Revista O Mundo da Saúde

Comparison of measured and estimated height in the elderly with different functional classifications

Ann Kristine Jansen*
Denise Angela Gonçalves dos Santos*
Déborah de Oliveira Ramiro**
Rodrigo Ribeiro dos Santos*

Abstract

One of the effects of aging on the body is the reduction of height, which may overestimate the body mass index (BMI). It is hypothesized that frail elderly people are more affected by this decline in height, however this is not clear in the literature. The aim of this study was to compare the measured and estimated height and the BMI derived from measured and estimated measurements, in the elderly according to the functional classification. A cross-sectional study with secondary data was carried out with elderly people in outpatient care, classified as robust, at risk of fragility, and fragile. Estimated height was calculated from knee height and estimated BMI with the estimated height. In the statistical analysis, ANOVA test and the Hochberg's GT2 test were applied, when comparing the 3 categories of functionality. The sample consisted of 116 elderly people with a mean age of 83.6 (8.5), mostly women 73.0 (62.9%), and classified as robust 54.0 (46.6%). The difference found for height was 4.2 (5.2), 4.6 (4.9), 7.1 (5.3) cm respectively for the robust, at risk of fragility, and fragile. The difference between the robust and the fragile was significant (p=0.033). A similar result was obtained by assessing the difference between BMIs (p=0.019). The study showed that frail elderly people have greater differences between measured and estimated height, in comparison with robust people, suggesting that frail elderly people have more height impairment, which can directly impact nutritional diagnosis. Caution is suggested in the use of measured height in the elderly, particularly in the frail.

Palavras-chave: Height; Elderly; Fragility; Healthy aging.

INTRODUCTION

Measured height and weight represent the main anthropometric measures used in the assessment of nutritional status, mainly as components for the calculation of body mass index (BMI), although the accuracy of BMI is being questioned in clinical practice[1], especially in the elderly[2]. In senescence, changes in body composition occur that cannot be detected by BMI, such as a reduction in muscle tissue, body water, bone mineral density, subcutaneous adipose tissue, and accumulation of fat in the central and intramuscular region[2,3,4,5]; changes that are often masked when body weight remains stable or increases[6].

On the other hand, BMI continues to be

DOI: 10.15343/0104-7809.202044445453

*Universidade Federal de Minas Gerais – UFMG. Belo Horizonte/MG, Brasil.
**Hospital Risoleta Tolentino Neves. Belo Horizonte/MG, Brasil.
E-mail: annkjansen@gmail.com

widely used in the evaluation of malnutrition and obesity due to its practicality, low cost, and relationship with chronic non-communicable diseases, including in the elderly. The Global Leadership Initiative on Malnutrition (GLIM) recently published a global consensus of indicators for assessing malnutrition in the clinical practice of adults and the elderly and included low BMI as a phenotypic criterion to be considered in diagnosis[7].

Thus, measures of weight and height must be reliable in order to avoid bias distortions in the calculation of BMI. One of the factors that can influence the result of this index is the reduction in height that happens throughout life[8,9,10]. Deformities in the spine associated with changes in bone metabolism in the vertebrae can cause a reduction in height as one ages. It is estimated that there is an average loss of 1 cm per decade starting from the age of 40[7], although there is no consensus in the literature regarding these changes. Longitudinal studies suggest that the reduction is greater in women (5 cm) than in men (3 cm) up to 70 years of age, but in octogenarians the differences between the sexes are less significant[10,11].

The literature suggests that the existing differences between the estimated and measured height in the elderly occur due to the decrease in height[12,13,14], and although this is more pronounced with age[10,11,15,16], the relationship with functional decline is not clear of this. As a consequence of the height reduction observed in the elderly, a false increase in BMI of 0.7 and 1.6 kg/m^2, respectively, in men and women in their seventies, in the absence of significant weight changes, as well as 1.4- 1.5 and 2.5-2.6 kg/m^2 in octogenarian men and women, we can find respectively[10]. Therefore, in cases where the measured height is lower than the actual height, the BMI may overestimate overweight or underestimate malnutrition[17,18].

Elderly people have different levels of functionality and the hypothesis is that anthropometric changes must be associated with different degrees of functionality. Robust elderly people are independent and autonomous individuals, without functional disability. Those considered at risk of frailty are the elderly who are independent and autonomous; however, they have chronic health conditions, such as sarcopenia or multiple comorbidities that induce functional decline[19]. The frail elderly have an established functional decline, are partially or totally dependent, and have a loss of autonomy due to the presence of single or multiple disabilities[19,20].

