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Functional Performance and Self-Perceived Health in Older Women: Development of an Integrated Functional Performance Index

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Abstract

Background

Functional performance is a key determinant of health during aging; however, its relationship with self-perceived health is not always considered. This cross-sectional study aimed to examine the association between widely used functional performance tests and self-perceived health status, and to developed an Integrated Functional Performance Index (IFPI) in community-dwelling older women, following STROBE guidelines.

Methods

A total of two hundred and seventeen older women (70.98 ± 6.07 years) were assessed using the 36-Item Short Form Health Survey (SF-36) questionnaire and a battery of functional tests, including the Five-Times Sit-to-Stand Test (5STS), Six-Meter Walking Test (6WS), Timed Up and Go (TUG), Handgrip Strength (HGS), and Two-Minute Step Test (2MST). The IFPI was constructed by normalizing and weighting results considering the SF-36 component(s) (Physical Component Summary, PCS; and/or Mental Component Summary, MCS) that showed significance correlations with all functional performance tests. Associations between were examined using Pearson (r) or Spearman (ρ) correlation coefficients, with statistical significance set at $p < 0.05$.

Results

PCS scores (43.70 ± 8.27) showed consistent and statistically significant absolute correlations with all functional test results (5STS: ρ = -0.25, $p < 0.001$; 6WS: r = 0.26, $p < 0.001$; TUG: ρ = -0.25, $p < 0.001$; HGS: r = 0.19, $p < 0.01$; and 2MST: ρ = 0.36, $p < 0.001$). In contrast, the MCS scores (50.70 ± 10.65) showed significant absolute correlations only with 5STS (ρ = -0.25, $p < 0.001$), 6WS (r = 0.15, $p < 0.05$), and 2MST (ρ = 0.26, $p < 0.001$). Based on these relationships, the IFPI was constructed by normalizing functional test results and weighting them according to their associations with PCS, resulting in index values ranging from 13.91 to 113.39 a.u.

Conclusions

In conclusion, the IFPI provides a multidimensional assessment of functional performance by integrating objective physical tests with older women's perceptions of physical health. This approach may offer a more sensitive tool for functional assessment, warranting further investigation in health screening and exercise programs.

Background

Population ageing is a global demographic phenomenon, primarily driven by increases in life expectancy [1, 2]. However, increased longevity does not necessarily imply autonomous and functional ageing [3, 4]. As ageing progresses, physiological systems undergo gradual deterioration, with the musculoskeletal system exhibiting pronounced declines in muscle strength, muscle mass, and functional capacity, thereby directly compromising activities of daily living in older adults [5, 6]. Beyond increased longevity, older women show a higher prevalence of chronic diseases, an increased risk of undernutrition [7], lower income levels, and a disproportionate burden of caregiving responsibilities, all of which heighten their vulnerability and risk of frailty [8]. In geriatrics, frailty is defined as a reduction in physiological reserve that compromises the ability to adapt to stressors [9, 10]. It is considered a dynamic and potentially preventable syndrome [11], with consequences that may include functional dependence, falls, hospitalization, and mortality [12, 13]. Given its clinical and public health relevance, early detection of frailty requires valid, sensitive, and context-appropriate assessment tools [14].

Within this framework, functional capacity or performance (i.e., ability to execute motor tasks relevant to independence) emerges as a key indicator of healthy ageing, as its deterioration is associated with a higher incidence of dependency, institutionalization, and reduced quality of life [15, 16], thereby constituting an operational marker of the frailty phenotype [11]. Functional performance can be assessed using simple, practical, and low-cost tests [17]—including the Five-Times Sit-to-Stand Test (5STS) [18], Gait or Walking Test [19], Timed Up and Go (TUG) [20], Handgrip Strength (HGS) [21], and Two-Minute Step Test (2MST) [22]—, all of which have demonstrated clinical validity. These tests allow for the objective estimation of strength, speed, balance, and muscular endurance—that is, functional performance—core dimensions underlying functional autonomy [23, 24]. In addition to objective physical assessments, the perception of health represents a fundamental complementary component of healthy ageing [25, 26]. This construct can be evaluated using validated and easily administered instruments such as the 36-Item Short Form Health Survey (SF-36), which comprises eight dimensions grouped into two components: the Physical Component Summary (PCS) and the Mental Component Summary (MCS) [27, 28]. Recent evidence has suggested potential associations between functional tests and SF-36 components. For instance, Alegría-Molina et al. examined the relationships between HGS, TUG, and the 30 s Sit-to-Stand Test with PCS and MCS in adults and older adults. Their findings revealed small to moderate significant correlations in adults between HGS and TUG with both PCS and MCS; whereas in older adults, small significant associations were limited to HGS, TUG, and the 30 s Sit-to-Stand Test with MCS [29]. Collectively, these findings suggest that linking functional performance with self-perceived health may provide a more comprehensive representation of functionality from an integrative perspective [30, 31].

Despite these promising findings, the relationship between SF-36 scores and functional performance in older adults—particularly in older women—remains insufficiently explored. Identifying significant associations between functional performance tests and self-perceived health would provide a robust empirical basis for the development of an integrated and weighted functional performance index. Expressed as a single composite score, such an index would synthesize functional capacity and perceived health status into an integrated value, offering a practical and more sensitive assessment tool for older women [32]. Therefore, the aims of this study were (a) to examine the association between widely used functional performance tests and self-perceived health status, and (b) to develop an Integrated Functional Performance Index (IFPI) for community-dwelling older women.

