Original article

# Ceiling and floor effects for functional independence measure, Hyogo activities of daily living scale, and assessment of motor and process skills in Alzheimer's disease

Yukiko Suzuki, Department of Occupational Therapy, Faculty of Health Sciences, Kyorin University
Akira Nagasawa, Department of Rehabilitation, Juntendo Tokyo Koto Geriatric Medical Center
Hideki Mochizuki, Department of Occupational Therapy, Faculty of Health Sciences, Kyorin University
Tomoko Kondo, Department of Occupational Therapy, Faculty of Health Sciences, Kyorin University
Nobuaki Shimoda*, Department of Rehabilitation, Faculty of Health Sciences, Tokyo Kasei University

**Abstract**

**Objective:** This study aimed to examine the presence or absence of ceiling and floor effects for the Functional Independence Measure (FIM), the Hyogo Activities of Daily Living Scale (HADLS), and the Assessment of Motor and Process Skills (AMPS) in patients with Alzheimer's disease (AD).

**Methods:** The participants consisted of 105 patients with AD. The results of the FIM, HADLS, and AMPS were evaluated. The ceiling and floor effects were defined as when the participants with the highest score and those with the lowest score accounted for over 20% of all the participants, which is consistent with the report.

**Results:** Ceiling effects were not observed in the FIM, HADLS, and AMPS results. Floor effects were observed in the HADLS-Instrumental Activities of Daily Living (IADL) scores (23 participants with the lowest score). The AMPS scores for the 23 participants had a wide range. Ceiling effects were observed in many FIM and HADLS sub-scales. Floor effects in the subscales were found only for 10 HADLS-IADL items.

**Conclusion:** Floor effects were observed in the HADLS-IADL and not in the AMPS scores. The AMPS scores among the 23 participants who recorded the lowest score of the HADLS-IADL had a wide range. These findings indicate that residual ability that cannot be measured by the HADLS-IADL may be fully understood by evaluating motor and process skills in the IADL using AMPS.

**Keywords:** clinical dementia rating, process skills, instrumental activities of daily living

## Introduction

Aging has progressed at an unprecedented rate globally, and in Japan, which became the country with the highest population aging rate in 2005, the rapid increase in the number of patients with dementia has become a major health issue. Medical approaches to patients with dementia include prophylaxis, medical treatment, and rehabilitation. Among rehabilitation strategies, occupational therapy is particularly highly anticipated. Compared to other rehabilitation strategies, occupational therapy adopts a unique occupation-focused approach, using procedural memory that remains in patients with dementia. For example, Graff et al. (2006) chose meaningful occupation of the people themselves for caregivers of patients with dementia and taught the meaning of compensation and environment

Accepted on 6 October, 2018
*: Corresponding Author

adjustment method to be possible for the occupation and reported an improvement in the activities of daily living (ADL). Smallfield et al. (2017) conducted a systematic review of the effect of occupational therapy intervention in promoting work accomplishment in Alzheimer's disease (AD) and patients with neurological disease. As a result, the intervention mainly on the occupation was shown to improve ADL ability and recreation - activity. Thus, occupational therapy was found to be very important to patients with dementia.

The types of dementia include AD, cerebrovascular dementia, dementia with Lewy bodies, and frontotemporal dementia. Of these dementia types, AD is the most important disease (Roberta, 1998), accounting for a half to three-fourths of dementia. AD is a progressive disease, and the ability of patients with AD gradually decreases. To delay the onset of disability as much as possible in patients with AD and help them to maintain a high quality of life for as long as possible, it is important to properly understand their residual ability.

Activities of Daily Living (ADL) and Instrumental Activities of Daily Living (IADL) are used to determine the residual ability of patients with AD. Some patients with AD partially accomplish IADL (e.g., folding the laundry, bring dishes to the kitchen) even if they need assistance for ADL. Therefore, evaluation of both ADL and IADL is necessary to determine the residual ability of patients.

The Functional Independence Measure (FIM) has been traditionally used for the evaluation of ADL in patients with AD (Pitkala, 2010; Talmelli, 2010; Tanaka, 2013). However, the FIM is not available for the evaluation of IADL and there are reports indicating the ceiling effects of the FIM (Ushiba, 2004; Osawa, 2009; Goto, 2015). But these studies were not performed in patients with AD. To the best of our knowledge, there are few reports on the ceiling and floor effects of the FIM in patients with AD.

