Utility of ADL Index for Partially Dependent Older People: Discriminating the Functional Level of an Older Population

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Abstract In the present study, the ADL index for the partially dependent older people (Demura et al., 1999) was applied to 218 bedridden (BED), 466 partially dependent (PD) and 245 independent living (IL) people in older groups. The purposes of this study were to clarify the meaning of the evaluation of this index and to examine how ADL items are useful in determining each older group. It is suggested that a perfect score with our ADL index means independent living level, and a score of zero means bedridden level. The results of discriminant analysis indicated that four items with low-difficulty, such as "eating," "going to the toilet," "tossing about in bed" and "writing," are useful in determining if the PD is becoming bedridden. While five items with high-difficulty, such as "putting on slacks," "putting on trousers," "standing up from a sitting posture," "going up stairs" and "washing the whole body," are useful in determining if the PD is becoming independent living. Furthermore, it is inferred that the possibility of falling into a bedridden situation increases when the total score is 5 or less, while the functional level is close to independent living when the total score is 13 or more. These findings make clear the meaning of the evaluation of our ADL index. Furthermore, the functional level of older population may be screened using evaluation of total and item scores of this ADL index. *J Physiol Anthropol 20 (6): 321-326, 2001* http://www.jstage.jst.go.jp/en/

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Introduction

The range of functional level of an older population extends from the bedridden situation to independent living (Sato et al., 1999a). An older population is conceptually classified into three groups of bedridden (BED), partially dependent (PD) and independent living (IL). The PD group is an important target group in ADL assessment for an older population, because if their functional level declines, they will become bedridden, and if their functional level improves, they will be independent. It is, therefore, possible to obtain an important suggestion regarding symptoms as falling into a bedridden or becoming independent, by assessing the ADL ability of the PD (Sato et al.,2001, 1999b; Demura et al., 1999).

We developed an ADL index for the PD group (Demura et al., 1999). This index is constructed with 17 ADL items, and assumes a unidimensional scale based on the difficulty among ADL items. The unidimensional scale has an advantage that one index can comprehensively assess ADL ability over a wide area (Sato et al., 2001; Kempen et al., 1995). Since our ADL index is intended for the PD group, it has, furthermore, a possibility that it can assess ADL function from BED to IL group, in addition to being the unidimensionality of the scal. The reliability and validity of this index were examined, but the application range of this index for an older population was not examined. In addition, the meaning of the evaluation of this index is sufficiently clarified.

Considering the functional characteristics of the PD, it is suggested that some of the low-difficulty ADL items for the PD group can be commonly used in the ADL

assessment of the BED group. Similarly, some of the high-difficulty ADL items for the PD group can be used in the ADL assessment of the IL group. Furthermore, it is hypothesized that these activities are important assessment items to determine if the PD is becoming bedridden or independent living.

In the present study, this ADL index was applied to the BED, PD and ID groups, and to the characteristics of the ADL score distribution of each older group. The purposes of the present study were to clarify the meaning of the evaluation of this index and to examine how ADL items were useful in determining each older group from the ADL ability characteristics of each older group.

Method

Subjects

Subjects of this study were 929 Japanese older people; 218 bedridden (64 males and 154 females) aged 61 to 108 years, 466 partially dependent (132 males and 334 females) aged 60 to 102 years, and 245 independent (80 males and 165 females) aged 61 to 96 years. Three older groups were defined based on a standard for the degree of independence for disabled older people approved by the Japan Ministry of Health and Welfare in 1991 (Tsuchiya et al., 1992). The partially dependent group (PD) consists of institutionalized older people who belong to either rank A (house-bound) or rank B (chair-bound). The bedridden group (BED) consists of institutionalized older people who belong to rank C (bed-bound). The independent group (IL) consists of community-dwelling older people who belong to rank J (independent living). The subjects who replied that they did not have any diseases was lower than 10 percent, indicating most of the PD and BED suffered from some type of disease. The morbidities of the following diseases were high in the PD and BED: cardiac disease (20.5%: PD, 16.6%: BED), cerebrovascular disorders (44.2%, 46.9%), joint disorders (16.8%, 11.8%), and bone disorders (16.5%, 10.0%), metabolic disease (35.8%, 35.1%).

