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Original Study

Association Between the Discrepancy in Self-Reported and Performance-Based Physical Functioning Levels and Risk of Future Falls Among Community-Dwelling Older Adults: The Locomotive Syndrome and Health Outcomes in Aizu Cohort Study (LOHAS)



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A B S T R A C T

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Objectives: A discrepancy in self-reported and performance-based physical functioning levels is often observed among older adults. We investigated the association of discrepancy in self-reported and performance-based physical functioning levels with risk of future falls among community-dwelling older adults.

Design: Prospective cohort study.

Setting: Two communities in Fukushima Prefecture, Japan.

Participants: 1379 older adults who took part in the yearly health checkup in both 2009 and 2010.

Measures: The performance-based and self-reported physical functioning levels were evaluated by the Timed Up and Go test and the Short-Form 12 Health Survey (Japanese version) physical functioning subscale, respectively. We divided the participants into 4 groups based on the combinations of low or high performance-based and self-reported physical functioning groups, which were classified by age- and sex-specific reference values. The main outcome was the occurrence of any falls within the 1-year follow-up period, assessed using a self-reported questionnaire.

Results: A total of 22% of the participants reported the occurrence of a fall during the follow-up period. In multivariable logistic regression analysis, the adjusted odds ratios of the high self-reported and low performance-based, low self-reported and high performance-based, and low self-reported and low performance-based physical functioning groups were 1.10 (95% confidence interval [CI], 0.67–1.82), 1.76 (95% CI, 1.17–2.66), and 1.80 (95% CI, 1.11–2.90), respectively, compared with the high self-reported and high performance-based physical functioning group.

Conclusions: Our findings suggest that the discrepancy as high performance-based but low self-reported physical functioning level is associated with an increased risk of future falls in older adults aged 65–89 years. Clinicians should carefully assess older adults whose subjective perception of their physical functioning capacity is lower than those in similar age and sex groups, even if their actual physical functioning appears to be objectively high.

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Falls are considered a serious health-related problem among older adults in an aging society. One-third of older adults aged ≥ 65 years experience falls at least once annually.¹ Falls account for 80% to 90% of the causes of bone fracture among older adults.² Furthermore, falls lead to significant public health issues, such as hospitalization, institutionalization, and development of many comorbidities.^{3,4} Therefore, fall prevention is an essential component of health promotion among older adults.

Declining physical functioning is well recognized as one of the most common risk factors for falls.⁵ The physical functioning of older adults can be evaluated using subjective assessments, including self-reported questionnaires⁶ and objective assessments, such as performance-based measurement of gait speed, muscle strength, and balance functioning.⁷ Several previous studies have demonstrated that discrepancy between self-reported and performance-based physical functioning levels is often observed among older adults. A previous study⁸ reported that approximately 20% of older adults aged >75 years over- or underestimated their physical functioning capacity. Another study⁹ reported that the risk factors for the discrepancy between self-reported and performance-based physical functioning levels include age, female sex, poor perceived health, and presence of cognitive impairment and comorbidity. Older adults whose self-perceived physical functioning level is higher than their actual physical functioning ability may have increased likelihood of falls because they may perform activities that are more difficult than what their actual physical functioning capacity permits. In contrast, older adults whose self-perceived physical functioning level is excessively low may also be at an increased risk for falls because they tend to restrict their physical activities. However, the relationship between the discrepancy in self-reported and performance-based physical functioning levels and future falls remain to be investigated. The present study aimed to examine the longitudinal association between the discrepancy in self-reported and performance-based physical functioning levels and risk of future falls among community-dwelling older adults using a population-based prospective cohort design.

Methods

Study Participants

The participants were selected from the Locomotive Syndrome and Health Outcome in Aizu Cohort Study (LOHAS), a cohort study that began in 2008 and involved residents aged 40–80 years who participated in an annual health checkup conducted in 2 communities (Tadami and Minamiaizu) in Fukushima Prefecture, Japan. Information regarding LOHAS is available in a previously reported study.¹⁰ In the present study, we included participants aged ≥ 65 years who took part in the yearly health checkup both in 2009 and 2010. We excluded those whose physical functioning and falls data in 2009 and 2010, respectively, were missing. The study protocol was approved by the Research Ethics Committee of Kyoto University Graduate School of Medicine and Fukushima Medical University, and all participants provided written informed consent.