To the best of our knowledge, the Hyogo Activities of Daily Living Scale (HADLS), developed in Japan, is the only evaluation tool for ADL and IADL in patients with AD (Hirono, 1997). In other words, the floor effects showed that we cannot evaluate the residual ability of the severe AD patients appropriately. Therefore, we analyzed the score distribution of participants to examine a method of evaluating the residual ability of severe AD patients appropriately in order to identify the floor effects. However, it is noted that floor effects are easily found in this evaluation and that detailed evaluation of patients with severe AD is challenging (Tanaka, 2014). To the best of our knowledge, the floor effects have not been analyzed in detail and there are no studies involving patients with AD only to which definitively indicate the floor effects of the HADLS.

The Assessment of Motor and Process Skills (AMPS) (Fisher, 2012a, b) is an evaluation tool that can measure the motor and process skills by observing and assessing the scene in which the participants address the tasks of the ADL and the IADL, and is also available for evaluation of the ability of IADL, unlike the FIM. Furthermore, it is postulated that the AMPS can evaluate participants with severe disorder. However, there are no studies clearly indicating that there is no floor effect for the AMPS in patients with AD. As preliminary research of AMPS, there are reports (Doble, 1997; Nygard, 1998; Graff, 2006; Liu, 2007; Robinson, 1996; Bouwens, 2008; Oakley, 1997) that examined the utility of AMPS, reports (Mori, 2007; Douglas, 2012; Hartman, 1999; Doble, 1997; Bouwens, 2008; Nygard, 1998; Liu, 2007) that examined the criterion-related validity with other rating systems, and reports (Lam, 2010; Oakley, 1997; Graff, 2006) that examined the utility of AMPS as the rating system to determine the effect of treatment among patients with dementia. Studies using AMPS that only targeted AD patients have been limited. These include a report by Doble et al.

(1999) that verified the validity of AMPS based on an investigation of the concordance rate between AMPS and family informants' Older Americans Resources and Services; a report by Oakley et al. (1997) that investigated the utility of AMPS in evaluating IADL, which is highly sensitive to drug trials; and reports by Cook et al. (2000) and Oakley et al. (2003) that investigated features of decreased ADL ability in AD patients compared with those in healthy individuals. However, a report that described score distribution and a floor effect of AMPS was not found.

The availability of a method allowing detailed evaluation of the ability of patients with AD, including those with severe AD, to perform ADL and IADL is very important to plan an appropriate occupational therapy approach and determine the effects of the selected approach. To that end, to properly evaluate the ability to perform ADL and IADL, it is desirable that there is no ceiling effect or floor effect in the evaluation. When ceiling effect appears in a rating system, the patients who obtained a perfect score by an evaluation in the occupational therapy approach cannot be evaluated even if speed and safety of the activity increased after occupational therapy. Alternatively, the evaluation could remain low even if in the activity it was slightly possible the patients who took the low point by an evaluation in front of occupational therapy approach by occupational therapy approach increased when a floor effect uses a rating system to appear.

In this study, the evaluation of the FIM, HADLS, and AMPS scores was performed in the same participants to determine the ceiling and floor effects in those evaluation methods. Based on the items indicating the ceiling effects and the floor effects in each assessment tool and the characteristics of the participants, we examined an appropriate evaluation tool available for detailed evaluation of the ability to perform ADL and IADL and suitable for understanding the residual ability in patients with AD.

This study was conducted after obtaining the approval of the ethics committee of the Juntendo Tokyo Koto Geriatric Medical Center, Juntendo University (approval number 75-1) and the ethical review board of Faculty of Health Sciences, Kyorin University (approval number 26-49). The participants and their live-in relatives were provided with verbal and written information regarding the purpose and methods of the study, and provided their consent to participate in this study.

## Participants and Methods

**1. Participants** (Table 1)

The participants consisted of 105 patients with AD admitted to a dementia treatment ward of a university hospital (46 men and 59 women; mean age 80.1 ± 6.7 years). The inclusion criteria were as follows: diagnosis of AD by physicians based on the ICD-10 criteria and ability to follow a verbal order. Patients with serious somatic disease, unstable chronic disease, or severe vision impairment were excluded. Participant characteristics (sex, age, years of education after graduation from an elementary school, and complications) were obtained by reviewing their medical records.

**2. Evaluation Tools**

The end-points of the FIM consisted of two items: movement items and cognitive items. Movement items consisted of 13 items in total: 6 self-care items; 2 excretion control items; 3 transferring items; 2 moving items. Cognitive items consisted of 5 items in total: 2 communication items; 3 social cognition items. Each item was evaluated using a scale of 1 to 7, according to the degree of independence and the degree of assistance required. Therefore, the FIM can evaluate the ADL in real life. The FIM-Total scores, the FIM-Motor (FIM-M) scores, and the FIM-Cognition (FIM-C) scores and the scores of their sub-scales were analyzed.

