Can the International Classification of Functioning, Disability and Health (ICF) be used to understand risk factors for falls in older Australian women?[*]

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ABSTRACT

Purpose: To evaluate the relevance and accuracy of determining and predicting risk factors for falls in older women using the International Classification of Functioning, Disability and Health (ICF). Methods: We tested the accuracy of the ICF against risk of falls amongst 568 community dwelling participants of the Australian Longitudinal Survey on Women's Health (ALSWH). We linked health-related variables to the ICF using ten linking rules. The logistic regression analysis evaluated the relationship between the variables and the outcome of falls. Self-report surveys measured daily functioning, health service use, medications, housing and social support. Results: Variables aligned with the ICF components of body function, health conditions, environment, activity and participation (ADL/IADL), and general health were significantly associated with falls. Discussion and conclusion: Mapping ALSWH health-related data to ICF components identified significant risk factors for falls are related to health conditions, functional limitations and home hazards. Biopsycho-social approaches guided by the ICF framework are crucial for fall prevention.

Keywords: Accidental Falls; Home Hazards; Activities of Daily Living; Participation; Occupational Therapy

1. INTRODUCTION

Fall is a major source of morbidity and mortality in older people. Preventing falls is a key health priority. Fall is the second leading cause of accidental or unintentional injury deaths worldwide [1]. Injuries from falls contribute to increased disability and mobility limitations for older people, and therefore, as the proportion of the aged population increases, the research of the risk factors for falls is becoming increasingly important. The cost of hospitalizations due to fall related injury for people aged 65 and over is projected to increase to US $240 billion by the year 2040 [2]. Due to the complexity of risk factors for falls, it is crucial to refine conceptual and methodological frameworks for understanding and predicting falls in the population to aid the formulation of more effective fall interventions. One such framework which may be applied to understanding and predicting risks of falls is the International Classification of Functioning, Disability and Health (ICF) [3].

The ICF is a classification system that documents the complex interactions of a person with his physical, social and psychological environments, and how this interaction affects his health status [3-5]. Together with the ICD10 [6], the World Health Organisation's diagnostic epidemiological, clinical and health management classification system, the ICF can describe health for an individual or a population and identify relationships between factors that are known to contribute to falls, or assist in detecting those most at risk [7]. The level of physical functioning experienced by an individual is an important factor in falls. The ICF's emphasis on personal functioning—on how an individual engages in activities and participates in society in the context of environmental and

personal factors [3], and the dynamic interaction between health states, the person and his/her environment [3], makes it particularly suitable for extending understandings of falls and falls risk. As a classification framework for fall prediction and intervention, the ICF can conceivably provide an inter-professional scientific basis for understanding and studying fall behaviour and risk, and ensure that important concepts are identified and measured.

The ICF allows a comprehensive study of fall risk that includes medical, social and psychological risk factors. As fall risk is multidimensional, the ICF is appropriate to systematically investigate falls in the clinical practice [8]. Further, the ICF has already been embraced across a number of falls-related disciplines, such as occupational therapy and rehabilitation [7,9], but has not been specifically related to fall risk. The interactions between the ICF components are reciprocal. Therefore, the ICF accommodates the dynamic interactions underpinning fall risk, so that any change in one of the ICF components can influence other interactions within the framework. In a study of the ICF and clinical assessment measures in relation to falls following stroke [7], the ICF was found to match the multidimensional nature of fall risk. However, this relationship was not empirically tested. Furthermore, little evidence exists on how to reliably map the ICF to fall risk, or whether an analysis of fall risk using the ICF components is able to confirm the theoretical assumptions underpinning the ICF [10].

The Australian Longitudinal Study on Women's Health (ALSWH) is well positioned to explore the prevalence of falls and serious injury among a large sample of older women with varying degrees of health, wellbeing, mobility and functional capacities or limitations and disability within the Australian community, and to observe and study the antecedents and outcomes of falls over the course of the study [11]. An exploratory cross-sectional study of the baseline older cohort (n = 12,000) of the ALSWH demonstrated that serious falls were significantly associated with the physical component score of the SF36 (Short-form-36 Health Survey) [12], taking drugs for nerves, having had a serious life event other than a fall in the previous year, and feeling dejected [11]. These results suggested that psychological, social, and occupational factors consistent with the ICF were important to understand serious falls in older women. However, previous studies have argued that the ICF is limited by its failure to meaningfully address the influence of personal factors such as socioeconomic status and gender which are critical to understanding the lives of individuals [13], and by inherent difficulties such as those posed by a lack of differentiation between conceptual boundaries, for example, the boundaries between the concepts of Participation and Activity [4,14]. Further, it is argued that it is

necessary to clarify these boundaries for the ICF to be scientifically useful for the empirical research [4]. We sought to map risk factors for falls (measured in the ALSWH) to the ICF, and to determine whether this conceptual model predicted falls statistically significantly.

