength (p > 0,05). In general, right hand (Mean = 24,1 ± 9,0 kg; min = 3,5, max = 58,0) was higher than left hand strength (Mean = 22,4 ± 8,7 kg; min = 3,0, max = 54,0) ($p \leq 0{,}001$, $CI_{95\%}$ = 1,43 a 1,76).

In tables 1, 2, 3 and 4 are shown the 10^{th}, 25^{th}, 50^{th}, 75^{th}, and 90^{th} percentile scores on each test by gender and age group. The percentile score represents the value below which a certain percentage of observations fall.

DISCUSSION

The purpose of the study was to develop normative data for anthropometric, adiposity and HGS variables in Costa Rican adults 60 to 110 years of age. Approximately 50% of the elderly adults assessed in this study showed a risk for metabolic disease. Almost 40% of both, men and women, were at least overweight, and particularly women (64,9%) showed high abdominal obesity. Older adults over 80 years old showed low cardiovascular risk as measured by the WHR.

The evaluation of body weight according to gender and age group was similar; however, the obesity classification based on BMI showed that women had higher type I and III obesity (18,5%) compared to men (14,4%). This finding coincides with Marques et al. (2014), who found more obese women than men. However, we found more men with type I overweight and obesity (43,3%) in the present study, which is also relevant to consider since both genders need to assess their nutrition lifestyle.

The BMI has been widely reported in other studies and the findings have not been conclusive considering age and gender. The study by Chen, Lin (14), showed an inverse association between age and BMI in men and women. A similar finding was reported in a study conducted in North India, where men, but not women, in the 70-74 age group showed the highest BMI (15). In a study conducted in Hong Kong, the BMI and other adiposity measures did not change over time regardless of gender (16).

Based on the WHR data, more than 75% of men and women showed cardiovascular risk. In addition, consistent with abdominal obesity, elderly 70-79 years showed a higher WHR than elderly 80-89 years. Women showed higher abdominal obesity than men (64,5% vs. 18,6%, respectively), a finding that also coincides with a previous study (3), where 69% of the women had elevated abdominal obesity. It has been reported that in men and women abdominal obesity as measured by waist circumference is increased at older ages (5). In the study by Marques, Baptista (3), the group with the highest waist circumference was the 80-84 years in both, men and women, increasing progressively in each age group and then decreasing after 85 years of age. Based on the BMI and WHR findings of the present study, it can be concluded that obesity is a complex construct depending on a myriad of cultural factors.

In this study, there were no significant gender or age HGS differences. This finding contradicts the results from previous studies (3, 6, 7, 14, 17), where it has been consistently reported the inverse association between age and HGS. There is some evidence showing this inverse association only in women (15, 16).

It is widely known that physical capabilities are reduced with aging in both, men and women (18). A reduction in upper body strength of 42,1% in men and 35,3% in women has been found over a

period of 30 years (60 to 90 years of age) when measured with the 30-s arm curl of the SFT (4). When measured by the HGS test these reductions showed 23% and 16.8% for men and women, respectively (19). In the present study, the reduction in upper body strength reached 4% for women, and men showed an extraordinary increase of 8,7%. Therefore, although we expected a general reduction in upper body strength as previously reported in the literature (5, 14, 16), Costa Rican men showed greater upper body strength at older ages. This result allows us to consider that cultural and epigenetic factors could be responsible for this unexpected finding. Rosero-Bixby (1), suggests that the exceptional life expectancy of Costa Rican nonagenarians might result from a selection process because the individuals that reached such an old age were "stronger" and survived an environment of high incidence of communicable diseases. This argument might be plausible to explain why the oldest old Costa Ricans have such favorable HGS values.

In conclusion, in this study, we present normative values for anthropometric, adiposity, and HGS of Costa Rican adults aged 60 to 110 years old. We suggest using percentile values for all the population aged 60 years and older when no significant age or gender differences are found. This study is relevant because it allows us to describe clearly the older adult population and use this valuable information for tailored and efficient health proposals. From the literature reviewed, we found that older adults from different countries do not exhibit the same anthropometric, adiposity, and HGS behaviors. We did not find normative Latin Americas studies assessing elderly functional capacity or adiposity and anthropometry features. Therefore, the information summarized in the tables will allow health professionals to monitor anthropometric, adiposity, and HGS of older adults and will encourage similar studies in Latin American countries.