**Table 1: Participants Characteristics and Evaluation Results**

| | |
|---|---|
| Characteristics | |
| n | 105 |
| men/women (participants) | 46 (42.8%)/59 (56.2%) |
| age (years; range) | 80.1 ± 6.7 (60-96) |
| years of education after graduation from elementary school (years; range) | 6.0 ± 3.2 (0-11) |
| complications (including overlapping) (participants) | |
| cerebrovascular diseases | 62 (59.0%) |
| diseases of internal medicine | 60 (57.1%) |
| diseases of orthopedics | 28 (26.7%) |
| Parkinson's syndrome | 9 (8.6%) |
| Evaluation Results | |
| MMSE (score) | 13.4 ± 7.4 |
| FIM-Total (score) | 89.0 ± 22.9 |
| FIM-Motor (score) | 69.1 ± 17.8 |
| FIM-Cognition (score) | 19.9 ± 6.7 |
| HADLS-Total (score) | 46.53 ± 22.89 |
| HADLS-ADL (score) | 18.39 ± 15.28 |
| HADLS-IADL (score) | 28.17 ± 9.46 |
| AMPS motor skills (logits) | 1.78 ± 0.68 |
| AMPS process skills (logits) | 0.58 ± 0.78 |

Age, years of education, MMSE (Mini-Mental State Examination-Japanese), FIM (Functional Independence Measure), HADLS (Hyogo Activities of Daily Living Scale), HADLS-ADL (Hyogo Activities of Daily Living Scale-Activities of Daily Living), HADLS-IADL (Hyogo Activities of Daily Living Scale-Instrumental Activities of Daily Living), AMPS (Assessment of Motor and Process Skills) are expressed as the mean ± standard deviation.

HADLS (Hirono, 1997) is a comprehensive disability scale of the ADL and IADL in patients with AD. It is based on an interview with caregivers using 18 items of activities of daily living on a scale from 3 to 7. For example, a specific example is stated clearly as follows, and the evaluation method of the stage about the second lunar month chooses the most applicable stage among the interview results to a caregiver. 1: It is carried out quite alone. 2: It is necessary to prepare clothes without being able to tell the difference between the winter in distinction and the summer with the clothes of other people. We need instruction about the time of the change of clothes and what to wear. We wear clothes one over another and wear dirty things. We do not include the degree of the problem of moderate fashion. 3: We require partial assistance for putting on clothes. 4: We require partial assistance in stripping. 5: It is all assistance, and mostly cooperative. 6: All assistance is necessary and rejected. In addition to the HADLS-Total score and the scores of their sub-scales, a total score of eight ADL items (toileting, eating, dressing, grooming, washing face, tooth brushing/washing dentures, bathing, and locomotion), defined as the "HADLS-ADL score", and a total score of 10 IADL items (using a telephone, shopping, cooking, cleaning, bed making, cleaning up the table after eating, laundry, treat a fire [gas burner etc.] using switches, and financial management) , defined as the "HADLS-IADL score", were analyzed.

AMPS (Fisher, 2012a, b) is an evaluation method used to measure motor skills and

process skills as the minimal unit of behavior. Motor skills are necessary to move a tool and the body when a person accomplishes a task. Process skills are necessary to adapt one's action according to the situation during the performance of a task. In this study, 16 motor skills items and 20 process skills items were evaluated depending on patient capability using a 4-point scale, by selecting two tasks according to the participant's interest and ability from a list of 125 standardized tasks with different degrees of difficulty and observing the attitude and state of the participant addressing the tasks. For the choice task, an occupational therapist chooses the task that is not too difficult without it being too easy that the participant found familiar. An occupational therapist who is an evaluator directly observes the scene where the target participants selected two tasks, and takes notes on the observed problem. After completion of the observation of the implementation of the assignment, based on the memorandum written during the observation, each of the 16 motor skills and 20 process skills is evaluated in 4 grades (4: readily and consistently, 3: questionable, 2: ineffective, 1: severe) for the problem observed. In addition, AMPS has a cutoff value (motor skills 2.0 logits, process skills 1.0 logits) that allows independent living in the area if it exceeds that value (Fisher, 2012a). The AMPS motor skills score and the AMPS process skills score were analyzed.

The participants were evaluated within one week of hospitalization. The FIM was evaluated on the basis of observation of patient behavior in the ward and the information about their living conditions, obtained from their attending nurses, for the HADLS. The first author interviewed live-in relatives or a person familiar with the patient's living conditions just before hospitalization. AMPS evaluated scenes in which ADL. IADL is performed under direct observation by the first author. The Japanese version of the Clinical Dementia Rating (CDR) (Otoyama, 2000) and the Mini-Mental State Examination-Japanese (MMSE) were used for the evaluation of the severity of dementia. For the CDR, the first author discussed the patients with their attending nurses. The first author also evaluated the MMSE.