Therefore, it is important to look for ways to predict height that are not affected by compression of the vertebral discs and postural problems present in the elderly. One way is to estimate height by measuring knee height[12,17,18,21,22,23,24], a quick method that is easy to apply, as it uses only one measurement and can be performed on an individual with standing and walking difficulties, and practically does not change with age[11]. Other methods of estimating height such as self-reported and demispan height are available but have some limitations. The literature shows that self-reported height tends to be overestimated in the elderly[9]. On the other hand, demispan, in addition to overestimating height, is not applicable in individuals with chronic pain and movement limitations in the upper limbs, conditions that are common in the elderly[25, 26,27], especially in the fragile.

In view of the scarcity of studies found evaluating the estimated height in elderly people according to the classification of their functionality, and based on the hypothesis that frail elderly people have greater height decline when compared to non-frail elderly people, this study aimed to compare height and BMI derived from measured and estimated height in the elderly.

METHODOLOGY

Study design

This was a cross-sectional study with secondary data, carried out with individuals seen at the multiprofessional outpatient clinic of the Jenny de Andrade Faria Institute at the Hospital das Clínicas of the Federal University of Minas Gerais (UFMG), evaluated from May 2015 to April 2019. The study was approved by the Teaching and Research Management of Hospital das Clínicas, UFMG and by the Research Ethics Committee of the Federal University of Minas Gerais, under number 80295616.1.0000.5149.

Participants

The sample consisted of individuals of both sexes, non-institutionalized, aged 60 years or older. Elderly people classified as robust, at risk of fragility, and fragile, according to the Visual Clinical-Functional Fragility Scale[19], were included. The use of this method is consistent with the World Health Organization's International Classification of Functionality (ICF) which emphasizes functionality.

This scale is based on functionality (dependence or independence for basic instrumental, or advanced activities of daily living) and the presence of risk factors for functional decline, diseases, and comorbidities. The elderly were classified into strata (1 to 10) considering the progressive reduction in vitality associated with the progressive increase in frailty, as well as in 3 categories (robust elderly, elderly at risk of frailty, and frail elderly). Robust elderly people comprise strata 1 to 3, those at risk of fragility, strata 4 and 5, and the fragile strata 6 to 10[19].

The robust elderly are those who are functionally independent, who may or may not have diseases. The elderly at risk of frailty, are in a dynamic state between senescence and senility, resulting in the presence of imminent functional decline. Fragile elderly people have reduced homeostatic reserve and/or the ability to adapt to biopsychosocial aggressions and, consequently, reduced autonomy and independence[19].

The study excluded individuals whose physical condition did not allow a complete anthropometric assessment, with edema and amputations, and individuals with incomplete anthropometric data.

Variables and measurements

Demographic, health, and anthropometric data were collected from nutrition records. Regarding demographic variables, age, sex, and education (in years of study) were analyzed. For health variables, the classification of functionality and the main health problems were assessed. The functional classification of the elderly according to the Visual Clinical-Functional Frailty Scale, described above, was categorized into robust, at risk of fragility, and fragile[19]. Concerning health problems, the most prevalent diseases in the studied sample were evaluated.

Regarding anthropometric measurements, data on height, weight, and knee height were collected. Height was measured on a stadiometer coupled to a Balmak ® mechanical scale, the ruler rod was positioned on top of the individual's head. Their head was in the Frankfurt position, upright within the elderly's possibilities, with the palms of the hands turned toward the body, with legs and feet parallel and bare[28]. Weight was measured with the individual standing, positioned in the center of the base of the scale and barefoot[28]. The knee height was obtained from the left leg with the individual sitting in a chair, with both knees and ankles flexed at 90º using an inextensible measuring tape, with a precision of 1mm positioned from the heel to the upper edge of the patella[28]. The height estimated in centimeters was obtained using the formulas described in Chart 1.

Gender	Formula
Male	(2.02 x knee height) – (0.04 x age (years)) + 64.19
Female	(1.83 x knee height) – (0.24 x age (years)) + 84.88

Table 1 – Formulas by Chumlea et al. (1985) for the elderly over 60 years[22].

BMI was calculated by dividing weight in kilograms by height in meters, squared. The cutoff points adopted were those proposed by Lipschitz for the elderly, underweight (<22 kg/m²), normal weight (22-27 kg/m²) and overweight (>27 kg/m²) 29. The estimated BMI was calculated from the measured weight and the estimated height.