2. METHOD

2.1. Data Collection

Participants in this study were drawn from the Australian Longitudinal Study on Women's Health (ALSWH), a population-based study of changes in health and wellbeing of three different age-cohorts of women living in Australia. The sample was randomly selected from the Medicare Australia database, which is the universal provider of health insurance in Australia [15], and surveys have been conducted at 3-yearly intervals since 1996. The study was approved by the University of Newcastle Human Research Ethics Committee. Further details on the ALSWH are available from the website, www.alswh.org.au. For this study, 650 women were randomly selected from ALSWH participants who were born in 1921-1926, and who had completed Survey 3 in 2002.

Women in this sub-sample were invited to complete a postal survey collecting additional falls information including the Modified Falls Efficacy Scale [16], Fear of Falling scale [17,18], the Home Falls and Accidents Screening Tool (HOME FAST-SR) for measuring home hazards [19], and use of walking aids, and activities of daily living (Lambeth Disability Scale) [20]. This survey supplemented the data collected within the main ALSWH surveys known to be significantly related to falls. The outcome of falls was assessed in the sub-study and again in Survey 4 (2005) of the main study from the question: *In the last 12 months have you had a fall to the ground* (*Yes, No*). This self-report item has been shown to have reasonable sensitivity and specificity when compared with falls calendars [21].

2.2. Mapping to the ICF

Items included in the four main surveys and sub-study were mapped to the corresponding ICF components using ICF definitions (but not the levels of classification) [3] and the linking rules developed by Cieza [22,23]. These linking rules have been used in many studies [24-27] and were the only available tool to use in assigning the ALSWH survey items to the ICF components. Initial mapping was done by two of the authors who were occupational therapists (AM, LM) according to their interpretations of the meaning of the ICF and the linking rules. Demographic information, use of health services, lifestyle factors and living arrangements were mapped to personal factors, despite these being unclassi-

fied within the ICF [3,28].

2.3. Longitudinal Analysis

Univariate analyses (chi-square and t-tests) were applied to assess associations between the variables aligned to the ICF and self-reported falls at Survey 4. Explanatory variables were selected as those items measured on the sub-study or on the most recent survey prior to the sub-study. Most variables were measured at Survey 3 but some variables were measured at Survey 2 and education and country of birth were measured at Survey 1 (See **Table 1**). Correlation matrices [29] were constructed to identify highly correlated explanatory variables. Where variables were highly correlated, the variable most strongly associated with falls at the univariate level was retained for inclusion in the multivariate modelling.

Logistic regression was used to construct sub-models of factors associated with falls at Survey 4 for each ICF component. Variables with $P \leq 0.3$ at the univariate level were included in multivariate analyses for each sub-model, with backward stepwise removal of variables [30]. A final composite model was constructed by systematically combining each sub-model into a forward stepwise regression model-building process in order of the strongest Akaike Information Criteria (AIC) [31] for each sub-model. The composite model examined statistically adjusted effects of the sub-models on the log odds of falls. A total of eight steps were conducted to create the final composite model from the sub-models. Statistical interactions between the strongest variables from each sub-model were also explored. All these analyses were performed by Stata v8.2 [32] (StataCorp, 2004) and SAS v9.1 [33]. (SAS Institute, 2007).

3. RESULTS

3.1. Results of the Mapping Process

Table 1 shows a summary of the item categories contained within the four surveys of ALSWH, and their relationship to the ICF components after the mapping process was completed. Some scale items appear in multiple components of the ICF, due to the nature of each scale item.

3.2. Sub-Study Survey and Cross-Sectional Analysis

Out of the 650 surveys that were mailed out to the ALSWH participants, 568 surveys were returned (a response rate of 87.4%). The demographic characteristics of sub-study participants are presented in **Table 2**. The mean age of participants was 79.7 years, and most participants were widowed and lived alone in their home. The sub-study sample was representative of the wider

ALSWH population. The outcomes of the additional falls variables included in the sub-sample survey are presented in **Table 3**. Generally, participants demonstrated relatively high levels of falls self-efficacy, low rates of functional disability, moderate numbers of home hazards, low levels of mobility aid usage and low rates of fear of falling.

