



Contents lists available at ScienceDirect

## Archives of Gerontology and Geriatrics

journal homepage: [www.elsevier.com/locate/archger](http://www.elsevier.com/locate/archger)

Full Length Article

## Comparing the loss of functional independence of older adults in the U.S. and China

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## ARTICLE INFO

## Keywords:

Population aging  
Disability  
ADL scales  
Functional loss  
Oldest-old

## ABSTRACT

**Background:** Functional loss among older adults is known to follow a hierarchical sequence, but little is known about whether such sequences differ across socio-cultural contexts. The aim of this study is to construct activities of daily livings (ADL) scales for oldest-old adults in the United States and China so as to compare their functional loss sequences.

**Methods:** We use data from the Asset and Health Dynamics of the Oldest Old (n = 1607) and Chinese Longitudinal Healthy Longevity Survey (n = 5570) for years 1998–2008. ADL items are calibrated within a scale using the Rasch measurement model. Rasch scores are averaged across survey waves to identify the ADL loss sequence for each study population. We also assess scale stability over measurement periods.

**Results:** Factor analyses confirm that the ADL items in each study population can be combined meaningfully to form a hierarchical sequence. Internal consistency assessed by Cronbach's alpha is high (0.81 to 0.95). We find that bathing is the first activity that both older Americans and Chinese have difficulty with, while eating is the last activity. There are, however, differences in the rank order for toileting (ranked more challenging in the Chinese sample) and dressing (ranked more challenging in the U.S. sample). Item orderings are stable over time.

**Conclusions:** The results highlight the relative importance of bathing in the functional loss sequence for older adults, regardless of socio-cultural context. Health interventions are needed to address deficits in the bathroom environment, especially in developing countries like China.

## 1. Introduction

The growth of the elderly population presents a major challenge for health and social care systems in both advanced and developing countries. Increases in the numbers of oldest-old are of particular concern because this demographic is often associated with loss of functional capacities and are reliant on long-term care supports. Activities of daily living (ADLs) – the ability to perform self-care routine tasks such as bathing and dressing – are essential measures of disability among older adults. Previous research show that ADL tasks are hierarchical in nature and can be combined to form a scale which is useful to clinicians and health professionals for identifying individuals at risk of disability; monitoring disability progression across episodes of care; determining eligibility for care services; and predicting long-term care use among older adults (Katz, Ford, Moskowitz, Jackson, & Jaffe, 1963; Kempen, Myers, & Powell, 1995; Fieo, Austin, Starr, & Deary, 2011; Edjolo, Proust-Lima, Delva, Dartigues, & Pérès, 2016; Saenger, Caldas, Raiche, & da Motta, 2017).

Existing studies have largely emphasized the disability experience of

elderly adults in Western developed countries (Jagger et al., 2001; Kempen & Suurmeijer, 1990; Spector & Fleishman, 1998). A general consensus which emerge from the literature is that older adults tend to lose ability in activities that require lower extremity strength (e.g., walking) earlier than activities that require upper extremity strength (e.g., eating) (Dunlop, Hughes, & Manheim, 1997; Ferrucci et al., 1998; Kingston et al., 2012). The hierarchy of functional decline among older adults in developing countries, however, is still unclear. At the same time, various international organisations including the World Health Organization have warned that many developing countries are aging at a faster rate than developed nations (World Bank, 2015; World Health Organization, 2017). By 2050, there will be approximately 400 million people aged 80 and older worldwide of which 70% will live in less developed regions. East Asia is the fastest aging region in the world; China, in particular, currently hosts the largest number of oldest adults in the world and will continue to do so for the coming decades. Although an earlier study by the authors traced some parallels between the ordered disability sequence of older Chinese adults and those previously documented for Western developed countries (see Fong & Feng,

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2016), a direct comparison of ADL hierarchies across different country studies is inconclusive since the study populations or methodology used may not be comparable.

Few studies have attempted cross-national comparisons of functional loss sequences which limit the ability for health researchers to compare disability progression among older adults in different socio-cultural contexts. Constructing valid and reliable scales to detect the ADL disability status of geriatric populations in different countries is valuable because it can provide researchers with adapted scales with more accurate interpretations (Cabañero-Martínez, Cabrero-García, Richart-Martínez, & Muñoz-Mendoza, 2009; Arik et al., 2015). Comparative analyses of functional loss sequences can also significantly expand our collective knowledge about how environmental factors affect the hierarchical structure of ADL dependence. This is important given how theoretical models of disability have evolved; functional disability is recognized as a context-embedded outcome with reference to situational factors rather than a pure biomedical impairment (Nagi, 1969; Verbrugge & Jette, 1994; World Health Organization, WHO, 2001). Though the theoretical underpinnings are clear, the extent to which different physical and socio-cultural environments shape the progression of ADL disabilities among older adults is an open empirical question.

