HUMAN MOVEMENT (ISSN 1899-1955)
2024; 25(1): 105–112

Assessment of the correlation between the occurrence of fine movements of the hand, pre-frailty, and body composition in the elderly

original paper
DOI: https://doi.org/10.5114/hm.2024.136061

ANNA SEBASTJAN[1], MAŁGORZATA KOŁODZIEJ[1], ANNA SKRZEK[2], ZOFIA IGNASIAK[1]

[1] Faculty of Physical Education and Sport, Wroclaw University of Health and Sport Sciences, Wroclaw, Poland
[2] Faculty of Physiotherapy, Wroclaw University of Health and Sport Sciences, Wroclaw, Poland

ABSTRACT
Purpose. The main objective of the study was to evaluate the correlations between fine movements of the hand, the tissue composition of the upper limb, and the occurrence of frailty syndrome in elderly people in the Polish population.
Methods. The study included 998 individuals living alone aged 60 to 87 years. Anthropometric and bioelectrical impedance measurements were taken, tests of motor skills of the upper limbs and functional efficiency were performed, and the phenotype of physical weakness was assessed.
Results. Participants identified as pre-frailty were observed to score less favourably in motor skills tests compared to other participants. The significance of the differences between the males and females was confirmed for most tests of precision, coordination, and speed of the upper limbs, in addition to the number of aiming errors. A correlation was observed between reduced fine movements of the hand and age, reduced functional efficiency, and low muscle mass of the upper limbs. Of all the included hand motor tests, only hand tremor scores in the stability test did not affect the risk of pre-frailty.
Conclusions. The study showed a significant, positive correlation between the fine movements of the hand, mainly with the weight and strength of the muscles of the upper limb, and negative in the case of the risk of frailty syndrome. It is advisable to focus on programs to raise awareness of the importance of physical activity, which translates into health and quality of life.
Key words: ageing process, efficiency, BMD

Introduction

The hand and its functions, as one of the most important evolutionary achievements in phylogeny, make it possible to perform very complex self-service, professional and hedonistic activities. Hence the high genetic determinant (HOX gene group) of these functions of the upper limb and hand [1,2] In ageing processes, they may be subject to greater protection and slower loss of complex functions compared to other parts of the musculoskeletal system. In phylogenetic development, hand functions were increasingly enriched with complex motor acts. These processes were an important achievement that enabled the transformation and expansion of the hand's motor functions, facilitating changes in the living environment towards safe functioning within it. The need for broadly understood interaction with the environment and the acquisition of new functions that are crucial for the development of civilization led to significant development of areas in the brain that are responsible for the function of the hand and the entire biokinematic chain of the upper limb [3]. Hands are extremely precise parts of the motor system. They also provide the opportunity to express one's emotional states, thus determining social, professional, and personal well-being.

The functions of the upper limb and hand are precisely controlled by the nervous system, coordinating and directing the optimal work of the muscles of the upper limb and hand. Changes at the muscular level are related to motor skills and learning movements, thus they occur at the very early stages of life and are among the most important [4].

The inevitable effects of ageing are associated with deterioration, both at the level of the musculoskeletal and the nervous systems. The effects overlap, enhanc-

Correspondence address: Anna Sebastjan, Wroclaw University of Health and Sport Sciences, al. I.J. Paderewskiego 35, 51-612 Wroclaw, Poland, e-mail: anna.sebastjan@awf.wroc.pl; https://orcid.org/0000-0001-6395-6147

Received: February 22, 2024
Accepted for publication: February 28, 2024

Citation: Sebastjan A, Kołodziej M, Skrzek A, Ignasiak Z. Assessment of the correlation between the occurrence of fine movements of the hand, pre-frailty, and body composition in the elderly. Hum Mov. 2024;25(1):105–112; doi: https://doi.org/10.5114/hm.2024.136061.

ing the adverse impact of the ageing process on the body [5]. Therefore, it is important to detect potential threats to the function of the upper limb and hand early. This will enable the incorporation of appropriately selected therapeutic methods that will stimulate both the nervous and musculoskeletal systems, thus creating the opportunity to preserve optimal hand functions until old age [6, 7].

