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Accuracy of Self-Reported Physical Capacities as a Clinical Screening Test for Older Adults With Mobility Disability

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Abstract

Background: Screening for poor physical performance has the potential to identify older adults at risk for loss of future independence, yet clinically feasible measures have yet to be identified. **Methods:** Using data from the National Health and Aging Trends Study, we evaluated the diagnostic utility of self-reported physical capacities of older adults (walking three blocks or six blocks, climbing 10 stairs or 20 stairs) compared to the objectively measured Short Physical Performance Battery (SPPB). Sensitivity, specificity, and likelihood ratio (LR) were calculated across three SPPB cut-points (≤8, ≤9, ≤10). **Results:** Sensitivity of single item-measures for detecting a low SBBP averaged 0.39 (range: 0.26–0.52), specific averaged 0.97 (range: 0.94–0.99) and likelihood ratio averaged 20.0 (range: 9.0–35.5). Among age and gender subgroups, all measures maintained clinically applicable LRs (minimum = 4.59). **Conclusion:** Single-item self-reported physical capacities are accurate for screening older adults with physical limitations, making them potentially useful in healthcare settings.

Keywords
physical performance, self-report, diagnostic screening

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What this paper adds? Please provide up to three bullet points on what the paper adds to existing literature. Applications of study findings

Point 1. This is the first study to compare the accuracy of self-report of physical limitations with a gold-standard measure of physical performance, the Short Physical Performance Battery.

Point 2. This study shows that simple single-item questions, which could be easily integrated into clinical settings, can be used to detect older adults with impaired mobility, who are at risk of future disability, morbidity and mortality.

Please provide up to three bullet points on the applications of study findings to gerontological practice, policy and/or research

Point 1. Gerontologists can use these findings to support the utility of screening for mobility disability in clinical settings using single-item self-report measures, which can be easily integrated into the process of rooming patients.

Point 2. This study serves to identity which self-report questions may be most useful for conducting

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future studies that test the impact of screening for mobility disability in clinical settings, to identify those that need to be treated (e.g., Physical Therapy).

Background

The Census Bureau projects that the number of US adults 65 and older will increase from 43.1 million to 83.7 million by 2050 (Ortman et al., 2014). Age-related functional decline (the gradual loss of independent activity of daily living performance) increases the need for assistance for older adults through physical and caregiving supports (Lunney et al., 2003; Stenholm et al., 2014). Functional decline is described as the gradual failure to independently perform activities of daily living such as eating, dressing, maintaining hygiene, and mobility (Bravell et al., 2011). Reducing the rate of functional decline among older adults is essential for successful population aging and reducing burdens on the healthcare and long-term care systems (Anton et al., 2015; Dall et al., 2013; Ortman et al., 2014).

Early detection of functional decline has the potential to enable healthcare providers to implement physical therapy and physical activity interventions, which can significantly improve functional declines and reduce the incidence of future declines (Pahor et al., 2014). The Short Physical Performance Battery (SPPB) test has emerged as the gold-standard measure of lower extremity performance, due to its reliability and ability to strongly predict future mobility disability, nursing home entry, and mortality (Chang et al., 2004; Guralnik et al., 1994; Marengoni et al., 2009; Ostir et al., 2002). The large-scale Lifestyle Interventions and Independence for Elders (LIFE) study utilized the SPPB as an inclusion criteria, given its accuracy and the intervention's goal of reducing future major mobility disability (Pahor et al., 2014). Screening for lower extremity function holds great promise for early intervention, as mobility disability is typically the first disability to emerge, before disabilities in the upper extremities (e.g., dressing, bathing)(Stineman et al., 2014).

The SPPB, however, requires training and approximately 10 min to administer, which are significant potential barriers for its use in typical primary care settings, given the median duration of a typical visit in family practice for older adults is <20 min (Hu & Reuben, 2002; Tai-Seale et al., 2007). Researchers have investigated more feasible options for measuring functional status, such as walking speed (Middleton et al., 2015; Studenski et al., 2011), but similar concerns over training and time for such a measure remain. Training each medical assistant or licensed practical nurse, who room the majority of patients in the US, would present a major barrier to widespread screening in care settings. Therefore, more pragmatic alternatives to measure patient functional status in primary care settings are worth considering.