Statistical analysis

Data analysis was performed using the Statistical Package for the Social Sciences (SPSS Inc., Chicago, Illinois, United States) version 19.0. Continuous variables were tested for normality using the Shapiro-Wilk test and the homogeneity of variances using the Levene test. All variables studied showed normal distribution. Quantitative variables were described as mean and standard deviation when symmetric, and median and interquartile range when asymmetric. Categorical variables were described in absolute and relative frequency. The independent quantitative variables were compared between measured and estimated height as well as measured and estimated BMI by Student's t-test for independent samples. Categorical variables were compared between BMI categories using Pearson's chi-squared test or Fisher's exact test, according to the proportion of expected frequencies less than 5. The analysis of variance comparing the differences between height and BMI (both measured and estimated) according to the three categories of functionality, was carried out through the analysis of variance test (ANOVA) and Hochberg's GT2 test of multiple comparisons of means. Values of p <0.05 were considered significant.

RESULTS

The sample consisted of 116 elderly people, the majority of whom were female 73 (62.9%). The individuals' age ranged from 63 to 107 years with a mean of 83.6 (8.5) years. Most elderly people were classified as robust 54 (46.6%) and 77 (67.0%) had systemic arterial hypertension (Table 1).

As shown in table 2, the estimated height was greater than that measured in all categories of functionality, (p <0.001). The difference in BMI was also significant, however the BMI calculated with estimated height was lower than the BMI calculated with measured height, in all categories of functionality (p <0.001).

The difference found for height was 4.2 (5.2), 4.6 (4.9), 7.1 (5.3) centimeters (cm), respectively for the robust, at risk of fragility, and fragile elderly. The difference being between robust and fragile elderly was significant (p=0.033). A similar result was obtained by assessing the difference between BMI calculated with measured and estimated height measurements (p=0.019), as shown in Table 3.

Table 1 – Characteristics of the elderly population studied. Belo Horizonte, MG, 2015-2019.

Studied variables	Studied elderly
Age according to functionality Mean (SD)	
Robust	85.9 (5.6)
Risk of Fragility	88.5 (6.8)
Fragile	77.0 (9.1)
Gender N (%)	
Male	43 (37.1)
Female	73 (62.9)
Complete years of schooling Mean (SD)	2.9 (3.8)
Functionality N (%)	
Robust	54 (46.6)
Risk of Fragility	24 (20.7)
Fragile	38 (32.7)
Main health problems N (%)	
Systemic arterial hypertension	77 (67.0)
Diabetes Mellitus	27 (23.3)
Neurological Diseases	21 (18.1)
Osteoporosis	21 (18.1)
Joint disease	12 (10.3)

DP: desvio padrão; N: número

Table 3 – Distribution of differences between estimated and measured heights, and difference between estimated and measured BMIs, according to the functionality of the elderly. Belo Horizonte, MG, 2015-2019.

Functionality	Height Difference	P-Value[1]	BMI difference	P-Value[1]
Robust[a]	4.2 (5.2)	0.033	-1.7 (1.7)	0.019
Risk of Fragility[a]	4.6 (4.9)		-1.0 (2.2)	
Fragilel[a]	7.1 (5.3)		-2.4 (3.1)	

BMI, body mass index. a) mean (standard deviation). 1-ANOVA test and Hochberg's GT2 test of multiple comparisons of means indicated a significant difference between the robust and the fragile, both in height and BMI differences.

Table 2 – Distribution of averages of the measured and estimated heights, and measured and estimated BMIs, according to the functionality of the elderly. Belo Horizonte, MG, 2015-2019.

Functionality	n	Height measured[a] (cm)	Height estimated[a] (cm)	P Value[1]	BMI measured[a] Kg/m²	BMI measured[a] Kg/m²	P Value[1]
Robust	54	153.2 (8.4)	157.4 (9.3)	<0.001	26.4 (4.1)	25.1 (4.4)	<0.001
Risk of Fragility	24	151.9 (11.0)	156.5 (10.3)	<0.001	23.2 (4.6)	21.8 (4.2)	<0.001
Fragile	38	152.6 (8.7)	159.7 (7.8)	<0.001	26.5 (7.7)	24.2 (6.7)	<0.001

BMI, body mass index. a) mean (standard deviation). 1- Student's t-test. Measured BMI calculated with measured weight and height data. Estimated BMI calculated with measured weight and estimated height.

