

The Interrelationship among Achievement Patterns of Activities of Daily Living for Institutionalized Dependent Elderly

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Abstract The purpose of the present study was to examine the interrelationship of achievement patterns between 74 activities by selecting nine ADL domains, including 27 items used in existing ADL index for the institutionalized disabled elderly (Disabled-ADL). For these 74 ADL items, 706 institutionalized dependent elderly were assessed using a dichotomous scale of “possible” or “impossible” by staff working at the subjects’ institutions. The difficulty of each item was examined by calculating the proportion of “possible” responses. The interrelationships among activities were determined by calculating ϕ coefficients. Furthermore, the degree of agreement assessed between ADL items was calculated by dividing the total response by the number of “possible-possible” and “impossible-impossible” responses, in order to examine the similarity of the achievement pattern of ADL. The ϕ coefficient values were high among ADL items with comparable difficulty where the item proportions were within about 10%. Even if belonging to a different ADL domain, the relationship was high among ADL items with similar difficulty and kinds of activity. All of the 27 activities used in Disabled-ADL indicated high agreement of over 80% with one or more activities among the other 47 activities used in this study. Especially, three lower extremity activities of “putting on trousers while standing”, “going up and down stairs” and “squatting down from a standing posture” agreed more than 90% with many other lower extremity activities. The possibility is suggested in determining lower extremity functional levels by assessing these three activities. The selection of ADL items considering these influences is necessary to comprehensively assess ADL ability of disabled elderly. *J Physiol Anthropol* 21 (3): 167-175, 2002 <http://www.jstage.jst.go.jp/en/>

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Introduction

The activities in daily life are generally classified into several ADL domains based on the subject of the activity, such as feeding, dressing, movement, and toileting (Demura et al., 1999). A selection of assessment items from each ADL domain is necessary to comprehensively assess ADL ability. On the other hand, each ADL domain consists of activities with various characteristics concerning difficulty and the use of body parts.

Ando (1992) analyzed the ADL structure of 39 activities selected from the ADL domains of movement, feeding, grooming, dressing, toileting and bathing by using Hayashi’s quantification theory III (Hayashi and Komazawa, 1983). His results indicated that there are some activity groups with similar characteristics concerning difficulty and the use of body parts even if these activities belong to different ADL domains, and that these activities in the same group correlate with each other. Namely, it was considered that the achievement patterns are also similar among these activities.

In ADL assessment, it is impossible to evaluate all daily activities. Generally, functional assessment is efficiently conducted using only some activities representing each ADL domain. Using various activities is necessary to comprehensively assess ADL ability, but practicality and simplicity of ADL assessment should also be considered, i.e., the practicality and amount of information in an assessment is an important problem for the utility of the ADL index.

As mentioned above, there are groups with similar achievement patterns among the daily activities. In other words, these activities have interrelationships, and if one can be achieved, another can also be done. Clarifying the general trend of interrelations among the daily activities provides important suggestions concerning the problem of practicality and the amount of information. The

present study aimed to determine the achievement patterns among daily activities for institutionalized dependent elderly.

Methods

Subjects

The subjects were 706 Japanese dependent elderly (179 males, mean age: 80.0 ± 7.4 years, 24 in the 60s group, 60 in the 70s group, 95 in the 80s and over group; 527 females, mean age: 81.9 ± 7.5 , 37 in the 60 s group, 146 in the 70 s group, 344 in the 80s and over group) living in five special homes for the aged and five health facilities in Akita and Ishikawa prefectures. The range of the subjects' age was from 60 to 99 years old. Four hundred twenty-three subjects (about 60%) lived in special homes for the aged, and 283 subjects (about 40%) lived in health facilities. The subjects' physical independence ranged from rank A (house-bound: needing partial assistance only in outdoor activities) to rank C (bed-bound: dependent for most daily activities) of the standard for the degree of independence for disabled elderly, approved by the Japan Ministry of Health and Welfare in 1991 (Tsuchiya et al., 1992). About 50% of the subjects used assisting devices for movement such as a stick, walker and wheelchair, and about 20% of them could not move by themselves.