Methods

Participants

A total of two hundred and seventeen community-dwelling older women from the Metropolitan Region of Santiago, Chile, were recruited to participate in this study (age, 70.98 ± 6.07 years; height, 153.53 ± 6.15 cm; body mass, 69.04 ± 12.72 kg; body mass index, 29.28 ± 4.94 kg·m^2). The recruitment of older women was conducted through advertisements and informational meetings. Data were collected between September 2024 and July 2025. The sample was considered relatively homogeneous according to conventional coefficients of variation thresholds: age (8.55%) and height (4.03%) showed low variability, whereas body mass (18.42%) and body mass index (16.90%) showed moderate variability. The following inclusion criteria were applied: (i) age between 60 and 80 years; (ii) non-smoker; (iii) self-reported independence in activities of daily living; and (iv) medical examination and clearance for participation. The exclusion criteria were: (i) mobility limitations; (ii) acute or chronic disease preventing participation; and (iii) abnormal electrocardiogram findings. All participants provided written informed consent. The study was approved by the Ethical-Scientific Committee of Santiago de Chile University, Santiago, Región Metropolitana, Chile (Ethics Approval No.: 570–2024), and was conducted in accordance with the ethical principles of the Declaration of Helsinki and the Ethical Standards for Exercise and Sport Science [33].

Sample Size

The sample size was calculated using G*Power software (version 3.1.9.6) [34], assuming a bivariate normal correlation model and an a priori power analysis. A two-tailed test was selected with an expected correlation under the alternative hypothesis (ρ_1) of r = 0.23, estimated from preliminary analyses, corresponding to a small effect size close to the moderate-range according to Cohen's classification [35]. The significance level was set at $\alpha = 0.01$, adjusted using the Bonferroni correction to account for multiple correlations, and statistical power was defined as 80% ($1 - \beta = 0.80$). Under these parameters, a minimum sample size of 216 participants was required to detect a statistically significant correlation with the specified power and significance level.

Study design

A non-experimental, cross-sectional correlational study with a quantitative approach was conducted to examine the association between functional performance and perceived health, and to develop an IFPI, following the Strengthening the Reporting of Observational Studies in Epidemiology (STROBE) guidelines to ensure transparent and complete reporting of methods and results [36]. Following a familiarization session, the validated health status survey and functional assessments were administered on the same day in a standardized sequence to minimize potential sources of measurement and procedural bias, with at least 15 minutes between protocols to mitigate fatigue and potential carryover effects. All assessments were conducted in a controlled environment (18–24°C), with adequate ventilation and age-appropriate ergonomic conditions, and were administered by trained professionals experienced in evaluating and training older adults.

Instruments

36-Item Short Form Health Survey (SF-36)

The SF-36 questionnaire is designed to assess health-related quality of life and has been extensively validated for use in both research and clinical practice [28]. It consists of 36 items encompassing eight core dimensions: physical functioning, role physical, bodily pain, general health, vitality, social functioning, role emotional, and mental health. Each dimension is scored on a 0–100 scale, with higher scores indicating better perceived health status [27]. A key feature of the SF-36 is the transformation of the eight-dimension scores into two standardized summary measures through a statistical procedure combining factor analysis and norm-based scoring [28]. This procedure yields the Physical Component Summary (PCS), primarily derived from the physical functioning, role physical, bodily pain, and general health scales, and the Mental Component Summary (MCS), composed of the vitality, social functioning, role emotional, and mental health scales [27].

Five-Times Sit-to-Stand test (5STS)

The 5STS assesses lower-limb strength and functional performance. Participants rose from and returned to a seated position five consecutive times as quickly as possible from a standardized 46-cm-high chair, with feet flat on the floor and arms crossed over the chest. Time recording (Polar® Electro Oy V800, Finland) began at the start signal and ended after the fifth repetition [37]. Only one attempt was performed, and time was recorded in seconds (s).

Six-Meter Walking Test (6WS)

The 6WS assesses gait speed as a marker of functional status [38]. A 6-m walking distance was measured using an odometer (Bosch GWM 32, Germany), with cones marking the start and finish points. Participants were instructed to walk as fast as possible, and the time required to complete the distance was recorded using a digital timer (Polar® V800, Polar Electro Oy, Finland). Gait speed was calculated as distance divided by time and expressed in meters per second ($m \cdot s^{-1}$) [39, 40], with only one trial performed.

Timed Up and Go (TUG)

The TUG test assesses dynamic balance and functional mobility [41]. Participants started seated on a standardized 46-cm-high chair with feet flat on the floor. At the start signal, they stood up, walked 3 m to a reference cone, turned 180°, returned to the chair, and sat down again. The 3-m distance was measured using an odometer (Bosch GWM 32, Germany), with cones used as reference markers. Timing began when the participant stood up and ended upon returning to the seated position [42], and was recorded in seconds (s) using a digital timer (Polar® V800, Polar Electro Oy, Finland), with only one trial performed.

Handgrip Strength (HGS)

Upper-limb strength was assessed using HGS test. Participants were seated with the elbow flexed at 90° and the forearm in a neutral position and performed a 5 s maximal isometric contraction upon the start signal [43], measured with a hand dynamometer (FEI 12–0240 Standard, USA). Two trials were conducted with each hand, separated by 3 min of passive rest (Polar® V800, Polar Electro Oy, Finland), and the average value of both hands was calculated to provide a more comprehensive representation of upper-limb strength and to reduce the influence of lateral dominance on the final outcome [44].

