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Role of cognitive impairments and decreased muscle strength in cardiovascular mortality of 55 years and older population

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Aim. To assess possible associations of impaired cognitive function (CF) with muscle strength, determined using handgrip test, as well as their role in cardiovascular mortality (CVM) in a population of 55 years and older.

Material and methods. This work was carried out in the framework of the prospective cohort study "Stress, aging and health". During the study 1876 men and women aged 55 and older were examined. CF was estimated on the Mini-Mental State Examination (MMSE) scale, the decrease of CF was recorded with scores of less than 24 points (overall 30 points). Muscle strength was estimated according to handgrip test. To assess the role of muscle strength in CVM, handgrip test values, corresponding to the first quintile, were used — less than 19 kg for women, and less than 32 kg for men. Mortality was estimated on the basis of death register using standard methods. During the observation, 247 deaths from cardiovascular diseases were recorded.

Results. The study included 1876 participants aged 55 years and older (48% of men and 52% of women). CF parameters according to the MMSE questionnaire were within the normal range of more than 80% of those examined. According to the results of the regression analysis, only low values of handgrip test (at the level of 1 quintile) were reliably associated with cognitive impairments ($p<0,05$). These associations were more pronounced in women (odds ratio (OR): 3,17; 95% CI 1,31- 7,69), compared with men (OR: 2,41; 95% CI 1,05-5,54). In 55 years and older men, cognitive impairments were significantly associated with CVM (OR: 1,97; 95% CI 1,40-2,78) and reduced muscle strength (OR: 1,63; 95% CI 1,18-2,25). Among women, only reduced muscle strength significantly increased the risk of CVM (OR: 1,77; 95% CI 1,19-2,61). The simultaneous presence of these pathologies was reliably associated with CVM.

Conclusion. The presented study revealed significant associations of cognitive impairments with reduced muscle strength. The presence of both pathological disorders is prognostically unfavorable for cardiovascular death in a population of 55 years and older (both among men and women). Thus, it is recommended to consider the possibility of including of muscle strength and cognitive functioning assessment in prognostic scales.

Key words: cognitive function, muscular strength, mortality, cardiovascular diseases, population 55 years and older.

Conflicts of Interest: nothing to declare.

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It is known that the prevalence of decreased cognitive function (CF) increases with age [1]. At the same time, every tenth one suffering from cognitive impairment has dementia in old age [2, 3]. In itself, cognitive pathology leads to functional disorders, quality of life decrements, and is also associated with premature mortality [4, 5].

According to studies conducted in different years, several risk factors of cognitive impairment were identified, such as old and senile age, lack of family, hypertension, diabetes and a low level of education [6]. Later, regarding to some of above-mentioned factors, contradictory and even paradoxical effects were presented. In particular, this concerned hypertension and high blood pressure (BP) [7, 8]. Conversely, factors that can prevent cognitive impairment in the elderly were also identified (for example, high physical activity) [9, 10].

Regular physical activity helps maintain normal body weight, muscle function, and reduces the risk of falls and fractures in the elderly. On the contrary, insufficient physical activity along with age is one of the main determinants of a muscle strength decrease [11]. One of the safest and easily reproducible methods for assessing muscle strength in the elderly is handgrip test [12]. At the same time, low values of muscle strength, measured by handgrip test, according to some reports, increase the risk of cardiovascular diseases (CVD), as well as all-cause and cardiovascular (CV) mortality [13-15].

However, there are only a few Russian studies that assessed the associations of cognitive functioning and handgrip strength test with CV mortality in middle-aged and older people. The aim of this study was to assess the contribution of cognitive impairment and decreased muscle strength, measured by handgrip test, to CV mortality in Muscovites of 55 years and older.