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Table 1. Age- and gender-specific norms for body weight, height and body mass index in the elderly Costa Rican population.

	Male						Female						All					
		Percentile						Percentile						Percentile				
Variable and age-group	**n**	**10th**	**25th**	**50th**	**75th**	**90th**	**n**	**10th**	**25th**	**50th**	**75th**	**90th**	**n**	**10th**	**25th**	**50th**	**75th**	**90th**
Weight (kg)																		
60-69 yr.	330	46,6	53,5	63,1	71,4	83,2	410	44,7	53,3	62,8	71,9	80,8	740	45,6	53,4	62,9	71,6	81,6
70-79 yr.	414	45,4	53,4	61,0	70,7	80,5	433	44,9	54,5	63,4	73,7	83,1	847	45,1	54,0	62,1	71,9	82,0
80-89 yr.	298	45,7	53,1	61,6	70,0	79,2	402	46,0	53,7	61,9	72,1	82,4	700	46,0	53,5	61,8	71,1	80,2
90-99 yr.	74	43,9	53,7	61,8	70,9	79,3	93	45,7	51,9	62,2	70,6	78,7	167	45,4	52,3	62,2	70,7	78,6
≥ 100 yr.	43	45,6	52,5	65,4	73,2	82,5	44	40,3	48,7	67,4	72,0	79,1	87	42,6	52,3	66,5	72,2	80,3
All age groups	1 159	45,8	53,4	61,7	70,9	80,4	1 382	45,3	53,7	62,9	72,1	81,8	2 541	45,5	53,5	62,4	71,5	80,9
Height (cm)																		
60-69 yr.	327	144,0	149,0	155,0	163,0	169,0	411	143,0	148,0	156,0	163,0	168,0	738	143,0	148,0	155,0	163,0	168,0
70-79 yr.	410	143,0	147,0	154,0	162,0	167,0	432	143,0	148,0	154,0	161,0	168,0	738	143,0	148,0	154,0	162,0	167,7
80-89 yr.	296	142,0	147,0	154,0	160,8	167,0	399	142,0	148,0	154,0	161,0	167,0	695	142,0	147,0	154,0	161,0	167,0
90-99 yr.	73	141,0	149,0	155,0	162,5	166,6	92	139,3	146,0	153,0	163,0	167,0	165	139,6	147,0	155,0	163,0	167,0
≥ 100 yr.	43	140,4	147,0	157,0	165,0	168,6	43	144,2	151,0	160,0	163,0	169,6	86	141,7	148,0	158,5	164,0	169,0
All age groups	1 149	143,0	148,0	155,0	162,0	167,0	1 377	142,0	148,0	155,0	162,0	168,0	2 422	143,0	148,0	155,0	162,0	167,3
BMI (kg/m^2)																		
60-69 yr.	326	20,3	22,9	25,9	29,0	32,3	409	20,3	23,0	25,5	28,9	32,5	735	20,3	22,9	25,6	29,0	32,5
70-79 yr.	410	20,3	22,8	25,8	28,6	31,8	430	19,9	23,5	26,3	30,1	33,2	840	20,0	23,0	26,0	29,4	32,6
80-89 yr.	296	20,0	22,7	26,1	28,9	31,9	397	20,6	23,0	26,0	29,6	32,1	693	20,4	22,9	26,0	29,2	32,0
90-99 yr.	73	20,5	22,6	26,3	28,8	33,6	92	21,2	23,3	25,7	28,5	31,7	165	21,0	22,9	25,9	28,6	31,8
≥ 100 yr.	43	20,4	23,3	26,3	29,7	35,4	43	18,4	20,3	26,4	28,9	32,3	86	19,5	22,6	26,4	29,2	33,8
All age groups	1 148	20,3	22,8	25,9	29,0	32,1	1 371	20,2	23,1	26,0	29,4	32,6	2 519	20,2	23,0	25,9	29,1	32,3

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Table 2. Age- and gender-specific norms for knee height, waist and hip circumferences and WHR in the elderly Costa Rican population

