



## Original article

## Functional decline and mortality in long-term care settings: Static and dynamic approach



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## ABSTRACT

**Background/Purpose:** Functional impairment is known to be associated with higher mortality risk and adverse health outcomes. However, little is known about whether functional decline could predict mortality among the elderly in the long-term care setting.

**Methods:** This is a prospective cohort study in two veteran homes in northern Taiwan with active use of the minimum data set (MDS). Evaluation tools retrieved from the MDS, including MDS Resource Utilization Group-III for Activities of Daily Living (RUG-III ADL), MDS Cognitive Scale, MDS Social engagement, triggers for resident assessment protocol (RAP) and Pain scale, were utilized for the analysis.

**Results:** A total of 1125 male participants were included in this study. The mean age of the participants was  $83.1 \pm 5.1$  years, and 65 (5.8%) developed physical functional decline within a 6-month period. Participants with functional decline [odds ratio (OR) 2.305, 95% confidence interval (CI) 1.002–5.303], poor baseline functional status (OR 1.116, 95% CI 1.002–1.242), positive RAP triggers for dehydration (OR 13.857, 95% CI 3.07–62.543), and underlying chronic lung diseases (OR 2.279, 95% CI 1.149–4.522), depression (OR 2.994, 95% CI 1.161–7.721), and cancer (OR 3.23, 95% CI 1.078–9.682) were more likely to have an additional 12-month mortality. By contrast, Parkinsonism (OR 3.875, 95% CI 1.169–12.841), increase in sum of RAP triggers (OR 6.096, 95% CI 2.741–13.562), and positive RAP triggers for cognitive loss (OR 3.164, 95% CI 1.612–6.212) and mood (OR 2.894, 95% CI 1.466–5.71) are strong predictors for functional decline within 6 months.

**Conclusion:** Physical function decline within 6 months predicted the subsequent 1-year mortality, whereas increased sum of RAP triggers and positive trigger for cognitive loss and mood were associated with functional decline.

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## 1. Introduction

Functional deficit, or physical dependence, is a major determinant for short-term mortality and institutionalization among older people because of the increased care need and care complexity.<sup>1–3</sup> Moreover, it is also an important factor for poor quality of life, poor social engagement, and higher healthcare service utilization.<sup>1–3</sup> Longitudinal studies have shown that a rapid decline in physical function is positively correlated with higher risk of mortality,<sup>4–7</sup> whereas limitations in basic activities of daily living (ADLs) and instrumental ADLs were significantly associated with quality of life

and clinical outcome among residents of long-term care facilities (LTCFs).<sup>8,9</sup> Several factors may result in functional limitation, such as aging, being male, malnutrition, comorbidities of cancer, diabetes mellitus, coronary artery disease, cerebrovascular disease, chronic lung disease, and low body mass index (BMI).<sup>10–15</sup> A number risk factors for a deterioration of ADL performance among nursing home residents were described using minimum data set (MDS), including poor balance, incontinence, cognitive impairment, depression, low BMI, loss of daily contact with proxies, and impaired vision and hearing.<sup>8,9,16</sup> Furthermore, a higher sum of MDS resident assessments protocol (RAP) triggers, a proxy indicator of care complexity, is associated with higher risk for physical functional decline and mortality.<sup>7,17</sup>

Most previous studies used the baseline characteristics of LTCF residents to predict their short-term health outcomes; however, it

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should be noted that those baseline conditions might be greatly influenced by recent acute illness or injuries, which may improve shortly after appropriate care. In contrast to the static point of view, the dynamic approach used for fall risk assessment had shown significant improvements in risk estimation. However, only a few studies took the same approach through evaluating changes of individual functional measurements in relation to adverse outcomes. In particular, changing individual RAP triggers to evaluate long-term care needs and functional outcomes has not been reported. The main aim of this study was to evaluate the impact of rapid functional decline and the increase in the sum of RAP triggers on 12-month mortality beyond the baseline functional status of LTCF residents.