### 3. Data analysis

The percentages of participants with the highest score and the lowest score for each evaluation (FIM-Total , FIM-M , FIM-C , HADLS-Total, HADLS-ADL, HADLS-IADL, AMPS motor skills, and AMPS process skills) were calculated.

The ceiling and floor effects were defined as when the participants with the highest score and those with the lowest score accounted for over 20% of all the participants, which is consistent with the report by Holmes et al. (1997) and Mchorney et al. (1994).

The percentage of the participants with the highest score and the participants with the lowest score for each sub-scale of the FIM-M, FIM-C, HADLS-ADL, and HADLS-IADL was calculated to identify the items indicating the ceiling effects or floor effects.

## Results

### 1. Percentage of the participants with the highest score in each evaluation

The percentage of the participants with the highest score in each evaluation was as follows: FIM-Total, 0%; FIM-M, 4.8% (5/105); FIM-C, 0%; HADLS-Total, 0%; HADLS-ADL, 5.7% (6/105); HADLS-IADL, 0%; AMPS motor skills, 0%; AMPS process skills, 0%. No ceiling effect was observed in any evaluation (Table 2).

### 2. Percentage of the participants with the lowest score in each evaluation

The percentage of participants with the lowest score in each evaluation was 21.9% for the HADLS-IADL (23/105), and floor effects were observed. The rest of the evaluation

methods indicated 0% (Table 2).

**Table 2: Percentage of participants with the highest or lowest score and the presence or absence of ceiling and floor effects in each evaluation**

Ceiling effects were not observed in all of the evaluations. Floor effects were observed only in the HADLS-IADL.

The ceiling and floor effects were defined as when the participants with the highest score and those with the lowest score accounted for over 20% of all the participants. The HADLS-Total, HADLS-ADL, and HADLS-IADL are an evaluation method in which a higher scorer shows a lower degree of independence while a lower scorer shows a higher degree of independence. In this study, to uniformize the expression of the FIM and the AMPS, the lowest scorer was defined as a person with a perfect score while the highest scorer was defined as a person with 0 points, and the results of calculation were described.

| | Percentage of the participants with the highest score | Ceiling effects | Percentage of the participants with the lowest score | Floor effects |
|---|---|---|---|---|
| FIM-Total | 0% | - | 0% | - |
| FIM-Motor | 4.8% | - | 0% | - |
| FIM-Cognition | 0% | - | 0% | - |
| HADLS-Total | 0% | - | 0% | - |
| HADLS-ADL | 5.7% | - | 0% | - |
| HADLS-IADL | 0% | - | 21.9% | + |
| AMPS motor skills | 0% | - | 0% | - |
| AMPS process skills | 0% | - | 0% | - |

MMSE; Mini-Mental State Examination-Japanese, FIM; Functional Independence Measure, HADLS; Hyogo Activities of Daily Living Scale, AMPS; Assessment of Motor and Process Skills

### 3. Characteristics of 23 participants with the lowest score for the HADLS-IADL, which showed the floor effects

Out of 23 participants with the lowest score for the HADLS-IADL, showing the floor effects, 15 participants (65.2%) were classified as CDR3 (severe); 7 participants (30.4%) were classified as CDR2 (moderate); and 1 patient (4.4%) was classified as CDR1 (mild).

With regards to the score distribution of the AMPS process skills among the 23 participants, the participants did not concentrate around the same score, with a wide score range. The mean AMPS process skills value (range) was -0.12 ± 0.78 (-1.68-1.38). The mean AMPS motor skills value (range) was 1.48 ± 0.67 (0.33-2.68).

A total of 19 out of 23 participants (82.6%) were assisted in all 8 items of the HADLS-ADL. All 23 participants were assisted in five items of the HADLS-ADL: “grooming,” “washing faces”, “tooth brushing/washing dentures,” “bathing,” and “locomotion.”

### 4. Items indicating ceiling effects in sub-scales of the FIM and HADLS

The ceiling effects, shown by the participants with the highest score who accounted for more than 20% of all the participants, were observed in 12 out of the 13 items in the sub-scales of the FIM-M. Only “stairs” showed no ceiling effects (Table 3).

For the FIM-C, the ceiling effects were observed for 1 item (“expression”) of all the 5 items (Table 3).

For the HADLS-ADL, the ceiling effects were observed for 6 items of the 8 items (Table 4). For the HADLS-IADL, the ceiling effects were observed in 1 (“using switches”) out of the 10 items (Table 4).

