Factors associated with decline in physical functional health in a cohort of older women

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Abstract

Objective: to identify minimum criteria to assist the prediction of decline in physical health-related quality of life in the elderly.

Study Design and Setting: participants were women from the Australian Longitudinal Study on Women’s Health, who responded to three separate Surveys conducted in 1996 (when they were aged 70–75 years), 1999 and 2002. Using data from these Surveys, three categories were generated which described current physical health-related quality of life and future physical decline as measured by the physical component summary score (PCS) of the MOS SF-36 quality of life survey.

Results: bivariate analyses reported a large number of variables significantly associated with physical decline (P<0.001), including age, falls, number of diagnoses, symptoms, doctor visits and medications, days spent in hospital, body mass index, living arrangements and social support. Multivariate analyses, using decision tree analysis, identified three items which accurately predicted 76% of the women who would exhibit physical decline according to our definition.

Conclusions: this study identified a number of variables that may be useful in clinical screening for vulnerability to physical decline.

Keywords: physical decline, screening, decision tree

Introduction

Decline in physical function is a common feature of older age and has important outcomes in terms of physical health-related quality of life, falls, health care use, admission to residential care and mortality [1, 2]. However, among individuals of similar chronological age, some individuals appear to be resistant to decline in physical function while others appear more vulnerable [3].

A number of factors have been associated with decline in functional outcome measures (measured in various ways but including disability in activities of daily living, and self-assessed activity limitations). In a systematic review of 78 studies, Stuck et al. [4] found that increased risk of functional decline among community-living older people was associated with cognitive impairment, depression, multiple morbidity, increased and decreased body mass index, lower extremity functional limitation, low frequency of social contacts, low level of physical activity, no alcohol use compared to moderate use, poor self-perceived health, smoking and vision impairment. Physical function contributes to functional health-related quality of life, which includes a subjective sense of physical well-being. Few studies have examined decline in physical health-related quality of life among community-dwelling older people, however, studies of predictors of older people’s self-rated health identified factors such as absence of serious disease [5], low body mass index [6] and a variety of preventive health activities [6].

The aim of this research was to measure decline in physical functional health (as measured by the Short Form-36 Health Survey [7, 8]) among a large cohort of older women as their ages ranged from 73 to 78 years and 76 to 81 years; and to identify a minimum number of items that might be useful in predicting women most at risk of decline in physical functional health. Such items could be used as brief clinical screening tools, so that individuals can be more closely monitored and supported.
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Method

Sample

Women in this study are participants in the Australian Longitudinal Study on Women’s Health [9]. The women were aged from 70 to 75 years when randomly selected from the national Health Insurance Commission database, which covers all people in Australia, for the baseline postal survey in 1996 (Survey 1–S1) [9]. Since S1, respondents have been resurveyed twice: Survey 2 (S2) in 1999 (aged 73–78 years) and Survey 3 (S3) in 2002 (76–81 years) [10].

Identifying information for each woman was matched annually with the National Death Index [11]. Phone calls and correspondence notifying of death or withdrawal (and reason) from the study were also logged. Women were considered to have withdrawn because of ‘frailty’ if they or an informant identified they were ‘too frail’ or otherwise unable to complete the questionnaire because of their decline in physical or mental health.

Measures

Each survey included basic demographic data and items measuring physical, social and mental health and health care use. The main measure of health status used across all three time points was the Medical Outcomes Study SF-36 Health Survey (SF-36) [7, 8] which is a generic profile measure of self-reported health-related quality of life. The SF-36 is a widely used and well-validated health profile that has been extensively reviewed for use with older populations. In a recent structured review of generic self-assessed instruments for older people, Haywood et al. [12] identified the SF-36 as one of three instruments with extensive evidence of internal consistency, test-retest reliability, construct validity, concurrent validity and responsiveness. The SF-36 is recommended where a detailed and broad-ranging assessment of health is required, particularly in community-dwelling older people with limited morbidity [12].

The SF-36 produces eight sub-scales and two summary scores. The measure of interest in this analysis was the Physical Component Summary score (PCS) which reflects performance on three sub-scales (physical functioning, role limitations due to physical problems, bodily pain) and which also incorporates scores from vitality, general health and social functioning sub-scales [7, 8]. A low score on PCS reflects limitations in physical activities (including bathing or dressing), role limitations (problems with daily activities as a result of physical health), severe bodily pain, frequent tiredness, ‘poor’ self-rated health and limitation of social activities due to physical and/or emotional problems [7, 8].