Two-Minute Step Test (2MST)

The 2MST was used to assess aerobic endurance. Participants performed as many full steps as possible in 2 min, raising each knee to the point midway between patella and iliac crest, following the standardized protocol described by Rikli & Jones [45], with the number of steps recorded using a pedometer (Yamax SW-200, Japan), and a single trial performed.

Construction of the Integrated Functional Performance Index (IFPI)

To combine the functional performance tests, the different measurement units (time, speed, strength, and steps) were normalized to a common 0–100 scale. This procedure allowed the standardization of results and ensured that all tests contributed equally to the calculation of the IFPI.

Normalization score calculation

Each functional performance test was normalized using a min–max scaling approach based on the minimum (MIN) and maximum (MAX) performance values observed in the present study. This procedure converted test outcomes to a common 0–100 scale, ensuring that all functional measures contributed uniformly to the final score. Scaling variables to a standardized range improves comparability and prevents variables with larger numerical magnitudes from disproportionately influencing the results [46–48]. Normalization equations were adapted according to the direction of performance interpretation. For tests in which higher values indicated better performance (e.g., 6WS, HGS, and 2MST), normalized scores increased proportionally with the observed values. Conversely, for tests in which lower values indicated better performance (e.g., 5STS and TUG), the normalization procedure incorporated an inversion of the scale so that lower observed values corresponded to higher normalized scores. The specific normalization procedures applied to each functional performance test are detailed below:

Equation 1. Normalized score for 5STS (s)

$$\text{Normalized score_5STS} = \left(\frac{(\text{MAX}-\text{value_5STS})}{(\text{MAX}-\text{MIN})}\right) \cdot 100$$

Equation 2. Normalized score for 6WS (m·s⁻¹)

$$\text{Normalized score_6WS} = \left(\frac{(\text{value_6WS}-\text{MIN})}{(\text{MAX}-\text{MIN})}\right) \cdot 100$$

Equation 3. Normalized score for TUG (s)

$$\text{Normalized score_TUG} = \left(\frac{(\text{MAX} - \text{value_TUG})}{(\text{MAX} - \text{MIN})} \right) \cdot 100$$

Equation 4. Normalized score for HGS (kg)

$$\text{Normalized score_HGS} = \left(\frac{(\text{value_HGS} - \text{MIN})}{(\text{MAX} - \text{MIN})} \right) \cdot 100$$

Equation 5. Normalized score for 2MST (steps)

$$\text{Normalized score_2MST} = \left(\frac{(\text{value_2MST} - \text{MIN})}{(\text{MAX} - \text{MIN})} \right) \cdot 100$$

Weighting of functional performance tests

To determine the relative relevance (weight) of each functional performance test, absolute correlation coefficients between each functional performance test and the two components of the SF-36 (i.e., PCS and MCS) were calculated. Absolute values were used to reflect the strength of the association regardless of its direction. The weighting strategy was defined a priori to avoid post-hoc analytical decisions. To ensure conceptual coherence, robustness, and construct validity of the index, the weighting procedure was based on the SF-36 component(s) showing statistically significant correlations with the functional performance tests assessed in this study (5STS, 6WS, TUG, HGS, and 2MST). If all functional performance tests demonstrated significant correlations with both the PCS and the MCS, correlations with both components were retained for weighting. If significant correlations were consistently observed with only one component (either PCS or MCS), only that component was included in the weighting procedure. Conversely, if statistically significant correlations were not observed across all five functional performance tests, those tests that showing statistically significant associations with one or both SF-36 components were incorporated into the weighting scheme. The total weighted score was subsequently calculated by multiplying each selected correlation coefficient by the corresponding Normalized Score (NS) of each functional performance test. This procedure enabled the estimation of the relative contribution of each test to the IFPI, as expressed in the following equation:

Equation 6. Integrated Functional Performance Index (IFPI)

$$\textit{IFPI} = \sum_i |\mathrm{r}i| \cdot \mathrm{NS}i$$

Legend/Notes:

- $|\mathrm{r}i|$ is the absolute correlation coefficient between PCS and/or MCS and functional performance test i (5STS, 6WS, TUG, HGS, and 2MST, respectively).
- $\mathrm{NS}i$ is the normalized score of functional performance test i (5STS, 6WS, TUG, HGS, and 2MST, respectively).

This approach grounds the IFPI on the health perception dimension(s) that most consistently and comprehensively reflect the overall functional performance of older women.

Statistical analysis

Normality was assessed using the Kolmogorov–Smirnov test, as that the paired samples exceeded 50 observations. A normal distribution was assumed when $p > 0.05$. Given the presence of both parametric and non-parametric variables, descriptive statistics are reported as mean, median, standard deviation, minimum and maximum values, and interquartile range (IQR), as appropriate. To examine the association between health perception, assessed using the SF-36, and functional performance, Pearson's correlation coefficient (r) was used when normally assumptions were met; otherwise, Spearman's rank correlation coefficient (ρ) was applied [49, 50]. Specifically, correlations were examined between the PCS

and MCS scores and the following functional performance tests: 5STS, 6WS, TUG, HGS, and 2MST. Ninety-five percent confidence intervals (95% CI) were calculated for correlation coefficients. Percentiles are reported for the IFPI scores. Statistical significance was set at $p < 0.05$. The magnitude of correlation coefficients was interpreted as small ($r/\rho < 0.30$), moderate ($r/\rho \geq 0.30$ and < 0.50), or large ($r/\rho \geq 0.50$), according to Cohen [35]. The magnitude and direction of these associations were used to determine the extent to which functional performance tests explained variability in SF-36 components. All statistical analyses were performed using Jamovi for macOS (The jamovi project (2024). *jamovi* (Version 2.5) [Computer Software]. Retrieved from https://www.jamovi.org; accessed on: 24 March 2024). Figures were generated using GraphPad Prism (version 8.0.1; GraphPad Software, San Diego, CA, USA).