	Male						Female						All					
		Percentile						Percentile						Percentile				
Variable and age-group	n	10th	25th	50th	75th	90th	n	10th	25th	50th	75th	90th	n	10th	25th	50th	75th	90th
Knee height (cm)																		
60-69 yr.	355	45,0	47,0	49,0	51,0	54,0	440	44,0	46,0	49,0	51,0	53,0	795	44,0	46,0	49,0	51,0	53,0
70-79 yr.	434	45,0	46,0	49,0	51,0	53,0	461	45,0	46,0	49,0	51,0	53,0	895	45,0	46,0	49,0	51,0	53,0
80-89 yr.	317	44,0	46,0	48,0	51,0	53,0	425	45,0	47,0	48,0	51,0	53,0	742	45,0	46,0	48,0	51,0	53,0
90-99 yr.	77	44,0	46,0	49,0	51,5	53,0	102	44,0	45,0	49,0	51,0	52,7	179	44,0	46,0	49,0	51,0	53,0
≥ 100 yr.	45	45,0	46,0	49,0	52,5	54,0	44	44,5	47,0	50,0	51,8	52,5	89	45,0	46,5	50,0	52,0	53,0
All age groups	1 228	44,9	46,0	48,0	51,0	53,0	1 472	45,0	46,0	49,0	51,0	53,0	2 700	45,0	46,0	49,0	51,0	53,0
Waist circumference (cm)																		
60-69 yr.	343	76,0	84,0	92,0	100,0	108,0	430	77,1	84,0	92,0	100,0	107,0	773	77,0	84,0	92,0	100,0	107,6
70-79 yr.	427	78,0	84,0	91,0	100,0	107,0	452	76,3	85,0	93,0	101,0	109,0	879	78,0	84,0	93,0	100,0	108,0
80-89 yr.	306	76,0	83,0	91,0	99,0	105,0	416	76,7	85,0	92,0	101,0	109,0	722	76,0	84,0	92,0	100,0	107,0
90-99 yr.	76	76,7	84,0	93,0	98,0	108,2	99	76,0	83,0	91,0	96,0	103,0	175	76,6	84,0	91,0	98,0	104,0
≥ 100 yr.	43	81,4	86,0	93,0	99,0	113,6	44	72,5	82,3	92,5	98,0	108,0	87	77,8	85,0	93,0	99,0	108,0
All age groups	1 195	77,0	84,0	92,0	99,0	107,0	1 441	77,0	84,5	92,0	100,0	108,0	2 636	77,0	84,0	92,0	100,0	107,0
Hip circumference (cm)																		
60-69 yr.	333	85,0	91,0	97,0	104,0	110,0	419	85,0	90,0	96,0	102,0	110,0	752	85,0	90,0	96,0	103,0	110,0
70-79 yr.	415	84,0	90,0	96,0	102,0	108,0	436	85,7	91,0	96,0	103,8	110,0	851	85,0	90,0	96,0	103,0	109,0
80-89 yr.	297	84,0	90,0	96,0	103,0	110,0	409	86,0	91,0	97,0	104,0	112,0	706	86,0	91,0	97,0	104,0	111,3
90-99 yr.	76	87,0	90,3	97,0	101,8	108,3	95	86,6	90,0	97,0	100,0	107,6	171	87,0	90,0	97,0	101,0	107,8
≥ 100 yr.	43	87,0	91,0	97,0	105,0	113,2	44	80,0	86,3	96,0	103,3	110,0	87	83,8	91,0	97,0	104,0	110,4
All age groups	1 164	85,0	90,0	96,0	103,0	109,0	1 403	86,0	91,0	96,0	103,0	110,0	2 567	85,0	90,0	96,0	103,0	110,0
Waist-to-Hip ratio (WHR)																		
60-69 yr.	333	0,86	0,90	0,96	1,00	1,04	419	0,85	0,90	0,95	0,99	1,03	752	0,86	0,90	0,96	1,00	1,03
70-79 yr.	415	0,86	0,91	0,96	1,01	1,06	436	0,86	0,91	0,96	1,00	1,05	851	0,86	0,91	0,96	1,00	1,05
80-89 yr.	297	0,84	0,89	0,94	0,99	1,02	409	0,85	0,90	0,95	1,00	1,04	706	0,84	0,90	0,95	0,99	1,04
90-99 yr.	76	0,86	0,89	0,96	1,00	1,04	95	0,85	0,90	0,96	0,99	1,02	171	0,85	0,90	0,96	0,99	1,02
≥ 100 yr.	43	0,87	0,91	0,97	1,01	1,04	44	0,87	0,91	0,96	0,99	1,04	87	0,87	0,91	0,96	1,00	1,04
All age groups	1 164	0,85	0,90	0,95	1,00	1,04	1 403	0,85	0,9	0,96	1,00	1,04	2 567	0,85	0,90	0,95	1,00	1,04