Physical Functioning Assessment

We used the Timed Up and Go (TUG) test¹¹ to assess the performance-based physical functioning level of the participants; this test measures the time required for an individual to rise from a chair, walk 3 m and return, and sit on the chair. The TUG test is considered an objective measure of mobility functioning, balance, and risk for falls.¹² We measured once for each participant and instructed them to walk as quickly and safely as possible. We classified the study participants into two groups (high or low performance-based physical functioning groups) based on the age-specific mean value calculated in a previous meta-analytic study.¹³ Meanwhile, we used the physical functioning

subscale of the Japanese version of the Short-Form 12 Health Survey (SF-12)¹⁴ to assess the participants' self-reported physical functioning capacity. The SF-12 physical functioning subscale, which consists of 2 questions regarding difficulties encountered when performing moderate-level activities and climbing several flights of stairs, with three levels of possible responses, has been broadly used in various studies involving the general population. In the present study, we calculated the norm-based subscale scores of the participants. Subsequently, we classified the participants into two groups (ie, high or low self-reported physical functioning groups) based on the sex- and age-specific mean value in Japan.¹⁵ The age-specific mean value of TUG and sex- and age-specific mean values of SF-12 physical functioning are described in [Supplementary Table 1](#) (available online).

Fall Assessment

We assessed the occurrence of any falls within the past 1-year period via self-reported questionnaire during the annual health checkup conducted in 2010. A fall is defined by the World Health Organization as an event resulting in a person inadvertently coming to rest on the ground.¹⁶ In cases wherein a participant experienced any fall, we asked the following additional question: "When you fell, did you require any medical care either as outpatient or inpatient in a hospital?" If the answer was "Yes," then the fall was further categorized as a fall needing care.

Potential Confounding Factors

We collected the participants' sociodemographic data, including age, sex, body mass index, living arrangement, current smoking habit, presence of depression symptoms and comorbidities (hypertension, cerebrovascular and cardiovascular diseases, and diabetes), and fall history at baseline. The existence of depressive symptoms was evaluated using the 10-item version of the Center for Epidemiological Studies Depression Screening Index (CES-D), where a depressive mood is defined as a CES-D score of ≥ 10 .¹⁷ The presence of comorbidities was evaluated through participants' self-reporting of seeking a physician for treatment. Fall history pertains to experience of any fall at least once within the past 1-year period from the baseline.

Statistical Analysis

Only the study participants who had no missing data were included in the statistical analysis. Subsequently, we classified the participants into 4 exposure groups based on the combinations of their self-reported and performance-based physical functioning levels as follows: high performance-based and high self-reported, low performance-based and high self-reported, high performance-based and low self-reported, and low performance-based and low self-reported physical functioning groups. The baseline characteristic data of the participants from the 4 exposure groups are presented as mean and standard deviation for continuous variables and as number and proportion for categorical variables. During the primary analysis, we calculated the adjusted odds ratio (OR) as an effect indicator using the multivariable logistic regression model. The occurrence of any fall within the 1-year follow-up period served as the dependent variable. Meanwhile, in terms of the independent variables, we included the 4 exposure categories (reference: high performance-based and high self-reported physical functioning level) as the dummy variables to assess the association between the discrepancy in self-reported and performance-based physical functioning levels, and risk of any falls. Additionally, we also determined the association between the same exposure categories as those in the primary analysis and risk of falls needing care using the same statistical model. All potential confounding factors were adjusted for in each analysis.

Additionally, to verify whether the effect of self-reported physical functioning level on the risk for any falls is consistent regardless of the TUG time, we included the self-reported physical functioning categories (reference: low self-reported physical functioning group) and TUG time (continuous variable) and their interaction term as independent variables in the logistic regression analysis, after adjusting for the same confounding factors as those in the primary analysis. We estimated and graphed the average probability of any falls based on self-reported physical functioning categories when the TUG time changed by 1 second from the 1st to the 99th percentile.

During the sensitivity analysis, we also performed a multiple-imputation procedure using the chained equation method for the 229 participants, with at least 1 missing confounding factor based on the missing-at-random assumption. The missing values were imputed using the TUG time, SF-12 physical functioning subscale scores, and other confounding factors. We created 20 imputed datasets. We conducted the same statistical analysis as the primary analysis and integrated the estimated results from each dataset. Then, the estimated results from each dataset were integrated. All analyses were conducted using Stata version 13.1 (StataCorp LP, College Station, TX). A P value $< .05$ (two-tailed) was considered statistically significant.