ADL index

The ADL index used consists of 17 ADL items selected from the following seven domains; 1) changing and holding posture (four items), 2) dressing (three items), 3) using the toilet (two items), 4) walking (two items), 5) bathing (two items), 6) manual activity (two items), 7) movement and carrying (two items). In a previous study (Demura et al., 1999), it was verified that the reliability of the ADL index was high (intra-reliability: $r = 0.996$; inter-reliability: $r = 0.940$; αcoefficient = 0.926). The validity of the index was also high since ADL scores significantly correlated to age and the score of Hosokawa's extended ADL scale (Hosokawa et al., 1994). Furthermore, unidimensionality of scale was also confirmed (coefficient of reproducibility = 0.939; coefficient of scalability = 0.691). The rating scale for each item used a dichotomous scale of "possible" or "impossible." The content of each ADL item is shown in Table 2.

Data collection

The surveys for the PD and BED groups were conducted in welfare institutions for the aged, such as homes for the aged, special nursing homes for the aged, and health facilities. The survey for the IL group was done in an adult education facility for the aged. Informed consent from the subjects was obtained via institutional staff in the PD and BED groups, and obtained from the subjects themselves in the IL group. For the PD and BED groups, the staff working at the subjects' institutions, such as OTs, PTs, nurses, and social workers, responded to the ADL index survey. The survey duration at each institution ranged between four and six weeks. For the IL group, subjects provided their own data, because they could sufficiently understand the aim and method of the survey, and they did not have specific caregivers. In this study, these differences in sampling procedures are considered methodological limitations.

Statistical analyses

Item proportions and total score were calculated to compare ADL ability characteristics among the three

Table 1 Study sample

		60–69 years	70–79 years	80–89 years	90 years	Total
BED	Male	3	24	31	6	64
n=218	Female	10	42	76	26	154
PD	Male	12	41	56	23	132
n=466	Female	23	90	179	42	334
IL	Male	26	43	9	2	80
n=245	Female	61	89	14	1	165
	Total	135	329	365	100	929

BED: Bedridden older people, PD: Partially dependent older people, IL: Independent living older people.

Table 2 ADL items selected in the present study

ADL domains	No.	ADL items	Contents of each ADL item
I Changing and holding the posture	1	Tossing about in bed	Can toss about in bed without assistance.
	2	Sitting up from a lying posture	Can change posture from lying to sitting.
	3	Standing up from a sitting posture	Can change posture from sitting to standing without hanging on to something.
	4	Holding standing posture	Can hold standing posture without assistance for about one minute*.
II Dressing	5	Putting on a shirt over the head	Can put on a shirt over the head within about thirty seconds*.
	6	Putting on slacks	Can put on slacks while standing.
	7	Putting on trousers (buttons, belt)	Can put on trousers including button, belt, and within about one to two minutes*.
III Going to toilet	8	Using the toilet (Western style)	Can use a Western-style toilet without assistance.
	9	Going to the toilet	Can go to a Western-style toilet without assistance.
IV Bathing	10	Washing the whole body	Can wash the whole body without assistance.
	11	Entering the bathtub	Can straddle the bathtub and go inside without assistance.
V Manual activities	12	Eating	Can eat something small such as a bean using chopsticks.
	13	Writing	Can write by hand in normal size.
VI Walking	14	Walking	Can walk without a self-help device.
	15	Going up stairs	Can go up and down stairs one step at a time without hanging on to a handrail.
VII Movement and carrying	16	Carrying objects	Can carry relatively light things such as a piece of clothing, a garden plant, or a pan.
	17	Range of activity	Can go for a walk in the neighborhood.