**Table 3: Percentage of participants with the highest score and the presence or absence of ceiling effects according to the FIM-Motor and FIM-Cognition items**

Ceiling effects were observed in 12 of out of 13 items in the FIM-Motor sub-scales. Ceiling effects were observed in 1 (expression) out of 5 items in the FIM-Cognition sub-scales. No ceiling effect was observed in any of the FIM-Motor and FIM-Cognition sub-scales.

| | Items | Percentage of participants with the highest score | Ceiling effects | Percentage of participants with the lowest score | Floor effects |
|---|---|---|---|---|---|
| FIM-Motor | eating | 54.3% | + | 1.0% | - |
| | grooming | 31.4% | + | 1.9% | - |
| | bathing | 24.8% | + | 1.0% | - |
| | upper body dressing | 29.5% | + | 0% | - |
| | lower body dressing | 27.6% | + | 0% | - |
| | toileting | 40.0% | + | 0% | - |
| | bladder management | 42.9% | + | 2.9% | - |
| | bowel management | 36.2% | + | 1.0% | - |
| | bed/chair/wheelchair transfer | 46.7% | + | 0% | - |
| | toilet transfer | | | | |
| | tub/shower transfer | 46.7% | + | 0% | - |
| | walk/wheelchair | 26.7% | + | 0% | - |
| | stairs | 42.9% | + | 2.9% | - |
| | | 11.4% | - | 5.7% | - |
| FIM-Cognition | comprehension | 3.8% | - | 1.0% | - |
| | expression | 23.8% | + | 0% | - |
| | social interaction | 0% | - | 12.4% | - |
| | problem solving | 0% | - | 12.4% | - |
| | memory | 0% | - | 6.7% | - |

Refer the abbreviations to the footnote of Table 2.

**5. Items indicating floor effects in sub-scales of the FIM and HADLS**

The floor effects, shown by participants with the lowest score who accounted for more than 20% of all participants, were observed in 0 of the 13 items in the sub-scales of the FIM-M (Table 3), in 0 of the 5 items in the sub-scales of the FIM-C (Table 3), and in 0 of the 8 items in the sub-scales of the HADLS-ADL (Table 4). On the other hand, in the HADLS-IADL, the floor effects were observed in all 10 items (Table 4).

## Discussion

**1. Percentage of participants with the highest score in each evaluation**

The proportion of participants with the highest score did not exceed 20% of all the participants in each evaluation and no ceiling effect was shown. These results indicated that the evaluation of the FIM-Total, FIM-M, FIM-C, HADLS-Total, HADLS-ADL, HADLS-IADL, AMPS motor skills, and AMPS process skills is available for appropriate measurement of the ability of the participants including participants with higher ADL and IADL ability unless the sub-scale of each evaluation is used.

Conversely, 5 out of 105 participants and 6 out of 105 participants showed the highest

**Table 4: Percentage of participants with the highest score and the presence or absence of ceiling effects according to the items in HADLS-ADL and HADLS-IADL**

Ceiling effects were observed in 6 out of the 8 items in the HADLS-ADL sub-scales. Ceiling effects were observed in 1 (using switches) out of the 10 items in the HADLS-IADL sub-scales. No ceiling effect was observed in any of the HADLS-ADL sub-scales. No floor effect was observed in any of the HADLS-IADL sub-scales.

| | Items | Percentage of participants with the highest score | Ceiling effects | Percentage of participants with the lowest score | Floor effects |
|---|---|---|---|---|---|
| HADLS-ADL | toileting | 47.6% | + | 1.9% | - |
| | eating | 67.6% | + | 1.9% | - |
| | dressing | 30.5% | + | 1.0% | - |
| | grooming | 40.0% | + | 3.8% | - |
| | washing face | 41.0% | + | 4.8% | - |
| | tooth brushing/washing dentures | 38.1% | + | 5.7% | - |
| | bathing | 19.0% | - | 7.6% | - |
| | locomotion | 6.7% | - | 1.9% | - |
| HADLS-IADL | using a telephone | 10.5% | - | 58.1% | + |
| | shopping | 3.8% | - | 43.8% | + |
| | cooking | 1.9% | - | 68.6% | + |
| | cleaning | 10.5% | - | 68.6% | + |
| | bed making | 6.7% | - | 77.1% | + |
| | cleaning up the table after eating | 11.4% | - | 52.4% | + |
| | laundry | 14.3% | - | 70.5% | + |
| | treat a fire (gas burner etc.) | 4.8% | - | 70.5% | + |
| | using switches | 26.7% | + | 33.3% | + |
| | financial management | 7.6% | - | 48.6% | + |

Refer the abbreviations to the footnote of Table 2.

score for the FIM-M and the HADLS-ADL, respectively. The severity of dementia (Japanese version of CDR) of 5 participants with the highest score for the FIM-M was as follows: CDR0.5 (very mild), 1 participant; CDR1 (mild), 3 participants; CDR1 (moderate), 1 participant. Out of 6 participants with the highest score for the HADLS-ADL, 1 and 5 participants were classified as CDR0.5 (very mild) and CDR1 (mild), respectively. Based on the results that there were patients who were completely independent in terms of the ADL evaluated by the FIM-M, even among patients with AD classified as CDR2 (moderate), it was thought that the FIM-M could not have measured the participant's situation thoroughly.