Results

At baseline, 113 (8.2%) of the 1379 participants had missing physical functioning and fall assessment data in the 2009 and 2010 health checkups, respectively (Figure 1). Following the exclusion of 229 participants who had missing data for at least 1 confounding variable, 1037 participants were included in the statistical analysis. Table 1 shows the baseline characteristics of the participants included in the statistical analysis. The mean age of the participants was 72 years, and men accounted for 41% of the total participants. A discrepancy between self-reported and performance-based physical functioning levels was noted in $>30\%$ of the participants (14% and 19% in the high self-reported and low performance-based, and low self-reported and high performance-based physical functioning groups, respectively). The proportions of participants who experienced any falls within the 1-year follow-up period, and falls needing care were 22% ($n = 229$) and 4.9% ($n = 51$), respectively.

The incidence of any falls in the 4 exposure categories was reported by 16.3%, 18.8%, 30.5%, and 37.0% in the high self-reported and high performance-based, high self-reported and low performance-based, low self-reported and high performance-based, and low self-reported and low performance-based physical functioning groups, respectively. Meanwhile, the incidence of falls needing care in the 4 exposure categories were reported by 3.1%, 5.4%, 5.6%, and 11.0% of the high self-reported and high performance-based, high self-reported and low performance-based, low self-reported and high performance-based, and low self-reported and low performance-based physical functioning groups, respectively (Table 2).

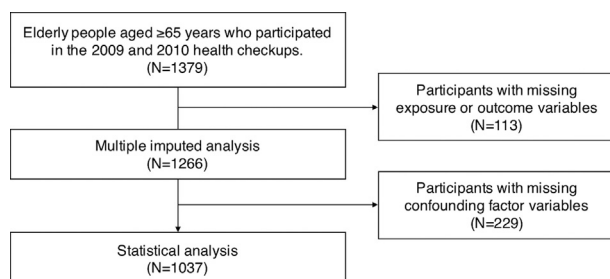


Fig. 1. Flow chart for the selection of study participants.

Longitudinal Association Between the Discrepancy in Self-Reported and Performance-Based Physical Functioning Levels and Future Falls

Based on the results of the multivariable analysis of any falls, the adjusted ORs of the high self-reported and low performance-based, low self-reported and high performance-based, and low self-reported and low performance-based physical functioning groups were 1.10 [95% confidence interval (CI), 0.67–1.82], 1.77 (95% CI, 1.17–2.66), and 1.85 (95% CI, 1.15–2.97), respectively, compared with that of the reference group. Furthermore, the results of the outcome analysis of falls needing care showed that the adjusted ORs of the high self-reported and low performance-based, low self-reported and high performance-based, and low self-reported and low performance-based physical functioning groups were 1.74 (95% CI, 0.72–4.20), 1.56 (95% CI, 0.70–3.48), and 2.54 (95% CI, 1.14–5.64), respectively, compared with that of the reference group.

Interaction Between Self-Reported and Performance-Based Physical Functioning Level

Figure 2 displays the plots of the estimated average probabilities of any falls of the high and low self-reported physical functioning groups when the TUG time changed by 1 second from 4.86 seconds (1st percentile) to 15.0 seconds (99th percentile). The high self-reported physical functioning group was observed to have a lower likelihood of experiencing any falls than the low self-reported physical functioning group. The interaction term was also not statistically significant based on the statistical model ($P = .63$).

Sensitivity Analysis

Meanwhile, the results of the sensitivity analysis using multiple imputations showed that the adjusted ORs for any falls were 1.07 (95% CI, 0.69–1.66), 1.60 (95% CI, 1.10–2.31), and 1.62 (95% CI, 1.06–2.47) for the high self-reported and low performance-based, low self-reported and high performance-based, and low self-reported and low performance-based physical functioning groups, respectively, compared with the reference group (Supplementary Table 2 [available online]).

Discussion

In this longitudinal study, a discrepancy between self-reported and performance-based physical functioning levels was observed in $>30\%$ of community-dwelling older adults aged 65 to 89 years. Older adults with low self-reported but high performance-based physical functioning levels had a higher risk of experiencing any falls than did those with both high self-reported and high performance-based physical functioning levels. However, a low performance-based but high self-reported physical functioning level was found not to be associated with the risk of any falls.