The increasing prevalence of frailty syndrome is an important issue in the area of public health. It may be a result of the physiological ageing of the body or be associated with multi-morbidity. In both cases, frailty syndrome is preceded by a pre-frailty phase. Researchers from this field are of the opinion that early detection of the symptoms of frailty syndrome and the inclusion of appropriate, personalised therapy will result in the withdrawal of the preclinical state of frailty syndrome and thus a delay in the ageing process [8–11]. It can therefore be assumed that the risk of frailty syndrome will also significantly affect the reduction of the fine movements of the hand and the tissue composition of the upper limb.

Since the functions of the hand are highly genetically determined and used in every area of human life, it can be expected that the frailty syndrome appearing with age may be a major threat to the optimal functioning of the hand. Therefore, the main goal of our research was to capture the correlations between the fine movements of the hand, the tissue composition of the upper limb, and the occurrence of frailty syndrome in elderly people in the Polish population.

Materials and methods

Participants and study design

The study involved 998 people aged 60 to 87, who signed up for free testing between 2009 and 2016 thanks to advertisements in local media and invitations addressed to health centres and associations of the elderly in southwestern Poland. The study included 998 individuals aged 60 to 87 years (67.2 ± 5.5 years). Place of research: Wroclaw University of Health and Sport Sciences. The inclusion criteria were the absence of medical contraindications, independence, and autonomy in everyday life. Participants were assessed as subjectively healthy based on self-declarations of good health, no difficulty in walking, normal cognition, and no limitation in daily activities. Exclusion criteria due to bioelectrical impedance measurements were the presence of an electronic implant or metal prosthesis, amputation of a limb, acute clinical condition, and high relative body mass index. The use of any drugs (e.g., corticosteroids, hormones) that could the alter body composition was also a reason for exclusion.

TANITA measurements and bioelectrical impedance analysis

Body height and weight were measured with an accuracy of 0.1 cm and 0.1 kg, respectively, using an electronic balance with an integrated SECA 764 digital stadiometer (Seca GmbH and Co. KG. Germany). Body composition, including limb skeletal muscle mass, was estimated by bioelectrical impedance analysis (BIA) using an 8-electrode TANITA MC 180 MA multi-frequency analyser (Tanita Corporation, Japan) with an operating frequency of 50 kHz, with an electrical current of 0.8 μA. The measurement was performed in a standing position on a platform with four built-in electrodes (2 for each foot) and two two-electrode hand grips. Prior to each examination, the repeatability of the impedance measurement results was checked in two successive trials in two volunteers. When registering for the study, participants were asked not to eat, drink or engage in any physical activity for at least three hours prior to the study and to empty their bladders immediately before the measurement. Of all segmental body composition parameters estimated by the BIA analyser, this study used fat mass and upper limb muscle mass, which, according to the manufacturer's information, is lean mass reduced by the bone mass of a given body segment.

Evaluation of frailty phenotype criteria (FP criteria)

According to Fried et al. [12], 1–2 of 5 criteria describe impending frailty syndrome (pre-frailty), and 3–5 describe the presence of this syndrome. The authors indicate that these criteria include a significant decrease in body weight in the last year (4–5 kg), a decrease in muscle strength, a sense of exhaustion for more than 3 days/week, slowed gait, and decreased weekly physical activity levels. In our study, 3 out of the 5 proposed criteria were evaluated.

Hand grip strength (HGS) was measured with an accuracy of 1 kg using a JAMAR hydraulic dynamometer (Sammons Preston Rolyan, USA) with an adjustable handle set in the second position. The recommendations of the American Society of Hand Therapists (ASHT) (13) were applied. The subjects were asked to perform two trials at maximum grip strength alternately for the right and left hand, with each trial lasting about 3–5 s, and with an interval of 15–20 s between the measurements. The highest value of all trials was recorded as the value of HGS. The frailty criterion for HGS was the cut-off values proposed by Fried, taking into account sex and BMI, i.e., HGS ≤ 29 kg at BMI ≤ 24 kg/m^2, HGS ≤ 30 kg at BMI = 24.1–28 kg/m^2 and HGS ≤ 32 kg at BMI > 28 kg/m^2 for the males and HGS ≤ 17 kg at BMI ≤ 23 kg/m^2, HGS ≤ 17.3 kg at BMI = 23.1–26 kg/m^2, HGS ≤ 18 kg at BMI 26.1–29 kg/m^2 and HGS ≤ 21 kg at BMI > 29 kg/m^2 for the females [12].