## 2. Methods

### 2.1. Participants

Residents of Banciao and Taipei Veterans Homes in northern Taiwan were invited to participate in the study from January 2006 to December 2010. This study is a substudy of the Longitudinal Older Veterans study, which evaluated the benefits of implementing Minimum data set for Nursing Home, Chinese version 2.1, for health management and care planning in Taiwan.<sup>17</sup> The socio-demographic characteristics of the residents of the two veteran homes were similar because of the universal admission criteria. Only data from participants who were older than 65 years and under regular assessment for 18 consecutive months at the same facilities were included for further analysis. Residents were excluded if they were younger than 65 years, in a completely dependent state, or unable to complete the regular assessment in this period. Every participant was interviewed by the research staff in the beginning and then every 3 months in the following period. The study was approved by the Institutional Reviewing Board of National Yang-Ming University, Taipei, Taiwan.

### 2.2. Measures

#### 2.2.1. Physical function

The Resource Utilization Group-III for Activities of Daily Living (RUG-III ADL) version 5.2 was used for physical function assessment.<sup>18</sup> The RUG-III ADL score were retrieved from MDS items for toilet use, transfer, bed mobility, and eating, in the range of 4–18. A higher score means more physical dependence and greater need for assistance, whereas a score of 4 means complete independence.

#### 2.2.2. Cognitive function

Cognitive function in this study was evaluated using the MDS Cognitive Scale (MDS COGS). The MDS COGS were calculated from eight items for cognitive patterns, communication patterns, and physical functioning, and classified all residents into four categories of cognitive status—"intact—mild impairment," "mild—moderate impairment," "moderate—severe impairment," and "severe—very severe impairment"—as previously described.<sup>19</sup>

#### 2.2.3. Social engagement

Social engagement indicates the ability to initiate social interaction and to be receptive to social overtures from others, including the formation of social ties, contact, and interactions. MDS social engagement (SocE) is calculated from the six categories of interaction, planned acts, self-initiated act, own-goal, involvement, and group acts. Each item was scored as present versus absent, and the sum ranged from 0 to 6.<sup>20</sup> A higher MDS SocE score indicated better social engagement and also represents better quality of life.

**Table 1**  
Demographic data and clinical characteristics among veterans home residents.

Variables	Mean $\pm$ SD, or n (%)
Age (y)	83.1 $\pm$ 5.1
Body mass index (kg/m <sup>2</sup> )	23.7 $\pm$ 3.5
Six-month ADL decline	65 (5.8)
Twelve-month mortality	113 (10)
Education (y)	
<6	778 (71.4)
6–9	278 (25.5)
>9	33 (3)
MDS COGS	
Intact—mild	965 (86.5)
Mild—moderate	106 (9.5)
Moderate—severe	42 (3.8)
Severe—very severe	3 (0.3)
Pain scale	
No pain	689 (61.6)
Less than daily pain	285 (25.5)
Mild—moderate daily pain	135 (12.1)
Severe daily pain	9 (0.8)
Baseline RUG-III ADL	4.6 $\pm$ 1.9
Baseline SocE	1.7 $\pm$ 1.3
Comorbidities	
Amputation	12 (1.1)
Anxiety	8 (0.7)
Arthritis	171 (15.2)
Cancer	38 (3.4)
Congestive heart failure	15 (1.3)
Chronic lung disease	146 (13.0)
Cerebrovascular disease	86 (7.6)
Dementia	69 (6.1)
Depression	42 (3.7)
Diabetes	225 (20.0)
Deep venous thrombosis	3 (0.3)
End-stage renal disease	14 (1.2)
Hip fracture	12 (1.1)
Hypertension	596 (53)
Osteoporosis	12 (1.1)
Peripheral arterial occlusive disease	5 (0.4)
Parkinsonism	40 (3.6)
RAP triggers	
Delirium	25 (2.2)
Cognitive loss	379 (33.7)
Visual function	559 (49.7)
Communication	382 (34.0)
Rehabilitation needs	799 (71.0)
Urinary incontinence	186 (16.5)
Psychosocial well-being	611 (54.3)
Mood states	180 (16.0)
Behavior symptoms	18 (1.6)
Activities	842 (74.8)
Falls	355 (31.6)
Nutrition status	66 (5.9)
Dehydration	13 (1.2)
Dental care	807 (71.7)
Pressure sore	154 (13.7)
Psychotropic drugs	704 (62.6)
Physical restraint	42 (3.7)
Sum of RAP triggers at baseline	5.4 $\pm$ 2.5
Increase in sum of RAP triggers within 6 mo	520 (46.2)

ADL = activity of daily living; MDS COGS = Minimum Data Set Cognitive Scale; RAP = resident assessment protocol; RUG-III ADL = Resource Utilization Group-III for Activities of Daily Living.