Table 3. Age- and gender-specific norms for calf and arm circumferences, triceps, and subscapular skinfolds in the elderly Costa Rican population.

		Male					Female						All					
		Percentile					Percentile						Percentile					
Variable and age-group	n	10th	25th	50th	75th	90th	n	10th	25th	50th	75th	90th	n	10th	25th	50th	75th	90th
Calf circumference (cm)																		
60-69 yr.	357	27,0	30,0	33,0	35,0	38,0	440	27,0	30,0	33,0	35,0	38,0	797	27,0	30,0	33,0	35,0	38,0
70-79 yr.	433	27,0	30,0	32,0	35,0	38,0	460	27,0	30,0	33,0	35,0	38,0	893	27,0	30,0	33,0	35,0	38,0
80-89 yr.	317	26,0	30,0	32,0	35,0	38,0	423	27,0	30,0	33,0	35,0	38,0	740	27,0	30,0	33,0	35,0	38,0
90-99 yr.	77	28,0	31,0	33,0	35,0	37,0	102	26,0	30,0	32,0	35,0	36,7	179	27,0	30,	32,0	35,0	37,0
≥ 100 yr.	45	28,0	29,5	33,0	36,0	37,4	44	26,0	29,3	32,0	35,0	37,5	89	27,0	29,5	33,0	36,0	37,0
All age groups	1 229	27,0	30,0	33,0	35,0	38,0	1 469	27,0	30,0	33,0	35,0	38,0	2 698	27,0	30,0	33,0	35,0	38,0
Arm circumference (cm)																		
60-69 yr.	358	23,0	26,0	28,0	32,0	34,0	441	23,0	25,0	29,0	31,0	34,0	799	23,0	26,0	28,0	32,0	34,0
70-79 yr.	435	23,0	25,0	28,0	31,0	34,0	463	23,0	25,0	29,0	32,0	35,0	898	23,0	25,0	28,0	31,0	34,0
80-89 yr.	317	21,0	25,0	28,0	31,0	34,0	424	23,0	26,0	29,0	32,0	34,0	741	23,0	26,0	29,0	32,0	34,0
90-99 yr.	77	23,0	26,0	28,0	31,0	35,0	102	23,0	25,0	27,5	31,0	34,0	179	23,0	26,0	28,0	31,0	34,0
≥ 100 yr.	45	23,0	26,0	30,0	33,0	36,0	44	21,5	26,0	30,0	32,0	33,0	89	22,0	26,0	30,0	33,0	34,0
All age groups	1 232	23,0	25,0	28,0	31,0	34,0	1 474	23,0	26,0	29,0	32,0	34,0	2 706	23,0	25,0	28,0	32,0	34,0
Triceps skinfold (mm)																		
60-69 yr.	357	8,0	12,0	19,0	24,0	30,0	438	9,0	12,0	18,0	25,0	30,1	795	9,0	12,0	18,0	24,0	30,0
70-79 yr.	431	7,0	11,0	18,0	25,0	30,0	460	8,0	12,0	18,0	25,0	33,0	891	8,0	12,0	18,0	25,0	31,0
80-89 yr.	314	8,0	13,0	18,0	25,0	32,5	423	9,0	13,0	20,0	25,0	31,0	737	8,0	13,0	18,0	25,0	32,0
90-99 yr.	77	8,0	12,0	18,0	25,0	31,2	101	9,2	12,5	17,0	23,0	30,8	178	9,0	12,0	17,0	24,0	31,0
≥ 100 yr.	44	9,0	12,5	18,0	23,0	33,5	44	7,5	11,8	18,0	23,8	29,0	88	8,9	12,5	18,0	23,0	30,0
All age groups	1 223	8,0	12,0	18,0	25,0	31,0	1 466	9,0	12,8	18,0	25,0	31,0	2 689	8,0	12,0	18,0	25,0	31,0
Subscapular skinfold (mm)																		
60-69 yr.	349	9,0	14,0	20,0	27,0	35,0	428	9,9	15,0	20,0	28,0	35,0	777	9,8	14,0	20,0	27,0	35,0
70-79 yr.	420	9,0	13,0	19,0	25,0	33,0	447	9,8	13,0	20,0	28,0	34,0	867	9,0	13,0	20,0	27,0	34,0
80-89 yr.	309	9,0	14,0	20,0	27,0	35,0	408	10,0	15,0	21,0	28,0	35,0	717	9,0	14,0	21,0	28,0	35,0
90-99 yr.	75	9,0	15,0	20,0	26,0	33,2	101	9,0	14,0	19,0	25,0	34,4	176	9,0	15,0	19,0	25,0	32,9
≥ 100 yr.	45	8,6	14,0	21,0	30,0	35,8	42	9,0	11,8	20,0	26,5	32,7	87	9,0	13,0	20,0	28,0	34,2
All age groups	1 198	9,0	13,0	20,0	26,0	34,0	1 426	10,0	14,0	20,0	28,0	34,0	2 624	9,0	14,0	20,0	27,0	34,0