Results

The SF-36 component scores and the results of the five functional performance tests in older women are presented in Table 1.

Table 1
SF-36 components scores and functional performance in Older Women

PCS (score)	Mean	Median	SD	Min	Max	IQR	KS p-value
	43.70	**44.37**	**8.27**	**17.84**	**64.50**	**39.46–48.40**	**0.367**
MCS (score)	50.70	51.73	10.65	23.32	72.46	44.08–59.05	0.150
5STS (s)	11.89	11.30	4.46	3.62	28.12	9.06–13.50	0.002
6WS ($m \cdot s^{-1}$)	1.19	1.20	0.32	0.40	1.94	0.95–1.44	0.145
TUG (s)	8.50	8.00	2.31	5.10	20.21	6.83–9.87	0.013
HGS (kg)	19.23	19.35	5.13	8.00	33.20	15.35–22.75	0.796
2MST (steps)	88.50	84.00	27.07	27.00	164.00	70.00–105.00	0.047

SF-36: Short Form-36 Health Survey; SD standard deviation; IQR: interquartile range (25th–75th percentile); Min: minimum; Max: Maximum; KS p-value: p-value of the Kolmogorov–Smirnov normality test; PCS: Physical Component Summary (derived from the physical functioning, role physical, bodily pain, and general health scales); MCS: Mental Component Summary (derived from the vitality, social functioning, role emotional, and mental health scales); 5STS: Five-Times Sit-to-Stand Test; s: seconds; 6WS: Six-Meter Walking Speed Test; $m \cdot s^{-1}$: meters per seconds; TUG: Timed Up and Go test; HGS: Handgrip Strength; kg: kilograms; 2MST: Two-Minute Step Test.

Insert Table 1 near here

PCS was significantly associated with all functional performance tests, showing small correlations with the 5STS ($\rho = -0.25$, $p < 0.001$), 6WS ($r = 0.26$, $p < 0.001$), TUG ($\rho = -0.25$, $p < 0.001$), and HGS ($r = 0.19$, $p < 0.01$), and a moderate correlation with the 2MST ($\rho = 0.36$, $p < 0.001$) (Fig. 1). In contrast, MCS showed generally weaker associations, presenting small correlations with the 5STS ($\rho = -0.25$, $p < 0.001$) and 2MST ($\rho = 0.26$, $p < 0.001$), a smaller correlation with 6WS ($r = 0.15$, $p < 0.05$), and no significant correlations with TUG ($\rho = -0.13$, $p > 0.05$) or HGS ($r = 0.05$, $p > 0.05$) (Fig. 2).

Integrated Functional Performance Index

The normalization equations for each functional performance test, derived from the observed performance data, are presented below.

Equation 1. Normalized score for 5STS (s)

Normalized score_5STS = $\left(\frac{(28.12-\text{value_5STS})}{(28.12-3.62)}\right) \cdot 100$

Equation 2. Normalized score for 6WS (m·s⁻¹)

Normalized score_6WS = $\left(\frac{(\text{value_6WS}-0.40)}{(1.94-0.40)}\right) \cdot 100$

Equation 3. Normalized score for TUG (s)

Normalized score_TUG = $\left(\frac{(20.21-\text{value_TUG})}{(20.21-5.10)}\right) \cdot 100$

Equation 4. Normalized score for HGS (kg)

Normalized score_HGS = $\left(\frac{(\text{value_HGS}-8.00)}{(33.20-8.00)}\right) \cdot 100$

Equation 5. Normalized score for 2MST (steps)

Normalized score_2MST = $\left(\frac{(\text{value_2MST}-27)}{(164-27)}\right) \cdot 100$

Since only the PCS showed significant correlations with all functional performance tests (absolute correlation coefficients: 5STS = 0.25, $p < 0.001$; 6WS = 0.26, $p < 0.001$; TUG = 0.25, $p < 0.001$; HGS = 0.19, $p < 0.01$; and 2MST = 0.36, $p < 0.001$), the IFPI was constructed using these correlations as weighting factors, combined with the Normalized Scores (NS) of each test:

Equation 6. Integrated Functional Performance Index (IFPI)

IFPI = (0.25 · NS_5STS) + (0.26 · NS_6WS) + (0.25 · NS_TUG) + (0.19 · NS_HGS) + (0.36 · NS_2MST)

Legend/Note: NS = normalized score of each functional performance test

The IFPI scores calculated for the total sample of the present study using the equation were 73.96 ± 18.43 arbitrary units (a.u.), with values ranging from 13.91 to 113.39. Table 2 presents reference values for age subgroups based on percentile distribution.