#### 2.2.4. Pain assessment

Pain scale is categorized for both frequency and intensity constructed from MDS items as four degrees of severity: "no pain," "less than daily pain," "mild/moderate daily pain," and "severe daily pain."<sup>21</sup>

#### 2.2.5. RAP triggers

RAPs are the fundamental components established from different combinations of MDS items to evaluate the care problems of residents.<sup>22</sup> A total of 18 RAP triggers for different situations were

included in MDS, such as delirium, cognitive loss, visual function, communication, rehabilitation needs, urinary incontinence, psychosocial well-being, mood, behavior, activities, falls, nutrition, enteral feeding, dehydration, dental care, pressure ulcers, psychotropic drug use, and physical restraint. The sum of RAP triggers was considered an important indicator for care complexity and a predictor for mortality.<sup>7,17</sup>

### 2.2.6. Outcome measures

A concept of dynamic functional change within the past 6 months was used in this study to evaluate the 12-month mortality risk afterward. A recent decliner was defined as a participant with an increase in RUG-III ADL score of at least 1 point in the past 6 months, and a nondecliner was defined as having a stable or an improved RUG-III ADL score during the same period. All residents were followed for 12 months to evaluate their mortality status. Changes in the sum of RAP triggers within 6 months were included in the analysis.

### 2.2.7. Statistical analysis

Data in the text and tables are expressed as mean  $\pm$  standard deviation or percentage when appropriate. All analyses were performed with the Statistical Package for the Social Sciences for Windows, version 18.0 (SPSS, Inc., Chicago, IL, USA). Comparisons between continuous variables were done using the Student *t*-test or Mann–Whitney *U*-test, whereas comparisons between categorical variables were done with the Chi-square test or Fisher exact test when appropriate. Variables with a *p* value  $<0.1$  in univariate analyses were included in a logistic regression model using the forward stepwise method. As the sum of RAP triggers had a strong association with both functional decline and mortality, it was removed in the logistic regression model of 12-month mortality because of the potential confounding effect. For all tests, a *p* value  $<0.05$  was considered statistically significant.

## 3. Results

Of the study participants ( $n = 1380$ ), 31 were excluded for being less than 65 years old or having a completely dependent status (RUG-III ADL score of 18) in the beginning of the study. A total of 151 individuals were excluded during the first 6 months for lost follow-up. Another 73 were excluded for lost follow-up, for reasons such as moving out of the veteran home. A total of 1125 participants were recruited for analysis in this observational cohort study. All participants were males with a mean age of  $83.1 \pm 5.1$  years, and their demographic profile and clinical characteristics are summarized in Table 1. Overall, 65 (5.8%) participants were categorized as functional decliners. A total of 113 (10%) residents died during the 12-month follow-up. Associative factors for 12-month mortality in the univariate analysis included BMI, baseline physical function, early functional decline, underlying disease of cancer, chronic lung disease, depression, and Parkinsonism, and positive RAP triggers of cognitive loss, urinary incontinence, nutrition status, dehydration, pressure sore, and use of psychotropic drugs (Table 2).

Participants with recent functional decline [odds ratio (OR) 2.305, confidence interval (CI) 1.002–5.303,  $p = 0.049$ ], higher baseline RUG-III ADL score (OR 1.116, CI 1.002–1.242,  $p = 0.046$ ), positive RAP triggers for dehydration (OR 13.857, CI 3.07–62.543,  $p = 0.001$ ), and underlying disease of depression (OR 2.994, CI 1.161–7.721,  $p = 0.023$ ), chronic lung disease (OR 2.279, CI 1.149–4.522,  $p = 0.018$ ), and cancer (OR 3.23, CI 1.078–9.682) were significantly more likely to die in the 12-month follow-up (Table 3).