ADL items

It was assumed that the daily activities of dependent elderly were from the following nine domains; 1) movement, 2) going up and down stairs, 3) changing and holding the posture, 4) bathing, 5) using the toilet, 6) dressing, 7) grooming, 8) eating and 9) manual activities. As shown in Table 1, seventy-four items were selected considering the following major indices: basic ADL indices (Klein and Bell, 1982; Mahoney and Barthel, 1965; Shoening and Iversen, 1968), instrument ADL (IADL) indices (Lawton and Brody, 1969; Koyano et al., 1991; Keith et al., 1987), unified indices of ADL-IADL (Kempen and Suurmeijer, 1990; Hosokawa et al., 1994), and disability scales (Winograd et al, 1994). These 74 items included the 27 items used in ADL index for institutionalized disabled elderly (Disabled-ADL), developed by Demura et al. (2000b). A dichotomous scale of "possible" or "impossible" was used to rate each item.

Data collection

The survey for the elderly was conducted in each subjects' institution. The subjects were selected at random by the staff, such as occupational therapists, physical therapists and nurses, working at the subjects' institutions. They responded to the ADL index survey. The survey duration at each institution ranged between four and six weeks. Informed consent from the subjects

was obtained via institutional staff after the aim and method of the survey were explained and understood.

Statistic analyses

The proportion of "possible" response was calculated for each item to confirm the difficulty of the activities. The ϕ coefficient was calculated mutually among 74 items to determine interrelationships and similarity of achievement patterns among 74 activities. The ϕ coefficient between items A and B was found from the following equation;

$$\phi = (ad - bc) / \sqrt{(a + b)(c + d)(a + c)(b + d)}$$

where a and c are a possible response for items A and B, respectively and b and d are an impossible response for items A and B respectively (Nunnally and Bernstein, 1994).

The agreement in achievement patterns was determined between 27 activities used in Disabled-ADL and other 47 items. The agreements in achievement patterns were calculated by the sum of the number of "possible-possible" responses and "impossible-impossible" responses for the both items divided by the total number of subjects.

Results

The proportion of "possible" response for each item is shown in Table 2. The highest proportion was obtained in "eating while holding the tableware on the table (59.7%)", and the lowest value was obtained in "putting on socks or stockings in a standing posture (10.2%)". Among nine ADL domains, the proportions for movement, going up and down stairs and bathing tended to be low, and those for eating and grooming were high. In changing and holding the posture, and dressing, the differences in the proportions tended to be large.

Table 2 shows the item numbers with ϕ coefficients of 0.7 and over calculated from 74 ADL items. Many items related to their own ADL domain items. However, the ADL items in movement, changing and holding the posture, toileting and dressing also related to the other domain items. Furthermore, in general, a higher relationship tended to be found between items with similar proportion values within their own item proportion $\pm 10\%$, regardless of ADL domain.

Table 3 shows the agreements of achievement patterns between 27 ADL items used in Disabled-ADL and other 47 items. In this table, the items are shown in order of difficulty of the item based on the proportions of "possible" responses. All of the other 47 items indicates high agreement of over 80%, and 29 of these 47 items indicate high agreement of over 90% with one or more items among the 27 ADL items used in Disabled-ADL.

