Association Between Health-Related Physical Fitness and Self-Reported Health Status in Older Taiwanese Adults

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Abstract

Background

This study aims to determine if an association exists between health-related physical fitness measurements and self-reported health status in older Taiwanese adults.

Methods

A total of 22,389 Taiwanese adults aged 65 years or older were recruited as study participants. Demographic characteristics, life habits, anthropometric assessments, health-related physical fitness measurements, and self-reported health status from this dataset were analyzed using the chi-square test, one-way analysis of variance, and logistic regression analysis.

Results

The results showed that there was significant association between back scratch and self-perceived health status (excellent/good) (odds ratio [OR], 1.003; 95% CI 1.000-1.006) after adjusting potential confounders. However, adjusted potential confounders OR for self-perceived health status (poor/very poor) decreased and significant for chair sit-and-reach test (OR 0.994, 95% CI 0.988–0.999).

Conclusions

The results of this study indicate that there are associations between health-related physical fitness measurements and self-reported health status in Taiwanese older adults. Future research may investigate the causality between health status and physical fitness.

Background

Aging is an inevitable process of life development. One characteristic of aging is the degradation of the human musculoskeletal system, which leads to a decrease in muscle mass and lower muscle function [1, 2]. These physical changes may cause a decline in the functional adaptability and health of older adults.

Recently, researchers have increased their focus on health and aging. According to the World Health Organization [3], “health is a state of complete physical, mental, and social well-being and not merely the absence of disease or infirmity.” Physical health is a multi-factor indicator. The measures of physical fitness include height, weight, body mass index (BMI), body function, medical history, body composition, and age. Numerous measures are also used to assess physical fitness, including cardiorespiratory endurance, muscular endurance, muscular strength, and body flexibility [4].
Musculoskeletal health consists of three elements: muscular strength, muscular endurance, and flexibility [4]. If these elements cannot be maintained, the fitness of the musculoskeletal system may be damaged. Poor fitness affects individuals’ physical health and health status. Kell et al. [5] pointed out that the execution of daily tasks may become a challenge due to age. They also illustrated that the combination of resistance training and stretching to improve musculoskeletal health is related to enhanced health. In addition, numerous studies have established the relationships of musculoskeletal composition with health status and quality of life [4].

Sato et al. used multiple discriminant analysis to quantify the relationship between the health status and physical fitness of middle-aged and older adults (ages 30 to 60 years) [6]. Their results revealed a relationship between health status and physical fitness. Daily physical activity may positively affect the health of middle-aged and older people. However, few studies have mentioned the relationship between physical fitness indicators and self-perceived health status. Instead, most researchers have used physician assessments to determine the health status of participants.

Sato et al. have explored the relationship between the health status and physical fitness of middle-aged and older men [7] and women [8] in Japan. The studies identified components of physical fitness that help to improve and maintain health in different age groups and quantified the relationship of health status with physical fitness in middle-aged and older individuals. We found no relevant research on the relationship between health status and physical fitness in Taiwan. Therefore, this study aims to determine if an association exists between health-related physical fitness measurements and self-reported health status in older Taiwanese adults.

**Methods**

**Study design and participants**

We conducted a cross-sectional study to determine the associations between physical fitness components and self-reported health status in older Taiwanese adults. We reviewed data derived from the National Physical Fitness Survey Databases in Taiwan (NPFSD 2014–15) from Taiwan's Sports Administration, a branch of the Ministry of Education. All participants were recruited using convenience sampling from 35 examination stations in 20 cities or counties in Taiwan; the detailed procedure has been described elsewhere [9–11]. Participants completed a questionnaire on their demographic characteristics and life habits, and we measured resting heart rate and blood pressure for safe preliminary screening before conducting physical fitness tests. Finally, for this study, we assayed the questionnaire and physical fitness measurement data of 22,389 Taiwanese adults aged 65 years or older between October 2014 and March 2015. This study was approved by the Ethical Committee of Fu Jen Catholic University (FJU-IRB-C108088), and written informed consent was obtained from each participant.