Other measures of interest in S2 had been associated with physical decline in other literature (e.g. [4]) and/or identified by clinicians as important markers of physical functional health in interviews (unpublished data). These measures included: physical factors (body mass index (BMI), physical activity, age, nutritional risk [13], vision, satisfaction with physical ability (item taken from SF-36 physical functioning measure) [14], ability to use public transport, falls and injuries); health service utilisation (days in hospital in the past year, number of prescribed and over-the-counter medications); disease conditions (self-reported doctor-diagnoses including arthritis, diabetes, heart disease, hypertension, stroke, thrombosis, low iron level, asthma, bronchitis/emphysema, osteoporosis, cancer, depression, anxiety and Alzheimer’s/dementia); self-reported symptoms (breathing difficulty, chest pain, tiredness, stiff or painful joints, back pain, foot problems, dysuria, nocturia, urinary urgency, incontinence, constipation, poor memory, clumsiness, dizziness); psychological (attitudes to life including optimism and hardness [15], stress about health, living arrangements and relationships, items from the Centre for Epidemiological Studies Depression scale (CESD) [16]); and social factors (items from the abbreviated Duke’s Social Support Index (DSSI) [17], living alone, availability of instrumental support [18]).

Definitions of physical decline

S2 responses were used to classify women into two groups according to the statistical distribution of PCS scores at S2: those with a PCS score below the 1st quintile (PCS<40.0) (Group 1); remaining women (Group 2). Women in Group 2 were then further classified according to the statistical distribution of the change in PCS scores from S2 to S3: Group 2a—women with a decline in PCS score of greater than 6.6% (2× median percentage change) and a PCS score in S3 below the first quintile for that time point (PCS<38.2); Group 2b—remaining women.

Statistical analysis

Bivariate analyses comparing the three groups of women were conducted using statistical program SAS [19]. Women in Groups 2a and 2b were included in a multivariate decision tree analysis, which was conducted using (Classification And Regression Trees) (CART) software [20] and weighted toward detecting those with physical decline rather than those who maintained good health. To avoid circular analysis, no items from the SF-36 instrument were included.

CART is a ‘decision tree’ algorithm that creates a tree-like structure to describe a data set. The decision tree is created by recursively partitioning the data set into subsets, where the distribution of the outcome variable (Groups 2a and 2b) is successively more homogeneous in the subsets. This procedure is continued on each subset until the minimum subset size (default is five) is reached. From the fully grown tree, a sequence of simpler trees is then constructed by combining subgroups relatively similar to one another. Cross-validation was used to assess the performance of each tree in this sequence. The tree that minimises overall cross-validated relative error estimate and most accurately predicts the outcome is regarded as final.
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Results

S1 included 12,432 women aged 70–75 years. There were 10,434 women who remained in the study at S2, and 8,646 women at S3. A total of 310 surveys were answered by proxy at S2 and 822 at S3. In most instances (67% of proxies at S3), the proxy wrote down the participant’s verbal answers; only a minority of surveys were completed based on the proxy’s judgement of the participant’s condition.

Of the 1,788 older women who completed S2 but did not complete S3, 216 withdrew because they were ‘too frail’ (by their own or an informant’s report) and 474 had died. We analysed information on the 7,025 women who responded to PCS items in both S2 and S3. For these women, mean PCS declined from 51.0 at S1 to 49.9 and 47.4 at S2 and S3.

There were 1,665 (24%) women in Group 1, 557 (8%) women in Group 2a, and 4,803 (68%) women in Group 2b. The distribution of some key variables across these categories is shown in Table 1 and Figure 1.

Many variables were significantly associated with group classification on bivariate analyses ($P < 0.001$). The groups differed in terms of age, symptoms and conditions, health care use and aspects of daily living. The lowest mean number of symptoms and conditions was seen among women in Group 2b, and this group had the lowest prevalence of specific conditions and symptoms. For example, compared to Group 2b, women in Group 2a (who had decline in PCS between S2 and S3) were 2.4 times as likely to have stiff or painful joints at S2. Differences in health care use were significant for number of prescribed medications, number of general practitioner and specialist visits and admission to hospital. There was a clear gradient in health care use with greatest use at S2 being reported by those in Group 1, and lowest use reported by those in Group 2b.

Significant differences between groups were also evident for all items on falls, BMI, satisfaction with physical ability, ability to use public transport, vision and hearing, stress about health, living arrangements and relationships and some items from the abbreviated DSSI. All items on instrumental support, optimism and hardiness, nutrition risk and all items from CESD were also significantly associated with group classification on bivariate analyses (data not shown).