Table 1. ADL items selected in this study

No.	domain	Contents
1	I Movement	Crawling.
2		Walking in the room.
*3		Walking to an adjoining room.
4		Going up a slope.
5		Going down a slope.
*6		Crossing the doorstep.
7	II Going up and down stairs	Going up the stairs.
8		Going down the stairs.
9		Getting on and off an automobile.
10	III Changing and holding posture	Shifting the body while lying on one's back.
*11		Sitting up from the lying posture.
12		Moving the face of the body towards a different direction in the sitting posture.
13		Getting off the bed.
14		Getting up on the bed.
*15		Sitting on a chair from the standing posture.
16		Sitting cross legged from the standing posture.
17		Sitting upright from the standing posture.
*18		Squatting down from the standing posture.
19		Standing up from the sitting posture.
20		Standing up from the squatting posture.
21		Walking on the knee.
*22		Tossing about in bed.
*23		Maintaining the sitting posture.
24		Maintaining the knee-standing posture.
*25	Keeping the standing posture.	
*26	IV Bathing	Entering the bathtub.
27		Getting out of the bathtub.
*28		Washing the hair in the bath.
29		Washing the back in the bath.
30		Washing the extremities in the bath.
31		Scooping water in the bathtub.
32		Rinsing the body with the shower.
*33		Drying the body with a towel after bathing.
*34		Squeezing a wet towel.
*35	V Using the toilet	Using a Western-style lavatory.
36		Using a Japanese-style lavatory.
*37		Pulling up and down the underwear during excretion.
38		Wiping off and flushing after excretion.
*39		Controlling urination.
40	Controlling defecation.	
*41	VI Dressing	Putting on pants or a skirt in the standing posture.
42		Putting on socks or stockings in the standing posture.
43		Putting on pants or a skirt in the sitting posture.
44		Putting on socks or stockings in the sitting posture.
45		Putting on mules.
46		Putting on wooden clogs.
*47		Putting on shoes without strings.
48		Putting on shoes.
49		Putting on a short-sleeved shirt with buttons.
*50		Putting on a long-sleeved shirt with buttons.
51		Pulling a zipper closed.
*52		Clasping buttons.
53		Tucking the hem of the jacket into pants or a skirt.
*54	VII Grooming	Washing the face.
*55		Wiping the body with a towel.
*56		Washing hands.
57		Taking care of dentures. (Brushing the teeth.)
58		Cutting the nails.
59	Shaving (males). Combing (females).	
60	VIII Eating	Eating with a spoon or a fork.
*61		Eating with chopsticks.
*62		Eating while holding the tableware on the table.
63		Eating while holding the tableware up towards the mouth.
64		Biting food.
65		Peeling a mandarin orange.
66		Cutting fruits and vegetables with a knife. Peeling fruits and vegetables with a knife.
67		Pouring hot water from a kettle into another vessel.
68		Opening and closing the faucet.
*69	IX Manual activity	Tying a string.
70		Writing characters.
71		Cutting paper with scissors.
72		Opening and closing a sliding door.
73		Undoing a package wrapped in cloth.
*74		Opening and closing a drawer.

The rating scale for each item was a dichotomous scale of "possible" or "impossible". *: Items used in Disabled-ADL index of Demura et al.