**Data collection**
Face-to-face interviews and physical examinations were completed by trained research assistants and nurses. The questionnaire data included demographic characteristics (i.e., age, gender, education, monthly income, and marital status), life habits (i.e., smoking, betel-nut chewing, and dieting), and self-reported health status. Anthropometric measurements including body weight, height, waist circumference (WC), and hip circumference (HC) were taken after the participants had removed their shoes and heavy clothes. Body weight was measured to the nearest 0.1 kg using a weighing scale [16]. Body height was measured to the nearest 0.1 cm using a metal measuring tape attached to a wall with an acute-angled head piece; the participants stood against this vertical wall and wore no shoes. BMI was calculated as weight in kilograms divided by the square of height in meters. WC was measured (to the nearest 0.1 cm) by using a soft measuring tape at the level of the natural waist, which was identified as the level at the hollow molding of the trunk when the trunk was bent laterally. HC was measured (to the nearest 0.1 cm) at the level of the greater trochanter. The waist-to-hip ratio (WHR) was also calculated. The cut-off BMI values were those suggested by Taiwan’s Ministry of Health and Welfare: underweight (BMI < 18.5 kg/m²), normal (18.5 ≤ BMI < 24 kg/m²), overweight (24 ≤ BMI < 27 kg/m²), and obese (BMI ≥ 27 kg/m²) [12].

**Self-reported health status**

Self-reported health status and obtained from the following questionnaire item: “In general, would you say your health is excellent, good, fair, poor, or very poor?” In this analysis, we have combined the responses into a ternary outcome, where self-perceived health could be good (a response of “excellent” or “good”), fair (a response of “fair”), or poor (a response of “poor” or “very poor”).

**Physical fitness measurements**

To determine the functional capacity of older adults, we assessed five main components of physical fitness based on nine indicators: aerobic endurance (2-minute step), muscle strength and endurance (30-second arm curl and 30-second chair stand), flexibility (back scratch and chair sit-and-reach), balance (one-leg stance with eyes open and 8-foot up-and-go), and body composition (BMI and WHR). Each physical fitness indicator had accompanying performance standards for male and female participants aged 65 years and older based on an annual national survey of more than 20,000 older Taiwanese adults. Measurements were recorded by examiners who had attended an official training seminar and passed a certification test on standardized procedures. The details of the 2-minute step, 30-second arm curl, 30-second chair stand, back scratch, chair sit-and-reach, and 8-foot up-and-go were strictly performed according to the Serious Fitness Test manual [13], and the one-leg stance with eyes open was as described in other articles [14].

The indicators were explained to the participants, and they had 10 minutes to warm up so that their optimum performance could be achieved. Measurements were scheduled before the exercises. All participates were assessed in the following order with sufficient rest (3 to 5 minutes) between measures: body weight, height, WC, HC, one-leg stance with eye open, 30-second chair stand, 30-second arm curl, 2-
minute step, chair sit-and-reach, back scratch, and 8-foot up-and-go. For each indicator, the participants were classified into four quartiles according to their physical fitness performance levels.

**Statistical analyses**

The data were analyzed using the Statistical Analysis System (SAS) software package (Version 9.4, SAS Institute Inc., Cary, NC). Differences in demographic data and physical fitness measurements between categories of self-reported health status were analyzed using one-way analysis of variance (ANOVA) or chi-square tests. When a significant $F$ value was found ($p < 0.05$), Tukey's post hoc test was performed to determine the differences between the pairs of means. Logistic regression models were used to estimate the odds ratios (ORs) and 95% confidence intervals (CIs) for the association between quartiles of each physical fitness measurements and self-reported health status (excellent/good vs. fair and poor/very poor vs. fair) while adjusting for potential confounders. All data are expressed as means ± standard deviation or frequency (percentage). The significance level adopted to reject the null hypothesis was $p < 0.05$.

**Results**

This study obtained data from 22,389 participants aged 65 years and older. The relationship between demographic characteristics and anthropometric indices of self-perceived health status are shown in Table 1. Significant associations were identified between self-perceived health status and all the demographic characteristics except age. Participants whose self-perceived health status was excellent or good were the tallest (156.77 ± 7.92 years) and heaviest (60.88 ± 9.75 years).