The purpose of this study is to investigate the potential utility of using self-reported walking ability as a screening tool to identify patients at risk of future mobility disability. The current study measures the sensitivity, specificity and predictive value of self-reported walking difficulty for identifying individuals with poor lower extremity physical performance, as measured by the SPPB. If a brief self-report measure could accurately identify individuals at risk for functional decline, its simplicity and low use of resources make it an attractive for screening older adults for mobility disability in primary care settings.

Methods

Data Source

The National Health and Aging Trends Study (NHATS) is a nationally representative study of adults 65 years of age or older in the United States (Freedman & Kasper, 2019). Details of the study design and the collected data are publicly available (https://www.nhatsdata.org) and are reported elsewhere (Freedman & Kasper, 2019). The current analysis includes study participants from the 2011 cohort with available measures of SPPB and self-reported mobility limitations, including those who lived at home as well as those who lived in assistive care facilities at the time of the study.

Measures

Demographic measures included self-reported and objectively-measured variables, previously shown to be associated with physical limitations (Freedman & Kasper, 2019). Age at interview was grouped by decade: 65 to 74, 75 to 84, and 75+. Race and ethnicity were grouped as White (non-Hispanic), Black (non-Hispanic), Hispanic, and Other, which included Asian and Pacific Islander. United States regions were categorized as Northeast, Midwest, South and West. Annual income was divided into four groups based on quartiles: ≤$12,999, $13,000 to $24,999, $25,000 to $49,999, ≥$50,000. Educational attainment was categorized into less than high school, high school diploma or equivalent (i.e., General Education Development Test), and college degree. Body mass index (BMI) was categorized as normal (≤24.9), overweight (25–29.9) and obese (≥30). SPPB scores were categorized as low (0–6), intermediate (7–9) and high (10–12). The number of reported chronic conditions were divided into four categories based on quartiles: 0 to 1, 2, 3, and 4 or more. Use of a mobility device (cane, walker, or wheelchair) over a 12-month period prior to the 2011 interview was based on self-report.

The Short Physical Performance Battery (SPPB) is a valid and reliable measure of lower extremity functional capacity (Guralnik et al., 1994). It includes three tests: balance test, five times sit to stand test, and walking speed over 3 m, each of which are scored from 0 to 4 (0 being poorest performance) then summed to a

composite score of 0 to 12. Detailed descriptions of the SPPB tests scoring have been previously described (Guralnik et al., 1994). Previous studies have used SPPB cut-points of ≤10 or ≤9 to identify those with limited mobility at risk of mobility disability (Pahor et al., 2014; Vasunilashorn et al., 2009), but a standardized threshold score has not been determined. To account for contrasting SPPB cut-points for defining reduced lower extremity performance in previous studies, a range of SPPB cut-points (≤10, ≤9, ≤8) was used in the current study to compare the clinical utility of self-report physical abilities across several thresholds.

Self-reported walking ability was assessed using four yes/no questions. Participants were asked "In the last month, were you able to (walk three blocks-3BL or walk up 10 stairs (10ST), or about half a mile by yourself (3BL)? [and without a cane or walker, if appropriate]." For those that could walk three blocks or 10 stairs, the question was repeated to assess the self-reported ability to walk six blocks (6BL) or up 20 stairs (20ST). Previous studies have used similar self-report physical limitations to accurately determine identify older adults with mobility disability (Chen et al., 2018; Kasper et al., 2017).