Table 4. Age- and gender-specific norms for upper body strength as measured by hand dynamometry in the elderly Costa Rican population.

		Male					Female						All					
		Percentile					Percentile						Percentile					
Variable and age-group	n	10th	25th	50th	75th	90th	n	10th	25th	50th	75th	90th	n	10th	25th	50th	75th	90th
Right hand strength (kg)																		
60-69 yr.	330	12,0	15,5	21,5	28,0	35,5	409	11,5	16,0	21,2	29,0	36,0	739	12,9	17,0	23,0	31,0	37,5
70-79 yr.	410	13,0	16,0	21,0	28,5	34,5	439	12,2	16,5	22,0	28,5	35,0	849	12,5	16,0	21,5	28,5	35,0
80-89 yr.	291	11,1	16,5	22,0	27,0	34,4	401	11,5	15,0	21,0	27,5	33,9	692	13,0	17,0	23,0	30,0	36,0
90-99 yr.	75	13,0	15,0	20,5	28,0	34,2	87	11,9	16,0	21,5	29,0	36,8	162	12,7	17,0	23,0	30,0	36,0
≥ 100 yr.	41	11,4	15,0	20,0	29,5	39,2	44	10,8	18,1	24,3	29,5	34,5	85	12,7	18,0	23,3	31,6	39,2
All age groups	1 147	13,5	17,9	23,0	30,0	36,2	1 380	13,0	17,0	23,0	30,5	37,0	2 527	13,0	17,5	23,0	30,0	37,0
Left hand strength (kg)																		
60-69 yr.	328	12,5	18,0	23,0	30,4	37,0	409	13,0	17,0	23,0	31,3	38,0	737	12,0	16,0	21,5	28,5	36,0
70-79 yr.	409	14,5	18,0	23,0	30,0	36,0	440	13,0	18,0	23,0	30,4	37,0	849	13,5	18,0	23,0	30,	37,0
80-89 yr.	292	13,0	17,5	23,0	30,4	36,0	400	12,6	17,0	23,0	29,5	36,0	692	11,5	15,0	21,5	27,5	34,0
90-99 yr.	75	13,6	17,0	22,0	29,0	35,0	88	12,0	17,1	23,5	30,0	37,6	163	12,7	15,8	21,0	28,6	35,0
≥ 100 yr.	42	12,3	17,0	21,5	31,6	39,9	44	13,0	18,6	26,0	31,9	38,3	86	11,0	17,0	22,0	29,5	39,2
All age groups	1 146	12,0	16,0	21,2	28,0	34,6	1 381	12,0	16,0	21,5	28,5	35,0	2 527	12,0	16,0	21,5	28,0	35,0