Walking Speed (WS) was assessed using the 8 Foot Up and Go test from Rikli and Jones [14]. The number of seconds required to get up from a seated position, walk 8 feet, turn, and return to a seated position was measured. It was recommended to cover the distance as quickly as possible. The critical walking time of 16 feet was adapted to Fried's criteria for time in the 15 feet walk test [12] (16 ft critical time = 15 ft critical time *16/15). Considering sex and body height, the frailty criterion was met when the test time ≥ 7.5 s (at Ht ≤ 173 cm) and ≥ 6.4 s (at Ht > 173 cm) for the males and ≥ 7.5 s (at Ht ≤ 159 cm) and ≥ 6.4 s (at Ht > 159 cm) for the females.

Weekly Physical Activity (PA) (kcal/week) was assessed using the IPAQ International Physical Activity Questionnaire [15]. Participants answered questions about the frequency and duration of physical activity at low, moderate, and intense levels. Values of PA < 383 kcal/week for males and PA < 270 kcal/week for females we considered to meet the frailty criterion [12].

Using the criteria of the frailty phenotypic model proposed by Fried et al. (2001), two groups of frailty status were distinguished from all those included in the study i.e., non-frailty (n = 619), who did not meet any of the criteria, and pre-frailty (n = 379), who met 1 or 2 criteria. Frailty status (at least 3 frailty criteria met) was not identified in any participant of the study.

Upper limb motor skills tests

The motor skills of the upper limbs were assessed using the Motor Performance Series (MLS, German for Motorische Leistungsserie) Workboard (PMC1-080 2004) included in the Vienna Test System Hardware (SCHUHFRIED GmbH, Austria). The measurement included static and dynamic tasks for finger, hand, and arm movements. Prior to the actual MLS test, each participant was explained how to perform the individual subtest and, if necessary, a mock test was conducted. Each participant performed tasks on a work board in a seated position using a contact pencil (one for the right hand and one for the left hand) and metal pins. Resting the arm was not allowed during the test. Since most participants were right-handed – only 14 of them declared left-handedness (5 males including 1 pre-frailty and 9 females including 2 pre-frailty) – the following measurements for the right upper limb were used in this study:

1. Number of errors due to hand and/or arm tremors (number of tremors) in the Steadiness test, consisting in maintaining a specific position of the arm and hand with as little change as possible for 32 seconds (assessment of arm and hand stability);
2. Aiming total time and the number of errors (aiming errors) resulting from imprecise aiming (assessment of eye-hand coordination and precision of arm-hand movements);
3. Inserting long pins test time (assessment of target arm-hand speed and eye-hand coordination);
4. Number of taps in 32 seconds in the Tapping test (assessment of the speed of non-targeted movements of the wrist-fingers).

Statistical analysis

The results of all measurements were presented as mean ± standard deviation (mean ± SD). For categorical variables, percentage structure indices were calculated. The normality of distribution of the variables was checked with the Shapiro-Wilk test. Since a normal distribution was not confirmed for most variables, the non-parametric Kruskal-Wallis rank test and the χ^2 test of independence were used to assess the differences between sex and frailty status groups. For multiple comparisons, the Mann–Whitney U test with Bonferroni correction was used (the adjusted significance level was $\alpha = 0.01$).

Correlations between the variables were checked with Spearman's rank coefficient, and their association with the probability of identifying the pre-frailty state (pre-frailty = 1; no frailty = 0) were assessed using logistic regression. The results of MLS tests, sex (males = 1, females = 0), age, muscle and fat mass of the upper limb were considered as independent variables. The variables that constituted the criterion of the frailty phenotype (HGS, WS, and PA) were not included. The statistical significance of the individual regression coefficients was tested using the Wald test. Variables that were found to be significantly correlated with pre-frailty in univariate analyses were included in a multiple logistic regression (multivariable analysis). Using a stepwise technique, all selected factors were initially entered into the model and then removed if the p-value for the Wald test was greater than 0.05. The number of variables was limited to those that were as uncorrelated as possible to reduce the risk of redundancy. All statistical analyses were performed using TIBCO Statistica® 13.3.0 (StatSoft Poland). The level of statistical significance was established at $p < 0.05$.

Ethical approval

The research related to human use has complied with all the relevant national regulations and institutional policies, has followed the tenets of the Declaration of Helsinki, and has been approved by the Senate Research Ethics Committee of the Wroclaw University of Health and Sport Sciences (February 18, 2009).