Table 2
Reference values of the Integrated Functional Performance Index (IFPI) according to age subgroups and percentile distribution

Subgroups		Percentiles										
	N	5th	10th	20th	30th	40th	50th	60th	70th	80th	90th	95th
60–64 years	34	55.47	63.89	73.69	75.25	80.74	84.89	89.44	92.55	95.92	100.89	102.33
65–69 years	62	51.96	54.71	63.64	67.12	74.45	78.92	84.70	87.46	92.04	95.59	103.00
70–74 years	50	32.28	43.37	56.39	60.38	67.15	71.67	74.28	80.79	87.71	93.79	96.74
75–80 years	71	36.52	45.92	56.36	60.01	63.20	67.41	74.15	83.93	86.37	92.46	93.59
N = number of older women per age subgroup. Percentiles range from the 5th to the 95th. IFPI scores are expressed in arbitrary units (a.u.).												

Insert Table 2 near here

Insert Fig. 1 near here

Insert Fig. 2 near here

Discussion

The main finding is that PCS was significantly associated, with small to moderate magnitude, with all functional performance tests, supporting its use as a global indicator of perceived physical health in older women. This finding is consistent with previous evidence linking PCS to functional capacity, dependency risk, and frailty in aging populations [51–53]. In contrast, MCS showed only partial associations, consistent with reports indicating that mental health in older adults is more strongly influenced by psychosocial factors than by physical performance [54, 55]. Based on these results, the IFPI was derived from normalized functional tests weighted according to their association with PCS and expressed as a continuous functional performance score. Although the correlations were small to moderate ($r/\rho = 0.19–0.36$), this pattern is consistent with the multifactorial nature of self-perceived health in older adults. Accordingly, the convergence of significant associations across multiple functional tests supports the construction of a multidimensional weighted index rather than reliance on a single performance indicator.

SF-36

Overall, participants reported potentially lower self-perceived physical health than mental health, reflecting distinct patterns in the appraisal of physical and mental health dimensions. This pattern is consistent with evidence showing greater physical decline in older Chilean women and a relatively preserved mental component [56, 57]. In this context, the PCS of the SF-36 showed consistent correlations with all functional performance tests. This supports its validity as an integrative indicator of perceived physical health in older women. The strength of these associations exceeded the partial relationships reported in previous studies [29, 58]. This difference is likely explained by the larger and more homogeneous sample. In contrast, MCS showed limited correlations, restricted to 5STS, 2MST, and 6WS. This pattern reflects a stronger dependence on psychosocial factors rather than physical performance [54–56]. These findings support the exclusive use of PCS in the construction of the IFPI.

5STS

The mean performance time on the 5STS assessment in the present study was close to the clinical cut-off of 11.64 s, which indicates reduced strength in older women [59], and above the < 8 s threshold associated with good functional performance and a lower risk of falls [60]. Overall, these findings place the sample within an intermediate range of functional capacity, while also indicating the presence of a subgroup with increased vulnerability. The 5STS was significantly correlated with PCS. This supports its use as an indicator of lower-limb strength and endurance in older women, in agreement with Vilarinho et al. [61] and Porto et al. [59]. The stronger consistency observed compared with previous heterogeneous studies is likely related to the sample homogeneity and size (n = 217). These characteristics reduce the influence of external factors and increase statistical power. From a neuromuscular standpoint, the 5STS primarily reflects the strength of the hip and knee extensors [62, 63]. These muscle groups are particularly susceptible to sarcopenia [64–66]. The test also incorporates elements of power and coordination [67]. This may explain its association with perceived physical health and limitations in activities of daily living [37]. Its inclusion in the IFPI complements other functional tests, ensuring that the index captures both mobility and the ability to perform basic tasks, thereby supporting its clinical validity.

6WS

Within the present sample, mean walking speed clearly exceeded the clinical threshold of 0.8 $m \cdot s^{-1}$ associated with functional independence and lower frailty risk [68–70]. This finding indicates good overall functional mobility in the sample, although the observed variability suggests the presence of subgroups with potential vulnerability. The 6WS was significantly correlated with PCS, confirming that perceived physical health is reflected in objective mobility. This result is consistent with findings by Studenski et al. [71], who validated gait speed as a predictor of disability and mortality, and contrasts with reports from smaller and more heterogeneous regional studies across several functional tests [29]. From a physiological perspective, gait integrates strength, coordination, balance which explains its close association with health perception and its strong clinical relevance [72], particularly given that even a reduction of 0.1 $m \cdot s^{-1}$ has been associated with increased mortality risk [71, 73, 74]. Its inclusion in the IFPI enhances the sensitivity of the index by complementing strength and balance tests, consolidating gait speed as one of its most robust components for geriatric assessment.

TUG

The results for functional transitions in the current study indicate that mean TUG time falls within ranges compatible with functional independence (< 10 s) and is clearly below the 13.5 s threshold proposed as a predictor of frailty in the Chilean population [75, 76]. These indicate that most participants maintained good mobility and functional balance, although the observed variability reflects individual differences within the sample. TUG showed a significant correlation with PCS, confirming that perceived physical health integrates mobility and dynamic balance. This finding is consistent with classical studies that validated the test as a functional indicator [42] and reinforces recent national evidence [76]. Although systematic reviews and meta-analyses have reported relatively low sensitivity for fall prediction [77, 78], the homogeneity of the sample—community-dwelling, independent women without severe functional impairment—allowed TUG to reflect everyday mobility more directly. From a physiological perspective, TUG assesses lower-limb strength, dynamic balance, and neuromotor coordination, which explains its association with PCS [29]. However, this finding should be interpreted with caution considering recent local evidence. Ugarte & Vargas [76] have pointed out that TUG may exhibit limited associative value regarding global functional status and clinical conditions in certain cohorts of Chilean older adults. This discrepancy reinforces the need for integrated indices like the IFPI, rather than isolated tests, to capture the complexity of functional health. Its inclusion in the IFPI captures dimensions of complex mobility and balance that are not fully reflected by linear tests, thereby increasing the sensitivity of the index to more demanding tasks [79]. In this way, TUG strengthens the ecological validity of the IFPI, making it more representative of functional performance in daily living among older adults.