The result for the multivariate decision tree analysis of women in Groups 2a and 2b is shown in Figure 2. The tree identifies three items as important in classifying those in Group 2a and those in Group 2b. According to the tree, the single best way to separate women according to the probability of decline in PCS is to consider their satisfaction with their physical ability: ‘How satisfied are you with your physical ability to do what you want to do?’ Women who were less than very satisfied with their physical ability and were more likely to be in Group 2a.

Among women who were ‘very’ or ‘completely’ satisfied with their physical ability, those who had problems with one or both feet ‘often’ were at greater risk of PCS decline. Among the remainder of the group, further differentiation can be achieved by considering the number of medications, with those who use five or more prescription medications being at risk of physical decline in the next 3 years.

Table 1. Descriptive statistics comparing characteristics at Survey 2 for the three groups of women

<table>
<thead>
<tr>
<th></th>
<th>Group 1 (low PCS at S2)</th>
<th>Group 2a (declining PCS S2–S3)</th>
<th>Group 2b (maintained PCS S2–23)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age: mean (SD)</td>
<td>75.6 (1.5)</td>
<td>75.5 (1.5)</td>
<td>75.4 (1.5)</td>
</tr>
<tr>
<td>No. diagnoses (in past 12 months)</td>
<td>2.5 (1.6)</td>
<td>2.0 (1.4)</td>
<td>1.3 (1.2)</td>
</tr>
<tr>
<td>No. symptoms (in past 12 months)</td>
<td>17.7 (10.0)</td>
<td>14.0 (8.6)</td>
<td>8.7 (7.4)</td>
</tr>
<tr>
<td>Body mass index</td>
<td>26.7 (5.1)</td>
<td>25.8 (5.1)</td>
<td>24.8 (4.1)</td>
</tr>
<tr>
<td>Prescription medications (% taking 5 or more in past 4 weeks)</td>
<td>46</td>
<td>29</td>
<td>12</td>
</tr>
<tr>
<td>No. GP visits (&gt;12 times in past 12 months) (%)</td>
<td>30</td>
<td>19</td>
<td>7</td>
</tr>
<tr>
<td>Specialist visits (in past 12 months) (%)</td>
<td>67</td>
<td>56</td>
<td>41</td>
</tr>
<tr>
<td>Hospital admission (in past 12 months) (% yes)</td>
<td>45</td>
<td>31</td>
<td>21</td>
</tr>
<tr>
<td>Been injured from a fall (% yes)</td>
<td>19</td>
<td>13</td>
<td>10</td>
</tr>
<tr>
<td>Satisfaction with physical ability (% satisfied)</td>
<td>48</td>
<td>80</td>
<td>93</td>
</tr>
<tr>
<td>Ability to use public transport (% yes)</td>
<td>44</td>
<td>65</td>
<td>69</td>
</tr>
<tr>
<td>Vision &amp; hearing (% yes)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Difficulty seeing newspaper print, even with glasses</td>
<td>25</td>
<td>20</td>
<td>10</td>
</tr>
<tr>
<td>Difficulty in hearing a conversation, even with a hearing aid</td>
<td>16</td>
<td>12</td>
<td>9</td>
</tr>
<tr>
<td>Stressed about . . . (% very/extremely stressed)</td>
<td>15</td>
<td>7</td>
<td>2</td>
</tr>
<tr>
<td>Own health</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Living arrangements</td>
<td>3</td>
<td>3</td>
<td>1</td>
</tr>
<tr>
<td>Health of family member</td>
<td>10</td>
<td>10</td>
<td>7</td>
</tr>
<tr>
<td>Family and friends</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>See someone who does not live with you (% none)</td>
<td>9</td>
<td>5</td>
<td>5</td>
</tr>
<tr>
<td>Go to meetings (% none)</td>
<td>42</td>
<td>32</td>
<td>28</td>
</tr>
</tbody>
</table>

All comparisons shown in Table statistically significant $P < 0.001$. 

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The decision tree, as a whole, accurately predicted 423 out of the 557 women in Group 2a (sensitivity = 76%), and 2,815 out of the 4,803 of the women in Group 2b (specificity = 59%). The pre-test probability that women in Group 2 would exhibit significant decline was 10%, and the positive predictive value of the tree (the probability that someone identified by the tree will exhibit decline) was 18%.

Further analysis was undertaken by including women lost to death or classified as ‘too frail’ to participate in Group 2a. A similar decision tree was produced, satisfied with physical ability and the number of medications taken being key decision points. In this alternative analysis, however, feeling depressed, social interaction and volunteer work were also in the tree. This alternative tree had a sensitivity of 70% and a specificity of 56%.