Data Analysis

An overview of participant demographics was quantified using descriptive statistics. Subjects with missing or inapplicable data (22.0% of participants) for the variables of interest were excluded from the analysis. Sensitivity, specificity, and positive likelihood ratio (LR) were calculated for each self-report physical capacity to evaluate their utility and accuracy in detecting physical limitations, using various SPPB thresholds as the comparative standard. Sensitivity, specificity, and LR were calculated using the standard formulas (McGee, 2002; Panzer et al., 2011) as seen below. Further, stratified analyses for age and gender were conducted to examine the accuracy of the self-report ability measures across key subgroups seen in clinical populations.

$$Sensitivity = \frac{TP}{(TP + FN)}\ Specificity = \frac{TN}{(TN + FP)}\ LR = \frac{Sensitivity}{(1 - Specificity)}$$

TP = True Positive; TN = True Negative; FP = False Positive; FN = False Negative

Results

The current analysis consists of6,433 participants from the NHATS 2011 cohort. Table 1 includes participant demographics, represented by group percentage. Most participants (51.9%) scored a low SPPB (≤6), while fewer scored an intermediate (7–9, 32.6%) or high (10–12, 20.1%) SPPB. Self-reported inability to walk three blocks (3BL) and walk six blocks (6BL) was 31.3% and 39.0%, respectively. Self-reported inability to walk 10 stairs (10ST) and walk 20 stairs (20ST was 23.3% and 32.4%, respectively. Sensitivities for each item (Table 2) ranged from 0.26 to 0.52 (mean = 0.39), specificity ranged from 0.94 to 0.99 (mean = 0.97) and LR ranged from 11.44 to 43.00 (mean = 20.2). The highest LR values were observed at highest SPPB threshold (≤10) and decreased with lower SPPB values.

Sensitivities, specificities and Likelihood Ratios among different age groups are reported in Table 3 and among men and women in Table 4. Wide ranges were observed; sensitivity ranged from 0.15 to 0.71, specificity ranged from 0.85 to 1.00 and LR ranged from 4.59 to 49.00. The highest LR values for the youngest age group (65–74) and oldest age group (85+) were observed among those with the highest SPPB threshold (≤10) and decreased with lower threshold values. No false positives were detected among the oldest age group at an SPPB threshold of ≤10, making several of the LRs in that subgroup incalculable. By contrast, among the middle age group of older adults (75–84), the highest LRs were observed at a threshold of ≤9.

Discussion

Our results demonstrate that four yes/no self-report questions measuring walking and stair climbing ability may be a clinically feasible and accurate way to quickly identify mobility limitations in older adults, making them possibly suitable for use in busy primary care practices and for future studies testing the clinical impact of screening. Assessing participants' self-rated ability to walk three blocks, walk six blocks, walk up 10 stairs, and walk up 20 stairs had high accuracy and clinical utility compared to an objective gold-standard measure of physical performance, the SPPB score. All LRs of the current analysis had diagnostic values (>1), across all SPPB thresholds, and the average LR across all four questions and 3 SPPB cut-points was quite high (>20). A LR greater than 1 signifies that a positive test result is associated with the "disease" of interest being present (i.e., a low SPPB) and values greater than 10 suggest a very high probability of a low SPPB being present (Panzer et al., 2011). Systematic reviews assessing self-report screening for depression, alcohol misuse, and dementia have observed LRs of 5.9, 4.5, and 4.8, respectively (Creavin et al., 2016; Levis et al., 2019; Toner et al., 2019), and have been implemented into primary care settings as screening interventions. Similarly, Toner and colleagues observed, in a systematic review of 135 studies, that self-reported alcohol screening questions had a 98% sensitivity and 78% specificity, yielding a LR of 4.5 (Toner et al., 2019). The results observed in the current study suggest that self-report, using just a single

Table 1. Characteristics of Participants.

