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ORIGINAL

Relationship between age and handgrip strength indexes in elderly women with low bone mass. Preliminary study

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Authors' Contribution:
A Study Design
B Data Collection
C Statistical Analysis
D Data Interpretation
E Manuscript Preparation
F Literature Search
G Funds Collection

abstract

Background The aim of this preliminary study was to characterize handgrip strength indexes in elderly women with low bone mass and determine their relationship with age.

Material/Methods The study sample consisted of 63 postmenopausal women with osteopenia and ostoporosis, aged 60-74. The subjects were divided into three age groups: 60-64 years, 65-69 years and 70-74 years. To perform this study two handgrip strength indexes were used: handgrip strength on body weight (HS/weight) and handgrip strength on body mass index (HS/BMI). Handgrip strength was measured with Jamar hand dynamometer.

Results These studies revealed a significant decrease in handgrip strength indexes between age groups: 60-64 years and 70-74 years. As for the average HS/weight, it was registered: 0.38 ±0.07 kg for the group 60-64 years, 0.33 ±0.06 kg for the group 65-69 years and 0.32 ±0.05 kg for group 70-44 years. The results of the average HS/BMI in three groups were as follows: 0.99 ±0.24 kg/kg/m^2, 0.86 ±0.19 kg/kg/m^2 and 0.8 ±0.16 kg/kg/m^2, respectively.

Conclusions Handgrip strength indexes in elderly women with low bone mass are gradually decreasing with age. Thus, handgrip strength indexes could provide a convenient tool for clinicians to set goals and to monitor the training progress in women with osteopenia and osteoporosis.

Key words handgrip, strength index, elderly women, low bone mass

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INTRODUCTION

Age-related decrease in muscle strength together with muscle waste and increased frailty are both major socioeconomic and medical problems [1]. Longitudinal analysis from the Health ABC Study showed that, regardless of the variation of muscle mass, both men and women (aged 70–79 years at baseline) lost muscle strength during the 5 years of the study [2].

Some scientists claim that muscle strength is a better indicator of adverse clinical outcomes of mortality and low physical performance (in a 5-year study) than muscle mass in people aged 65 years or older [3,4].

A number of studies suggest that the factors related to frailty and disability in the elderly can be measured by hand dynamometry. Handgrip strength (HS) has been shown to predict survival and is associated with changes in body composition, the nutritional status, inflammation, and the functional ability in several chronic disease conditions [5]. There are also other studies suggesting that grip strength is a screening tool for women at risk of osteoporosis [6]. Osteoporosis is a disease characterized by decreased bone mass and impaired microarchitecture resulting in bone fragility and an increased risk of fractures [7], particularly among older women [8]. This problem is estimated to affect 200 million women worldwide [9].

Recent evidence suggests that muscle strength per body weight would be particularly appropriate to evaluate the risks of lower mobility in older adults. That is the reason why we use two relative strength indexes basing on handgrip strength. Similarly, it is recommended by Dong et al. [10] and Choquette et al. [11].

A review of the literature on this topic found that there is a relation between age and handgrip strength in the elderly [12,13]. However, there are no studies analyzing handgrip strength indexes in elderly women with low bone mass taking age as a category. Therefore, the aim of this preliminary study was to characterize handgrip strength indexes in elderly women with low bone mass and to determine their relationship with age.

MATERIAL AND METHODS

PARTICIPANTS

The sample consisted of 63 postmenopausal woman aged 60–74 (M = 67.9 years, ±4.19). All participants were recruited from 724 women attending a variety of lectures at the University of the Third Age (in all cases subjects' consent to the primary screening was obtained). The sample was divided into three groups, each composed of 21 women. Groups were formed according to age – each one with the age range of 5 years, i.e. the first group (60–64-year-old), the second group (65–69-year-olds) and the third group (70–74-year-olds). The inclusion criteria were as follows: postmenopausal female (i.e. a female who had the last period >12 months before), non-smoking female, diagnosed osteopenia or osteoporosis. For diagnosing purposes, osteopenia and osteoporosis were defined by a T-score between -1 and -2.5 and above -2.5, respectively [14]. Subjects were excluded according to the following criteria: uncontrolled hypertension, oophorectomy, rheumatoid arthritis, pulmonary disease, type II diabetes treated with insulin.

The ethical consideration was approved by the Bioethics Commission of the Regional Medical Chamber.

ASSESSMENT OF ANTHROPOMETRY

The instrument used for weight measuring was octopolar bioimpedance InBody 720 (Biospace, Seoul, Korea). Examinations were held according to standard protocols with participants wearing light clothing without shoes.