**Table 1** Demographic characteristics and anthropometric indices of study subjects according to self-perceived health status
| Variables                          | Self-perceived health status | p     | Tukey's post hoc test |
|-----------------------------------|-----------------------------|-------|-----------------------|
|                                   | Excellent/Good | Fair | Poor/Very poor | |
| No. of subjects                   | 14959 | 5729 | 1701 | |
| Age (y)                           | 73.27 ± 6.48 | 73.32 ± 6.40 | 73.38 ± 6.06 | 0.713 | |
| Gender (% men)                    | 37.3% | 33.4% | 31.0% | < 0.001 | |
| Height (cm)                       | 156.77 ± 7.92 | 156.14 ± 7.67 | 155.82 ± 7.68 | < 0.001 | EG > F, PV |
| Body weight (kg)                  | 60.88 ± 9.75 | 60.41 ± 9.95 | 60.84 ± 10.21 | 0.009 | EG > F |
| Obese Status (%)                  |       |       | 0.011 | |
| Underweight                       | 2.0%  | 2.8%  | 3.2%  | |
| Normal weight                     | 40.6% | 40.5% | 36.7% | |
| Overweight                        | 33.7% | 31.3% | 31.4% | |
| Obese                             | 23.7% | 25.4% | 28.6% | |
| Education (%)                     |       |       | < 0.001 | |
| Elementary school or lower        | 57.7% | 61.1% | 68.9% | |
| Junior or senior school           | 28.2% | 26.2% | 21.8% | |
| College or higher                 | 14.1% | 12.8% | 9.3%  | |
| Monthly Income (%)                |       |       | < 0.001 | |
| ≤ 20,000 NTD                      | 87.6% | 89.5% | 93.0% | |
| 20,001–40,000 NTD                 | 7.3%  | 6.2%  | 3.5%  | |
| ≥ 40,001 NTD                      | 5.1%  | 4.3%  | 3.5%  | |
| Marital Status (%)                |       |       | < 0.001 | |

Values are expressed as means ± standard deviation.

Abbreviations: EG, Excellent/Good; F, Fair; NTD, new Taiwan dollar; PV, Poor/Very poor.

* p < 0.05.
Table 2 compares the physical fitness measurements between self-perceived health status categories. Significant associations were observed between self-perceived health status and physical fitness. Both men and women whose self-perceived health status was excellent or good had the highest levels of physical fitness (2-minute step test, 30-second arm curl, 30-second chair stand, back scratch, chair sit-and-reach test, 8-foot up-and-go, and one-leg stance with eyes closed), but no significant association was identified between self-perceived health status and BMI in men ($p = 0.112$).
Table 2
The comparison of functional fitness measurements according to self-perceived health status

| Variables                  | Self-perceived health status | p          | Tukey’s post hoc test |
|----------------------------|-----------------------------|------------|-----------------------|
|                            | Excellent/Good | Fair | Poor/Very poor |    |                     |
| Men                        |                |      |                |    |                     |
| 2-minute step test         | 87.40 ± 27.69 | 82.36 ± 28.11 | 76.24 ± 30.87 | < 0.001 | EG > F > PV         |
| 30-second arm curl         | 18.13 ± 6.27  | 17.41 ± 6.13  | 15.91 ± 5.96  | < 0.001 | EG > F > PV         |
| 30-second chair stand      | 15.62 ± 5.25  | 14.88 ± 5.27  | 13.26 ± 4.93  | < 0.001 | EG > F > PV         |
| Back scratch               | -10.86 ± 13.55| -12.04 ± 14.19| -15.00 ± 13.91| < 0.001 | EG > F > PV         |
| Chair sit-and-reach test   | 1.28 ± 10.82  | 0.57 ± 10.73  | -2.08 ± 11.62 | < 0.001 | EG > F > PV         |
| 8-foot up-and-go           | 7.43 ± 2.52   | 7.84 ± 2.66   | 8.81 ± 3.23   | < 0.001 | EG < F < PV         |
| One-leg stance with eye open| 16.24 ± 11.44 | 15.37 ± 11.63 | 12.57 ± 11.29 | < 0.001 | EG > F > PV         |
| BMI (kg/m²)                | 24.66 ± 3.03  | 24.77 ± 3.32  | 24.92 ± 3.45  | 0.112  | EG < F < PV         |
| WHR                        | 0.92 ± 0.06   | 0.93 ± 0.06   | 0.93 ± 0.06   | < 0.001 | EG < F, PV          |
| Women                      |                |      |                |    |                     |
| 2-minute step test         | 84.68 ± 27.25 | 81.09 ± 29.00 | 74.71 ± 32.10 | < 0.001 | EG > F > PV         |
| 30-second arm curl         | 17.62 ± 6.04  | 16.85 ± 5.93  | 16.01 ± 5.78  | < 0.001 | EG > F > PV         |
| 30-second chair stand      | 15.05 ± 4.89  | 14.25 ± 4.80  | 13.08 ± 4.82  | < 0.001 | EG > F > PV         |
| Back scratch               | -4.40 ± 11.08 | -5.65 ± 11.60 | -7.55 ± 12.65 | < 0.001 | EG > F > PV         |