Characteristics	Groups	*n*	Percent (%)
Age	65–74	2615	40.6
	75–84	2534	39.4
	85+	1284	20.0
Gender	Female	3727	57.9
	Male	2706	42.1
Race/ethnicity	White, non-hisp	4488	69.8
	Black, non-hisp	1348	21.0
	Hispanic	382	5.9
	Other race	215	3.3
Region	Northeast	1183	18.4
	Midwest	1481	23.0
	South	2528	39.3
	West	1241	19.3
Income	≤$12,999	3570	55.5
	$13,000–$24,999	841	13.1
	$25,000–$49,999	960	14.9
	$50,000+	1062	16.5
Education	< High school	1660	26.0
	High School Grad	1748	27.3
	College	2984	46.7
SPPB	Low (0–6)	3340	51.9
	Intermediate (7–9)	1908	29.7
	High (10–12)	1185	18.4
BMI	≤24.9	2281	36.5
	25–29.9	2321	37.1
	≥30	1655	26.5
Chronic conditions	0–1 conditions	1710	26.6
	2 conditions	1619	25.2
	3 conditions	1436	22.3
	4+ conditions	1668	25.9
Used mobility device	Yes	1813	28.2
	No	4618	71.8
Self-report	Unable to 3BL	2016	31.3
	Unable to 6BL	2512	39.0
	Unable to 10ST	1500	23.3
	Unable to 20ST	2084	32.4

Table 2. Sensitivity, Specificity, and Likelihood Ratio (LR) of Self-Reported Physical Capacity Compared to Various SPPB Thresholds.

		SPPB score threshold		
Physical capacity	Test	≤10	≤9	≤8
Unable to 3BL	Sensitivity	0.35	0.38	0.43
	Specificity	0.99	0.98	0.97
	Likelihood Ratio	24.71	19.00	13.71
Unable to 6BL	Sensitivity	0.43	0.47	0.52
	Specificity	0.97	0.96	0.94
	Likelihood Ratio	12.65	11.44	9.00
Unable to 10ST	Sensitivity	0.26	0.28	0.32
	Specificity	0.99	0.99	0.99
	Likelihood Ratio	43.00	35.50	24.62
Unable to 20ST	Sensitivity	0.36	0.39	0.44
	Specificity	0.98	0.98	0.96
	Likelihood Ratio	18.84	16.33	11.53

Note. 3BL = Walk 3 blocks (3BL); 6BL = walk 6 blocks; 10ST = walk up 10 stairs; 20 ST = walk up 20 stairs.

Table 3. Age Stratified Analysis for Sensitivity, Specificity, and Likelihood Ratio of Self-Reported Physical Capacity Compared to Various SPPB Thresholds.

		SPPB score threshold								
		Age 65–74			Age 75–84			Age: 85+		
Physical capacity	Test	≤10	≤9	≤8	≤10	≤9	≤8	≤10	≤9	≤8
Unable 3BL	Sensitivity	0.21	0.24	0.29	0.33	0.36	0.40	0.61	0.62	0.63
	Specificity	0.99	0.98	0.97	0.97	0.99	0.97	1.00	0.95	0.92
	Likelihood Ratio	18.64	11.43	9.97	11.93	27.54	13.69	[a]	12.10	7.41
Unable 6BL	Sensitivity	0.28	0.32	0.38	0.43	0.45	0.51	0.69	0.70	0.71
	Specificity	0.98	0.96	0.95	0.93	0.96	0.94	0.93	0.87	0.85
	Likelihood Ratio	12.00	8.45	7.66	6.14	11.15	8.16	10.25	5.45	4.59
Unable 10ST	Sensitivity	0.15	0.18	0.22	0.25	0.26	0.29	0.47	0.48	0.49
	Specificity	1.00	0.99	0.99	0.98	0.99	0.98	1.00	0.97	0.96
	Likelihood Ratio	49.00	29.17	24.00	11.71	26.40	18.38	[a]	18.31	11.57
Unable 20ST	Sensitivity	0.23	0.27	0.33	0.35	0.37	0.41	0.59	0.60	0.61
	Specificity	0.98	0.97	0.97	0.97	0.99	0.96	1.00	0.97	0.92
	Likelihood Ratio	13.53	9.57	9.56	12.43	28.62	10.25	[a]	23.15	7.21

Note. 3BL = Walk 3 blocks (3BL); 6BL = walk 6 blocks; 10ST = walk up 10 stairs; 20 ST = walk up 20 stairs.
[a]LR cannot be calculated due to 1.00. . . specificity within group observation.

