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Research Article

Using Health-Related Quality of Life (SF-36v2®) to Predict Falls in Community-Dwelling Older Adults

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Abstract

Background: Falls are the leading cause of hospitalization and death among older adults; therefore, the ability to predict fall risk among older adults is critical. Several performance-based outcome measures exist to assess fall risk. Psychological factors are also associated with fall risk yet can be difficult to assess and are often overlooked. In this study, we investigated whether the Short Form 36 Item Health Survey (SF-36v2®), a measure of health-related quality of life (HRQOL), predicted future falls in a sample of community-dwelling older adults. A secondary purpose was to examine relationships between the SF-36v2® and balance performance.

Methods: Forty-three community-dwelling older adults completed the SF-36v2® and 3 well-established measures of balance performance: Berg Balance Scale, Tinetti Mobility Assessment, and Timed Up and Go. After testing, the number of future falls were recorded for 12 months.

Results: The SF-36v2® physical component summary (PCS) scores predicted future fall status at 12 months. The PCS was correlated with all three measures of balance performance, in which higher PCS scores were associated with better balance. The mental component summary scores were not associated with balance performance.

Conclusions: In this study, HRQOL as measured by the SF-36v2® predicted future falls and was associated with well-established balance performance measure scores. The instrument should be considered for inclusion in a comprehensive fall risk evaluation.

Keywords
Falls; quality of life; SF-36v2® health survey; community dwelling older adults; balance

1. Introduction

Falls are very prevalent, and a significant health concern among older adults. About one third of older adults report at least one fall per year [1-3]. Falls often result in serious consequences including injury [4, 5], hospitalization [6], and even death [7, 8]. Importantly, falls account for over half of all unintentional injury-related deaths among adults aged 65 and over [7].

Due to the prevalence of falls and their unfortunate consequences, the ability to predict fall risk accurately is critical. Identification of individuals at high fall risk is the initial step in appropriate allocation of resources and measures that aim to prevent falls. Several fall predictors have been reported, including extrinsic risk factors (i.e., obstacles or tripping hazards) and intrinsic risk factors (i.e., increasing age, fall history, gait abnormalities, and poor balance performance [9-11]). Intrinsic psychological factors, though often overlooked, are also associated with falls [12]. Recently, self-reported balance confidence and fear of falling avoidance behaviours were reported to be even more predictive of prospective falls than physical measures of fall risk in a sample of community-dwelling older adults [13].

Perceived mobility, perceived health, and quality of life are also associated with falls [14]. Factors that diminish health-related quality of life (HRQOL) can largely be attributed to the immobility and loss of functional independence associated with fall-related injuries [15]. The Short Form 36 Item Health Survey (SF-36v2®) is widely considered the gold standard instrument to measure HRQOL [16]. Previous work has demonstrated a relationship between various fall risk factors and HRQOL [17-19]. Researchers have also reported an association between HRQOL and fall history [20, 21]. A recent longitudinal study reported reduced aspects of HRQOL using the SF-36v2® in older adult nursing home residents who fell during a year of follow-up [1].

The purpose of this study was to determine whether HRQOL predicted *future* falls in a sample of community-dwelling older adults. A secondary purpose was to assess whether SF-36v2® scores were associated with scores on well-established balance performance measures including the Berg Balance Scale (BBS), Tinetti Mobility Assessment (Tinetti), and Timed Up and Go (TUG).

2. Materials and Methods

2.1 Participants

Participants were recruited from an independent living retirement community in the northwest region of the United States. Mailings and informational flyers were placed in shared areas, which explained the purpose of the study, study procedures, and inclusion/exclusion criteria. To be eligible, subjects had to be at least 65 years of age, be able to provide informed consent, and be able to ambulate inside their homes independently (with or without an assistive device). The Institutional Review Board of Eastern Washington University approved this study.

2.2 Short-Form 36 Item Health Survey (SF-36v2®)

The SF-36v2® is a common measure of HRQOL, widely considered to be the gold-standard assessment of HRQOL. The instrument consists of 36 items that assess the patient's perceived mental and physical health [16]. Questions encompass eight domains of HRQOL: vitality, physical function, bodily pain, general health perception, physical role function, emotional role function, social role function, and mental health. The domains are combined to create two separate summary scores: the physical component summary (PCS) and the mental component summary (MCS) [16, 22]. Scores are based on a 0 to 100 scale where 100 represents the highest possible HRQOL score.

2.3 Balance Performance

The BBS is a 14-item balance measure [23]. Subjects are instructed to perform functional activities or maintain positions for a given amount of time (for example: "please close your eyes and stand still for 10 seconds"). Each item is scored on a scale from 0 to 4, for a total of 56 points possible. Higher scores indicate better balance performance.