Table 4 – BMI classification as thin and overweight, according to the functionality of the elderly. Belo Horizonte, MG, 2015-2019.

Functionality	N	Thin			Overweight		
		BMI measured[a]	BMI estimated[a]	P value[1]	BMI measured[a]	BMI estimated[a]	P Value[1]
Robust	54	10 (18.5)	13 (24.1)	<0.001	26 (48.1)	17 (31.5)	<0.001
Risk of Fragility	24	7(29.2)	12 (50.0)	<0.001	4 (16.7)	3(12.5)	<0.001
Fragile	38	13 (34.2)	14 (36.8)	<0.001	17 (44.7)	14 (36.8)	<0.001

a) number (percentage). 1- Chi-squared test.

DISCUSSION

The present study shows that the estimated height differed from the measured height, with the estimated average height being greater than the measured one, a finding that is similar to that of other studies that used the same height estimation methodology as this study[13,14]. The work of Closs *et al.*[13] evaluated elderly people aged 60 to 93 years and found an average difference between the estimated and measured height of +3 cm. Fogal *et al.*[14] found an average difference of +2 cm for females and found no difference between males.

Several factors can contribute to this difference. Malnutrition, sarcopenia, and osteoporosis are some examples. These disorders are caused, among others, by inadequate lifestyle and eating habits[30] that can, in the long term, directly or indirectly impact the postural control of the elderly, making the measured height not a reliable measurement.

In this study, the estimated heights were higher than those measured in all categories of functionality, however the difference was greater in the frail elderly (+ 7.1 cm) compared to the robust elderly (+4.2 cm). As for the BMI, the estimated was lower than that derived from the measured height, mainly in the frail elderly (-2.4 kg/m2), in comparison with the robust (-1.7 kg/m2). The present study did not find other studies in the literature with this theme that took into account the functional classification of the elderly, a fact that makes it impossible to compare the results found.

However, understanding the different characteristics of these groups can help us evaluate the results found. Considering the Activities of Daily Living (ADLs), the robust individuals walk without difficulties and, therefore, they have no greater impediments to remain active. They usually have a dietary pattern that keeps them healthy and they display comorbidities of low complexity. The fragile, however, have a pronounced functional decline which makes them partially or totally dependent for basic, instrumental, and advanced ADLs. In general, they are not very active and are affected by diseases that directly impact their quality of life[19,20]. It is believed that these factors may justify the significant difference found between the estimated and measured heights of these two functional categories of the elderly.

The literature shows that older elderly people have greater postural impairment than younger elderly people[10,11,15]. However, in this study it was found that the difference in height was more pronounced in the fragile, even the fragile elderly with a lower average age than the robust, suggesting that this is more related to frailty and not to the age of individuals. This corroborates with the statement that the reduction in height should not be explained only by senescence, but by deteriorated health conditions[31] present in fragile elderly people. Factors of a social, biological order and the individual's nutritional condition may positively or not interfere in the reduction of height with aging[31].

In addition, 18% of the elderly people studied had osteoporosis and 34% of fragile elderly people had a measured BMI of less than 22.0 kg/m^2, situations associated with a possible reduction in measured height[31,32]. With aging, men and women have a decrease in the synthesis of estrogen, a hormone that is related to bone mass health. In males, the decrease in this hormone occurs gradually and at older ages. In women, however, this reduction occurs abruptly soon after the onset of menopause[32].

Thus, it is believed that the height measured in fragile elderly is not the appropriate measurement to be used in clinical practice, due to the difficulty to position them acording to the recommends of the World Health Organization[28]. Fragile elderly people, usually, have difficulties to stand on the scale, need to spread their legs to maintain balance, and are unable to maintain their upright posture due to postural changes.

The difference found in the height of the elderly reflected directly in the calculation of BMI. The measured BMI underestimated thinness in all functional categories. There was also an overestimation of overweight. Other studies have also found differences in BMI derived from estimated measurements[14,15], but these did not consider the functionality of individuals, making it impossible to compare the results. Gavriilidou *et al.*[15] observed that the difference in BMI overestimated obesity in younger elderly people and underestimated for older elderly people. In the sample by Fogal *et al.*[14], obesity was underestimated in women. This study attributes these differences to the postural changes present in the elderly, as previously discussed.

BMI remains a widely used tool in clinical practice for diagnosing malnutrition and obesity and helps in the diagnosis of sarcopenia, in addition to being used in equations to define drug doses[7,33,34,35]. Therefore, the diagnosis derived from the wrong BMI can harm the individual's health. There is a need for studies that propose formulas that estimate the stature of elderly Brazilians and that take into account the individual's functionality for more accurate results, thus, avoiding wrong nutritional diagnoses.