Table 4. Gender Stratified Analysis for Sensitivity, Specificity, and Likelihood Ratio of Self-Reported Physical Capacity Compared to Various SPPB Thresholds.

		SPPB score threshold					
		Male			Female		
Physical capacity	Test	≤10	≤9	≤8	≤10	≤9	≤8
Unable to 3BL	Sensitivity	0.25	0.28	0.32	0.42	0.44	0.49
	Specificity	0.99	0.99	0.98	0.98	0.96	0.95
	Likelihood Ratio	41.00	35.00	18.00	16.60	12.31	10.59
Unable to 6BL	Sensitivity	0.32	0.37	0.42	0.50	0.54	0.58
	Specificity	0.98	0.97	0.96	0.95	0.94	0.92
	Likelihood Ratio	14.00	13.52	9.98	10.27	9.08	7.63
Unable to 10ST	Sensitivity	0.18	0.21	0.25	0.31	0.33	0.37
	Specificity	0.99	1.00	0.99	0.99	0.99	0.98
	Likelihood Ratio	30.67	52.50	35.14	38.63	25.46	19.26
Unable to 20ST	Sensitivity	0.26	0.29	0.35	0.42	0.45	0.49
	Specificity	0.99	0.99	0.98	0.97	0.96	0.94
	Likelihood Ratio	23.73	20.43	17.30	15.11	11.89	8.50

Note. 3BL = Walk 3 blocks (3BL); 6BL = walk 6 blocks; 10ST = walk up 10 stairs; 20 ST = walk up 20 stairs.

item, is even more accurate, with an average LR > 20 when used to screen for mobility limitations.

Specificity was consistently greater than sensitivity. Similar differences have been observed by other researchers comparing self-reported physical performance to objective measures in older adults. Sayers and colleagues observed that self-reported inability to walk a quarter of a mile had low sensitivity (0.46) but high specificity (0.97) for detecting individuals who could not walk 400 m when directly observed (Sayers et al., 2004). Additionally, Chen and colleagues similarly observed low sensitivity (0.40–0.48) and high specificity (0.92–0.95) using self-reported walking ability at baseline to predict whether participants could walk 400 m, when directly observed, 2 years in the future (Chen et al., 2018). While beyond the scope of this analysis, these findings suggest that the lower sensitivity and higher specificity may be due to many older adults not being aware of their mobility limitation, but if they report a mobility limitation, it is quite accurate.

Sensitivity of self-report increased as the SPPB threshold decreased, though the specificity and LR both decreased. Similar patterns have been observed in studies of other health conditions. Schueller and colleagues, for example, observed that higher Patient Health Questionnaire (PHQ-9) threshold scores (representing

less severe depression symptoms) were consistently associated with lower sensitivity for identifying cases of major depressive disorder (27). Further, the more difficult tasks (i.e., 6BL and 20ST) had higher sensitivities compared to the less difficult tasks (i.e., unable 3BL and 10ST), regardless of the SPPB threshold. As the LIFE Study observed that most all of the benefit of a physical activity program accrued to individuals with an SPPB < 8 (Pahor et al., 2020), it would seem prudent to ask about inability to walk six blocks, which had the highest sensitivity (0.51) while also having high specificity (0.94). Ultimately, the choice of screening question to be used used involves tradeoffs of sensitivity and specificity, though LR has the potential to be used to optimize these tradeoffs.

LR evaluates how much a test result increases or decreases the likelihood of having the disease before the test was performed; the pre-test probability. Based on a scale developed by McGee to approximate the change in probability due to test results of varying likelihood ratio (McGee, 2002), the post-test probability of disease for a test with a likelihood ratio greater than 10, the highest value considered in the McGee study, is over 45% higher than the pre-test probability, indicating that it would likely have a large impact on clinical decision making if the result was positive. In the current study, self-reported walking and stair climbing difficulties were consistently associated with LRs near 10 or greater than 10, signifying that each of the four physical capacity questions assessed had a high diagnostic utility for identifying participants with mobility limitations, regardless of SPPB threshold chosen. The stratified analysis for age and gender (Tables 2 and 3) showed similar patterns, except for the observation that the middle age group (age 75–84) had the highest LRs at a SPPB threshold of ≤ 9. Regardless of the variations observed in the age and gender sub-groups, all LRs observed were considered to be highly clinically useful for each of the self-report physical capacity measures.