Each item was assessed on dichotomous scale of "possible" or "impossible" regarding to the above-stated questions. *: The times using in criterion of assessment were determined based on the results of survey for occupational therapists.

older groups. The proportion of a "possible" response for each item was calculated. Total score was calculated on a 17 point scale. The total score distribution was examined using combined data from the three groups, and the percentage of each group in each total score was calculated. Furthermore, stepwise linear discriminant analysis of the three groups, using the forward selection method, was used to determine the items useful for classifying the three groups, and to examine discriminate probability. In the discriminant analysis, ADL item scores were used for independent variables and the older group was used for the dependent variable. Statistical significance was set at $P<0.05$.

Results

ADL ability characteristics of each older group

Seventeen ADL item proportions and the range of total score of each older group are shown in Table 3. In the PD group, item proportions ranged from 9.0% (going up stairs) to 65.7% (eating). Low values were shown for ADL items concerning movement and dressing lower limbs activities, such as "going up stairs," "putting on slacks," and "putting on trousers." High values were shown for ADL items concerning manual activity and changing posture activity, such as "eating," "tossing about in bed," "sitting up from a lying posture." In the BED group, item proportions ranged from 0% (nine items: ex. going up stairs, putting on a shirt over the head, putting on slacks) to 14.2% (tossing about in bed). Only two items of "tossing about in bed" (14.2%) and "sitting up from a lying

posture" (13.3%) were 10% or more. In the IL group, item proportions ranged from 76.3% (going up stairs) to 100% (three items: carrying, going to the toilet, and eating). Only "going up stairs" (76.3%) was less than 90%.

The total score ranged from 0 to 6 in BED, 0 to 17 in PD, and 13 to 17 in IL. The proportions of each group with a score of 0 were 79.6% in BED, 20.4% in PD, and 0% in IL, while with a perfect score of 17 the proportions were 0% in BED, 15% in PD and 85% in IL. Only the PD group had a total score distribution from 7 to 12 (Fig. 1).

Discriminant analysis

As a result of stepwise linear discriminant analysis with the three groups (Table4), the following two significant discriminant functions were obtained: the first discriminant function (F1) which classified IL and the other two groups; and the second discriminant function (F2) which classified the BED and PD groups. From the discriminant function coefficient and the structure matrix (the correlation between the discriminant function and each variable), four items of "eating," "going to the toilet," "tossing about in bed," "writing" were significantly related to F2, and these four items were included within five from the bottom of the difficulty-ordering. On the other hand, the other five items of "putting on slacks," "putting on trousers," "standing up from a sitting posture," "going up stairs" and "washing the whole body" were significantly related to F1, and these items corresponded to items placed within five from the top of the difficulty-ordering. The discriminant probabilities for each group in this study, using the two

Table 3 Summary of results of this study (item ordering was described based on difficulty-ordering of PD)

Difficulty-ordering	No.	Item	Item proportion			Discriminant analysis	Range of total score			
			BED	PD	IL					
1	15	Going up stairs	0.0	9.0	*76.3	U	17		PD	IL
2	6	Putting on slacks	0.0	13.7	98.0	U	16		PD	IL
3	7	Putting on trousers	1.8	17.4	97.6	U	15		PD	IL
4	3	Standing up from a sitting posture	0.5	20.0	95.5	U	14		PD	IL
5	10	Washing the whole body	0.0	22.1	99.2	U	13		PD	IL
6	17	Range of activity	0.0	23.6	99.2		12		PD	
7	16	Carrying an object	0.9	27.5	100.0		11		PD	
8	14	Walking	0.9	29.4	99.2		10		PD	
9	11	Entering the bathtub	0.0	33.5	95.5		9		PD	
10	5	Putting on a shirt over the head	2.8	34.6	98.4		8		PD	
11	4	Maintaining a standing posture	1.8	40.6	99.2		7		PD	
12	8	Using the toilet	2.3	42.5	99.2		6	BED	PD	
13	13	Writing	7.3	46.1	95.5	L	5	BED	PD	
14	2	Sitting up from a lying posture	*13.3	51.1	90.2		4	BED	PD	
15	1	Tossing about in bed	*14.2	54.5	98.8	L	3	BED	PD	
16	9	Going to the toilet	4.6	61.6	100.0	L	2	BED	PD	
17	12	Eating	8.3	65.7	100.0	L	1	BED	PD	