Informed consent

The participants were informed about the purpose and methods of the research, the procedures used, and the experimental risks. Informed consent has been obtained from all individuals included in this study.

Results

Pre-frailty was identified in 38% of the study participants, with the prevalence twice as high in females as in males (44% vs 21%, $\chi^2 = 41.7$, $p < 0.001$). The descriptive characteristics of the measurement results in the sex and frailty status groups are presented in Table 1. For all variables, the Kruskal–Wallis test confirmed the significance of differences between the study groups. As a result of detailed comparisons, in addition to the expected differences between the males and females for somatic parameters, strength, fat, and muscle mass of the upper limb, differences between sexes were found in both pre-frailty status groups in walking speed (shorter time for males), the Inserting long pins test (shorter time for females) and the Tapping test (more taps for males). In addition, the females in the non-frailty group had lower BMI and fewer aiming errors than the males (Table 1).

The participants identified as pre-frailty were observed to perform worse on the MLS tests compared to the other participants (apart from the differences resulting from the frailty phenotype criteria, i.e., HGS, WS, and PA). Between the males and females, the significance of the differences was confirmed for all subtests, except for the number of aiming errors.

There was a correlation between low MLS test scores (indicative of reduced motor skills of the hand) and age, low HGS (only for aiming time and tapping speed), low WS (with subtest performance speed), and low upper limb muscle mass (with aiming speed and accuracy and tapping speed). The correlations between the MLS results and PA and the limb fat mass were not confirmed (Table 2).

The MLS subtests that correlated significantly (although weakly/strongly: $\rho \leq 0.30$) with variables that

Table 1. Descriptive characteristics of study participants

	Males mean ± *SD*			Females mean ± *SD*		
	non-frailty (n = 200)	pre-frailty (n = 53)	p-value	non-frailty (n = 419)	pre-frailty (n = 326)	p-value
Age (years)	**67.8 ± 5.3**	**70.8 ± 6.2**	0.002	**65.6 ± 4.6**	**68.2 ± 5.8**	< 0.001
Height (cm)	**172.6 ± 5.8**	**172.1 ± 6.3**	0.857	**158.5 ± 5.5**	**158.0 ± 6.0**	0.149
Weight (kg)	**87.6 ± 12**	**80.8 ± 11.8**	0.001	**72.1 ± 13.2**	**70.4 ± 11.3**	0.335
BMI (kg/m^2)	**29.4 ± 3.5**	27.3 ± 3.5	0.001	**28.7 ± 5.3**	28.2 ± 4.0	0.988
HGS (kg)	**46.0 ± 8.4**	**37.8 ± 9.5**	< 0.001	**27.1 ± 5.2**	**24.2 ± 7.7**	< 0.001
WS (s)	**5.0 ± 0.6**	**6.1 ± 1.0**	< 0.001	**5.3 ± 0.7**	**6.7 ± 0.8**	< 0.001
PA (kcal/week)	446 ± 149	344 ± 131	0.001	438 ± 157	367 ± 170	< 0.001
FM (kg)	**1.1 ± 0.4**	**0.9 ± 0.3**	0.001	**1.5 ± 0.7**	**1.5 ± 0.5**	0.967
MM (kg)	**3.4 ± 0.5**	**3.1 ± 0.5**	< 0.001	**2.2 ± 0.3**	**2.1 ± 0.3**	0.001
Steadiness (number of tremors)	2.6 ± 4.2	4.2 ± 6.5	0.047	2.5 ± 5.0	3.4 ± 5.9	0.001
Aiming total time (s)	9.7 ± 2.4	10.5 ± 2.7	0.062	10.0 ± 2.4	10.6 ± 2.7	0.002
Aiming errors (number)	**1.4 ± 2.1**	1.0 ± 1.8	0.294	**0.8 ± 1.7**	1.0 ± 2.1	0.387
Inserting long pins (s)	**47.3 ± 5.7**	**50.5 ± 7.6**	0.006	**44.0 ± 7.3**	**47.7 ± 6.9**	< 0.001
Tapping (number of taps)	**192.4 ± 20.6**	**183.2 ± 27.6**	0.009	**182.2 ± 21.3**	**176.7 ± 20.2**	< 0.001

BMI – body mass index, HGS – hand grip strength, PA – physical activity, FM – fat mass, MM – muscle mass,
Motor skills test results for the right limb
Significant differences between males and females in the frailty status groups are shown in bold.