Some limitations must be considered in the present study. The formula used in this study was developed from a sample of Caucasian individuals. Studies show that there can be precision gaps when the formula is used in different populations[14]. Another limitation was that the sample made it impossible to subdivide the functionality categories by sex and age groups. The robust elderly, coming from the healthy aging clinic, have as inclusion criteria only elderly people aged over 80 years, so this functional category did not include younger elderly people.

CONCLUSION

The estimated height was greater than that measured in all categories of functionality. The fragile elderly have greater differences between the measured and estimated heights, compared to the robust, suggesting that the fragile elderly have greater height impairment which can directly impact the nutritional diagnosis. Caution is suggested in the use of the height measured in the elderly and the use of the estimated height in the assessment of nutritional status is recommended, particularly in the fragile elderly individuals.

REFERENCES

1. Gonzales MC, Correia MITD, Heymsfield, SD. A requiem for BMI in clinical setting. Curr Opin Clin Nutr Metab Care 2017; 20:314–321.
2. Serván PR, Poyatos RS, Rodríguez JS, Gómez-Candela C, Luna PPG, Serra-Majem L. Special considerations for nutritional studies in elderly. Nutr Hosp. 2015; 31:84-90.
3. Fantin F, Di Francesco V, Fontana G, Zivelonghi A, Bissoli L, Zoico E, et al. Longitudinal body composition changes in old men and women: interrelationships with worsening disability. J Gerontol A Biol Sci Med Sci 2007; 62:1375-1381.
4. Reinders I, Murphy RA, Koster A, Brouwer IA, Visser M, Garcia ME, et al. Muscle quality and muscle fat infiltration in relation to incident mobility disability and gait speed decline: the Age, Gene/Environment Susceptibility-Reykjavik Study. J Gerontol A Biol Sci Med Sci 2015; 70:1030–1036.
5. Almeida MF, Marucci MFN, Gobbo LA, Ferreira LS, Dourado DAQS, Duarte YAO, et al. Anthropometric Changes in the Brazilian Cohort of Older Adults: SABE Survey (Health, Well-Being, and Aging). J Obes 2013; 2013:695496.
6. Hughes VA, Roubenoff R, Wood M, Frontera WR, Evans WJ, Singh MAF. Anthropometric assessment of 10-y changes in body composition in the elderly. Am J Clin Nutr 2004; 80:475–82.
7. Jensen GL, Cederholm T, Correia MITD, Gonzalez MC, Fukushima R, Higashiguchi T, et. Al. GLIM Criteria for the Diagnosis of Malnutrition: A Consensus Report From the Global Clinical Nutrition Community. JPEN J Parenter Enteral Nutr 2018; 38:1-9.
8. García-Peña C, Pérez-Zepeda MU. Validity of Knee-Estimated Height to Assess Standing Height in Older Adults: A Secondary Longitudinal Analysis of the Mexican Health and Aging Study. J Nutr Health Aging, 2017; 21:262–265.
9. Butler R, McClinchy J, Morreale-Parker C, Marsh W, Rennie KL. BMI calculation in older people: The effect of using direct and surrogate measures of height in a community-based setting. Clin Nutr ESPEN 2017; 22:112–115.
10. Sorkin JD, Muller DC, Andres R. Longitudinal change in height of men and women: Implications for interpretation of body mass index. Am J Epidemiol. 1999; 150:969-977.
11. Baumgartner RN, Stauber PM, McHugh D, Koehler KM, Garry PJ. Cross-sectional Age Differences in Body Composition in Persons 60 + Years of Age. J Gerontol A Biol Sci Med Sci 1995; 50:M307-M316.
12. Frid H, Adolfsson ET, Rosenblad A, Nydahl M. Agreement between different methods of measuring height in elderly patients. J Hum Nutr Diet. 2013; 26:504-11.
13. Closs VE, Feoli AM, Shwanke CH. Altura do joelho como medida alternativa confiável na avaliação nutricional de idosos. Rev Nutr. 2015; 28:475-484.
14. Fogal AS, Franceschini S do C, Priore SE, Cotta RM, Ribeiro AQ. Stature estimation using the knee height measurement amongst Brazilian elderly. Nutr Hosp. 2015; 31:829-834.
15. Gavriilidou NN, Pihlsgård M, ElmståhS l. High degree of BMI misclassification of malnutrition among Swedish elderly population: Age-adjusted height estimation using knee height and demispan. Eur J Clin Nutr. 2015; 69:565-571.
16. Carvalho EMS, Mota SPF, Silva GPF, Filho JMC. A postura do idoso e suas implicações clínicas. Geriatr Gerontol. 2011; 5:170-174.
17. Karadag B, Ozturk AO, Sener N, Altuntas Y. Use of knee height for the estimation of stature in elderly Turkish people and their relationship with cardiometabolic risk factors. Arch Gerontol Geriatr. 2012; 54:82-89.
18. Souza R, Fraga JS, Gottschall CBA, Busnello FM, Rabito EI. Avaliação antropométrica em idosos: estimativas de peso e altura e concordância entre classificações de IMC. Rev Bras Geriatr Gerontol 2013; 16:81-90.
19. Moraes EN, Moraes FM, Santos RR, Bicalho MAC, Machado CJ, Romero DE. A new proposal for the clinical-functional categorization of the elderly: visual scale of frailty (Vs- Frailty). J Aging Res Clin Practice 2016; 5:24-30.