3.3. Multivariate Longitudinal Analysis

The prevalence of falls experienced in the previous year at survey 4 was 20% (n = 103). According to the AIC [31] the strongest sub-model was for health conditions (AIC 458.6), followed by body function (AIC 463.5), personal factors (AIC 472.3), environmental factors (AIC 475.8), general health (AIC 501.8), activity and participation (AIC 507.6), not-covered (AIC 520.7). The final composite model (step 8) is presented in **Table 4**.

After adjusting for all variables in the sub-models, the final composite model shows that participant *health conditions* significantly associated with falls were low iron levels and cataracts with diabetes being protective for falls. Women reporting a "major illness/injury in last three years" were about three times more likely to have a fall and those reporting "most time spent in chair/bed" were about twice as likely to have fall, after adjusting for all other variables.

The only items related to ICF components significantly associated with falls were using medication for high blood pressure (*body functions*), activities of daily living and instrumental activities of daily living as measured by the Lambeth Disability Scale (*activity and participation*) [20], and home hazards as measured by the self-rated version of the Home Falls and Accidents Screening Tool (HOME FAST-SR) (*environment*) [19].

In order to check the interaction terms, three significant variables from the strongest ICF model component "health condition" were assessed with the "HOME FAST-SR Score" from the environmental component and with the "Lambeth Disability Scale" from the activity & participation ICF component. Checking the model using the Wald Chi Squared test revealed that none of the interactions were significant.

4. DISCUSSION

4.1. Consistency of Identified Risk Factors for Falls with Previous Research

The findings have confirmed many of the significant risk factors for falls in community populations, whilst other risk factors have not been confirmed with this sample. This study found cataracts were related to falls, consistent with other studies indicating visual problems

Table 1. Summary of the ALSWH items in the surveys (1 - 3 and sub-study) mapped to the ICF.

ICF component: Health Condition/General health		
Survey items and item categories	S1 –S3 surveys (* = all surveys)	Sub-study
Using health services:		
Fracture as a result of a fall	*	
Hospital admission	*	
Medical attention after fall/accident	(S2 & 3)	*
Operation/procedure		
Slip/trip/fall/accident (S2 & 3)	(S2 & 3)	*
SF36: #		
General health	*	
Daily functioning:		
Confined to chair	(S3)	
Eating habits #	(S1 & 2)	
Satisfaction with physical ability	(S3)	
Stress#	(S1 & 2)	
Life events #	(S1 & 2)	
ICF component: Body functions and structures		
Fear of falling		*
SF36: #		
Role emotional	*	
Social functioning	*	
Pain index	*	
Mental health	*	
Vitality	*	
Using health services		
Medications	*	
Functioning:	(S2)	
Depression	(S2 & 3)	
Disability # Memory Assessment Clinic—Q (MACQ)	(S3)	
Sleeping problems		
Stress#	(S2 & 3)	
Symptoms	(S1 & 2)	
	*	
Elder abuse scale #	*	
ICF component: Activity and Participation		
Modified Falls Efficacy Scale		*
Lambeth Disability Scale		*
SF36:#		
Physical functioning	*	
Role physical/emotional	*	
Social functioning	*	
Life events #	*	
Healthy lifestyle:		
Eating habits #	(S1 & 2)	
Physical activity	*	
Time spent sitting down	(S3)	
Functioning		
Able to use public transport	(S2& 3)	
Disability #	(S2 & 3)	
Need help travelling to places	(S2 & 3)	
Activities		
Sharing tasks #	(S1)	
Stress reduction activities	(S1)	
Time pressure	(S2)	

Continued

ICF component: Environmental Factors		
Survey items and item categories	Survey items and item categories	Survey items and item categories
Home Falls and Accidents Screening Tool—SR		*
Using health services:		
GP cost	(S2 & 3)	
GP satisfaction	(S1)	
Health service access	(S2 & 3)	
Life events #	*	
Daily life:		
Assistance from organizations	(S2 & 3)	
Help with daily tasks	(S2)	
Main means of transport	(S3)	
Need for care	(S2 & 3)	
Problems with transport	(S2 & 3)	
Public transport availability	(S2 & 3)	
Home and neighbourhood:		
Housing	(S2 & 3)	
Neighbourhood	(S2)	
Pets	(S2 & 3)	
Source of income	(S2 & 3)	
Social support:		
Duke Social Support Index	*	
Elder abuse scale #	*	

#indicates that variables have items allocated across more than one ICF component.

