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Research Article

Body Mass Index in the Elderly and its Correlation with Anthropometric Parameters Evaluated by Body Impedance

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Abstract

The results of the evaluation are presented to a group of older adults in whom the Body Mass Index (BMI) and anthropometric measurements determined by impedance were evaluated. 124 people aged 60 years and over were included. In the results found in this group of older adults, an adequate correlation was found between the BMI and the measurements of the waist-hip index, the percentage of body fat and the degree of obesity, all of them parameters related to the metabolic syndrome and cardiovascular mortality. These findings suggest that elevated BMI appears to be a reliable marker of metabolic risk in the study population.

Keywords: Body mass index; Cardiovascular risk; Elderly; Impedance measurement

Keymessages

- With increasing age, structural changes in body compartments occur that can modify the nutritional assessment
- The body mass index has been a widely used measurement to estimate the amount of body fat and it retains its usefulness in the elderly
- The anthropometric evaluation obtained by impedance measurement adequately complements the traditional nutritional evaluation in the elderly

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Introduction

Due to the increase in older adults in the population, it is essential to define whether the evaluations used to assess nutritional status are applied in the same way and have the same utility in the elderly. At the level of the general structure, when aging, the human being presents a decrease in total body water, a decrease in muscle mass, an increase in fat mass [1] and loss of height due to dehydration of the intervertebral discs [2]. In relation to weight, an increase has been documented up to the age of 50, stabilization for a decade and weight loss from the age of 60 [3]. While in young adults the proportion of muscle mass represents up to 45% of body weight, in the elderly it is reduced to 27% [4].

Obesity, defined as the unhealthy accumulation of body fat, is a relevant medical condition as it increases the risk of metabolic syndrome, type 2 diabetes mellitus, cardiovascular disease, and increases all-cause mortality [5]. Although there is certainty of the harmful implications for health derived from obesity and metabolic syndrome; there are no standardized criteria to define metabolic health, thus making it difficult to compare between different studies [6].

The World Health Organization (WHO) has defined obesity as the presence of a Body Mass Index (BMI) equal to or greater than 30 kg/m^2 [7]. The advantage offered by this measurement lies essentially in the ease of obtaining it; however, there is controversy regarding its usefulness to assess the elderly, since it is a generic measure used for both sexes and independent of age. On the other hand, its use in geriatric patients is still discussed, taking into account the physiological changes in this stage of life. In this sense, changes in body fat, muscle mass, water composition, and height are variables that ostensibly modify BMI parameters, which is why the evaluation of body composition has recently been defined as a better marker of health than weight or BMI isolated [8].

Bioelectrical Impedance Analysis is a widely used and non-invasive method that is proposed as an alternative in the assessment of body parameters without the limitations of BMI. It is plausibly proposed as a reliable and highly accurate tool, since it allows estimating body composition from body resistance to the passage of a small electrical current [9]. In this sense, we propose an investigation that aims to evaluate in a population of older adults, the correlation of BMI with other anthropometric variables obtained through direct measurement and body impedance measurement and the implications in terms of global cardiovascular risk.

Materials and Methods

A descriptive correlational study was carried out, for which the information of 124 patients older than 60 years of the Geriatric outpatient service of the "Instituto de aging de Nariño", located in the city of Pasto (Colombia), in the period of study, was included the months of July to December 2022.

Anthropometric and body composition variables were measured in these patients by impedancemetry in the 5 segments (Right Arm, Left Arm, Trunk, Right Leg, Left Leg) (In Body 120-DSM-BIA Segmental Multifrequency. 20kHz, 100kHz). Circumferences were taken using a tape measure, using the standard technique, and height using a wall-mounted stadiometer, both were reported in centimeters. The evaluation period was from January 1 to July 30, 2020. For the continuous variables, the means and standard deviation were calculated, and for the discrete variables, medians and ranges. The Shapiro-Wilks or Kolmogorov-Smirnov tests were used as normality tests. Subsequently, a Pearson correlation analysis was performed for the variables with normal distribution and Spearman for those that did not meet this condition. Initially, an analysis of the general population was carried out, followed by a subgroup analysis categorized by age. For the correlation analysis, the following parameters were established: high correlation: 0.70-0.99; moderate correlation: 0.50-0.69; weak correlation: 0.20-0.49) and very weak correlation: 0.09-0.19.

The data were analyzed with the statistical program SPSS version 25. The participants signed authorization for the procedure and for the use of the data collected for research purposes.

Results

Of the 124 study participants, 96 (corresponding to 77.4%) were women. The most frequent age group was 60 to 79 years. The gender distribution in the age groups is shown in table 1.

Age group	Gender	no	%
60-79	Man	19	22.9
	Women	64	77.1
	Total	83	100.0
80+	Man	9	22.0
	Women	32	78.0
	Total	41	100

Table 1: Sociodemographic characteristics of the study population categorized by age.