This paper examines the ADL hierarchical structures of the oldest-old in the United States and China using data from large-scale national health surveys (1998–2008). These two countries – one a Western developed nation and the other a non-Western developing nation – make for interesting comparison since they feature dissimilar physical, geographical, and socio-cultural environments. By design, the population-based samples are comparable in terms of age range, ADL types, and survey time period. Our analysis adopts the Item Response Theory (IRT) methodology to rank the ADL items and derive the hierarchy of function loss. To our knowledge, this study is the first to apply a standardized methodology to examine how older Americans and Chinese compare in the way they purportedly lose functional capacity.

## 2. Materials and methods

### 2.1. Data

The study uses 1998–2008 data from the Asset and Health Dynamics of the Oldest Old (AHEAD) study and the Chinese Longitudinal Healthy Longevity Survey (CLHLS). Older adults aged 80 and above who have zero ADL disabilities as at 1998 baseline, and complete health and mortality data for all follow-up waves, are included. The final sample size is 1607 for the U.S. and 5570 for China.

The CLHLS is a nationwide survey conducted in 631 randomly selected cities and counties in 22 provinces, covering about 85% of the total population of China. More than 8500 individuals aged 80 and above were interviewed at the 1998 baseline survey, and re-interviewed face-to-face every two to three years. The CLHLS represents one of the most extensive dataset of oldest-old cohorts in the world; a complete description of the CLHLS is given elsewhere (Zimmer, Martin, Nagin, & Jones, 2012; Zeng, Feng, Hesketh, Christensen, & Vaupel, 2017). We adopt the 1998 baseline and use data from waves 2000, 2002, 2005, and 2008.

A comparable sample of U.S. older adults is obtained from the AHEAD study, which is a prospective panel study of older Americans born in 1923 or earlier. ADL question wordings and response coding for AHEAD respondents was made consistent only when the AHEAD be merged with the Health and Retirement Study in 1998 (Health and Retirement Study, 2004). Thus we set 1998 as baseline and use data from waves 2000, 2002, 2004, 2006, and 2008. Note that the selected time frame for the U.S. AHEAD matches that of the Chinese CLHLS.

### 2.2. Types of ADL disability

Functional disability is measured by self-reports of having difficulty or needing help with basic daily activities. AHEAD respondents are asked: “Because of a health or memory problem do you have any difficulty with [ADL]?, where [ADL] refers to dressing; walking across a room; bathing; eating; getting in and out of bed; and using the toilet.” The responses to each ADL item are coded as six dichotomous variables in each wave (Fong, Mitchell, & Koh, 2015). CLHLS also collects data on dressing, bathing, eating, transferring, and toileting. In lieu of “walking”, CLHLS uses “continence”. Subjects are asked whether they need help performing each activity. Responses to each item are also coded as dichotomous variables. Five of the six ADL items in the surveys are identical and allows for meaningful comparison.

### 2.3. Statistical analyses

We utilize the IRT framework and Rasch measurement model to construct the ADL scales. The Rasch model transforms ordinal-level data to interval-level data such that the probability of endorsing a particular item is converted to a logit value. Logits are an equal interval level of measurement. Thus, the Rasch scale can be visualized as an equal-interval linear continuum whereby ADL items are ranked in descending order of difficulty (from lowest to highest logit value). We also evaluate the relative degree of difficulty across items: for example, a wide gap between two items on the scale would suggest that one activity is considerably more difficult than the other. A narrow gap would suggest that both activities are about of the same level of difficulty and one activity is just slightly more difficult than the other.

Analysis proceeds in four stages. First, principal component factor analysis is used to investigate whether the items form a single dimension. The Cronbach’s alpha is calculated to assess the internal reliability of the items within a factor. Second, we assess item fit to verify the assumptions of the Rasch model (unidimensionality and local independence). Item infit values in the range of 0.7 to 1.3 are considered acceptable; values greater than 1.3 indicate departures from unidimensionality, while values less than 0.7 indicate redundancy (Smith, Schumacker, & Bush, 1998; Finlayson, Mallinson, & Barbosa, 2005). Third, we perform item calibration using maximum likelihood estimation. We estimate logit values for five waves of AHEAD and four waves of CLHLS, then calculate the average logit scores to derive a single representative ADL scale for each study population. Finally, we examine the stability of item calibrations over time. Item calibrations are stable if the estimated logit values over multiple measurement periods are no more than two standard errors apart (Finlayson, Mallinson, & Barbosa, 2005). All analyses are performed using R Statistical Software version 3.4.0.

## 3. Results

### 3.1. General characteristics of the study population

Table 1 presents the demographic characteristics. We see that the samples are comparable in terms of age at baseline and gender composition. As at the 1998 baseline, the average age of AHEAD subjects is 84.7 and that for CLHLS subjects is 90.3. Approximately three-fifths of each sample comprises of females, and the majority of these oldest-old individuals are widowed. In wave 2008, for example, the three most prevalent types of disability are bathing (38.7%), walking (35.4%), and dressing (31.3%) for the U.S. sample and bathing (54.7%), dressing (18.7%), and transferring (18.7%) for the Chinese sample. Mortality is substantial among the oldest-old. Of the 5570 CLHLS respondents at baseline, 3110 are still alive as at wave 2002 and 687 remain as at wave 2008. Over the same time period, the sample size for the AHEAD also decrease from 1607 to 1105 in wave 2002, and then 444 in wave 2008.

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