A low self-reported physical functioning level can be associated with the development of a fear of falling. Fear of falling is known to cause restrictions in physical and social activities, which results in an increased risk of falls.^{18,19} The increased risk of falls in the low self-reported but high performance-based physical functioning group compared with the high self-reported and high performance-based group may be attributed to a similar mechanism. In contrast, a low performance-based but high self-reported physical functioning level was not observed to be associated with the risk of any fall. A previous study suggested that the cut-off value of the TUG time for falls is 13.5 seconds.¹² Considering that the reference values we used in this study were higher than 13.5 seconds, several older adults with lower risk of falls in terms of objective physical function were included in the low performance-based physical functioning group. Therefore, we

Table 1
Baseline Characteristics of the Study Participants

	Total	High Self-Reported, High Performance-Based (n = 553, 53.3%)	High Self-Reported, Low Performance-Based (n = 149, 14.4%)	Low Self-Reported, High Performance-Based (n = 197, 19.0%)	Low Self-Reported, Low Performance-Based (n = 138, 13.3%)
Timed Up and Go, mean (SD)	8.3 (2.2)	7.3 (1.3)	10.3 (1.7)	7.5 (1.1)	11.1 (2.7)
SF-12 physical functioning subscale*, mean (SD)	46.0 (13.6)	54.1 (5.3)	53.2 (5.3)	32.0 (9.0)	26.1 (11.9)
Age, mean (SD)	72.3 (4.3)	72.0 (4.2)	72.8 (4.4)	72.0 (4.2)	73.5 (4.3)
Men, n (%)	426 (41.1)	246 (44.5)	70 (47.0)	76 (38.6)	34 (24.6)
BMI, mean (SD)	23.9 (2.9)	23.5 (2.7)	24.3 (3.2)	24.2 (2.9)	25.0 (3.2)
Living alone, n (%)	134 (12.9)	61 (11.0)	17 (11.4)	25 (12.7)	31 (22.5)
Smoking habit, n (%)	81 (7.8)	41 (7.4)	21 (14.1)	10 (5.1)	9 (6.5)
Depression symptom, n (%)	130 (12.5)	48 (8.7)	8 (5.4)	34 (17.3)	40 (29.0)
Comorbidities, n (%)					
Hypertension	541 (52.2)	252 (45.6)	84 (56.4)	115 (58.4)	90 (65.2)
Diabetes	70 (6.8)	30 (5.4)	11 (7.4)	15 (7.6)	14 (10.1)
Cerebrovascular disease	56 (5.4)	24 (4.3)	9 (6.0)	9 (4.6)	14 (10.1)
Cardiovascular disease	80 (7.7)	36 (6.5)	14 (9.4)	20 (10.2)	10 (7.3)
Fall history, n (%)	166 (16.0)	56 (10.1)	21 (14.1)	46 (23.4)	43 (31.2)

BMI, body mass index; SD, standard deviation.

*Express as norm-based score.

evaluated the interaction between self-reported physical functioning level and TUG time to verify whether the effect of self-reported physical functioning level on falls is consistent, even if the TUG time slowly varies. Figure 2 presents the consistency in the likelihood of fall occurrence, regardless of the TUG time. These findings suggest that high self-perceived physical functioning capacity can prevent the occurrence of falls even if the actual physical functioning level is lower than those with average physical functioning ability.

Meanwhile, the decline in neither self-reported nor performance-based physical functioning level was significantly associated with risk of falls needing care. However, despite the absence of a significant association between these variables, the degree of association between the discrepancy and risk of falls needing care was comparable to that in both discrepancy patterns. This finding may indicate that only the decrease in self-reported physical functioning was related to the increase in fall frequency, although the falls did not lead to severe injury requiring hospital care. Additional studies with higher statistical power than the present study will be needed to verify the association between low self-reported physical functioning level and increased incidence of severe falls requiring hospital care, as well as to determine the difference thereof from the relationship between the self-reported physical functioning level and occurrence of any falls.