Material and methods

This research was conducted in the framework of the prospective cohort study "Stress, Aging and Health in Russia" (SAHR), carried out at National Medical Research Center for Preventive Medicine (Moscow, Russia), with the direct involvement of the Max Institute for Demographic Research Planck (Rostock, Germany) and Duke University (Durham, USA). This study was approved by the Independent Ethics Committee of the National Medical Research Center for Preventive Medicine and the Expert Council of Duke University. In the period from 2007 to 2009, all participants were examined at the National Medical Research Center for Preventive Medicine. The assessment included questionnaire survey developed by the epidemiology department of the National Medical Research Center for Preventive Medicine with the participation of international experts [16]. The analysis included such socio-demographic parameters as gender, age, education (below secondary, secondary and above secondary) and marital status (never married, married, divorced (or separated) and widower/widow). CF was assessed using the Mini-Mental State Examination (MMSE), a decrease in which was recorded with scores less than 24/30. Blood pressure was measured on the right hand twice in a sitting position using an Omron HEM-712 electronic automatic tonometer. Hypertension (HTN) was established in systolic blood pressure ⩾140 mm Hg or diastolic blood pressure ⩾90 mm Hg, or in the case of taking antihypertensives. The diagnosis of stroke and diabetes was established by the questionnaire. Alcohol intake status was determined depending on the consumption of alcoholic beverages during the last year. Muscle strength was evaluated according to handgrip test. This test was performed

Table 1

Gender characteristics of study participants

Parameter	Men (n=898)	Women (n=978)
Age (years)	69,4 (±8,14)	67,7 (±7,26)
Education (%)		
primary	13,9	8,1
secondary	37,2	39,1
higher	48,9	52,9
Marital status (%)		
never married	1,5	7,1
married	79,7	42,2
divorced	7,2	15,8
widower/widow	11,7	35
Alcohol consumption (%)	71,6	34
Hypertension (%)	75,0	72,3
History of stroke (%)	10,3	5,9
History of diabetes (%)	10,3	12,2
Reduced EF (%)		
55-64 years old	8,2	6,2
65-74 years old	11,82	9,1
75-84 years old	29,6	29,5
85 years and older	50,0	41,7
Muscle strength measured by handgrip test (kg)		
55-64 years old	43,0	24,6
65-74 years old	38,1	22,2
75-84 years old	32,5	18,4
85 years and older	27,3	16,2

Table 2

Associations between reduced EF and muscle strength measured by handgrip test* among men and women

Quintiles of muscle strength (M/W)	OR	95% CI	p	OR	95% CI	p
	Men (n=898)			Women (n=974)		
Q1 (<32 kg/<19 kg)	2,41	1,05-5,54	0,03	3,17	1,31-7,69	0,01
Q2 (32-36 kg/19-21 kg)	1,46	0,64-3,32	0,36	2,51	0,99-6,36	0,05
Q3 (37-40 kg/22-24 kg)	1,50	0,65-3,45	0,35	2,09	0,82-5,32	0,12
Q4 (41-45 kg/25-27 kg)	0,89	0,36-2,22	0,80	1,56	0,57-4,25	0,39
Q5 (>45 kg/>27 kg)	1 (reference range)			1 (reference range)		

Note: * Q1-Q5 — quintiles of muscle strength; data are given after adjusting for age, education, marital status, alcohol use, hypertension presence, stroke and diabetes.
Abbreviations: OR — odds ratio, CI — confidence interval.

three times with each hand in a standing position. The final analysis used the maximum values obtained during the survey. Mortality was estimated on the basis of a mortality register using standard methods. During the observation, 411 deaths were recorded, including 247 as a result of CVD. To assess the contribution of muscle strength to CVD mortality, values of handgrip test corresponding to the first quintile were used — less than 19 kg for women and less than 32 kg for men.

Statistical analysis of the results was performed using the STATA® Software. Methods of standard descriptive statistics, such as calculating of average values, standard deviations and standard errors, and rank statistics were used. Associations were evaluated using logistic regression; mortality was studied using the Cox proportional hazards.