Table 2. Demographic characteristics of participants (N = 568) compared to the ALSWH reference population (N = 8418).

	Sub-study (N = 568)	ALSWH population at survey 3 (N = 8418)
Marital Status:		
Married	42%	44%
Widowed	48%	47%
Other	10%	9%
Lives alone	52%	47.5%
State of residency		
NSW	37%	34%
Victoria	23%	25%
Queensland	18%	18%
South Australia	9%	10%
Western Australia	8%	8%
Other	5%	5%
Location		
Rural	59%	55%
Urban	39%	43%
Remote	2%	2%
Type of Housing		
House	73%	69%
Flat/Unit/Apartment	17%	21%
Retirement village	9%	8%
Other	1%	1%

are an important risk factor for falls [34-38]. Harwood [38] reported a reduction in the rate of falls for those who received cataract surgery for the first eye, whereas surgery on a second eye has not been reported to reduce the rate of falls [39]. The finding that low iron levels increased fall risk is also consistent with other studies [40.41]. The finding that high blood pressure medication increases the risk of falls is less straightforward, as this could be related to the underlying pathology of higher blood pressure or the effects of the medication, where antihypertensive (alpha blockers) drugs may increase the risk of falls [42].

Table 3. Fall-related measures used in the sub-study survey (N = 568).

Measure	Mean Score	95% C.I
Modified Falls Efficacy Score (n = 541) *Possible score 0 - 150* *Higher scores indicate higher falls self-efficacy*	131.6	129.4 - 133.7
Lambeth Disability Scale (n = 553) *Possible score = 0 - 20* *High scores indicate increased disability*	2.37	2.1 - 2.6
Home Falls and Accidents Screening Tool HOME FAST –SR (N = 568)	9.39	9.1 - 9.7
	%	n
Uses a walking stick for mobility	11%	63
Fear of falling Very Afraid	4%	20
Fairly Afraid	9%	48
A little Afraid	52%	282
Not at all Afraid	36%	194

Table 4. Significant variables related to the outcome of falls at S4 within each component of the ICF in the final composite model (N = 453)[*].

ICF component	Variable	Odds Ratio (95% CI)
Health conditions and general health	Diabetes	0.14 (0.04 - 0.55)
	Low iron level	2.00 (1.03 - 3.91)
	Cataract	2.06 (1.19 - 3.55)
	Major illness/injury in last 3 years	2.91 (1.45 - 5.84)
	Most time spent in chair/bed	1.99 (1.14 - 3.49)
Body systems and structures	High blood pressure medication	1.71 (1.01 - 2.88)
Activity and participation	Lambeth Disability Scale	1.09 (1.01 - 1.17)
Environmental factors	HOME FAST—SR score	1.11 (1.02 - 1.20)

[*]N = 453 due to missing data on some items included in the models.

One unanticipated finding was that having diabetes was a protective risk factor for falls for these women. This may be due to the adjustment of different variables (such as cataract) in the final model, and may represent the main mechanism by which diabetes results in falls. Furthermore, 22% of diabetics in the ALSWH study were controlled by diet or exercise alone and these women may have fewer complications that could have contributed to a falls. In addition, women with diabetes may have visited their physician or other health care professional more frequently, placing them in a better position to access services that would also protect them from falls. Findings from other research is mixed, with some studies concluding that diabetes is a positive risk factors for falls, especially for people who are insulin dependent [43] with other studies concluding that diabe-

tes is not a significant factor contributing to falls [44,45].

The identification of risk factors for falls for this sample may also be related to the lower prevalence of falls reported by participants (20%), compared to other studies of community-dwelling older people. The older women in this study demonstrated better health and higher levels of functioning that may have contributed to a lower reported prevalence of falls.

4.2. Hazardous Home Environments Contribute to Falls

The HOME FAST-SR score [19] was the only significant variable in the ICF environmental component related to falls and further supports the use of this self-report tool to determine home hazards for older people at risk of falls. Findings indicate that living in a haz-

ardous home environment increases the risk of falls for older people, and at each increase in the HOME FAST-SR score, there is an 11% increase in the odds of a fall. The contribution of modifying the home environment to reduce the risk of falls has been investigated. A meta-analysis by Clemson *et al.* [46] concluded that single home modification interventions are effective for both high and low risk fallers, whereas Gillespie *et al.* [47] concluded that home hazard assessment and management are effective for high risk fallers only. These findings indicate that hazardous home environments remain a significant risk factor for a population of older women who are functioning well in the community.