The Tinetti is a balance measure in which gait and balance are assessed during performance of various functional tasks [24]. Each item is scored on a scale from 0 to 2, for a total of 28 points possible. As in the BBS, higher scores indicate better performance.

The TUG is a timed balance test. Subjects are instructed to rise from an armed chair, walk 3 meters, turn around, return to the chair, and sit back down [25]. The time it takes to complete the sequence is the subject's score. Thus, lower scores indicate better balance performance.

2.4 Experimental Design

In this prospective cohort study, subjects provided informed consent, demographic data, and then completed the SF-36v2®. Participants also self-reported their fall history (number of falls in the past 12 months). A fall was defined as "unintentionally coming to rest onto a lower level such as the ground or floor," a definition established by the Falls and Injury Committee [26]. Next, subjects performed balance tests in randomized order: BBS, Tinetti, and TUG. The same research team of licensed physical therapists and doctor of physical therapy students, trained to collect data in a standardized fashion, administered all assessments.

After the in-person baseline test day, interviews were conducted every 3 months for one year to determine the number of falls subjects had experienced, if any, during the most recent 3 months. Subjects who experienced at least one fall prospectively within the 12-month follow-up period were classified as *fallers*, while those who had not experienced a fall were classified as *non-fallers*.

2.5 Statistical Analysis

Descriptive statistics were used to summarize demographic data and clinical characteristics. Descriptive differences between fallers and non-fallers were analysed by Chi-square for nominal data and by independent t-tests for continuous data. Independent t-tests were used to determine whether SF-36v2® scores differed between subjects with and without a positive fall history (past 12 months). The p-value was adjusted for the violation of equal variances assumption when Levene's Test was significant. Spearman's rho was used to assess relationships between SF-36V2® scores and baseline balance performance on the BBS, Tinetti, and TUG.

Standard multiple regression was conducted to determine the accuracy of the independent variables (PCS, MCS) in predicting the number of future falls experienced within the 12-month follow-up period. Additionally, a binomial logistic regression (standard method), with PCS and MCS scores as variables in the model, was conducted to determine whether the SF-36v2® could predict fall status (faller or non-faller) at 12 months. Alpha was set to 0.05 and all tests were two-tailed. Bonferroni correction was used to address the issue of multiple comparisons between those with and without a fall history, and between outcome measures, to protect from Type 1 Error (in these cases, alpha was set to 0.005). Analyses were conducted using SPSS v23.

3. Results

3.1 Subject Characteristics and Fall Status

Forty-six older adults participated in the study. Three subjects were excluded from all analyses as two subjects did not answer all of the SF-36v2® questions, and one subject dropped out of the study before the 12-month follow-up period concluded, producing a total sample size of 43 subjects. Of the 43 subjects who completed the study, 30 (69.8%) were female. Mean (± SD) age for the sample was 83.6 (± 6.2) years, with a range of 67 to 94 years old. At baseline, mean (± SD) number of comorbidities was 3.9 (± 1.8) and number of prescribed medications was 5.4 (± 3.3). Fifteen (34.9%) subjects had a positive fall history at baseline (at least one fall in the previous 12 months). Among these 15 subjects, the mean (± SD) number of falls reported was 2.2 (± 1.1).

Fifteen (34.9%) of the subjects who completed the study reported a fall within the 12-month follow-up period and were classified as "fallers." The mean (± SD) number of falls at 12 months among these subjects was 2.4 (± 1.6). The remaining 28 (65.1%) subjects reported no prospective falls and were classified as "non-fallers." There were no differences between fallers and non-fallers in self-reported changes in health status at 12-month follow-up (X^2=2.14, p=0.14). There were no significant differences between future fallers and non-fallers in characteristics like age, gender, number of comorbidities, or number of prescription medications (p>0.05). While more likely to have reported falling in the previous 12 months (X^2=4.20, p=0.04), some of the prospective fallers in this study actually had a negative fall history (n=6). In addition, some subjects with a positive fall history at baseline testing did not experience a fall during the study's 12 month observation period (n=7).

3.2 SF-36v2® Scores and Fall History

The SF-36v2® scores for each domain and the summary scores are presented in Table 1 for the total sample and for subjects with a positive and negative fall history. Subjects with a history of falls in the previous 12 months had lower scores on all domains, though differences were statistically significant for only the vitality (p<0.01) and social functioning (p<0.01) domains, with a trend toward significance for the role physical (p=0.07) and bodily pain (p=0.07) domains. The PCS scores were significantly lower for subjects with a positive fall history (p=0.04), while there was no difference between groups in MCS scores (p=0.10).

Table 1 Short Form 36 Item Health Survey (SF-36v2®) scores for total sample and based on fall history (mean ± SE).