Results

The study included 1876 participants aged 55 years and older, including 898 (48%) men. Table 1 presents the socio-demographic characteristics, as well as the prevalence of risk factors for the study population included in the analysis. The average age of the subjects was 68,4 (±7,6) years. More than half of the participants had higher education (51%) and at the time of assessing were married (60%). Gender differences in marital status are noteworthy: men are less likely to be single, they are much more likely to be married than women, less divorced and almost three times less likely to remain widowers. HTN was diagnosed in 70% of participants, while about 8% had a history of stroke.

According to the MMSE questionnaire, CF parameters were within normal limits for more than 80% of subjects. As expected, the prevalence of cognitive impairment increased with age. So, if in the group of 55-60 years old people every tenth one suffered from cognitive impairment, then in the group of ⩾85 years already half of the participants had this pathology. Along with a CF decrease, muscle strength measured by handgrip test decreased with age.

The results of a regression analysis of associations between cognitive impairment and muscle strength measured by handgrip test, after adjusting for age, education, marital status, alcohol intake, HTN, stroke and diabetes are presented in Table 2. It was revealed that only low values of handgrip test (at quintile level 1) were significantly associated with cognitive impairment (p<0,05). These associations were more pronounced in women (odds ratio (OR): 3,17; 95% confidence interval (CI) 1,31-7,69) compared with men (OR: 2,41; 95% CI 1,05-5,54).

According to the proportional risk analysis (Table 3), after adjusting for age, socio-demographic indicators and risk factors, it turned out that in a population of men ⩾55 years, cognitive impairment was significantly associated with CV mortality (risk ratio (RR): 1,97; 95% CI 1,40-2,78) and decreased muscle strength (RR: 1,63; 95% CI 1,18-2,25). In a female cohort of the same age, only decreased muscle strength significantly increases the risk of CV mortality (RR: 1,77; 95% CI 1,19-2,61). Regardless of gender, after adjusting for age and other risk factors, the combination of cognitive impairment and decreased muscle strength was significantly and independently associated with CV mortality (p=0,01).

Discussion

The etiology of age-related dementia is not fully understood, but there is no doubt that it is multifactorial disease. The difficulty lies in the fact that some parameters, in addition to being risk factors, may be the results of dementia. For example, meta-analysis

Table 3

Contribution of cognitive impairment and decreased muscle strength to cardiovascular mortality

Parameter	Model 1[a]	Model 2[b]	Model 3[a]	Model 4[b]
	Men		Women	
	HR (95% ДИ)	HR (95% ДИ)	HR (95% ДИ)	HR (95% ДИ)
Reduced CF	2,01 (1,43-2,81)*	1,97 (1,40-2,78)*	1,61 (1,01-2,56)*	1,40 (0,87-2,27)
Reduced MS	1,80 (1,32-2,45)*	1,63 (1,18-2,25)*	1,93 (1,31-2,86)*	1,77 (1,19-2,61)*
Reduced CF+MS	2,03 (1,48-2,79)*	1,91 (1,38-2,64)*	1,90 (1,27-2,85)*	1,66 (1,10-2,51)*

Note: [a] — after adjusting for age and education, [b] — after adjusting for age, education, marital status, alcohol use, hypertension presence, stroke, diabetes, risk factors, * — p<0,05.

Abbreviations: MS — muscle strength, CF — cognitive function.

by Rockwood K. and Middleton L. (2007) showed that low physical activity, being a risk factor for obesity, diabetes and HTN, together with these diseases leads to cognitive impairment [17]. On the other hand, some authors believe that cognitive impairment itself can lead to decreased physical function and muscle strength. For example, according to Rosso AL, et al., decreased motion in some older people may be associated with cognitive impairment [18]. According to other authors, reduced muscle strength is not a risk factor, but an early marker of CF reduction [19]. However, all authors agree that CF decrease is associated with low physical activity and low muscle strength.