The range of discriminating IL and the others

The range of discriminating BED and PD

*: Item where the proportion is more than 10% in BED or less than 90% in IL. U means the items useful to discriminate IL and the others. L means the items useful to discriminate BED and PD. Shaded items were useful items to discriminate IL and the others or BED and PD. The total score were predicted assuming that this ADL index is considered to be a perfect scale. If this ADL index is considered to be a perfect scale, total score corresponds to item difficulty-ordering.
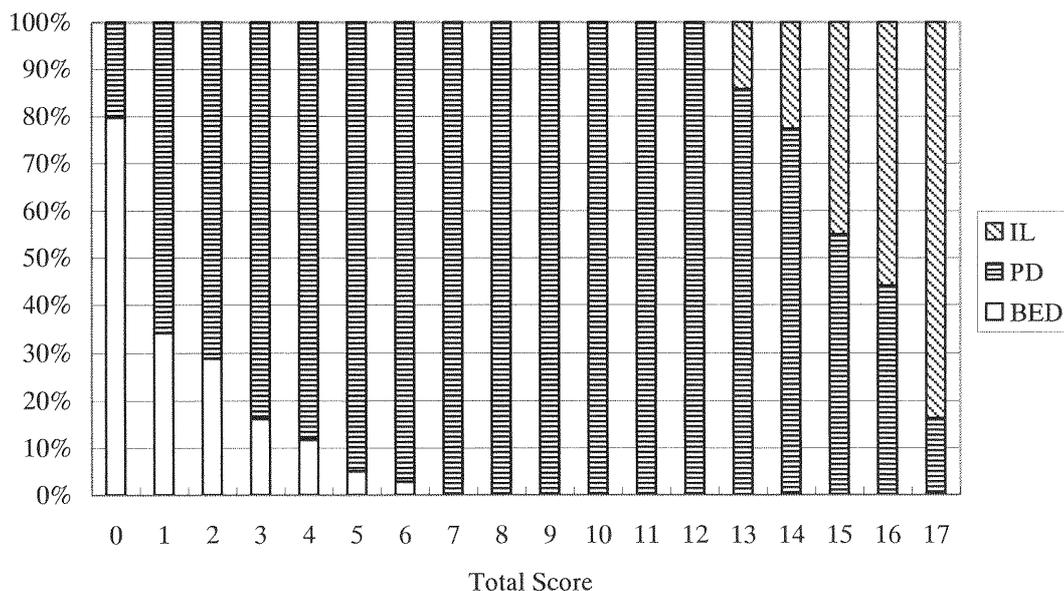

Fig. 1 Each group proportion of each total score

above stated functions, were 89.9% in BED, 72.9% in PD, 97.8% in IL, and 83.1% in total.

Discussion

The results of the present study are shown in Table 3. From the results of item proportion and total score distribution, the functional level of the three older groups is considered to be higher in order of BED, PD and IL. When ADL ability of older people was assessed using our ADL index, individual differences in ADL ability in PD showed a broad range. On the other hand, many BED subjects had difficulty achieving most of ADL items except "tossing about in bed" and "sitting up from a lying posture." Many IL subjects also easily performed most of ADL items except "going up stairs." It is suggested that a

Table 4 The result of discriminant analysis

No.	Item	Coefficient		Structure matrix	
		F1	F2	F1	F2
6	Putting on slacks	−1.377	−0.982	−0.781	−0.208
12	Eating	−0.342	1.595	−0.424	0.659
3	Standing up from a sitting posture	−0.878	−0.423	−0.658	−0.085
9	Going to the toilet	−0.244	1.665	−0.447	0.625
7	Putting on trousers	−0.878	−0.638	−0.696	−0.117
15	Going up stairs	−0.692	−0.588	−0.559	−0.210
1	Tossing about in bed	−0.109	0.760	−0.393	0.370
10	Washing the whole body	−0.322	−0.658	−0.614	−0.025
13	Writing	−0.328	0.366	−0.414	0.269
	Intercept	2.114	−1.638		
Mean of discriminant score of each group	BED	2.040	−1.325		
	PD	0.749	0.707		
	IL	−2.771	−0.340		