Values are expressed as means ± standard deviation.

Abbreviations: BMI, body mass index; CEI, cardiorespiratory endurance index; EG, Excellent/Good; F, Fair; PV, Poor/Very poor; WHR, waist-to-hip ratio.

*Significantly different males and females by one-way ANOVA at $p < 0.05$. 
| Variables                             | Self-perceived health status | \( p \) | Tukey's post hoc test |
|--------------------------------------|------------------------------|--------|----------------------|
|                                      | Excellent/Good   | Fair   | Poor/Very poor       |        |
| Chair sit-and-reach test             | 5.41 ± 9.75      | 4.83 ± 9.80 | 3.67 ± 10.29       | < 0.001 | EG > F > PV |
| 8-foot up-and-go                     | 7.65 ± 2.42      | 8.03 ± 2.60 | 8.84 ± 2.99       | < 0.001 | EG < F < PV |
| One-leg stance with eye open         | 14.91 ± 11.16    | 13.85 ± 11.00 | 11.64 ± 10.45       | < 0.001 | EG > F > PV |
| BMI (kg/m\(^2\))                    | 24.77 ± 3.50     | 24.74 ± 3.58 | 25.09 ± 3.78     | 0.001   | EG, F < PV |
| WHR                                  | 0.88 ± 0.07      | 0.88 ± 0.07 | 0.89 ± 0.07       | < 0.001 | EG, F < PV |

Values are expressed as means ± standard deviation.

Abbreviations: BMI, body mass index; CEI, cardiorespiratory endurance index; EG, Excellent/Good; F, Fair; PV, Poor/Very poor; WHR, waist-to-hip ratio.

*Significantly different males and females by one-way ANOVA at \( p < 0.05 \).

Tables 3 and 4 represent the relationship between physical fitness and self-perceived health status (excellent/good) after adjusting for potential confounders. Before adjusting, no significant associations were identified between five physical fitness indicators (back scratch: OR = 1.002, 95% CI 0.999–1.004; chair sit-and-reach test: OR = 1.002, 95% CI 0.999–1.005; one-leg stance with eye open: OR = 1.002, 95% CI 0.998–1.005; BMI: OR = 1.004, 95% CI 0.995–1.014; WHR: OR = 1.047, 95% CI 0.670–1.637) and self-perceived health status (excellent/good). However, after adjustment, a significant association between the back scratch indicator and self-perceived health status (excellent/good) was revealed (OR = 1.003; 95% CI 1.000–1.006). No significant relationships were observed between six physical fitness indicators (2-minute step test: OR = 0.999, 95% CI 0.997–1.001; 30-second arm curl: OR = 0.992, 95% CI 0.982–1.003; back scratch: OR = 0.997, 95% CI 0.993–1.002; chair sit-and-reach test: OR = 0.995, 95% CI 0.989–1.001; BMI: OR = 1.012, 95% CI 0.995–1.028; WHR: OR = 1.010, 95% CI 0.449–2.273) and low self-perceived health status (poor/very poor). However, once the results were adjusted for potential confounders, the ORs for self-perceived health status (poor/very poor) decreased, and the correlation became significant for the chair sit-and-reach test (OR = 0.994, 95% CI 0.988–0.999).
Table 3
Multivariate adjusted ORs for excellent/good in relation to each functional fitness measurement after adjustment for potential confounders