The body height in cm was measured with the accuracy of 0.1 cm. During the measurement the subject was placed barefoot in the orthostatic position. The body mass index was calculated as body mass in kilograms divided by height in square metres (kg/m^2).

ASSESSMENT OF HANDGRIP STRENGTH INDEXES

Handgrip strength (HS) has been widely used in many studies, especially as a marker for overall muscle strength and health status for the elderly [4, 15]. Handgrip strength was measured to estimate muscle strength and was performed with a hand dynamometer (Jamar® Hydraulic Hand Dynamometer, Germany). During a handgrip strength test, participants had to hold the dynamometer in their hands with the arm stretched parallel to the body and with the instruction to stand upright. This measure was performed three times on the non-dominant hand with a rest interval of one minute between measurements. The best performance was used as the maximum peak handgrip strength in kilograms. The statistical analysis also included average peak handgrip (average result of three contractions).

In this study two recommended handgrip strength indexes were used. To calculate the first strength index, the following formula was used: HS/weight (kg) [10]. The second strength index was calculated as HS (kg) divided by BMI (kg/m^2) [11].

STATISTICAL ANALYSIS

Standard statistical methods were used to calculate means and standard deviations (mean ± standard deviation). Additionally, in statistical analysis the Shapiro-Wilk test was applied to verify the normality of the data. To determine the difference among the age groups, one-way ANOVA were used. When a statistical difference existed, Tukey post-hoc test was used to determine which group was different from the other groups. In addition, the effect size was calculated to describe the magnitude of a treatment effect.

All data were analyzed using the statistical package Statistica 10 (StatSoft, 2010), and the level of significance was set at $p < 0.05$.

RESULTS

Table 1 shows the participants' age, anthropometry and strength characteristics.

Table 1. Descriptive characteristics of age, anthropometry and strength among women with low bone mass

Variables	1 group 60–64 (N = 21)	2 group 65–69 (N = 21)	3 group 70–74 (N = 21)
	Mean ±SD	Mean ±SD	Mean ±SD
Age	62.833 ±1.213	67 ±0.784	73 ±1.967
Weight	70.208 ±7.183	66.226 ±8.083	69.04 ±10.272
BMI (kg/m^2)	25.877 ±6.2	24.44 ±6.523	27.43 ±4.405
HG peak (kg)	26.212 ±4.153	23.197 ±4.558	21.242 ±3.223
HG avg peak (kg)	23.646 ±4.016	21.944 ±4.395	20.977 ±3.603
HS/weight (kg)	0.381 ±0.079	0.337 ±0.061	0.327 ±0.057
HS/BMI (kg/kg/m^2)	0.996 ±0.243	0.866 ±0.198	0.809 ±0.166

The mean of age in the first group was 62.8 ±1.2 years old, whereas in the second group it was 67 ±0.7 years old and, finally, in the third group it was 73 ±1.9 years old. The mean BMI in three groups were as follows: 25.8 ±6.2 kg/m^2, 24.4 ±6.5 kg/m^2 and 27.4 ±4.4 kg/m^2, respectively. Registered here was a tendency of handgrip strength indexes to decrease with age. It is presented in Fig 1 and Fig 2.