The anthropometric parameters of the impedance measurement are shown in table 2.

Variable	Half	Median	Standard deviation	Minimum	Maximum	Range
BMI	27.23	26.90	4,407	17	43	26
Age	74.68	73.50	9,261	60	96	36
Weight (kg)	64.95	64.70	11,907	41	106	64
Height (cm)	154.41	154.00	9,479	136	186	fifty
Waist Circumference (cm)	95.24	96.00	10,298	65	123	58
Hip Circumference (cm)	101.11	101.50	8,340	80	127	47
Waist Hip Index	.92	.93	.059	1	1	
Body Fat Mass (kg)	25.39	25.00	7,951	10	49	39
Skeletal Muscle Mass (kg)	21.29	20.75	4,592	13	37	24
Body Fat Percentage	38.62	39.10	7,813	18	53	35
Basal Metabolic Rate (Cal)	1223.94	1203.00	164,706	944	1793	849
Degree of Obesity	126.05	124.50	20,767	79	202	123

Table 2: Anthropometric characteristics of the study population.

When comparing by age groups, all anthropometric variables are higher in the 60 to 79-year-old group, in absolute values, although a difference measure was not obtained (Table 3).

Age group	Variable	Half	Median	Standard deviation	Minimum	Maximum	Range
60-79	BMI	27.75	27.30	4,056	19	38	19
	Weight (kg)	68.00	67.70	11,355	46	106	60
	Height* (cm)	156.53	155.00	8,764	141	186	Four. Five
	Waist Circumference (cm)	95.72	96.00	10,996	65	123	58
	Hip Circumference (cm)	102.11	102.00	8,087	80	126	46
	Waist Hip Index	.93	.93	.056	1	1	
	Body Fat Mass	26.59	26.30	8,141	eleven	49	38
	Skeletal Muscle Mass	22.47	21.40	4,487	14	37	23
	Body Fat Percentage	38.63	39.60	8,213	18	52	35
	Basal Metabolic Rate	1264.01	1228.00	162,035	967	1793	826
	Degree of Obesity	128.44	126.00	19,189	89	178	89

80+	BMI	26.21	25.60	4,923	17	43	26
	Weight (kg)	58.93	59.20	10,722	41	84	43
	Height (cm)	150.22	149.00	9,543	136	175	39
	Waist Circum-ference (cm)	94.29	95.00	8,810	74	110	36
	Hip Circum-ference (cm)	99.12	97.00	8,574	86	127	41
	Waist Hip Index	.91	.91	.062	1	1	
	Body Fat Mass	23.03	22.40	7,077	10	44	3. 4
	Skeletal Muscle Mass	18.95	18.00	3,887	13	28	fifteen
	Body Fat Percent-age	38.61	38.10	7,054	24	53	29
	Basal Metabol-ic Rate	1144.78	1106.00	140,986	944	1469	525
	Degree of Obesity	121.32	119.00	23,101	79	202	123

Table 3: Analysis by age subgroups of the anthropometric characteristics.

When analyzing the correlation values in the total group, the BMI is found to have a highly positive correlation with the waist-hip ratio, body fat mass, percentage of body fat and degree of obesity. There is a low correlation, although it remains significant with skeletal muscle mass and basal metabolic rate. There is no correlation with height (Table 4).

Variable	BMI						
	Pearson correlation			Sperman's correlation			t-Stu-dent
	p-Val-ue	R.	R2	p-Value	R.	R2	p-Value
Gender							0.017**
Age*				0.022	-0.205	0.042	
Weight	0	0.742	0.551				
Height*				0.053	-.174	0.030	
Waist Circumfer-ence*				0	0.749	0.561	
Hip*				0	0.801	0.642	
Waist Hip Index	0	0.89	0.792				
Body Fat Mass	0	0.917	0.841				
Skeletal Muscle Mass*				0.005	0.248	0.062	
Body Fat Percentage	0	0.753	0.567				
Basal Metabolic Rate*				0.005	0.249	0.062	
Degree of Obesity	0	0.998	0.996				

Table 4: Correlation between BMI and anthropometric and demographic variables (Total population).

*The variable does not have a normal distribution **Equal variances are assumed (p<0.05 Levene's test).

When analyzing by age groups, the values of the anthropometric variables are very similar to the total population, except that the significance of the correlation between skeletal muscle mass and basal metabolic rate is lost in the 60 to 79-year-old group (Table 5).