Table 2. Spearman's rank correlation coefficients for right limb measurements

	Age (years)	HGS	WS	PA	FM	MM
Steadiness (number of tremors)	0.19*	–0.03	0.14*	–0.06	–0.01	0.02
Aiming total time (s)	0.25*	–0.18*	0.23*	–0.01	0.06	–0.08*
Aiming errors (number)	0.10*	0.03	–0.01	0.05	0.05	0.11*
Inserting pins (s)	0.41*	0.01	0.29*	0.02	0.01	0.09*
Tapping (number of taps)	–0.20*	0.24*	–0.30*	0.06	–0.06	0.16*

HGS – hand grip strength, WS – walking speed, PA – physical activity, FM – fat mass, MM – muscle mass
* statistically significant correlations at $p < 0.05$ (critical value $\rho = 0.062$)

Table 3. Logistic regression models for the risk of pre-frailty in adults over 60 for the right hand

	Predictor	Coefficient estimate	SE	OR	95%CI	Wald statistic	*p*-value
Univariate models	sex	–1.08	0.17	0.34	0.24–0.48	39.56	< 0.001
	age	0.08	0.01	1.08	1.05–1.11	39.18	< 0.001
	FM (kg)	–0.09	0.11	0.91	0.73–1.13	0.72	0.398
	MM (kg)	–1.04	0.13	0.35	0.27–0.46	61.86	< 0.001
	steadiness (number of tremors)	0.04	0.03	1.04	1.01–1.06	8.34	0.004
	aiming time (s)	0.14	0.03	1.15	1.09–1.21	26.69	< 0.001
	inserting pins (s)	0.07	0.01	1.07	1.05–1.09	39.37	< 0.001
	tapping (number of taps)	–0.02	0.00	0.98	0.98–0.99	29.48	< 0.001
Multiple model	intercept	–1.21	0.90	0.30	0.05–1.76	1.79	0.181
	sex	–1.20	0.19	0.30	0.21–0.44	41.10	< 0.001
	aiming time (s)	0.08	0.03	1.08	1.02–1.14	7.99	0.005
	inserting pins (s)	0.04	0.01	1.05	1.02–1.07	15.39	< 0.001
	tapping (number of taps)	–0.01	0.00	0.99	0.98–0.99	13.53	< 0.001

Sex: males = 1, females = 0, FM – fat mass, MM – muscle mass, SE – standard error, OR – odds ratio,
95% CI – confidence interval

constituted the criteria for the frailty phenotype were included as independent variables in the logistic regression analysis, while the variables that were the criteria for the frailty phenotype (HGS, WS, and PA) were excluded. The univariate logistic regression method was used to preliminarily test the association of selected variables (without their interaction) with the probability of pre-frailty status. Age was a positive predictor of pre-frailty, while sex and upper limb muscle mass were the strongest and most negative predictors (Univariate models in Table 3). The males had an almost 3 times lower risk of pre-frailty than the females (OR = 0.34, $p < 0.001$). A similar reduction in odds was observed for each unit increase in muscle mass of the right limb. Limb fat mass was not associated with the risk of pre-frailty. Of all the included hand motor tests, only hand tremor scores in the stability test did not affect the odds of pre-frailty.

In multivariate analyses, the number of variables was limited to those possibly linearly independent but correlating with pre-frailty in the univariate analyses. Age and muscle mass significantly correlated with all MLS variables and their inclusion in the multivariate analyses resulted in model redundancy. In addition, the presence of muscle mass in the logistic regression, which was strongly determined by sex, caused the other coefficients to lose statistical significance. Ultimately, the significant predictors of pre-frailty turned out to be sex and the speed of aiming, pinning, and tapping tests (Multiple models in Table 3). The sensitivity, specificity, and accuracy of this model were 59.1%, 88.0%, and 77.1%, respectively. The predictive power of the MLS test results in the multiple regression was comparable to that obtained in the univariate analyses, while the contribution of sex in explaining the risk of pre-frailty increased.