SF-36v2® Domain	**N=42[#]**	**+ Fall History n=15**	**- Fall History n=27**	**t value**	***p***
Physical Function	37.79 ± 1.78	34.44 ± 2.83	39.95 ± 2.28	1.48	0.15
Role Physical	40.51 ± 1.57	37.26 ± 1.74	42.52 ± 2.23	1.86	0.07
Bodily Pain	46.99 ± 1.58	43.16 ± 2.56	49.32 ± 1.97	1.89	0.07
General Health	49.61 ± 1.43	46.58 ± 2.12	51.26 ± 1.89	1.56	0.13
PCS	40.95 ± 1.52	37.11 ± 2.24	43.50 ± 1.92	2.08	0.04*
Vitality	50.30 ± 1.80	43.77 ± 2.89	54.44 ± 2.00	3.10	<0.01**
Social Functioning	47.72 ± 1.76	40.85 ± 2.63	51.40 ± 2.08	3.09	<0.01**
Role Emotional	43.68 ± 1.80	41.63 ± 2.70	44.36 ± 2.42	0.71	0.48
Mental Health	53.32 ± 1.34	51.32 ± 2.14	54.13 ± 1.74	0.99	0.33
MCS	52.60 ± 1.53	48.95 ± 2.60	54.26 ± 1.86	1.68	0.10

[#] N=42: one subject did not report fall history and was excluded from this analysis

* Indicates significant difference between subjects based on fall history ($p < 0.05$)

** Indicates significant difference between subjects based on fall history after Bonferroni correction ($p < 0.005$)

PCS, physical component summary; MCS, mental component summary

3.3 Association between SF-36v2® Scores and Balance Performance

Overall mean (± SD) scores on balance performance measures were 48.1 (± 6.3) on the BBS, 23.3 (± 4.7) on the Tinetti, and 14.7 (± 7.8) on the TUG. Table 2 shows the relationships between each SF-36v2® domain or summary score and balance performance. There were significant positive associations between six domains and the BBS, and between five domains and the Tinetti. There were significant negative associations between five domains and the TUG. Correlations between the PCS score and all three balance performance measures were moderate to moderately strong and significant (Table 2). There was no relationship between the MCS score and any of the balance performance measures.

Table 2 Relationship between Short Form 36 Item Health Survey (SF-36v2®) scores and balance performance**:** Spearman's rho (*p* value).

SF-36v2® Domain	BBS	Tinetti	TUG
Physical Function	0.75 (*p*<0.01)**	0.71 (*p*<0.01)**	-0.71 (*p*<0.01)**
Role Physical	0.47 (*p*<0.01)**	0.43 (*p*<0.01)**	-0.35 (*p*=0.02)*
Bodily Pain	0.42 (*p*<0.01)*	0.33 (*p*=0.03)*	-0.28 (*p*=0.07)
General Health	0.25 (*p*=0.11)	0.13 (*p*=0.41)	-0.03 (*p*=0.86)
PCS	0.58 (*p*<0.01)**	0.51 (*p*<0.01)**	-0.47 (*p*<0.01)**
Vitality	0.35 (*p*=0.02)*	0.27 (*p*=0.08)	-0.29 (*p*=0.06)
Social Functioning	0.46 (*p*<0.01)**	0.35 (*p*=0.02)*	-0.36 (*p*=0.02)*
Role Emotional	0.34 (*p*=0.03)*	0.36 (*p*=0.02)*	-0.13 (*p*=0.40)
Mental Health	0.31 (*p*=0.41)	0.21 (*p*=0.18)	-0.30 (*p*<0.05)*
MCS	0.22 (*p*=0.15)	0.19 (*p*=0.23)	-0.13 (*p*=0.42)

* Indicates significant correlation between SF-36v2® domain and balance measure ($p < 0.05$)

** Indicates significant correlation between SF-36v2® domain and balance measure after Bonferroni correction ($p < 0.005$)

PCS, physical component summary; MCS, mental component summary

3.4 SF-36v2® Fall Predictive Ability

The multiple regression model was statistically significant, where SF-36v2® summary scores (PCS, MCS) predicted the number of future falls experienced at 12 months (F=4.96, p=0.01, R^2=0.22). Results of the logistic regression indicated that the model fit of the SF-36v2® predictors (PCS, MCS) was good (-2 Log likelihood=47.58) and statistically reliable in distinguishing between future fallers and non-fallers (X^2=8.04, p=0.02). Table 3 shows regression coefficients for each variable in the logistic regression model. The model correctly classified 74.4% of the subjects. Specifically, 89.3% of non-fallers and 46.7% of fallers were classified correctly based on the instrument summary scores.

Table 3 Regression coefficients of variables in the fall status predictive model.