Table 2-1. Item proportions and ϕ coefficients among ADL items

Domain	Item contents	%	I	II	III	IV	V	VI	VII	VIII	IX
I Movement	1 Crawling.	32.7			10, 11, 13, 14, 15			48			
	2 Walking in the room.	29.2	3, 6		13, 14, 15		35				
	*3 Walking to an adjoining room.	27.3	2, 4, 5, 6		13, 14, 15		35				
	4 Going up a slope.	18.0	3, 5, 6	7, 8, 9							
	5 Going down a slope.	17.5	3, 4, 6	7, 8, 9	16	26					
	*6 Crossing the doorstall.	22.2	2, 3, 4, 5	7, 8, 9							
II Going up and down stairs	7 Going up the stairs.	13.5	4, 5, 6	8, 9							
	8 Going down the stairs.	13.7	4, 5, 6	7, 9							
	9 Getting on and off an automobile.	20.4	4, 5, 6	7, 8				43, 44			
III Changing and holding posture	10 Shifting the body while lying on one's back.	41.9	1		11, 12, 13, 14, 15		35				
	*11 Sitting up from the lying posture.	40.5	1		10, 12, 13, 14, 15		35				
	12 Moving the face of the body towards a different direction in the sitting posture.	42.4			10, 11, 13, 14, 15		35				
	13 Getting off the bed.	39.1	1, 2, 3		10, 11, 12, 14, 15		35	45-48			
	14 Getting up on the bed.	38.6	1, 2, 3		10, 11, 12, 13, 15		35	45-48			
	*15 Sitting on a chair from the standing posture.	34.8	1, 2, 3		10, 11, 12, 13, 14, 19		35	46, 48			
	16 Sitting cross legged from the standing posture.	18.2	5		17, 18, 19, 20						
	17 Sitting upright from the standing posture.	16.1			16, 18, 19, 20						
	*18 Squatting down from the standing posture.	13.5			16, 17, 19, 20						
	19 Standing up from the sitting posture.	21.9			15, 16, 17, 18, 20						
	20 Standing up from the squatting posture.	14.0			16, 17, 18, 19		43				
	21 Walking on the knee.	17.8			43						
IV Bathing	*22 Tossing about in bed.	63.1									
	*23 Maintaining the sitting posture.	45.8									
	24 Maintaining the knee-standing posture.	15.1			40, 44						
	*25 Keeping the standing posture.	18.1			43						
	*26 Entering the bathtub.	18.5	5			27	43				
V Using the toilet	27 Getting out of the bathtub.	18.5				26					
	*28 Washing the hair in the bath.	22.7				29					
	29 Washing the back in the bath.	17.1				28, 30, 31					
	30 Washing the extremities in the bath.	19.1				29, 31, 32, 34			58		
	31 Scooping water in the bathtub.	23.5				29, 30, 32, 33, 34					
	32 Rinsing the body with the shower.	28.7				30, 31, 33		53			
	*33 Drying the body with a towel after bathing.	29.9				31, 32					69, 73
	*34 Squeezing a wet towel.	27.7				30, 31					
	*35 Using a Western-style lavatory.	34.8	1, 2		10, 11, 12, 13, 14, 15		37	47, 48			
	36 Using a Japanese-style lavatory.	15.7			20	26					
VI Controlling defecation	*37 Pulling up and down the underwear during excretion.	38.0			14		35	43, 45, 47, 49, 50			
	38 Wiping off and flushing after excretion.	46.1					39, 40		57		
	*39 Controlling urination.	52.8					38, 40				
	40 Controlling defecation.	55.6					38, 39		56		

Table shows the item numbers indicating 0.7 and over of the ϕ coefficients. % means the item proportions. *: Items used in Disabled-ADL index of Demura et al.

Table 2-2. Item proportions and \emptyset coefficients among ADL items

Domain	Item contents	%	I	II	III	IV	V	VI	VII	VIII	IX
VI Dressing	*41 Putting on pants or a skirt in the standing posture.	12.2						42			
	42 Putting on socks or stockings in the standing posture.	9.0						41			
	43 Putting on pants or a skirt in the sitting posture.	26.9					37	44, 46			
	44 Putting on socks or stockings in the sitting posture.	26.1						43			
	45 Putting on mules.	45.5			13, 14		37	46-50			
	46 Putting on wooden clogs.	34.0			13, 14, 15			43, 45, 47, 48, 49			
	*47 Putting on shoes without strings.	37.2			13, 14		35, 37	45, 46, 49, 50			
	48 Putting on shoes.	35.1	1		13, 14, 15		35	43-47, 49, 50	55		
	49 Putting on a short-sleeved shirt with buttons.	36.2					35	45-48, 50	55		
	*50 Putting on a long-sleeved shirt with buttons.	35.3					35	45-49	55		
	51 Pulling a zipper closed.	13.6									
	*52 Clasp buttons.	13.4									
	53 Tucking the hem of the jacket into pants or a skirt.	37.0		32							
VII Grooming	*54 Washing the face.	47.6							55		
	*55 Wiping the body with a towel.	37.8						48, 49, 50	54		
	*56 Washing hands.	60.0					40		54	60-63, 67	
	57 Taking care of dentures. (Brushing the teeth.)	38.4				30	38				
	58 Cutting the nails.	14.0									
	59 Shaving (males). Combing (females).	44.8									
VIII Eating	60 Eating with a spoon or a fork.	64.9							56	61, 62, 63	
	*61 Eating with chopsticks.	53.0							56	60, 62, 63	
	*62 Eating while holding the tableware on the table.	66.3							56	60, 61, 63	
	63 Eating while holding the tableware up towards the mouth.	58.6							56	60, 61, 62	
	64 Biting food.	49.7									
	65 Peeling a mandarin orange.	26.3									
	66 Cutting fruits and vegetables with a knife.										
	Peeling fruits and vegetables with a knife.	25.8									
	67 Pouring hot water from a kettle into another vessel.	57.7							56		
68 Opening and closing the faucet.	24.9										
IX Manual activity	*69 Tying a string.	36.7				34					71, 73
	70 Writing characters.	19.3									69, 73
	71 Cutting paper with scissors.	28.4									74
	72 Opening and closing a sliding door.	44.0									69, 71
	73 Undoing a package wrapped in cloth.	31.0				34					72
	*74 Opening and closing a drawer.	56.0									