| Factors not adjusted | OR  | 95% CI       | p    | OR  | 95% CI       | p    |
|----------------------|-----|--------------|------|-----|--------------|------|
| 2-minute step test   | 1.002 | 1.000-1.003 | 0.010 | 1.001 | 1.000-1.003 | 0.031* |
| 30-second arm curl   | 1.007 | 1.001–1.013 | 0.014 | 1.007 | 1.001–1.013 | 0.016* |
| 30-second chair stand| 1.013 | 1.005–1.021 | 0.002 | 1.012 | 1.004–1.020 | 0.004* |
| Back scratch         | 1.002 | 0.999–1.004 | 0.253 | 1.003 | 1.000-1.006 | 0.031* |
| Chair sit-and-reach test | 1.002 | 0.999–1.005 | 0.236 | 1.003 | 1.000-1.006 | 0.089 |
| 8-foot up-and-go     | 0.977 | 0.962–0.992 | 0.003 | 0.983 | 0.968–0.998 | 0.031* |
| One-leg stance with eye open | 1.002 | 0.998–1.005 | 0.328 | 1.001 | 0.998–1.004 | 0.683 |
| BMI (kg/m²)          | 1.004 | 0.995–1.014 | 0.391 | 0.967 | 0.885–1.056 | 0.454 |
| WHR                  | 1.047 | 0.670–1.637 | 0.841 | 0.744 | 0.469–1.183 | 0.212 |

Abbreviations: BMI, body mass index; CEI, cardiorespiratory endurance index; CI, confidence interval; OR, odds ratio; WHR, waist-to-hip ratio.

*Adjusted for gender, height, weight, BMI, education, monthly income, marital status, smoking status, and chewing betel nuts.

* p < 0.05.
Table 4
Multivariate adjusted ORs for poor/very poor in relation to each functional fitness measurement after adjustment for potential confounders

|                          | Factors not adjusted | Factors adjusted* |
|--------------------------|----------------------|-------------------|
|                          | OR       | 95% CI    | p     | OR       | 95% CI    | p     |
| 2-minute step test       | 0.999    | 0.997–1.001 | 0.297 | 0.999    | 0.997–1.001 | 0.313 |
| 30-second arm curl       | 0.992    | 0.982–1.003 | 0.149 | 0.991    | 0.980–1.002 | 0.092 |
| 30-second chair stand    | 0.981    | 0.966–0.995 | 0.011 | 0.984    | 0.969–0.999 | 0.041* |
| Back scratch             | 0.997    | 0.993–1.002 | 0.202 | 0.996    | 0.991–1.001 | 0.090 |
| Chair sit-and-reach test | 0.995    | 0.989–1.001 | 0.076 | 0.994    | 0.988–0.999 | 0.030* |
| 8-foot up-and-go         | 1.055    | 1.029–1.081 | < 0.001 | 1.054   | 1.027–1.080 | < 0.001* |
| One-leg stance with eye open | 0.993    | 0.987–0.999 | 0.014 | 0.993    | 0.988–0.999 | 0.026* |
| BMI (kg/m²)              | 1.012    | 0.995–1.028 | 0.167 | 1.018    | 0.981–1.056 | 0.347 |
| WHR                      | 1.010    | 0.449–2.273 | 0.981 | 1.132    | 0.489–2.622 | 0.771 |

Abbreviations: BMI, body mass index; CEI, cardiorespiratory endurance index; CI, confidence interval; OR, odds ratio; WHR, waist-to-hip ratio.

*Adjusted for gender, height, BMI, education, monthly income, marital status, smoking status, and chewing betel nuts.