HGS

Regarding upper-limb strength in the study cohort, the average HGS performance exceeded the clinical cut-off associated with frailty and sarcopenia in older women (< 16 kg) [80–82]. Overall, the sample falls within an acceptable functional range, although the observed interindividual variability indicates the presence of cases close to clinical vulnerability. HGS showed a significant correlation with PCS, in line with evidence identifying it as a functional marker of global health and a predictor of mortality [83, 84]. Low values have been associated with increased risk of hospitalization and functional dependence [85, 86], reinforcing its role as a transversal indicator of physiological reserve [87, 88]. Nevertheless, the magnitude of the association with PCS was lower than that observed for other functional tests, consistent with previous reports [89, 90]. This likely reflects the fact that HG primarily assesses static force of the hand and forearm flexors [91] and could estimate dynamic dimensions such as balance, speed, or endurance [92]. When integrated into the IFPI, however, HGS contributes within a multidimensional construct rather than as an isolated marker, enhancing its clinical value in the global assessment of functional capacity, as supported by its association with PCS.

2MST

Aerobic endurance assessed by the 2MST in the current sample exceeds the < 60-step cut-off indicative of low functional capacity [45]. Overall, the sample demonstrated an adequate level of effort tolerance related to aerobic capacity, although

marked interindividual variability was observed. In addition, the 2MST showed the strongest correlation with PCS, supporting its sensitivity as a predictor of perceived health in older women, in line with Poncumhak et al. [93]. Although the literature often highlights strength and gait speed as more consistent predictors [71, 85], the 2MST showed a relatively stronger association in this study. This may be explained by its ability to capture cardiorespiratory dimensions that are not fully reflected by other functional tests. Its inclusion in the IFPI incorporates both effort tolerance and endurance capacity, thereby enhancing the sensitivity of the index to discriminate performance levels and identify risk of functional decline.

IFPI

The correlations observed between PCS and the five functional performance tests were of small to moderate magnitude but consistent across all measures. Although no single test fully explains perceived physical health, their integration allows the identification of a stable pattern of association with objective functional performance. Unlike previous studies that examined these relationships in a fragmented manner [29, 89, 90], the present approach provides a more integrative perspective, which supported the construction of the IFPI on a coherent empirical basis. From a conceptual standpoint, integrating small- to moderate-magnitude correlations into a weighted index prevents any single test from dominating the assessment and enables the synthesis of complementary dimensions, including static strength, lower-limb functional strength, mobility, dynamic balance, and effort tolerance related to endurance capacity. Compared with established indices such as the SPPB [71], the GDLAM protocol [94], the Fried frailty phenotype [11], or the Searle deficit index [95], the IFPI combines subjective perception (PCS) with objective measures (functional performance tests) in a continuous score. This approach is sensitive to subtle variations in functional performance and is representative of the functional demands of daily living. The consistency of the findings supports the IFPI as a tool that integrates objective functional performance with perceived physical health, distinguishing it from existing approaches by providing a continuous, practical, and context-sensitive measure.

Practical Applications

The IFPI provides a continuous, weighted measure of functional performance that integrates objective functional tests with physical health perception, allowing a more comprehensive characterization of functional status in community-dwelling older women. It's simple and practical tool [17] facilitates the identification of subtle differences in functional performance that may not be captured by categorical classifications, supporting individualized monitoring and follow-up in both clinical and community-based settings [32, 71]. The IFPI may also serve for tracking global functional changes over time and for evaluating the effects of exercise or rehabilitation programs from a more multidimensional perspective, particularly when small but clinically meaningful improvements are expected. Importantly, the IFPI is not intended to replace established geriatric assessment batteries or widely used functional screening tools [45, 94], but rather to complement them by providing an integrated, continuous, and easily interpretable index of functional performance related to physical health perception. To the best of our knowledge, no existing index incorporates the perception of physical health into its weighting scheme derived empirically from its association with the PCS, which constitutes a novel strength of the present proposal. Its simplicity of application and reliance on commonly used functional tests support its potential application in primary care, community programs, and research settings with limited material and human resources.

Limitations and Future research

Further validation of the IFPI in diverse populations and longitudinal designs is warranted to assess its predictive value and responsiveness to intervention. Reference curves may enable global functional classification and frailty risk cut-offs in older [71, 85], while comparisons or associations with established indices will clarify its relative strengths [11, 71, 94, 95]. Because normalization of the functional performance tests was based on the minimum and maximum values observed in the present sample, IFPI values should be interpreted within the context of this specific population (i.e., older women). In this sense, limitations such as the lack of age-group stratification, the absence of adjustments for body composition, and the lack of inclusion of men in the sample should be acknowledged, while also highlighting directions for future research addressing these aspects. Accordingly, direct comparisons of absolute IFPI values across different samples or studies

should be made with caution until external reference values or normative ranges are established. Nevertheless, despite limitations related to design, sample selection, and the use of self-report measures [27, 57, 96], the large sample—relatively homogeneous in terms of its descriptive characteristics (coefficient of variation of age, height, body mass and body mass index < 19 %)—and the development of a wighted, continuous, multidimensional index support the IFPI as a robust tool for clinical and community use.