4.3. The Importance of Functional Activities

Instrumental ADL and personal ADL as measured by the Lambeth Disability Scale [20] were significantly associated with falls in this sample. As difficulty in IADL tasks precedes ADL difficulties [48], this scale was relevant to a community population of relatively healthy older women. Difficulty in ADL and IADL tasks can be both a consequence and a risk factor for falls [49], and this study suggests that functional difficulties can be an early indicator for falls risk. The item relating to time spent in a bed or chair was mapped to the general health category, but also indicated severe mobility limitations that were significantly associated with falls. It could be argued that the environment is an important component of independence in ADL & IADL, however the interaction terms used in the longitudinal analysis did not indicate that the two components were significantly related.

4.4. Application of the ICF to Falls Risk

Findings demonstrate that falls in a community sample of older women are associated with a wide range of health, functional and environmental factors that are consistent with the ICF classification. Six out of the eight final significant variables were related to specific health/medical conditions which were not explicitly covered in the linking process. These items are important aspects to screen for and monitor to prevent falls. The inclusion of significant functional and environmental variables in the final model indicates that these should also be identified to reduce falls risk in community populations. The study demonstrated that whilst the ICF was developed as a classification system, it is a valid framework to use to guide future studies related to falls risk in a community population.

However, the study identified some issues in utilising the ICF as a framework. The mapping process highlighted difficulties with the conceptual distinctions between activity and participation [4,50,51]. Reduced activity is a falls risk [52] and a lack of participation in

meaningful roles or alienation from the community is also identified as a separate risk factor [11]. The lack of detail within the ICF about personal factors is also an issue. Cerniauskaite *et al.* [53] identified a clear need to define and develop personal factors within the ICF classification framework that might be considered risk factors for disease development or have negative effects on individual functioning. Many concepts related to personal aspects of an individual are an important part of understanding falls, for instance, levels of risk taking behaviour. Personal factors listed in the ICF such as gender, age, and living alone are known to have a role in falls risk [54]. However, important personal factors that determine increased falls risk may extend beyond the factors listed in the ICF classification and include unique, individual features associated with a person-centred approach to health professional practice [55]. Therefore, without their inclusion, using the ICF is bound to underestimate the contribution of personal factors to the outcome of falls risk.

The fundamental process for this study was the linking of ICF components to the items from the ALSWH surveys and the sub-study. The intuitive process used by the researchers to link items did not always agree with the ICF linking rules, which were used as the final authority to link items. As there were no anatomical structures explicitly assessed in the ASLWH data, similar items could only be linked with body functions. The linking rules led to a large number of items being allocated to the body function component, whereas specific medical conditions were not covered. Furthermore, the linking rules required several standardised measures such as the SF36 to be broken up so that different items could be allocated to different ICF components (see **Table 1**). This may have ramifications for the interpretation of the constructs that the tools were originally designed to measure.

4.5. Strengths and Limitations of the Study

This study had several strengths. Falls were measured in a randomly selected nested sub-study from a large national cohort, over an extended period of follow-up. Participants were living in urban, rural and remote areas representative of the diversity of Australian living conditions, access to health care, and other social aspects. Data were available on a range of risk factors known to be associated with falls. Ideally, a survey designed specifically to test the ICF would have allowed items to be directly linked to the ICF, but such a survey may not have included some variables that were significant in the final model.

Limitations of the study include data obtained through self-report, therefore some misclassifications may have occurred due to under or over-reporting of health issues

[21]. Under-reporting is more likely, and would have led to weakening any real associations with falls. The falls outcome was also measured by self-report, and the prevalence of falling was the study factor, as opposed to the number of falls reported. The participants in this study were volunteers and were relatively healthy community-dwelling women; therefore the study results are not generalisable to the broader population of older people, especially older men. There were high rates of missing values for some data items, and where possible this was managed by replacing data using logic checks for important variables. This may have led to some limitations in the analysis.

5. CONCLUSION

In this study, the access to the ALSWH data set allowed the ICF to be tested with a broadly representative population of older women. Key risk factors that were significantly associated with falls included health conditions, functional limitations in IADL and ADL and hazardous home environments, which suggested that any population-based fall studies should include person-related factors, activity and participation factors and environmental factors. Further classification work of personal factors needs to be done. The ICF framework is updated to reflect the contribution of personal factors such as gender, education, life style, habits and socio-economic status in relation to falls risk. This will allow for more consistency, accuracy and ease of use of the definition of fall by health professionals in their everyday practice.

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