* p < 0.05.

Discussion

In this study, we examine the relationship between self-perceived health status and physical fitness measurement results. The results indicate that regardless of gender, participants who perceived their health status as good exhibited significantly higher physical fitness test results than those in the other two groups, who reported their health status as either fair or poor. Therefore, we can conclude that people with good self-perceived health status also perform higher in physical fitness.

In addition, body shape is a factor that affects self-reported health status. Nonetheless, the relationship between BMI and self-perceived health status was not significant in men (p = 0.112). However, for women
in this sample, the relationship between BMI and self-perceived health status was statistically significant ($p < 0.001$). This gender difference may be caused by the convenience sampling which the gender ratio subjects was not close to 1:1 in this convenience sample. Therefore, in future research design, we suggest increasing the sample size and controlling the gender ratio to examine gender differences in the association between BMI and self-perceived health status.

The advantage of this study is that it uses data collected by the NPFSD for Taiwan's Sports Administration. This data comes from different counties and cities across Taiwan and is therefore representative. Thus, it eliminates the researcher's sampling selection bias. Furthermore, according to the literature review, few studies have examined the correlation between physical fitness performance and health among older adults. Sato et al. examined the relationship between anatomical structure and the quality of life related to body function and health [15]. Another study confirmed that different musculoskeletal components have a strong influence on health status and quality of life [4]. In this analysis, we examine the association between physical fitness and self-reported health status. However, because this is a cross-sectional study design, we cannot confirm the causality between these two variables. Therefore, we can continue to examine whether living habits may be mediating or moderating variables. In addition, different physical fitness measures could also be compared in future studies.

Evidence clearly supports the notion that exercise contributes to healthy aging. Angevaren et al. concluded that aerobic physical exercise that improves cardiorespiratory health is beneficial to adults’ cognitive function [16]. However, in their research, most of the comparisons results were not statically significant. Therefore, their findings cannot confirm that the improvement in cognitive function were due to physical exercise. In addition, with regard to improving the health of older adults, healthcare providers must take into account appropriate physical exercises to maintain and improve the level of physical health [17]. Studies have also shown that physical exercise can effectively increase the health of older adults [18]. Therefore, we also suggest that surveys on exercise habits should be administered to older adults to achieve a more comprehensive examination of the factors affecting health. Finally, the data used in this analysis may be too preliminary in the self-health report survey. Cuesta-Vargas and Galán-Mercant used the Health Status Questionnaire (short-form SF-12, the short version of SF-36) to evaluate the health status [4]. They also administered health-related quality of life surveys. Their results indicated that this questionnaire can be used to correctly distinguish health status. In future research, we suggest that a more comprehensive self-reported health status survey be provided to obtain more information.

**Conclusion**

In conclusion, the analysis results reveal significant associations between health-related physical fitness measurements and self-reported health status in older Taiwanese adults. Future research may investigate the causality between health status and physical fitness.

**Abbreviations**
Declarations

Ethics and consent to participate

This study was conducted with a secondary database provided by the Sports Cloud: Information and Application Research Center of Sports for All, Sport Administration, Ministry of Education in Taiwan. All consents obtained from the study participants were written prior the data collection. This study's design and analysis procedure was approved by the Ethical Committee of Fu Jen Catholic University (FJU-IRB-C108088).

Consent for publication

Not applicable.

Availability of data and material

The data that support the findings of this study are available from [the Sports Cloud: Information and Application Research Center of Sports for All, Sport Administration, Ministry of Education in Taiwan] but restrictions apply to the availability of these data, which were used under license for the current study, and so are not publicly available. Data are however available from the authors upon reasonable request and with permission of [the Sports Cloud: Information and Application Research Center of Sports for All, Sport Administration, Ministry of Education in Taiwan].

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**Competing interests**

The authors declare that they have no competing interests.

**Authors’ contributions**

YJS and CCH participated in the design, conducted the statistical analyses, interpreted the data, and drafted the manuscript. CTH supervised the study, assisted in data interpretation, and critically reviewed the manuscript. CL and PFL helped in conducting the study and revising the manuscript. CFL and HTC helped to manage and analyze the data. All authors read and approved the final manuscript.