Conclusions

In conclusion, PCS was consistently associated with objective functional performance in older women, whereas associations with mental health MCS were limited. Based on this evidence, the IFPI was developed as an integrative index that combines objective functional performance with perceived physical health into a single, continuous measure. By capturing strength, mobility, balance, and endurance alongside personal health perception, the IFPI provides a comprehensive representation of functional status with clear applicability for exercise prescription and individualized monitoring of healthy aging. Despite the need for further validation, the IFPI represents a practical and feasible alternative to traditional geriatric assessment batteries.

Abbreviations

2MST
Two-Minute Step Test
5STS
Five-Times Sit-to-Stand Test
6WS
Six-Meter Walking Test
BMI
Body Mass Index
HGS
Handgrip Strength
IFPI
Integrated Functional Performance Index
MCS
Mental Component Summary
NS
Normalized Score
PCS
Physical Component Summary
SF-36
Short-Form 36 Health Survey
STROBE
Strengthening the Reporting of Observational Studies in Epidemiology
TUG
Timed Up and Go

Declarations

Ethics approval and consent to participate

This study was approved by the Ethical-Scientific Committee of Santiago de Chile University, Santiago, Región Metropolitana, Chile (Ethics Approval No.: 570-2024). All participants provided written informed consent

Consent for publication

Not applicable.

Availability of data and materials

The datasets used and/or analyzed during the current study are available from the corresponding author on reasonable request.

Competing interests

The authors declare that they have no competing interests.

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Authors´ Contributions

Methodologic conception and study design, EJ-S; project administration, EJ-S; data collection EJ-S, RCP, DEM, and RNMI; statistical analysis, RRF; data interpretation, EJ-S and RRF; writing- original draft preparation, EJ-S and RRF; writing- review and editing, EJ-S, RRF, AV-G, AHO, CF-V, RGO, RCP, DEM, RNMI, CJ-A, and AALL. All authors have read, edited, and contributed to the final version of the manuscript.