**2. Percentage of the participants with the highest or lowest score in each evaluation and characteristics of patients with AD showing floor effects**

The proportion of participants with the lowest score was 21.9% for the HADLS-IADL (23/105), and floor effects were observed. The rest of the evaluation methods indicated 0% and no floor effect was observed.

Out of 23 patients with AD with the lowest score for the HADLS-IADL, 15 participants (65.2%), 7 participants (30.4%), and 1 participant (4.4%) were classified into CDR3 (severe), CDR2 (moderate), and CDR1 (mild), respectively. It has been reported that detailed evaluation of patients with severe AD is difficult using the HADLS (Tanaka, 2014).

However, no detailed analysis of the floor effects was performed. The results of this study revealed that some patients including patients with moderate or mild AD showed floor effects for the HADLS-IADL. In the score distribution of the AMPS process skills, in 23 patients with AD, there was a wide score range from –1.68 at the lower end to over 1.0 at the upper end. These results suggest that persons who "did no" IADL may include persons with mild or moderate AD who retain the ability to "be able to do it" in real life scenarios. These findings also indicate that the participant's residual ability may be measured appropriately by evaluation of the AMPS process skills.

Floor effects were observed in the evaluation of the HADLS-IADL, based on information regarding the patient's actual state of ADL and AD obtained from the main caregivers. These findings suggest that the HADLS-IADL is a limited tool for the detailed measurement of the residual ability of patients with AD. The use of the HADLS-IADL evaluation alone makes it hard to understand whether a person cannot do it or does not do it even though it is a part of the activities, or how assistance will be helpful. The floor effects were observed for the evaluation of the HADLS, while no floor effect was observed for evaluation of the AMPS. Furthermore, as the IADL, which cannot be evaluated by the FIM, can be chosen as the task in the AMPS, the residual ability, which cannot be measured by the HADLS, can be accurately measured by evaluating motor and process skills in IADL using the AMPS in patients with AD who have never performed IADL at home. This result also shows that it is important to evaluate by directly observing the behavior of the participant and it is important to evaluate focusing on performance of occupation. If we can properly grasp the remaining task performance skills using AMPS without floor effect even for severe AD patients, the result leads to an increase in choice of intervention method for occupational therapy. Occupational therapy intervention in AD is reported in group programs of cognitive training (Farina, 2006), approach to morning care (Sidani, 2012), intervention using enjoyable video-sports games (Yamaguchi, 2011), and so on. However, these methods of intervention are difficult to adapt to patients with severe AD and are not used after grasping the remaining occupational performance skills of individuals. Even if the participant has severe AD, it is likely to be able to properly grasp the occupational performance skills remaining by using AMPS, to do what can be done even slightly in ADL/IADL, or practice. We believe that occupation-based intervention of repeatedly practicing ADL. IADL during hospitalization can contribute to maintenance and improvement of occupational performance of AD patients. Also, it is important to communicate the results of AMPS evaluation and information on remaining ADL / IADL ability to families and to teach the proper method of assistance to carry out adequate and continuous ADL / IADL and role acquisition in home life after discharge we believe to be connected.

### 3. Items indicating ceiling effects or floor effects in FIM sub-scales

No ceiling or floor effects were observed for the FIM-Total, FIM-M, and FIM-C, while ceiling effects were observed for 12 out of the 13 items in the FIM-M sub-scales. For the FIM-C, the ceiling effects were observed for 1 item out of the 5 items. A study, which was not performed in patients with AD, described the issues by showing the ceiling effects for the FIM (Ushiba, 2004; Osawa, 2009; Goto, 2015). The results of this study show that in patients with AD, ceiling effects were observed for many items, particularly, FIM-M. These results suggest that it is difficult to measure the changes in patients with AD with a certain level of ADL ability by evaluation of each FIM sub-scale.

### 4. Items indicating ceiling effects or floor effects in sub-scales of the HADLS

The contents of the HADLS are useful to measure the severity depending on patients with AD-specific difficulties in activities (Hirono, 1997). However, in this study, no ceiling or floor effect was observed for the HADLS-Total and HADLS-ADL, while floor effects were observed for the HADLS-IADL. According to the sub-scales for the HADLS-ADL, ceiling effects were observed for 6 items out of the 8 items. For the HADLS-IADL, ceiling effects were observed only for “using switches”. These results indicate that in patients with AD with a certain level of ADL ability, the probability of achieving the highest score for the HADLS-ADL sub-scales is high and detailed evaluation was difficult.