The results of this study are consistent with data obtained previously by foreign researchers. So, in a recent study by Vancampfort D, et al. it was shown that in the middle-aged and older population, low muscle strength measured by handgrip test is significantly associated with cognitive impairment, regardless of gender, age and other risk factors [20]. In conclusion, the authors write that further studies are likely to provide evidence that low muscle strength is a clinically reliable marker for CF disorders, and the development and implementation of exercise programs will allow modifying cognitive health along with physical. Although we share this view, the results of our study do not allow us to determine whether muscle strength measured by handgrip test is a risk factor for cognitive impairment or a result of this pathology. That is because the study of the associations between cognitive impairment and low muscle strength was carried out on the data of one-time survey. Further prospective studies are required to clarify the nature of the interaction of cognitive function and muscle strength.

At the same time, we obtained significant associations between decreased muscle strength and CV mortality among men and women, while the contribution of reduced CF to CV mortality in a multivariate model was significant only in the male cohort.

In recent decades, a number of studies devoted to the effect of cognitive impairment on CV mortality were conducted. However, the results of these studies regarding the elderly population are often controversial. So, in a study by Ji An, et al. significant associations between cognitive impairment and all-cause and CV mortality have been shown [21]. However, Kerola T, et al. found that the contribution of reduced CF to CV mortality remained significant only after adjusting for gender and age, while in the multivariate model this parameter became insignificant [22]. As for the associations of decreased muscle strength and mortality, the results of studies in this field indicate the significant prognostic value of this risk factor. Moreover, some authors propose using this parameter as an indicator of the elders' health in clinical practice [23].

Thus, the results of our analysis showed that with a decrease in muscle strength in people ⩾55 years of age, we can expect a decrease in CF three times more often in women and 2 times more often in men compared to those with high values of handgrip strength test (Q5).

Low muscle strength along with both pathological disorders, is the most unfavorable prognostic factor for CV mortality in the male and female population of the studied age. An isolated CF decrease increases the risk of death only in men. Given the results obtained, inclusion an assessment of muscle strength and CF as independent risk factors in the practical prognostic scales should be considered.

Conflicts of Interest: nothing to declare.