Discussion

In older adults, significant changes in body composition occur, which are derived, among others, from metabolic modifications as well as imbalances between energy intake and the demands of sedentary lifestyles [10]. These changes facilitate the appearance of overweight-obesity, which is considered the most frequent nutritional disorder in older adults in Western populations [11]. Between the second and ninth decades the percentage of body fat increases from 35 to 50%. In addition, with aging there is a redistribution of fat from peripheral to central, which is more associated with cardiovascular risk and metabolic syndrome [12]. In the results found in this group of older adults, an adequate correlation was found between the BMI and the measurements of the waist-hip ratio, the percentage of body fat and the degree of obesity, all of them parameters related to metabolic syndrome and cardiovascular mortality. These findings suggest that regardless of the changes in the physiology of geriatric patients, elevated BMI appears to be a reliable marker of metabolic risk in the study population. A direct relationship between the degree of obesity, the presence of morbidity and functional deterioration related to the metabolic and mechanical detriments produced by excess fat has been evidenced, highlighting the concept of sarcopenic obesity [13,14]. In this investigation, a lower correlation of BMI with skeletal muscle mass was demonstrated, which suggests that BMI is a parameter that, as expected, does not contribute significantly to assessing sarcopenia.

The decrease in muscle mass and the increase in body fat are important factors in the functional limitation and disability of elderly patients [15]. On the other hand, the coexistence between obesity and sarcopenia can have a deleterious potentiating effect, constituting a pathophysiological continuum that increases general morbidity and mortality, particularly in old age [13,16,17]. For this reason, the comprehensive geriatric assessment incorporates other elements such as the measurement of strength, gait speed or instruments such as the "short battery of physical performance" (SPSS), which allow assessment of sarcopenia and its functional repercussions.

Variable	Correlation with BMI													
	Age=60-79							Age=80+						
	Pearson correlation			Sperman's correlation			t-Student	Pearson correlation			Sperman's correlation			t-Student
	p-Value	R.	R2	p-Value	R.	R2	p-Value	p-Value	R.	R2	p-Value	R.	R2	p-Value
Gender							0.025**							0.278**
Weight	0	0.736	0.542					0	0.757	0.573				
Height*				0.026	-0.244	0.060		0.034	-0.331	0.110				
Waist Circumference	0	0.761	0.579					0	0.696	0.484				
Hip Circumference	0	0.796	0.634								0	0.810	0.656	
Waist Hip Index	0	0.899	0.808					0	0.867	0.752				
Body Fat Mass (kg)	0	0.921	0.848					0	0.933	0.870				
Skeletal Muscle Mass (kg)*				0.163	0.154	0.024					0.03	0.339	0.115	
Body Fat Percentage	0	0.769	0.591					0	0.779	0.607				
Basal Metabolic Rate (cal)*				0.168	0.153	0.023					0.022	0.357	0.127	
Degree of Obesity	0	0.998	0.996					0	0.999	0.998				

Table 5: Correlation between BMI and anthropometric and demographic variables (Analysis of subgroups by categorized ages).

*The variable does not have a normal distribution **Equal variances are assumed ($p<0.05$ Levene's test).

The determination by impedancemetry of anthropometric parameters, together with the functional evaluation, allow the development of rehabilitation programs that promote the gain of muscle mass and the control of adipose mass and, importantly, carry out a control evaluation to verify the achievement of the proposed goals initially. In this sense, in addition to dietary programs, there is a beneficial effect of physical conditioning programs. Thus, for example, in a study conducted by Moreno et al., in older people from 13 regions of Colombia, an association was demonstrated between physical exercise and increased muscle strength and functional capacity, as well as an inverse relationship with body fat [18].

The relationship between the degree of obesity and outcomes in the elderly is controversial, some mention possible benefits of a lower degree of overweight, including a reduction in the risk of fractures [19], a disputed advantage in survival, referred to by some as the "obesity paradox" or also in reference to the increase in energy reserves during prolonged periods of illness [20]. On the other hand, in healthy elderly people in the community, the behavior between BMI and risk of all causes of mortality takes the form of a "J-curve", with its extreme low values of 18.5 or less. At the high end, the risk of death appears to be lower in older adults who are overweight (BMI 25-30) or moderately obese (BMI 30-35) [21].

However, there is a more or less general consensus that obesity at all ages significantly increases mortality attributable to cardiovascular disease [22]. Besides the Mortality risk in the obese older adult is more related to fat distribution than to total body fat [22], which suggests that at any given weight, the risk of death increases with increasing waist circumference, a measure that is easy to perform and that in this study was correlated with the BMI. The importance of measuring not only the BMI but also the abdominal perimeter and the waist-hip ratio is then highlighted, in the measurements carried out by nutritionists and doctors in the physical examination of geriatric patients. Impedance analysis adds valuable data to traditional anthropometric assessment, such as body fat mass, skeletal muscle mass, body fat percentage.

Conclusion

In this group of older adults, it was found that the BMI is a measure that correlates well with the anthropometric variables obtained by impedancemetry, from which it can be inferred that the BMI retains its usefulness as an estimator of nutritional status, coupled with clinical and laboratory assessment, if relevant. The early and periodic measurement of these parameters is intended to carry out multimodal interventions that allow modifying the risk.

Author's Contribution

All authors participated in the preparation of the manuscript and in its final revision.

Conflict of Interest

None of the authors declare conflicts of interest in the development and preparation of this research.

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