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Figures

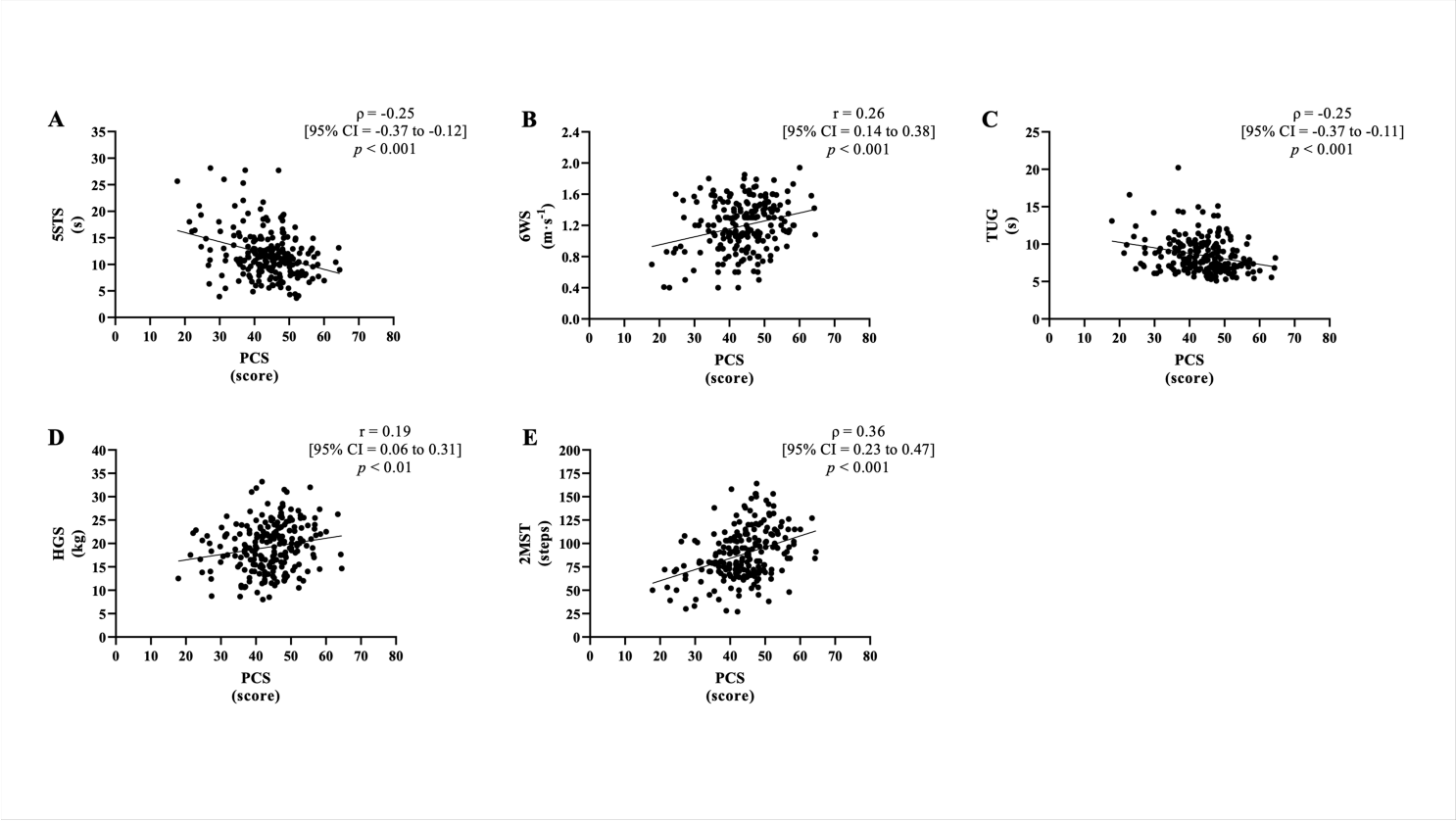


Figure 1

Correlations between the SF-36 Physical Component Summary (PCS) and the Five-Times Sit-to-Stand (5STS) [A], Six-Meter Walking Test (6WS) [B], Timed Up and Go (TUG) [C], Handgrip Strength (HGS) [D], and Two-Minute Step Test (2MST) [E], respectively.

r: Pearson's correlation coefficient; ρ: Spearman's rank correlation coefficient; 95% CI: 95% confidence interval.

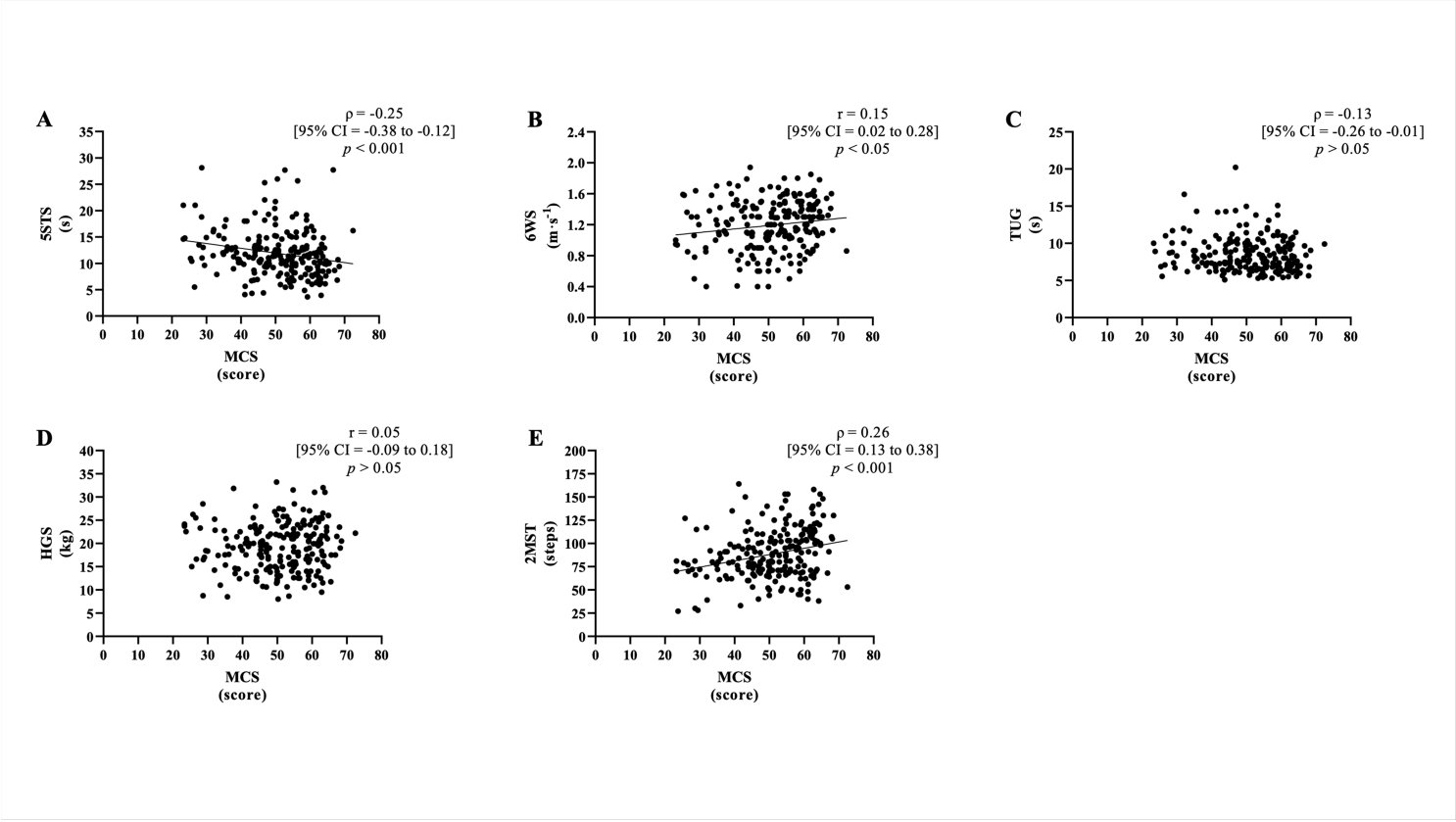


Figure 2

Correlations between the SF-36 Mental Component Summary (MCS) and the Five-Times Sit-to-Stand (5STS) [A], Six-Meter Walking Test (6WS) [B], Timed Up and Go (TUG) [C], Handgrip Strength (HGS) [D], and Two-Minute Step Test (2MST) [E], respectively.

r: Pearson's correlation coefficient; ρ: Spearman's rank correlation coefficient; 95% CI: 95% confidence interval.