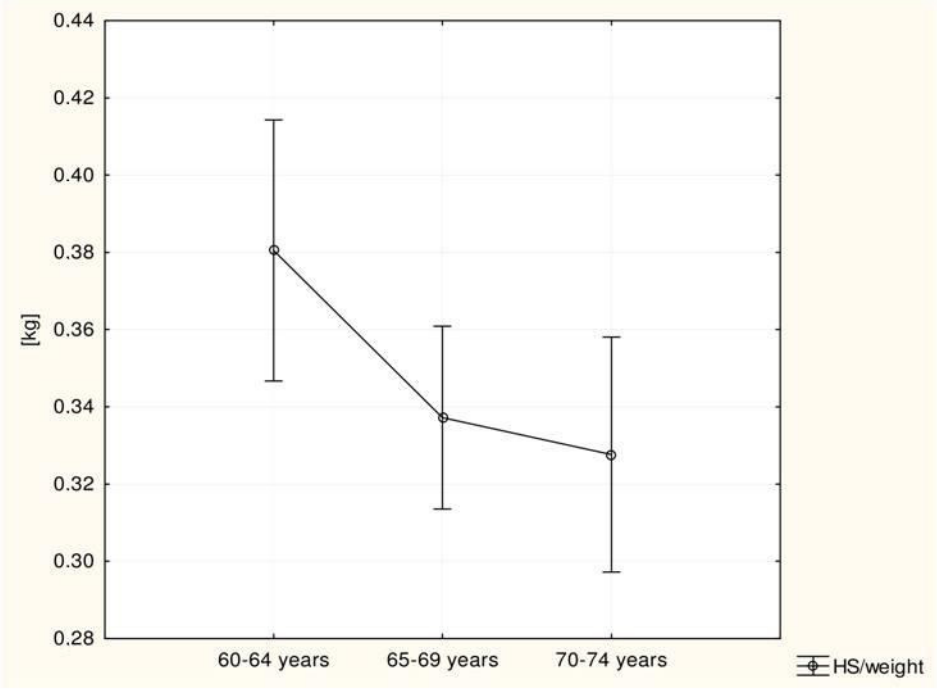

Fig. 1. The differences in the mean HS/weight between age groups

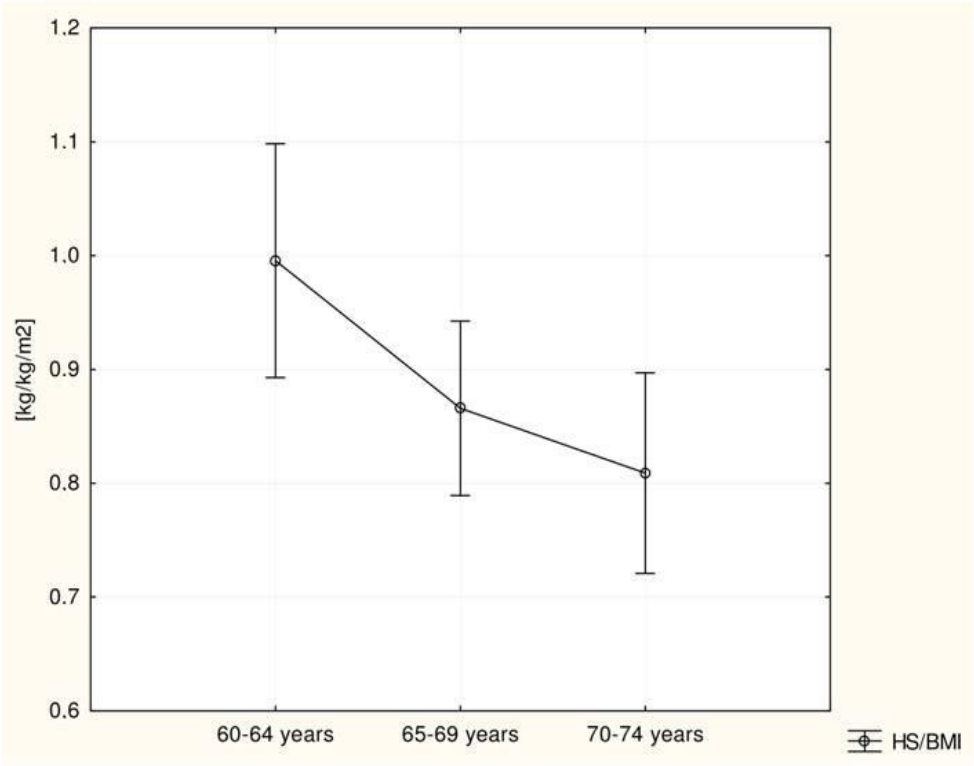

Fig. 2. The differences in the mean HS/BMI between age groups

The mean HS/weight were as follows: 0.38 ±0.07 kg for the group 60–64 years old, 0.33 ±0.06 kg for the group 65–69 years old and 0.32 ±0.05 kg for group 70–44 years old. The second handgrip strength index HS/BMI mean values for three groups were 0.99 ±0.24 kg/kg/m^2, 0.86 ±0.19 kg/kg/m^2 and 0.8 ±0.16 kg/kg/m^2, respectively.

Table 2 compares age, anthropometry and strength between the age groups. The findings provide no differences between age groups as for weight (p = 0.176) and BMI (p = 0.101). However, the F-value for age (p = 0.000), HG peak (p = 0.001), HG avg peak (p = 0.033), HS/weight (p = 0.034) and HS/BMI (p = 0.016) inform about statistically significant differences between the groups.

Table 2. ANOVA table for the data on age, anthropometry and strength

Variables	Sum of squares	df	Mean squares	F	p
Age	1,506.495	2	753.247	394.825	0.000*
Weight	267.476	2	133.738	1.77	0.176
BMI (kg/m^2)	159.094	2	79.547	2.348	0.101
HG peak (kg)	260.269	2	130.134	7.592	0.001*
HG avg peak (kg)	114.199	2	57.099	3.579	0.033*
HS/weight (kg)	0.033	2	0.017	3.83	0.026*
HS/BMI (kg/kg/m^2)	0.384	2	0.192	4.417	0.016*

Notes: *p-value less than 0.05 for the differences in means/medians induced groups

Further analysis with Tukey post-hoc test (Table 3) showed that women from the first group had statistically significantly higher HG peak (p = 0.027) compared with women from the second group. In the second and the third groups there were no statistically significant differences in the above parameter. It is crucial to note that the mean difference between the first group and the third group were the highest. In the group of the youngest women Tukey post-hoc test identified significant higher HG peak (p = 0.001), HG avg peak (p = 0.028), HS/weight (p = 0.055) and HS/BMI (p = 0.019) in comparison with the oldest group.