The proportion of older adults with a discrepancy between self-reported and performance-based physical functioning levels in our study was slightly higher than that of previous studies.^{9,20} This difference can be explained by the inconsistencies in the targeted physical functions in two assessments. Additionally, the proportion of adults with a discrepancy between self-reported and performance-based physical functioning levels changes based on the activity level or performance targeted for assessment, as reported in previous studies.^{9,20}

A study in Finland⁸ evaluated the level of difficulty in performing 13 mobility tasks as self-reported mobility limitation; as performance tests, it also measured abilities to walk, to stand up from and sit down on a chair, to squat, and to climb up and down two steps. However, of these tasks, only the stair-climbing task was used to assess the proportion of disagreement between self-report and performance test. A study in Spain⁹ evaluated the same tasks (abilities of walking and standing up from and sitting down on a chair) on the basis of self-rating and a performance test and assessed the proportion of agreement between them. In both studies, the performance test was classified on the basis of an established cut-off value, and the self-report was classified based on having any level of difficulty or not. Although our assessment using SF-12 physical functioning and TUG was similar to those of previous studies, the targeted activities among these assessments were not entirely consistent. However, we believe that our classification using age-specific mean values for both assessments will help older adults better understand their individual situation.

This study is the first to report on the association of the discrepancy in self-reported and performance-based physical functioning levels with the risk of falls among community-dwelling older adults. We believe that our findings have several significant implications for clinical practice and policy making. First, our findings can serve as a basis for clinicians to develop a more effective fall prevention plan through the provision of appropriate interventions to these individuals, in terms of the discrepancy between subjective physical functioning assessment and objective physical functioning measurement in preventing falls. Second, we believe that the low subjective perception of individual physical functioning level among the older adults is modifiable. Several interventions, such as exercises that can improve physical performance, are shown to be effective in reducing

Table 2
Association Between the Discrepancy in Self-Reported and Performance-Based Physical Functioning Levels and Risk of Future Falls*

	Any Falls		Falls Needing Care	
	Incidence (%)	Adjusted OR (95% CI)	Incidence (%)	Adjusted OR (95% CI)
High self-reported/high performance-based	16.3 (90/553)	Ref.	3.1 (17/553)	Ref.
High self-report/low performance-based	18.8 (28/149)	1.10 (0.67–1.82)	5.4 (8/149)	1.74 (0.72–4.20)
Low self-reported/high performance-based	30.5 (60/197)	1.77 (1.17–2.66)	5.6 (11/197)	1.56 (0.70–3.48)
Low self-reported/low performance-based	37.0 (51/138)	1.85 (1.15–2.97)	11.0 (15/138)	2.54 (1.14–5.64)

*Multivariable logistic regression analysis was conducted with adjustments for age, sex, body mass index, living alone, smoking habit, presence of depression symptom and comorbidities (hypertension, diabetes, and cerebrovascular and cardiovascular disease), and fall history. Self-reported and performance-based physical functioning levels were evaluated using the Short-Form 12 Health Survey physical functioning subscale and Timed Up and Go test, respectively.