Table shows the item numbers indicating 0.7 and over of the \emptyset coefficients. % means the item proportions. *: Items used in Disabled-ADL index of Demura et al.

Table 3. Agreements of achievement pattern among activities of Demura's index and the others

Table with columns for No, Domain, No Domain, and 28 numbered items (1-28) representing various achievement patterns. The table contains numerical values for each item across different domains.

means items obtained high agreement of achievement pattern between lower extremity activities. means item obtained high agreement activities between upper extremity activities. means items obtained high agreement of achievement pattern between changing body direction activities. means the pairs obtained high phai coefficient values (>0.7). Item and domain number correspond to Table 1. *: items used in Disabled-ADL index of Demura et al.

Discussion

Demura et al. (1999) reported that judging from the results in examining the interrelationship among the activities for independent elderly people, the difficulty of the activities, determined as item proportions, closely influenced the interrelationship. Also in the present study, the higher ϕ coefficient values (>0.70) were mainly found between items indicating similar difficulty (within their item proportion $\pm 10\%$ of itself). For example, an item with a proportion of 20% highly related to items with proportions ranging from about 10 to 30%. Similarly, items with a proportion of 30% highly related to items with proportions ranging from about 20 to 40%.

Furthermore, movement activities indicated high relationships to the activities of "dressing in a standing position", "standing from a sitting position" and "changing posture from a standing position". These activities have common difficulty and functional characteristics required for achievement, such as the functions of holding a standing position and strength of lower extremities. The same trends were also recognized in the upper extremity activities of feeding, grooming and dressing. Ando (1992) indicated that the grooming activities of "washing the hair", "washing the face" and "fixing the hair" are less related to eating and other grooming activities, but they are more related to dressing activities. The difficulties of these activities were considered to differ because of the difference in the required level of ability in holding a sitting posture, between dressing activity and eating and other grooming activities. In contrast, even if the activities were within the same ADL domain and used the same body parts, the relationships tended to be low among activities with different difficulty. For example, although "59. Clasping buttons (13.4%)", "69. Tying a string (36.7%)" and "47. Eating while holding the tableware at the table (66.3%)" were all activities using hands, the difficulties of these activities were different, and the agreements were low. A similar trend was found among the changing and holding activities of "18. Squatting down from a standing posture (13.5%)", "15. Sitting in a chair from a standing posture (34.8%)", "11. Sitting up from the lying posture (40.5%)" and "41. Tossing about in bed (63.1%)". These findings show that interrelations among the activities are influenced by the difficulty and the similarity of functional characteristics, and that the selection of assessment items considering these influences is necessary to comprehensively assess ADL ability.

Furthermore, these results also indicate that more practical and simpler ADL assessments are possible using fewer items by determining interrelations among ADL items. If the activities used in an existing ADL index for disabled elderly people showed higher interrelationships to the other activities, there is a possibility of extending

the utility of the existing index. This study examined the agreement of achievement patterns between 27 activities used in Disabled-ADL, and other 47 activities from 74 items.