No floor effect was observed for any HADLS-ADL items. Conversely, the floor effects were observed for the 10 HADLS-IADL items. These results suggest that the evaluation of the HADLS is available to assess the real living conditions of patients. However, it is difficult to perform a detailed evaluation in order to determine how the residual ability for IADL.

This study was performed in patients with AD to evaluate the FIM, HADLS, and AMPS and calculate their ceiling and floor effects. Floor effects were observed for the HADLS-IADL, but not for the AMPS. For the assessment of patients with AD, the evaluation of the IADL is also very important. The results of this study suggest that the evaluation of the IADL using the AMPS is available for detailed measurement of the residual ability in patients with AD who had never performed the IADL at home.

**Acknowledgements**

We would like to thank Dr. Teruya Koji, Department of Public Health, Faculty of Health Sciences, Kyorin University who provided insight and expertise and the staff of Juntendo Tokyo Koto Geriatric Medical Center, Juntendo University and all participants and their families for their cooperation in this study. We declare that this paper content has no conflicts of interest.

## REFERENCES

Bouwens S F, van Heugten CM, Aalten P, Wolfs CA, Baarends EM, van Menxel DA, Verhey FR, 2008. Relationship between measures of dementia severity and observation of daily life functioning as measured with the assessment of Motor and Process Skills (AMPS). Dement Geriatr Cogn Disord, 25(1), 81-87.

Cooke KZ, Fisher AG, Mayberry W, Oakley F, 2000. Differences in activities of daily living process skills of persons with and without Alzheimer’s disease. Occup Ther J Res. 20, 87-104.

Doble SE, Fisk JD. Macpherson KM, Fisher AG, Rockwood K, 1997. Measuring functional competence in older persons with Alzheimer’s disease. International Psychogeriatrics. 9(1), 25-38.

Doble SE, Fisk JD, Rockwood K, 1999. Assessing the ADL functioning of persons with Alzheimer's disease: comparison of family informants' ratings and performance-based assessment findings. Int Psychogeriatr. 11, 399-409.

Douglas A, Letts L, Eva K, Richardson J, 2012. Use of the cognitive performance test for identifying deficits in hospitalised older adults. Hindawi Publishing Corporation Rehabilitation Research and Practice. 1-9.

Farina E, Mantovani F, Fioravanti R, Pignatti R, Chiavari L, Imbornone E, Olivotto F, Alberoni M, Mariani C, Nemni R., 2006. Evaluating two group programmes of cognitive training in mild-tomoderate AD: Is there any difference between a “global” stimulation and a “cognitive-specific” one? Aging and Mental Health. 10, 211–218.

Fisher AG, Jones KB,2012a. Assessment of motor and process skills. 7th edition, Revised Vol.1. Fort Collins: Colorado, Three Star Press. §1p.1-§14p.21.

Fisher AG, Jones KB, 2012b. Assessment of motor and process skills. 7th edition, Revised Vol.2. Fort Collins: Colorado, Three Star Press. §1p.1-§8p49.

Goto Y, Sato Y, Kawabe T, Kashiwagi C, Kohzuki M, 2015. A new activities of daily living measurement scale at home in patients with COPD (in Japanese). The Journal of the Japan Society for Respiratory Care and Rehabilitation. 25(3), 423-428.

Graff MJ, Vernooij-Dassen MJ, Thijssen M, Dekker J, Hoefnagels WH, Rikkert MG, 2006. Community based occupational therapy for patients with dementia and their care givers: randomized controlled trial. BMJ. 9, 333.

Hartman ML, Fisher AG, Duran L, 1999. Assessment of functional ability of people with Alzheimer's disease. Scandinavian Journal of Occupational Therapy. 6, 111-118.

Hirono N, Mori E, Yamashita H, Tokimasa S, Yamadori S, 1997. A novel scoring system of activities of daily Living for patients with Alzheimer's disease : Hyogo activities of daily living scale (HADLS) (in Japanese). Jpn J Neuropsychol 13(4), 260-269.

Holmes WC, Shea JA, 1997. Performance of a new, HIV/AIDS-targeted quality of life (HAT-QoL) instrument in asymptomatic seropositive individuals. Quality of Life Research. 6(6), 561-571.

Lam LC, Lui VW, Luk DN, Chau R, So C, Poon V, Tam P, Ching R, Lo H, Chiu J, Fung A, Ko FS, 2010. Effectiveness of an individualized functional training program on affective disturbances and functional skills in mild and moderate dementia-a randomized control trial. Int J Geriatr Psychiatry. 25(2), 133-141.