While the current analysis suggests that single-item physical capacity assessments are highly accurate and may, therefore, be useful in primary care or geriatric care settings, the study has several limitations. First, various studies use similar SPPB thresholds to identify physical disability, but a specific clinical standard has not been determined. Vasunilashorn and colleagues reported that SPPB scores of 10 or lower predicted future mobility disability (Vasunilashorn et al., 2009). In contrast, the LIFE study used a threshold of 9 or lower to identify risk for future major mobility disability and reported significant improvements in mobility following an exercise intervention (Pahor et al., 2014). Of note, Pahor and colleagues suggested that future studies should include a SPPB threshold of 8 or lower as those individuals experienced the greatest benefit from the exercise intervention (Pahor et al., 2014). Overall, our results suggest that, regardless of SPPB cut-point chosen, self-report of walking and stair climbing ability had very high diagnostic utility, as the LR averaged >20 across all cut-points. Second, the highest LRs had high specificity but low sensitivity. Of note, sensitivity did increase at lower SPPB thresholds, but with the tradeoff of decreasing LR and specificity. Using these questions clinically, therefore, has the downside of missing individuals with poor mobility, but the upside of directing clinical interventions, and thereby financial resources, only to individuals who need it, based on the high levels of specificity observed.

Overall, the results indicate that asking simple self-reported questions about walking and stair climbing ability may provide a highly feasible and accurate method for identifying older adults with mobility limitations who can benefit from intervention. The LIFE study observed that a physical activity program that included-walking and strength training, among individuals with a SPPB ≤ 9, significantly reduced future major mobility disability (Pahor et al., 2014). Future research should consider whether including single-item physical ability questions in primary care settings could prove useful for identifying older adults in need of intervention. Fewer than 10% of individuals with access to free, insurance-based physical activity programs, such as Silver Sneakers, ever attend (Greenwood-Hickman et al., 2015). It is possible that screening, using one of these simple self-reported questions, could enable providers to encourage patients who report a mobility limitation and have access to free programs, to make use of them. The last baby boomers turn 65 in 2030, when older adults will outnumber children for the first time in US history (Vespa et al., 2020). Mobility limitations may be quit costly to the US health care system; one study observed that older adults who have difficulty walking six blocks or are unable to walk six blocks consume an additional $2,773 and $3,919, respectively, in health care costs each year (Hardy et al., 2011). The cumulative effect of these walking difficulties, according to Hardy and colleagues, is an additional 2 million hospitalizations and $42 billion in health care costs annually (Hardy et al., 2011). These sizeable burdens should create a sense of urgency to use these findings and others to test feasible and scalable approaches for identifying older adults who can benefit most from interventions to improve their mobility and, thereby, their functional independence.

Conclusions

Accurately screening for mobility disability in clinical settings is possible using single-item self-report measures. Asking a single question about an individual's ability to walk 3 or 6 blocks or 10 or 20 stairs can accurately predict a low SPPB, a gold standard for measuring lower extremity physical performance. These results suggest that future studies should be done to test the impact of screening for mobility disability in clinical settings using one of these single item assessments

during the patient intake process, to identify those that need to be referred to either physical therapy or encouraged to participate in physical activity intervention such as that used in the LIFE study, to improve mobility and the functional independence that it provides.

Declaration of Conflicting Interests

The author(s) declared the following potential conflicts of interest with respect to the research, authorship, and/or publication of this article: Dr. Sciamanna is part-owner of BandUp, Inc. and Play Fitness, LLC, formed to test the viability of various business models to disseminate findings from exercise studies. No other authors have competing interests.

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