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**References**

1. Pedrero-chamizo R, Gómez-cabello A, Mélendez A, Vila-maldonado S, Espino L, Gusi N, Villa G, Casajús JA, González-gross M, Ara I. Higher levels of physical fitness are associated with a reduced risk of suffering sarcopenic obesity and better perceived health among the elderly. the EXERNET multi-center study. J Nutr Health Aging. 2015; 19(2): 211–7.

2. Frontera WR, Hughes VA, Fielding RA, Fiatarone MA, Evans WJ, Roubenoff R. Aging of skeletal muscle: A 12-yr longitudinal study. J Appl Physiol. 2000; 88(4): 1321–6.
3. World Health Organization. (n.d.). *WHO remains firmly committed to the principles set out in the preamble to the Constitution.* https://www.who.int/about/who-we-are/constitution

4. Cuesta-Vargas A, Galán-Mercant A. Contribution of physical fitness component to health status in elderly males and females over 60 years-short report. SA Journal of Physiotherapy. 2012; 68(1): 4–8.

5. Kell R, Bell G, Quinney A. Musculoskeletal fitness, health outcomes and quality of life. Sports Med. 2001; 31(12): 863–73.

6. Sato T, Demura S, Murase T, Kobayashi Y. Quantification of relationship between health status and physical fitness in middle-aged and elderly males and females. J Sports Med Phys Fitness. 2005; 45(4): 561–9.

7. Sato T, Demura S, Murase T, Kobayashi Y. Contribution of physical fitness component to health status in middle-aged and elderly males. J Physiol Anthropol. 2006; 25(5): 311–9.

8. Sato T, Demura S, Murase T, Kobayashi Y. Contribution of physical fitness component to health status in middle-aged and elderly females. J Physiol Anthropol. 2007; 26(6): 569–77.

9. Chen HH, Chen HL, Lin YT, Lin CW, Ho CC, Lin HY, Lee PF. The associations between functional fitness test performance and abdominal obesity in healthy elderly people: results from the National Physical Fitness Examination Survey in Taiwan. Int J Environ Res Public Health. 2020; 18(1): 264.

10. Lee PF, Ho CC, Yeh DP, Hung CT, Chang YC, Liu CC, Tseng CY, Hsieh XY. Cross-sectional associations of physical fitness performance level and sleep duration among older adults: results from the National Physical Fitness Survey in Taiwan. Int J Environ Res Public Health. 2020; 17(2): 388.

11. Ho CC, Lee PF, Chen HL, Tseng CY, Hsieh XY, Chiu CH. Poor health-related physical fitness performance increases the overweight and obesity risk in older adults from Taiwan. BMC Geriatr. 2021; 21(1): 170.

12. Mo H, Wo T. Health promotion administration: annual report; 2016.

13. Rikli RE, Jones CJ. Development and validation of a functional fitness test for community-residing older adults. J Aging Phys Act. 1999; 7(2): 129–61.

14. Jonsson E, Seiger Å, Hirschfeld H. One-leg stance in healthy young and elderly adults: a measure of postural steadiness? Clin Biomech. 2004; 19(7): 688–94.

15. Sato T, Demura S, Murase T, Kobayashi Y. Estimation equation for the evaluation of the health status of middle-aged and elderly individuals based on the results of physical fitness tests: a proposal for use as an initial screening test. Human Performance Measurement. 2009; 6: 1–9.

16. Angevaren M, Aufdemkampe G, Verhaar HJ, Aleman A, Vanhees L. Physical activity and enhanced fitness to improve cognitive function in older people without known cognitive impairment. Cochrane Database Syst Rev. 2008; (3): CD005381.

17. Elsawy B, Higgins KE. Physical activity guidelines for older adults. Am Fam Physician. 2010; 81(1): 55–9.

18. Nawrocka A, Mynarski W, Cholewa J. Adherence to physical activity guidelines and functional fitness of elderly women, using objective measurement. Ann Agric Environ Med. 2017; 24(4): 632–635.