Liu KP, Chan CC, Chu MM, Ng TY, Chu LW, Hui FS, Yuen HK, Fisher AG, 2007. Activities of daily living performance in dementia. Acta Neurol Scand. 116, 91-95.

Mchorney CA, Ware JE, Rachel JF, Donald AC, 1994. The MOS 36-Item Short-Form Health Survey (SF-36): Tests of Data Quality, Scaling Assumptions, and Reliability Across Diverse Patient Groups. MEDICAL CARE. 32(1), 40-66.

Mori A, Sugimura K., 2007. Characteristics of assessment of motor and process skills and rivermead behavioral memory test in elderly women with dementia and community-dwelling women. 69, 1-2, 45-53.

Nygard L, Amberla K, Bernspang B, Almkvist O, Winblad B., 1998. The relationship between cognition and daily activities in cases of mild Alzheimer's disease. Scandinavian Journal of Occupational Therapy. 5, 160-166.

Oakley F, Duran L, Fisher A, Merritt B., 2003. Differences in activities of daily living motor skills of persons with and without Alzheimer’s disease. Australian Occupational Therapy Journal. 50, 72-78.

Oakley F, Sunderland T., 1997. Assessment of motor and process skills as a measure of IADL functioning in pharmacologic studies of people with Alzheimer's disease: a pilot study. Int Psychogeriatr. 9(2), 197-206.

Osawa A, Chida N, Tabata T, Iijima S, 2009. Evaluation of ADL/QOL in patients with upper extremity disability due to musculoskeletal disorders: evaluation of the utility of DASH (Disabilities of the Arm, Shoulder and Hand) in occupational therapy (in Japanese). Sogo Rehabilitation. 37(1), 55-59.

Otoyama W, Niina R, Homma A, Sanada J, Takahashi M, Kamimura N, Mimori Y, Katayama S, Urakami K, Yamada M, Takeuchi H, Mizuno K, Nishizawa Y, Ono Y, 2000. Inter-rater reliability of the Japanese version of clinical dementia rating (CDR) (in Japanese). Japanese Journal of Geriatric Psychiatry. 11(5), 521-527.

Pitkala KH, Raivio MM, Laakkonen ML, Tilvis RS, Kautiainen H, Strandberg TE, 2010. Exercise rehabilitation on home-dwelling patients with Alzheimer’s disease - a randomized, controlled trial. Study protocol.

Trials. 11, 92-99.

Roberta DB, Yamazaki RS, 1998. Advances and Challenges in the Prevention and Treatment of Alzheimer's disease. Pharmaceutical Research. 15(3), 386-398.

Robinson S.E., Fisher A.G., 1996. A study to examine the relationship of the assessment of motor and skills (AMPS) to other tests of cognition and function. British Journal of occupational therapy. 59, 260-263.

Sidani S, Streiner D, Leclerc C, 2012. Evaluating the effectiveness of the abilities-focused approach to morning care of people with dementia. International Journal of Older People Nursing. 7, 37–45.

Smallfield S, Heckenlaible C., 2017. Effectiveness of occupational therapy interventions to enhance occupational performance for adults with Alzheimer's disease and related major neurocognitive disorders: A Systematic Review. AOTA. 71(5), 1-7.

Talmelli LF, Gratão ACM, Kusumota L, Rodrigues RAP, 2010. Functional independence level and cognitive deficit in elderly individuals with Alzheimer's disease. Rev Esc Enferm USP. 44(4), 932-938.

Tanaka H, Uematsu M, Koshiro R, Nagata Y, Fukuhara K, Naito Y, Ohnishi H, Nishikawa T, 2014. Association of cognitive function , activities of daily living and behavioral and psychological symptoms of dementia in dementia patients - Focusing on severe dementia patients - (in Japanese). Japanese Journal of Geriatric Psychiatry. 25(3), 316-323.

Tanaka N, Nakatsuka M, Ishii H, Nakayama R, Hosaka R, Meguro K, 2013. Clinical utility of the Functional Independence Measure for assessment of patients with Alzheimer's disease and vascular dementia. Japanese Psychogeriatric Society. 13, 199-205.

Ushiba N, Liu M, Fujiwara T, Hanayama K, Tanuma A, Tsuji T, Kawashiro T, Chino N, 2004. Activities of daily living in persons with chronic pulmonary diseases - A preliminary study with the pulmonary functional status and dyspnea questionaire modified (PFSDQ - M) - (in Japanese). Journal of Japan Society for Respiratory Care. 14(2), 240-245.

Yamaguchi H, Maki Y, Takahashi K., 2011. Rehabilitation for dementia using enjoyable video-sports games. International Psychogeriatrics. 23, 674–676.