Covariate	*B*	*Wald*	*p*	Odds Ratio	95% CI
PCS	-0.09	5.44	0.02	0.91	0.841 – 0.985
MCS	-0.02	0.36	0.55	0.98	0.913 – 1.050

PCS, physical component summary; MCS, mental component summary

4. Discussion

In this study, the number of subjects who reported a fall history in the previous 12 months (34.9%) was similar to the number of subjects who reported a fall prospectively within the 12-month follow-up period (34.9%), and analogous to fall incidence reported by previous literature [1-3, 27]. Also parallel to previous research [28], the presence of a positive fall history in our subjects was associated with a future fall. Conversely, we did not find differences between fallers and non-fallers in age, gender, number of comorbidities, or number of prescription medications—characteristics commonly identified as fall risk predictors [9, 29, 30]. The relationships between gender and fall risk predictors are nonlinear and complex [31-35]. Our sample was rather small and consisted of more women than men, which may have contributed to the lack of significance between fall status and subject characteristics.

Consistent with previous observations [20, 21], our findings support the association between fall history and perceived health and quality of life. Of interest, we found that the PCS of the SF-36v2®, but not the MCS, exposed relationships between HRQOL and falls, and associations between HRQOL and balance performance. Subjects with a positive fall history scored significantly lower on the PCS. Furthermore, the PCS was significantly correlated with all three well-established balance performance measures: the BBS, Tinetti, and TUG. In contrast, there was no relationship between fall history and the MCS, and no association between the MCS and any of the three balance performance measures.

While the MCS includes aspects of mental health, emotional roles, and social functioning, the PCS emphasizes facets of perceived general health and physical function. Researchers have demonstrated similar relationships between physical or performance-based fall risk factors and HRQOL. Our findings are in line with previous work that revealed that the PCS of the SF-36 exposed a stronger relationship with balance confidence and fear of falling than the MCS [17]. Moreover, scores on two of four PCS domains, in particular—the physical function and bodily pain domains of the SF-36—showed greater declines among subjects with poorer falls self-efficacy [19]. In other work, the PCS of the SF-12, a shortened version of the SF-36, was also reported to strongly correlate with physical measures, including balance and muscle strength [18].

Our findings contribute to previous work by underlining the usefulness of the physical component of HRQOL in the assessment of future fall risk in community-dwelling older adults. Our logistic regression indicated that the PCS and MCS of the SF-36v2®, together as variables in the model, distinguished between fallers and non-fallers prospectively. Evidently, regression coefficients of each variable indicated that the PCS ($p=0.02$), but not the MCS ($p=0.55$), was the driving predictor of future fall status (Table 3).

Study interpretations are to be made with caution. While our sample size provided sufficient statistical power to detect significant differences, our sample size was small, limiting the inclusion of additional variables into the regression model. The purpose of the present study was to assess the predictive ability of a quality of life measure, alone, in predicting future falls. However, it is important to recognize the existence of several other factors previously identified to influence fall risk. These factors, including increasing age, gender, fear of falling, frailty, or fall history, may also influence quality of life [20, 21, 36-40] and, thus, may act as confounding variables in the regression analyses. As such, the statistical outcome presented cannot describe the true causal effect; the intricate relationship among these variables is beyond the scope of this paper.

Additionally, the odds ratio value of the logistic regression model, though statistically significant, was close to one. While the addition of a quality of life measure may be useful in a comprehensive fall risk assessment, the clinical implication of its use alone is unclear and warrants further investigation. Study findings may also be limited by our sample of convenience, in which subjects volunteered to participate. Subjects who chose to participate may have had a stronger interest in learning about their balance and fall risk compared to their peers who did not choose to participate. All subjects were recruited from a single independent living retirement centre in the northwest region of the United States. It may be difficult to generalize our findings to populations in other regions of the United States or to individuals with different subject characteristics. Furthermore, participants' self-report of both fall history and the number of falls over time is an important study limitation. A request to self-recall fall history may lead to recall bias, where the true rate of falls may have been miscalculated [41]. However, when subjects live independently in the community, alternative means of recording falls is difficult. Future research should address these limitations with a larger sample size, and more rigorous methods of calculating falls both retrospectively and prospectively.

5. Conclusions

Overall, our findings suggest that HRQOL, as measured by the SF-36v2®, is lower in older adults with a positive fall history, and lower in those with poorer balance performance. Specifically, we found that the variables predominantly associated with falls and balance performance emphasized the physical components of the SF-36v2®. Our results indicate that the SF-36v2® can prospectively predict both the number of falls and fall status among a sample of community-dwelling older adults. These findings support the notion that HRQOL is an important component of fall risk assessment and should be considered integral to a comprehensive fall risk evaluation.

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Author Contributions

KC designed the study and directed data collection. KC and EC contributed to data analysis and interpretation. EC wrote the manuscript in consultation with KC.

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Competing Interests

The authors have declared that no competing interests exist.

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