References

1. Millán-Calenti JC, Tubío J, Pita-Fernández S, et al. Prevalence of cognitive impairment: effects of level of education, age, sex and associated factors. Dementia and geriatric cognitive disorders. 2009;28(5):440-5. doi:10.1159/000257086.
2. Jorm AF. Using the Delphi expert consensus method in mental health research. Australian & New Zealand Journal of Psychiatry. 2015;49(10):887-97. doi:10.1177/0004867415600891.
3. Prince M, Bryce R, Albanese E, et al. The global prevalence of dementia: a systematic review and metaanalysis. Alzheimer's & dementia. 2013;9(1):63-75. doi:10.1016/j.jalz.2012.11.007.
4. Murad K, Goff DC, Morgan TM, et al. Burden of comorbidities and functional and cognitive impairments in elderly patients at the initial diagnosis of heart failure and their impact on total mortality: the Cardiovascular Health Study. JACC: Heart Failure. 2015;3(7):542-50. doi:10.1016/j.jchf.2015.03.004.
5. Nishiguchi S, Yamada M, Fukutani N, et al. Differential association of frailty with cognitive decline and sarcopenia in community-dwelling older adults. Journal of the American Medical Directors Association. 2015;16(2):120-4. doi:10.1016/j.jamda.2014.07.010.
6. van Gelder BM, Tijhuis M, Kalmijn S, et al. Marital status and living situation during a 5-year period are associated with a subsequent 10-year cognitive decline in older men: the FINE Study. The Journals of Gerontology Series B: Psychological Sciences and Social Sciences. 2006;61(4):213-9. doi:10.1093/geronb/61.4.P213.
7. Corrada MM, Hayden KM, Paganini-Hill A, et al. Age of onset of hypertension and risk of dementia in the oldest-old: The 90+ Study. Alzheimer's & Dementia. 2017;13(2):103-10. doi:10.1016/j.jalz.2016.09.007.
8. Roselli F, Tartaglione B, Federico F, et al. Rate of MMSE score change in Alzheimer's disease: influence of education and vascular risk factors. Clinical neurology and neurosurgery. 2009;111(4):327-30. doi:10.1016/j.clineuro.2008.10.006.
9. Boyle PA, Buchman AS, Wilson RS, et al. Association of muscle strength with the risk of Alzheimer disease and the rate of cognitive decline in community-dwelling older persons. Archives of neurology. 2009;66(11):1339-44. doi:10.1001/archneurol.2009.240.
10. Auyeung TW, Lee JSW, Kwok T, Woo J. Physical frailty predicts future cognitive decline–a four-year prospective study in 2737 cognitively normal older adults. The journal of nutrition, health & aging. 2011;15(8):690-4. doi:10.1007/s12603-011-0110-9.
11. Hollmann W, Strüder HK, Tagarakis CV, King G. Physical activity and the elderly. European Journal of Cardiovascular Prevention & Rehabilitation. 2007;14(6):730-9. doi:10.1097/HJR.0b013e32828622f9.
12. Roberts HC, Denison HJ, Martin HJ, et al. A review of the measurement of grip strength in clinical and epidemiological studies: towards a standardised approach. Age and ageing. 2011;40(4):423-9. doi:10.1093/ageing/afr051.
13. Leong DP, Teo KK, Rangarajan S, et al. Prognostic value of grip strength: findings from the Prospective Urban Rural Epidemiology (PURE) study. The Lancet. 2015;386(9990):266-73. doi:10.1016/S0140-6736(14)62000-6.
14. Lawman HG, Troiano RP, Perna FM, et al. Associations of relative handgrip strength and cardiovascular disease biomarkers in US adults, 2011-2012. American journal of preventive medicine. 2016;50(6):677-83. doi:10.1016/j.amepre.2015.10.022.
15. Lenardt MH, Binotto MA, Carneiro NHK, et al. Handgrip strength and physical activity in frail elderly. Revista da Escola de Enfermagem da USP. 2016;0(1):86-92. doi:10.1590/S0080-623420160000100012.
16. Shkolnikova M, Shalnova S, Shkolnikov VM, et al. Biological mechanisms of disease and death in Moscow: rationale and design of the survey on Stress Aging and Health in Russia (SAHR). BMC Public Health. 2009;9(1):293. doi:10.1186/1471-2458-9-293.
17. Rockwood K, Middleton L. Physical activity and the maintenance of cognitive function. Alzheimer's & dementia. 2007;3(2):S38-S44. doi:10.1016/j.jalz.2007.01.003.
18. Rosso AL, Verghese J, Metti AL, et al. Slowing gait and risk for cognitive impairment: the hippocampus as a shared neural substrate. Neurology. 2017;89(4):336-42. doi:10.1212/WNL.0000000000004153.
19. Mielke MM, Roberts RO, Savica R, et al. Assessing the temporal relationship between cognition and gait: slow gait predicts cognitive decline in the Mayo Clinic Study of Aging. Journals of Gerontology Series A: Biomedical Sciences and Medical Sciences. 2012;68(8):929-37. doi:10.1093/gerona/gls256.
20. Vancampfort D, Stubbs B, Firth J, et al. Associations between handgrip strength and mild cognitive impairment in middle-aged and older adults in six low-and middle-income countries. International journal of geriatric psychiatry. 2019;34(4):609-16. doi:10.1002/gps.5061.
21. An J, Li H, Tang Z, et al. Cognitive Impairment and Risk of All-Cause and Cardiovascular Disease Mortality Over 20-Year Follow-up: Results From the BLSA. Journal of the American Heart Association. 2018;7(15):e008252. doi:10.1161/JAHA.117.008252.
22. Kerola T, Hiltunen M, Kettunen R, et al. Mini-Mental State Examination score and B-type natriuretic peptide as predictors of cardiovascular and total mortality in an elderly general population. Annals of medicine. 2011;43(8):650-9. doi:10.3109/07853890.2010.526137.
23. Chainani V, Shaharyar S, Dave K, et al. Objective measures of the frailty syndrome (hand grip strength and gait speed) and cardiovascular mortality: A systematic review. International journal of cardiology. 2016;215:487-93. doi:10.1016/j.ijcard.2016.04.068.