Two discriminant functions were obtained by discriminant analysis. F1 and F2 indicate the first discriminant function and second function, respectively. Coefficient means coefficient of discriminant function. Structure matrix indicates the correlation between the discriminant function and each variables.

perfect score with our ADL index means an independent living level, and a score of zero means bedridden level.

As a result of the discriminant analysis, determining if the PD is becoming bedridden is predicted more by four low-difficulty items which significantly correlates to the discriminant function that distinguishes PD from BED. On the other hand, determining if the PD is becoming independent living is predicted more by five high-difficulty items, which significantly correlates to the discriminant function that distinguishes IL from the other older groups. In addition, the total score distribution was lower than 6 points in BED, and higher than 13 points in IL. As shown in Table 3, in the unidimensional scale, if the scale is perfect (no error), total score of the scale corresponds to the difficulty-ordering of items (Menzel, 1953). In the case of this ADL index, if a subject cannot achieve five items placed within five from the top of difficulty-ordering, it means that the total score of the subject is theoretically assumed to become 13. From this viewpoint it may be said that the ranges of the total score distribution in BED and IL approximately corresponded to the results of the discriminant analysis. These results, therefore, support our hypothesis that high difficulty items are useful in determining if the PD is becoming independent living, and that low difficulty items are useful in determining if the PD is becoming bedridden. It follows that the five high-difficulty items and the four low-difficulty items of this ADL index are important in assessing if the PD is becoming independent or bedridden. When this is applied to total score, if the total score is 13 or more the possibility of becoming independent living is high and if it is 5 or less the possibility of becoming bedridden is high.

It was suggested that disability in ADL increases with advancing age, and that there is a hierarchy of disability in ADL (Sato et al., 2001; Dunlop et al., 1999; Ranberg et al., 1999). Furthermore, the pattern in which disabilities occur over time within individuals was also examined, and this pattern dependent on the difficulty of performing (Dunlop et al., 1999; Sato et al., 2001). The unidimensional ADL index assesses ADL ability with the hierarchical relationship in the scale (Spector et al., 1987). Unidimensional ADL indexes have been developed in previous studies (Lawton & Brody, 1969; Kempen et al., 1995; Spector et al., 1987). However, most of them combined the basic ADL index and the instrumental ADL index of previous studies, and the functional level of the assessment group of each unidimensional ADL index was not clearly placed within the whole older population (Demura et al., 1999). There is still the problem that it is difficult to interpret the meaning of the evaluation. In other words, it has been indicated that meaning of the score is not clear, since a perfect score does not mean independent living (Hosokawa et al., 1994). The unidimensional scale has an advantage that one index can comprehensively assess ADL ability over a wide area (Sato et al., 2001; Kempen et al., 1995; Spector et al., 1987). The problem of how to cover the functional level of older population, therefore, is important in making full use of the features of a unidimensional ADL scale. In this respect, it is meaningful that by using our ADL index the measurements of ADL ability of PD can be interpreted as relating to the ADL ability characteristics of the BED and IL.

In conclusion, it is suggested that a perfect score with our ADL index means an independent living level, and a score of zero means bedridden level. Furthermore, when the PD cannot perform the four items placed at the bottom of the difficulty-ordering, or when the total score of our index is 5 or less, the probability that the PD is falling into a bedridden situation is considered to increase. On the other hand, when the PD can perform the five items placed at the top of the difficulty-ordering, or when the total score is 13 or more, the functional level of the PD is close to independent living level. The present study makes clear the meaning of the evaluation of our ADL index. Furthermore, the functional level of older population may be screened using evaluation of total and item score of this ADL index.

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