Discussion

The study analysed the correlations between the fine movements of the right hand, the tissue composition of the upper limb, and the frailty syndrome in independence, and autonomy in everyday life elderly people. To the best of our knowledge, the presented problem is the first study aimed at explaining objectively measured hand function with the Vienna test and the risk of frailty syndrome and body composition in the Polish population. The study group of males and females was divided into individuals without signs of frailty and those with 1 or 2 criteria indicating the risk of frailty syndrome. There were no individuals with the full picture of frailty syndrome. The percentage of participants at risk of frailty syndrome was close to 40%, which is comparable to other European populations [16–18].

In our studies, pre-frailty was twice as common in the females than in the males, and the risk of frailty syndrome increased in both sexes with age. This observation is consistent with a study by Santos-Eggimann et al. [17] in 10 European countries. The authors point out that some minor differences may result from methodological differences, inclusion criteria, or exclusion of people with comorbidities potentially associated with frailty syndrome. In our research, the principle of inclusion in the program was a positive assessment of one's own health and no contraindications from the attending physician. These results were also confirmed in Brazilian studies, which can be justified by the greater loss of physiological reserves in females, or faster deteriorating socio-economic conditions. Females have a longer life expectancy, lower muscle mass index, more severe functional disability, and more frequent depressive symptoms, which may put them at greater risk of pre-frailty compared to males [19].

The results of the study indicate more favourable values of muscle mass and lower body fat in the males than in the females and in individuals without signs of frailty syndrome. The body fat of all the females was at a similar level. The problem of the correlation between body composition and frailty syndrome was also analysed by García-Esquinas et al. [20]. They assessed the correlation between obesity, fat mass distribution, and pre-frailty in a population of over 3,000 elderly Spanish females. The authors showed that the risk of frailty was highest in those with coexisting general obesity and abdominal obesity.

The weekly physical activity did not differ between sex groups but was significantly lower in those at risk of frailty syndrome. Many researchers emphasise the importance of physical activity in maintaining healthy well-being [21, 22] and counteracting many diseases of civilization [22]. Physical activity also has a beneficial effect on the functions of neurotransmitters and brain morphofunction, reducing cognitive disorders and the risk of depression [23].

In conclusion, the analysis of the motor skills tests showed significantly lower levels in the pre-frailty compared to the non-frailty subjects except for the number of aiming errors. The markedly lower overall physical activity of those at risk of frailty syndrome was also accompanied by a significantly reduced level of fine hand movements (wrist and fingers), speed, and dexterity of the movements. The results of the subtests were significantly correlated with age, muscle mass, and strength as well as dynamic balance, thus indicating reduced functional efficiency of the hand. However, there were no significant correlations between the MLS subtests and the level of physical activity and the amount of body fat.

The results of this study showed that reduced functional efficiency of the upper limbs is significantly correlated with a higher risk of pre-frailty, regardless of the sex of the subjects. However, the determinant role of age in explaining both variables may make it difficult to assess the strength of the correlation between frailty syndrome and MLS test results.

It is reasonable to believe that promoting physical activity among the elderly should be treated as a priority, as it may result in a reduction in morbidity and maintenance of independence in life. An important element of these preventive measures is the use of occupational therapy at any stage of ageing, illness, or disability. Based on research, it seems that the hand, which in everyday life serves as a 'tool' to perform fine movements, becomes inefficient as a result of ageing, injury, or disease. Regardless of the reasons for limiting the motor function of the hand, the functioning of every human being deteriorates at the same time. When restoring hand dexterity, the occupational therapist must pay attention to six elements important for improving function, such as grip quality, grip type, fine movements, open hand training, grip value, and performing activities with both hands. Work in occupational therapy teams, taking place on many levels and in different sequences, improves a variety of motor functions [24–27].

Study strengths

Our research has several strengths. These include the large study group, subjectively healthy and non-community dwelling people. We measured the real efficiency of the fine movements of the hand using the highly diagnostic and objective Vienna tests using computers. The tests are easy to perform by the elderly and do not induce tiredness, weariness, or reluctance. This also applies to the tissue composition of the upper limb by BIA (Tanita apparatus). Epidemiological studies mainly use diagnostic survey methods, which make this type of research burdened with the high subjectivity of the examined person, mood, and level of cognitive functions. This was avoided in our research. We would like to emphasise that, in this era of ageing societies, screening tests of the real functional efficiency of the body should be a priority. Further analyses should be performed and correlations between the functional parameters of the body and factors of the environment assessed, which will allow for more dignified ageing.