20. Fried LP, Tangen CM, Walston J, Newman AB, Hirsch C, Gottdiener J et al. Frailty in older adults: evidence for a phenotype. J Gerontol A Biol Sci Med Sci. 2001; 56:146-156.
21. Acuña K, Cruz T. Nutritional assessment of adults and elderly and the nutritional status of the Brazilian population. Arq Bras Endocrinol Metabol. 2004; 48:345-61.
22. Chumlea WC, Roche AF, Steinbaugh ML. Estimating stature from knee height for persons 60 to 90 years of age. J Am Geriatr. Soc. 1985; 33:116-120.
23. Varela FR, Ciconelli RM, Campolina AG, Soarez PC. Quality of life evaluation of frail elderly in Campinas, São Paulo. Rev Assoc Med Bras. 2015; 61:423-30.
24. Melo APF, Salles RK, Vieira FGK, Ferreira MG Métodos de estimativa de peso corporal e altura em adultos hospitalizados: uma análise comparativa. Rev Bras Cineantropom Desemp Hum. 2014; 16:475-484.
25. Sant'Anna BC, Lage GM, Dores SMC, Velarde LGC, Barroso SG, Rocha GS. Análise de concordância entre métodos para estimativa da estatura de idosos atendidos em ambulatório de nutrição. Rev. Bras. Geriatr. Gerontol. 2018; 21:743-748.
26. Rech CR, Petroski EL, Böing O, Júnior RJB, Soares MR. Concordância entre as medidas de peso e estatura mensuradas e auto-referidas para o diagnóstico do estado nutricional de idosos residentes no sul do Brasil. Bras Med Esport. 2008; 14:127-131.
27. Bolton-Smith C, Woodward M, Tunstall-Pedoe H, Morrison C. Accuracy of the estimated prevalence of obesity from self reported height and weight in an adult Scottish population. J Epidemiol Community Health 2000; 54:143-8.
28. World Health Organization. Physical status: the use and interpretation of anthropometry. Genebra, 1995.452p.
29. Lipschitz DA. Screening for nutritional status in the elderly. Primary Care. 1994; 21:55-67.
30. Lorenzo-López L, Maseda A, de Labra C, Regueiro-Folgueira L, Rodríguez-Villamil JL, Millán-Calenti JC. Nutritional determinants of frailty in older adults: A systematic review. BMC Geriatr 2017; 17:108-121.
31. Fernihough A, McGovern ME. Physical stature decline and the health status of the elderly population in England. Econ Hum Biol. 2015; 16:30-44.
32. Cauley JA. Estrogen and bone health in men and women. Steroids. 2015; 99:11-15
33. Naruishi K, Yumoto H, Kido JI. Clinical effects of low body mass index on geriatric status in elderly patients. Exp Gerontol. 2018; 110:86-91.
34. Beaudart C, McCloskey E, Bruyère O, Cesari M, Rolland Y, Rizzoli R, et al. Sarcopenia in daily practice: assessment and management. BMC Geriatr. 2016; 16:170-180.
35. Ix JH, Wassel CL, Stevens LA, Beck GJ, Froissart M, Navis G, et al. Equations to Estimate Creatinine Excretion Rate: The CKD Epidemiology Collaboration. Clin J Am Soc Nephrol. 2011; 6:184–191.

Received in april 2020.
Accepted in september 2020.