Comparisons between recent functional decliners and nondecliners revealed that BMI, baseline MDS COGS status, baseline social engagement, underlying disease of dementia, depression,

**Table 2**

Characteristics between surviving and deceased participants by univariate analysis.

Variables	Deceased <i>n</i> = 113	Surviving <i>n</i> = 1012	<i>p</i>
Age (y)	83.7 $\pm$ 5.4	83.0 $\pm$ 5.1	0.154
Body mass index (kg/m <sup>2</sup> )	22.6 $\pm$ 3.8	23.7 $\pm$ 3.4	0.01*
Baseline RUG-III ADL	5.1 $\pm$ 2.7	4.5 $\pm$ 1.8	0.017*
ADL decliner	15 (13.3)	50 (4.9)	$<0.001^*$
Comorbidities			
Cancer	12 (10.6)	26 (2.6)	$<0.001^*$
Chronic lung disease	22 (19.5)	124 (12.3)	0.03*
Depression	9 (8.0)	33 (3.3)	0.03*
Parkinsonism	10 (8.8)	30 (3)	0.004*
RAP triggers			
Cognitive loss	48 (42.5)	331 (32.7)	0.037*
Visual function	66 (58.4)	493 (48.7)	0.051
Urinary incontinence	30 (26.5)	156 (15.4)	0.003*
Nutrition status	15 (13.3)	51 (5)	$<0.001^*$
Dehydration	5 (4.4)	8 (0.8)	0.006*
Pressure sore	24 (21.2)	130 (12.8)	0.014*
Psychotropic drugs	88 (77.9)	616 (60.9)	$<0.001^*$
Baseline sum RAP	6.1 $\pm$ 2.4	5.4 $\pm$ 2.5	0.002*

\* $p < 0.05$ .

ADL = activity of daily living; RAP = resident assessment protocol; RUG-III ADL = Resource Utilization Group-III for Activities of Daily Living.

hypertension, and Parkinsonism, RAP triggers for cognitive loss, visual function, rehabilitation needs, urinary incontinence, mood states, behavior symptoms, falls, pressure ulcers, psychotropic drug use and physical restraint, baseline sum of RAP triggers, and increased sum of RAP triggers were significantly associated with recent functional decline (Table 4). Moreover, participants with an underlying disease of Parkinsonism (OR 3.886, CI 1.172–12.88,  $p = 0.026$ ), baseline RAP triggers of cognitive loss (OR 3.178, CI 1.619–6.238,  $p = 0.001$ ) and mood problems (OR 2.898, CI 1.468–5.719,  $p = 0.002$ ), and increased sum of RAP triggers (OR 6.091, CI 2.738–13.549,  $p \leq 0.001$ ) were significantly more likely to experience functional decline after enrolment (Table 5).

## 4. Discussion

Poorer current physical function and the presence of recent functional decline were both significant predictors for 12-month mortality among older men living in veteran retirement communities. Although comorbidity of cancer and chronic lung disease were also major factors for mortality, physical dependence, and recent functional decline remained independently associated with 12-month mortality after adjustment for comorbidities. Previous studies have shown that poor baseline ADL and presence of physical functional decline could predict long-term mortality in the elderly population.<sup>23–25</sup> In addition, functional decline was also strongly associated with short-term mortality of older patients discharged from hospitals.<sup>26</sup> Even a part of recent functional

**Table 3**

Predictors of 12-month mortality for residents after 6 months' admission.

Variables	Odds ratio	95% confidence interval	<i>p</i>
Age (y)	1.008	0.956–1.062	0.777
Body mass index (kg/m <sup>2</sup> )	0.929	0.855–1.008	0.077
Depression	2.994	1.161–7.721	0.023*
Chronic lung disease	2.279	1.149–4.522	0.018*
Cancer	3.23	1.078–9.682	0.036*
Baseline RUG-III ADL	1.116	1.002–1.242	0.046*
ADL decline	2.305	1.002–5.303	0.049*
RAP trigger for dehydration	13.857	3.07–62.543	0.001*

\* $p < 0.05$ .

ADL = activity of daily living; RAP = resident assessment protocol; RUG-III ADL = Resource Utilization Group-III for Activities of Daily Living.