At the same time, the research was safe for the subjects. In our opinion, the problem is extremely important from the point of view of public health, because promoting physical activity in the elderly will contribute to improving their quality of life and greater independence while reducing the financial effects on social and health care of people in late adulthood.

Study limitations

In our research, we did not avoid certain limitations. These include, above all, the cross-sectional nature of the study, which limits tracking of the pace and dynamics of ageing processes. Secondly, the research included individuals from southwestern Poland only, who might live in economically and socially better conditions than citizens from other regions, therefore the research cannot be treated as defining the entire Polish elderly population. Another limitation is that it was not a random sample, but a targeted selection prone to selection bias. The participation in the study was based on self-enrolment, so individuals who were more socially active constituted the study group. This is why the results of the study cannot be extrapolated to the entire population of this age.

The seniors who were tested were independent in making decisions about joining the tests and independent in travelling to the tests. Of course, this is a specific group that should be differentiated from seniors, e.g., in social welfare homes, rehabilitation centres or family homes, with limited physical or mental independence. Therefore, the studies probably did not identify people with full frailty syndrome. Of course, in groups of seniors with greater physical fitness limitations, the results may be different. Such studies are planned and successively conducted by the authors, but they require longer time scales due to greater difficulties in reaching such centres.

Conclusions

The fine movements of the hand show a significant correlation with the mass and strength of the muscles of the upper limb and the risk of frailty syndrome. Age and sex were significant risk factors as the females were twice as likely to be at risk of frailty compared to the males, and the risk increased with age in both sexes. In the subjects at risk of frailty syndrome, we observed significantly lower parameters not only of fine movements of the hand but also of other measurements. At the same time, the high percentage of people at risk of frailty syndrome and significantly reduced fine movements of the hand should result in the establishment of programs activating this social group and increasing the awareness of factors that determine their own health and thus their quality of life.

Disclosure statement
No author has any financial interest or received any financial benefit from this research.

Conflict of interest
The authors state no conflict of interest.

References

1. Lappin TR, Grier DG, Thompson A, Halliday HL. HOX genes: seductive science, mysterious mechanisms. Ulster Med J. 2006;75(1):23–31.
2. Manning JT. The finger book: sex, behaviour and disease revealed in the fingers. London: Faber and Faber; 2008.
3. Marzke MW. Evolutionary development of the human thumb. Hand Clin. 1992;8(1):1–8; doi: 10.1016/S0749-0712(12)00687-9.
4. Aoyama T, Kohno Y. Temporal and quantitative variability in muscle electrical activity decreases as dexterous hand motor skills are learned. PLoS ONE. 2020; 15(7):e0236254; doi: 10.1371/journal.pone.0236254.
5. Benda RN, Marinho NFS, Duarte MG, Ribeiro-Silva PC, Ortigas PR, Machado CF, et al. A brief review on motor development: fundamental motor skills as a basis for motor skill learning. Braz J Mot Behav. 2021;15(5): 342–355; doi: 10.20338/bjmb.v15i5.257.
6. Cerejeira J, Lagarto L, Mukaetova-Ladinska EB. Behavioral and psychological symptoms of dementia. Front Neurol. 2012;3:73. doi: 10.3389/fneur.2012.00073.
7. Ehsani H, Mohler MJ, O'Connor K, Zamrini E, Tirambulo C, Toosizadeh N. The association between cognition and dual-tasking among older adults: the effect of motor function type and cognition task difficulty. Clin Interv Aging. 2019;14:659–669; doi: 10.2147/CIA.S198697.