Table 3. Post-hoc comparison of means strength using Tukey test

Variables	1 group versus 2 group			2 group versus 3 group			1 group versus 3 group		
	Change mean (%)	p Val	ES	Change mean (%)	p Val	ES	Change mean (%)	p Val	ES
HG peak (kg)	-11.502	0.027*	0.691	-8.428	0.294	0.495	-18.960	0.001*	1.337
HG avg peak (kg)	-7.198	0.242	0.404	-4.407	0.422	0.24	-11.287	0.028*	0.7
HS/weight (kg)	-11.549	0.062	0.623	-2.967	0.892	0.169	-14.173	0.046*	0.783
HS/BMI (kg/kg/m^2)	-13.052	0.073	0.587	-6.582	0.669	0.312	-18.775	0.019*	0.899

Notes: *p-value less than 0.05 for the differences in means/medians induced groups

DISCUSSION

Muscle strength has an integral role in the structure and function of joints and bone mass, which is especially crucial in elderly women with osteopenia and osteoporosis [16,17,18].

Swedish researchers reported on the fact that sex, age, height and body weight are important determinants of hand strength [19]. Other studies exploring the relationship between BMI and handgrip strength have provided incongruent findings. Some researchers claim a positive relationship between grip strength and BMI in both genders and all ages, while other researchers found no relationship [20, 21]. Taking into consideration the above determinants, this study was conducted in a group of women divided into three age subgroups taking into account their weight and BMI. Our analysis did not show significant differences between age groups insofar as weight and BMI. Thus, the received results of weight and BMI had no relation with mean differences of strength between the age groups.

Handgrip strength is a reliable measurement; however, the force has most commonly been measured in kilograms, kilopascals, pounds and in newtons. Furthermore, many studies noted different equipment, measurement position, not dividing subjects according to age or the hand which was measured. There are considerable differences between the grip data, which poses difficulties with comparing between the data [21].

To our knowledge, this is one of the first studies to use relative strength indexes to analyze strength in elderly women with low bone mass. However, in research by Choquette [11], HG/BMI index was measured in a group of men

and women aged 67-84 years old in good general physical and mental health, with functional independence. The force of handgrip strength was measured in kPa. Handgrip strength indexes were as follows: HG/BMI 0.4–2.1 kPa/kg/m^2 (lowest tertile), 2.1–2.7 kPa/kg/m^2 (middle tertile), and 2.7–4.8 kPa/kg/m^2 (highest tertile). In other studies HS/weight was 0.684 (95% CI = 0.628–0.739) in women aged 60 years old and older [10]. Authors indicate that the cutoffs of the most relevant index in women that effectively identified individuals at risk of mobility limitation were 0.281.

The present study has also demonstrated a lack of significant differences of handgrip strength indexes between age group 60–64 and 65–69 as well as 65–69 and 70–74 years old. The obtained results suggest that the process of decreasing strength in women of the analyzed age group is stable, without any sudden decreases. Further analysis revealed that women from age group 70–74 years old had statistically lower strength in comparison with women from the first age group (60–64 years old). The results of our experiment are consistent with results of Mathiowetz at al., who indicated that mean scores for strength were relatively stable from 20 to 59 years old, with a gradual decline from 60 to 79 years old [12]. Other studies also found that the age-related decline in muscle function is stronger in women [22] and because of that women are more at risk of sarcopenia than men [23].

In the literature there are no strength assessment studies with taking into consideration the participants' chronic illness or malnutrition. Meanwhile, grip strength is related to and predictive of other health conditions. Some scientists suggest that grip strength be a screening tool for women at risk of osteoporosis [6].

CONCLUSIONS

Our study shows that mean scores of strength gradually decline from 60 to 74 years. Additionally, a significant decrease in all handgrip strength indexes between 60–64 years and 70–74 years old was notes. The proposed characteristic of handgrip strength indexes in the manuscript is initial for the preparation of quantity and quality scale auxiliary in a diagnosis of strength in women with osteopenia and osteoporosis. What is more, the received results can provide an interesting tool for clinicians to set goals and to monitor training progress.

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