Discussion

Many variables were found to be statistically significantly associated with women’s physical functional health. The value of the CART technique is that it allows for a minimum number of important variables to be identified without losing information to missing data. The analysis also allows assessment of the clinical usefulness of the decision structure in terms of predictive values.

This study incorporated many variables into longitudinal analysis of data from a large sample of women in the...
community. However, some potentially important variables were not available (e.g. observational and clinical data) from the surveys. Another limitation is that some women did not provide data on the outcome variable and so could not be included in the analysis. These women may be more likely to be physically or cognitively disabled. Similarly, women with significant cognitive impairment were unlikely to participate in S1 and are also more likely to be lost to follow-up. A further limitation is the relatively long interval between surveys. The women with decline in PCS scores are likely to be heterogenous in terms of the rate of decline. If the lead time between developing risk factors for physical decline (e.g. symptoms) and the actual decline is less than 3 years, then the power to detect risk factors in these analyses will be reduced.

Results of bivariate analyses are consistent with other studies of factors associated with physical decline. Physical diagnoses such as arthritis (and associated symptoms such as back pain and stiff and painful joints) were strongly associated with physical functional health decline, and women who were already in poor health at S2 (Group 1) had almost twice as many diagnoses as women who maintained good physical functional health (Group 2b). Likewise the number of medications was also associated with decline, whether this association is due to this variable acting as a marker for morbidity or due to the potential for adverse events associated with polypharmacy.

In the decision tree analysis, the predominant variable was the individual’s own rating of satisfaction with their physical ability. Such self-rated health indicators have been shown in other research to be strongly predictive of health outcomes [21]. Problems with feet was another important variable. This symptom may reflect poor circulation or neuropathy due to vascular disease or complicated diabetes. Foot problems may also reflect arthritis, a common cause of physical difficulty.

In its current form, the decision tree is likely to have only limited clinical usefulness. The sensitivity of the tree in predicting declining physical functional health was 76%. However, the positive predictive value of the tree was only 18%, a small gain on the pre-test probability of 10%.

Whether the tree could be improved by the addition of clinical information is open to testing. Potentially, the addition of simple physical tests such as the ‘timed up and go’ or chair stands, or simple cognitive tests such as the Folstein Mini-Mental Status Examination (MMSE) might improve the predictive ability [22]. Performance measures have been shown to provide information beyond that available in a self report [23]. Gill et al. [24] demonstrated
that four timed physical performance tests were predictive of functional decline [25, 26]. However, physical performance measures have not been shown to be strong enough predictors in isolation. Gill et al. [27, 28] showed that a combination of physical performance measures and cognitive status predicted functional decline and also that a reduced six-item set was as useful as the MMSE in this context. Peak Flow could also contribute to predictive ability [29, 30].

Further improvement in clinical usefulness may also be achieved by attempting to predict more imminent decline. In this study, the interval between surveys was set at 3 years: however, for clinical purposes a 3-year lead time may be too long.

**Conclusion**

This analysis of factors associated with physical functional health decline among older women identifies variables that may be included in a brief screening instrument. Further development is necessary to improve predictive ability.

**Key points**

- A majority of women in the study did not experience significant physical decline over the 3 years of follow-up.
- Those who experienced a decline were more likely to have diagnosed conditions and symptoms, used more medications and had higher health care use at baseline.
- An individual’s own rating of satisfaction with their physical ability, problems with feet and, taking five or more medications were the strongest predictors of subsequent decline.

**Acknowledgements**

The Australian Longitudinal Study on Women’s Health was developed by groups of inter-disciplinary researchers at the Universities of Newcastle and Queensland, and is funded by the Australian Department of Health and Ageing. We thank all participants for their valuable contribution to this project. Researchers in the Faculty of Health at the University of Newcastle are also members of the Hunter Medical Research Institute.

Figures show most common diagnoses and symptoms only.

**Conflict of interest statement**

None.

**References**


18. Suurmeijer TPBM, Doeglas DM, Briancon S, Krijnen WP, Lee C, Dobson A, Brown WJ, Bryson L, Byles J, Warner-Smith P Cognitive status predicted functional decline and also that a reduced six-item set was as useful as the MMSE in this context. Peak Flow could also contribute to predictive ability [29, 30]. Further improvement in clinical usefulness may also be achieved by attempting to predict more imminent decline. In this study, the interval between surveys was set at 3 years: however, for clinical purposes a 3-year lead time may be too long.

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Received 8 May 2006; accepted in revised form 2 February 2007