**Table 4**  
Associated factors between ADL decliner and ADL non-decliner by univariate analysis.

Variables	Decliner (n = 65)	Non-decliner (n = 1060)	p
Age (y)	84.2 ± 5.6	83 ± 5.1	0.084
Body mass index (kg/m <sup>2</sup> )	22.6 ± 3.9	23.7 ± 3.4	0.026*
Baseline RUG-III ADL	5.1 ± 2.7	4.5 ± 1.9	0.127
Twelve-month mortality	15 (23.1)	98 (9.2)	<0.001*
MDS COGS			
Intact–mild	40 (61.5)	925 (88)	<0.001*
Mild–moderate	19 (29.2)	87 (8.3)	
Moderate–severe	5 (7.7)	37 (3.5)	
Severe–very severe	1 (1.5)	2 (0.2)	
Pain scale			
No pain	36 (55.4)	653 (62)	0.077
Less than daily pain	15 (23.1)	270 (25.6)	
Mild/moderate daily pain	13 (20.0)	122 (11.6)	
Severe daily pain	1 (1.5)	8 (0.8)	
Baseline SocE	1.2 ± 1.1	2 ± 1.3	<0.001*
Comorbidities			
Arthritis	5 (7.7)	166 (15.7)	0.082
Cerebrovascular disease	9 (13.8)	77 (7.3)	0.086
Dementia	12 (18.5)	57 (5.4)	<0.001*
Depression	8 (12.3)	34 (3.2)	0.002*
Hypertension	26 (40.0)	570 (53.8)	0.031*
Parkinsonism	7 (10.8)	33 (3.1)	0.006*
RAP triggers			
Delirium	4 (6.2)	21 (2.0)	0.051
Cognitive loss	44 (67.7)	335 (31.6)	<0.001*
Visual function	40 (61.5)	519 (49.0)	0.049*
Communication	29 (44.6)	353 (33.3)	0.062
Rehabilitation needs	55 (84.6)	744 (70.2)	0.013*
Urinary incontinence	22 (33.8)	164 (15.5)	<0.001*
Mood states	24 (36.9)	156 (14.7)	<0.001*
Behavior symptoms	4 (6.2)	14 (1.3)	0.017*
Falls	30 (46.2)	325 (30.7)	0.009*
Pressure sore	17 (26.2)	137 (12.9)	0.003*
Psychotropic drugs	55 (84.6)	649 (61.2)	<0.001*
Physical restraint	7 (10.8)	35 (3.3)	0.008*
Sum of RAP triggers at baseline	7.2 ± 2.7	5.3 ± 2.5	<0.001*
Increase in sum of RAP triggers within 6 mo	55 (84.6)	465 (43.9)	<0.001*

\*p < 0.05.

ADL = activity of daily living; MDS COGS = Minimum Data Set Cognitive Scale; RAP = resident assessment protocol; RUG-III ADL = Resource Utilization Group-III for Activities of Daily Living.

decline among residents might be influenced by other acute illness or exacerbation of underlying chronic conditions; however, most attributable causes to recent functional decline should result from the geriatric syndrome. In this study, it is clearly shown that both physical dependence and recent functional decline were major factors for 12-month mortality, which was compatible with the terminal trajectory of physical function in the frail and diseased population.<sup>6</sup> Developing strategies to manage physical dependence and to prevent functional decline is important to prevent premature mortality in this setting.

**Table 5**  
Risk factors associated with functional decline after adjustment by age and body mass index.

Variables	Odds ratio	95% confidence interval	p
Age (y)	1.043	0.979–1.111	0.194
Body mass index (kg/m <sup>2</sup> )	0.929	0.845–1.021	0.127
Parkinsonism	3.875	1.169–12.841	0.027
RAP trigger for cognitive loss	3.164	1.612–6.212	0.001
RAP trigger for mood	2.894	1.466–5.71	0.002
Increase in sum of RAP within 6 mo	6.096	2.741–13.562	<0.001

\*p < 0.05.

RAP = resident assessment protocol.