8. Chandler JM, Hadley EC. Exercise to improve physiologic and functional performance in old age. Clin Geriatrc Med. 1996;12(4):761–782.
9. 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(3): 146–156; doi: 10.1093/Gerona/56.3.M146.
10. Łęt P, Polak Szabela AP, Porzych K. The process of human aging and involution changes in the brain. Med Biol Sci. 2013:27(4):23–26; doi: 10.12775/mbs-2013-0031.
11. Sebastjan A, Skrzek A, Ignasiak Z, Sławińska T. Age-related changes in hand dominance and functional asymmetry in older adults. PLoS One. 2017;12(5): e0177845; doi: 10.1371/journal.pone.0177845.
12. Fess EE. Grip strength. In: Casanova JS (ed.) Clinical assessment recommendations. 2nd ed. Chicago: American Society of Hand Therapists; 1992:41–45.
13. Jones CJ, Rikli RE. Measuring functional fitness in older adults. J Active Aging. 2002;1:24–30.
14. Craig CL, Marshall AL, Sjöström M, Bauman AE, Booth ML, Ainsworth BE, et al. International physical activity questionnaire: 12-country reliability and validity. Med Sci Sports Exerc. 2003;35(8):1381–1395; doi: 10.1249/01.MSS.0000078924.61453.FB.
15. Abizanda P, Romero L, Sanchez-Jurado PM, Martínez-Reig M, Alfonso-Silguero SA, Rodríguez-Mañas L. Age, frailty, disability, instutionalization, multimorbidity or comorbity. Which are the main targets in older adults? J Nutr Health Aging. 2014;18(6):622–627; doi: 10.1007/s12603-014-0033-3.
16. Furtado G, Patrício M, Loureiro M, Teixeira AM, Ferreira JP. Physical fitness and frailty syndrome in institutionalized older women. Percept Mot Skills. 2017; 124(4):754–776; doi: 10.1177/0031512517709915.
17. Santos-Eggimann B, Cuénoud P, Spagnoli J, Junod J. Prevalence of frailty in middle-aged and older community dwelling Europeans living in 10 countries. J Gerontol A. 2009;64A(6):675–681; doi: 10.1093/gerona/glp012.
18. dos Santos Tavares DM, de Freitas Corrêa TA, Dias FA, dos Santos Ferreira PC, Sousa Pegorari M. Frailty syndrome and socioeconomic and health characteristics among older adults. Colomb Med. 2017;48(3):126–131; doi: 10.25100/cm.v48i3.1978.
19. García-Esquinas E, José García-García F, León-Muñoz LM, Carnicero JA, Guallar-Castillón P, Gonzalez-Colaço Harmand M, et al. Obesity, fat distribution, and risk of frailty in two population-based cohorts of older adults in Spain. Obesity. 2015;23(4):847–855; doi: 10.1002/oby.21013.
20. Hamer M, Lavoie KL, Bacon SL. Taking up physical activity in later life and healthy aging: the English longitudinal study of aging. Br J Sports Med. 2014;48(3): 239–243; doi: 10.1136/bjsports-2013-092993.
21. Svantesson U, Jones J, Wolbert K, Alricsson M. Impact of physical activity on the self-perceived quality of life in non-frail older adults. J Clin Med Res. 2015;7(8):585–593; doi: 10.14740/jocmr2021w.
22. Middleton LE, Barnes DE, Lui LY, Yaffe K. Physical activity over the life course and its association with cognitive performance and impairment in old age. J Am Geriatr Soc. 2010;58(7):1322–1326; doi: 10.1111/j.1532-5415.2010.02903.x.
23. Bujnowska-Fedak MM, Waligóra J, d'Avanzo B, Holland C, Kurpas D. Approaches to therapy and prevention of frailty in the light of contemporary medicine. Fam Med Prim Care Rev. 2017;19(3):289–297; doi: 10.5114/fmpcr.2017.69293.
24. GBD 2016 Neurology Collaborators. Global, regional, and national burden of neurological disorders, 1990–2016: a systematic analysis for the Global Burden of Disease Study 2016. Lancet Neurol. 2019;18(5):459–480; doi: 10.1016/S1474-4422(18)30499-X.
25. Fujisaki-Sueda-Sakai M, Takahashi K, Yoshizawa Y, Iijima K. Frailty checkup supporters' intentions to participate in human-resource development and training activities. J Frailty Aging. 2020;9(4):238–43; doi: 10.14283/jfa.2020.6.
26. Lee IM, Shiroma EJ, Lobelo F, Puska P, Blair SN, Katzmarzyk PT, et al. Effects of physical inactivity on major non-communicable diseases worldwide: an analysis of burden of disease and life expectancy. Lancet. 2012; 380(9838):219–229; doi: 10.1016/S0140-6736(12)61031-9.
27. Sebastjan A, Siwek K, Kozieł S, Ignasiak Z, Skrzek A. Age and sex variation in the results of the 2HAND test in an adult population. Hum Mov. 2014;15(1):21–24; doi: 10.2478/humo-2013-0048.