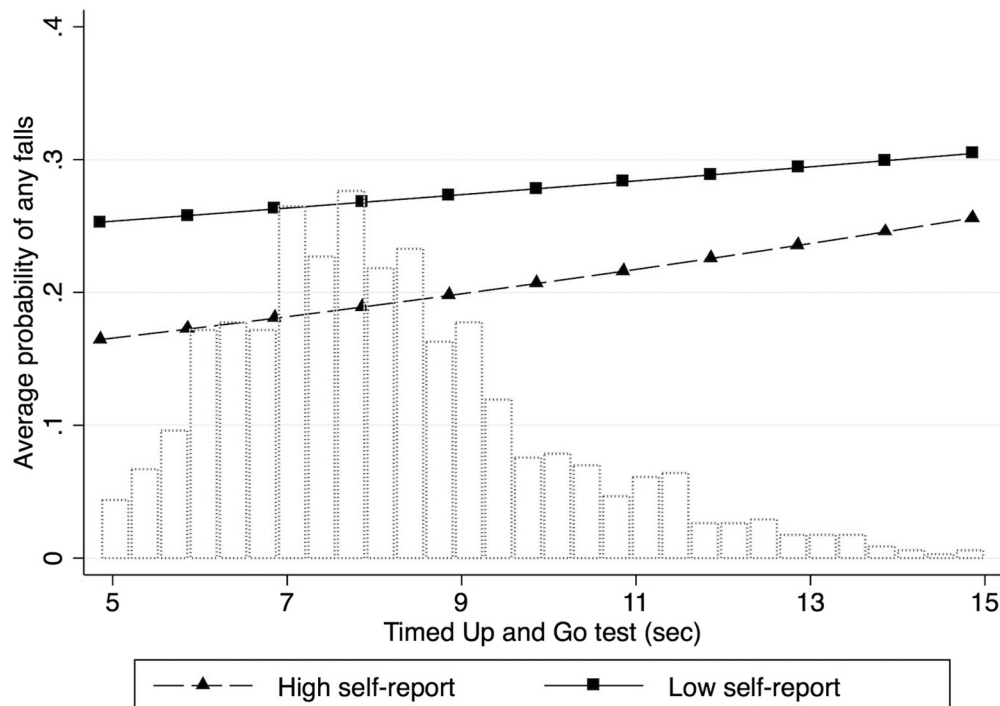


Fig. 2. Average probability of any falls based on self-reported physical functioning categories; The independent variables used in the multivariable logistic regression analysis were as follows: self-reported physical functioning categories, Timed Up and Go (TUG) test time, and interaction term with adjustments for age, sex, body mass index, living alone, smoking habit, presence of depression symptom and comorbidities (hypertension, diabetes, and cerebrovascular and cardiovascular disease), and fall history. The bars indicate the TUG time distribution from the 1st to the 99th percentile.

the fear of falls among community-dwelling older adults.²¹ Furthermore, appropriate feedback on the perception of physical functioning may be effective in modifying the self-reported physical functioning level that is excessively lower than the actual physical functioning ability. Third, health care providers can identify the populations who are at a high risk for falls, based on the results of a self-reported physical functioning assessment, which is a convenient approach that does not require specific skill or knowledge.

However, there are several potential limitations to consider when interpreting these results. First, as previously mentioned, the targeted activity for the SF-12 physical functioning subscale assessment, that is, self-reported physical functioning, was not entirely consistent with that targeted by the TUG test, namely, performance-based physical functioning. Although a previous study demonstrated the association between TUG time and difficulties in activities of daily living,²² simply interpreting the discrepancy pattern observed in our study as over- or underestimation of physical functioning among older adults would be difficult. Second, we were unable to obtain the data for some unmeasured potential confounding factors, including cognitive and visual impairments, which are established risk factors for falls.^{23,24} Although the participants in our study were considered to have understood the contents of the informed consent and to have been able to read and answer our questionnaires at the baseline survey of the original LOHAS study, further study excluding those with cognitive impairment is required to accurately evaluate the discrepancy in performance-based and self-reported physical functioning and its association with falls. Third, 229 participants had missing data for at least 1 confounding variable, which might have resulted in selection bias, although the results of the sensitivity analysis using multiple imputations and primary analysis were consistent. Fourth, only those who participated in the annual health checkups in both 2009 and 2010 were included in the study. Therefore, our population may have included relatively healthy older adults, which can influence the

generalizability of our findings. Sixth, our assessment of falls was based on a questionnaire asking about the experience of falls during the past 1 year. This approach can cause underreporting of falls as a result of recall bias.

Conclusions/Relevance

We conducted a large population-based cohort to investigate the association of the discrepancy in self-reported and performance-based physical functioning levels with risk of future falls among community-dwelling older adults. Our findings suggest that low self-reported physical functioning level can increase the risk of any falls, even if the performance-based physical functioning level is high. Clinicians should carefully assess the subjective physical functioning in older adults, even if their actual physical functioning appears to be objectively high.

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Appendix

Supplementary Table 1

Cut-Off Values for TUG and SF-12 Physical Functioning

Age	TUG, s	SF-12 Physical Functioning	
		Male	Female
60–69 y	8.1	47.7	47.8
70–79 y	9.2	43.4	40.9

SF-12, Short-Form 12 Health Survey; TUG, Timed Up and Go.

Supplementary Table 2

Results of the Sensitivity Analysis With Multiple Imputations

	Primary Analysis	Multiple Imputations
	Adjusted ORs (95% CI)	Adjusted ORs (95% CI)
High self-reported/high performance-based	Ref.	Ref.
High self-reported/low performance-based	1.10 (0.67–1.82)	1.07 (0.69–1.66)
Low self-reported/high performance-based	1.77 (1.17–2.66)	1.60 (1.10–2.31)
Low self-reported/low performance-based	1.85 (1.15–2.97)	1.62 (1.06–2.47)

CI, confidence interval; ORs, odds ratios.