Increased sum of RAP triggers was positively correlated to recent functional decline, and may subsequently increase mortality risk. Furthermore, the dynamic increase in the sum of RAP triggers outweighed the importance of baseline sum of RAP triggers in this study related to functional decline. The sum of RAP triggers was believed to be a good indicator for the burden of care need and care complexity of individual residents, and it might be a better indicator for disease burden and severity than the other comorbidity indices based on MDS implementation. In the previous Longitudinal Older Veterans study results, the sum of RAP triggers showed a positive correlation with functional decline in an 18-month period and was associated with higher 12-month mortality risk.<sup>7,17</sup> Increase in the sum of RAP triggers suggested increased care burden and deterioration of physical independence, and was shown to have a good correlation with the trajectory of physical functional decline. Thus, a multidisciplinary approach should be used to appropriately manage and reverse each individual RAP trigger early and effectively to prevent increasing triggers of RAPs.

Positive RAP trigger for baseline dehydration was also found to be a strong predictor for additional 12-month mortality. Dehydration was not a rare problem to residents in LTCFs, and it affected the homeostatic status of individual organs and systems.<sup>27</sup> It was proven to be a major risk factor for morbidity and mortality because of related electrolytes and fluid imbalance among the elderly with impaired physiological reserve and reduced compensatory ability.<sup>28</sup> Many studies revealed that dehydration was a significant factor in predicting mortality among nursing home residents or in populations with dementia.<sup>29–32</sup> Unlike other factors such as underlying diseases or necessary medications, dehydration should be a reversible cause for mortality, and more attention should be paid to early identification and intervention.<sup>28</sup> The systemic approach and adequate assessment of fluid status would facilitate early and proper intervention of hydration among the elderly.<sup>28,32–34</sup>

Residents with depression were revealed to have a higher risk for mortality in our study, and positive RAP trigger for mood state was also found to be an associated factor for functional decline. Depression has been recognized as a major factor that worsened health outcomes of diseases and promoted disabilities, and was also revealed as a factor for functional decline by previous studies.<sup>35–37</sup> However, depression was influenced by various underlying diseases and socioeconomic statuses, and thus the association between depression and mortality was still controversial.<sup>38</sup> But it was generally believed that the diagnosis of depression was less appropriate, and the prevalence of depression was underestimated especially in the geriatric population.<sup>35–38</sup> As subsyndromal depression in the elder population is estimated to be 8–9% in Asia, early detection for depression by effective tools and adequate treatment for both depression and associated factors were of great importance.<sup>39–41</sup>

In addition to the neurological disease of Parkinsonism, positive RAP trigger for cognitive loss was identified to be a risk factor of functional decline. Cognitive impairment or dementia was proven to affect the deterioration of physical function in various durations, either due to behavior and psychological symptoms, or other acute illness associated with dementia.<sup>7,16,42</sup> Residents with cognitive impairment would have less ability to cope with environmental changes or cooperate with active intervention programs, and thus had higher risk of developing disabilities and physical dependence.<sup>7,8,43,44</sup> Multidimensional programs including reminiscence therapy and group exercise regimens might benefit cognitive impairment and further prevent advanced functional decline.<sup>45–47</sup>

Although this study showed that ADL decline was a risk factor of short-term mortality, there are still several limitations. First, the demographic characteristics of the study participants were

homogeneous, especially in terms of sex, which would limit the generalizability of these study results to the common population. However, these findings should still be applicable to residents hosted in long-term care settings. Second, this study is mainly an observational study and thus the effectiveness of intervention programs for each reversal of modifiable risk factors would prevent functional decline and reduce mortality. Further multidisciplinary intervention programs are needed to clarify whether change of modifiable risk factors would improve functional status and reduce mortality. Third, residents who died within the first 6 months were not included for analysis, and thus there might be bias related to a better health status among the remaining residents. However, an analysis of the baseline profile among deceased individuals within 6 months and those included in our study showed no significant difference in each category. Thus, we believed the factors distributed among different groups should not be disregarded after including those deceased individuals.

## 5. Conclusions

Functional decline independently predicts additional 12-month mortality among LTCF residents, whereas the increased sum of RAP triggers as well as a positive trigger for cognitive loss and mood were associated with functional decline. The implementation of an active screening strategy for RAP triggers and adequate interventional programs before the true development of functional decline was suggested.

## Conflicts of interest

The authors have no conflicts of interest relevant to this article.

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