Lower extremity activities with high difficulty used in Disabled-ADL, such as "26. Putting on trousers in a standing posture", "7. Going up and down stairs", "18. Squatting down from the standing posture", "44. Keeping the standing posture", "21. Entering the bathtub", "6. Crossing the doorsill" and "3. Walking to an adjoining room", showed high agreement with lower extremity activities indicating less than 20% of the "possible" proportions in ADL domains of dressing, going up and down stairs, changing and holding posture, toileting, movement and bathing. Especially, since items 26, 7 and 18 indicated very high agreement of over 90% with the above items, it may be possible to determine the achievement patterns of most of the movement and standing activities by assessing these three items. The lower extremity activities represented by the movement activity are frequently used in daily life. It was, furthermore, reported that the decline of lower extremity functions closely correlate to the decline of ADL ability (Demura et al., 1999; Sato et al., 1999; Winograd et al., 1994), and that ADL ability level also closely correlates with the level of the quality of life (Kawaminami et al., 2000). It is meaningful that the results of a few lower extremity activities can provide useful information concerning other lower extremities functions.

Middle-difficulty upper extremity activities used in Disabled-ADL, such as "65. Squeezing a wet towel", "64. Drying the body with a towel after bathing", "35. Putting on a long-sleeved shirt with buttons", "69. Tying a string", "32. Putting on shoes without laces", "37. Wiping the body with a towel" and "25. Pulling underwear down and up for excretion", showed high agreement with bathing, feeding, dressing, manual and grooming activities with proportions ranging from 30% to 40%. In addition, manual activities with lower difficulty showed high agreement with feeding activities having proportions over 40%. These activities have similar difficulty and functional characteristics. On the other hand, upper extremity activities with high difficulty, "59. Clasping buttons" and "38. Washing the hair in the bath", also showed high agreement with lower extremity activities with high difficulty. Although there is no direct causal relationship between the achievement patterns of these activities, this high agreement is caused by the similarity of difficulty of these activities.

The 27 ADL items used in Disabled-ADL indicated high agreement of over 80% with many of 47 ADL items selected in the present study, and agreement of over 90% with 29 of the items. This does not necessarily indicate that the properties of these 29 ADL items were completely explained by assessing 27 items in Disabled-

ADL. Actually, in the case of disabled elderly people, since there are various individual differences in their physical fitness status, it is dangerous to apply the results of the present study completely to the whole disabled elderly population. In the present study, however, the agreements of achievement patterns between activities with proportions of 90% were very high, and the relationship may be generalized. These results indicate that the results of assessing 27 ADL items used in Disabled-ADL can provide more information concerning activities with high relationships.

The investigation of the interrelationship among activities on dependent elderly people in this study was exploratory in nature, and the results cannot conclude a causal relationship among activities. Furthermore, in drawing conclusions, additional studies with a larger sample must investigate the age and gender dependent differences in this interrelationship. The results in this study, however, may provide important fundamental information for additional studies that might empirically investigate this interrelationship considering the influences of age and gender.

In conclusion, the interrelations among the activities are influenced by the difficulty and the similarity of functional characteristics. All of the 27 activities used in Disabled-ADL indicated high agreement of achievement patterns of over 80% with one or more activities used in this study. Since three lower extremity activities of "putting on trousers while standing", "going up and down stairs" and "squatting down from a standing posture" agree more than 90% with many other lower extremity activities, the possibility is suggested in determining lower extremity functional levels by assessing these three activities. A selection of assessment ADL items considering these influences is necessary to comprehensively assess ADL ability of disabled elderly people.

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References

- Ando T (1992) Structure analysis of ADL. In Tsuchiya K, Imada H, Okawa T eds. *Activities of daily living*. Ishiyaku Publishers, Inc., Tokyo, 37-52
- Demura S, Sato S, Minami M, Noda Y, Matsuzawa J, Miyaguchi H, Nishijima T, Goshi F, Tada N, Arai T (1999) Examination of difficulty and relationship among activities of daily living (ADL) items on the elderly. *J Educ Health Sci* 44: 500-511
- Demura S, Sato S, Minami M, Toyoshima Y, Goshi F, Ishikawa Y (2000a) Characteristics of activities of daily living (ADL) ability in institutionalized disabled older adults: Comparison according to usage conditions of assisting devices for movement. *Jpn J Physiol Anthropol* 5: 1-8
- Demura S, Sato S, Minami M, Kobayashi H, Noda M (2000b) The proposal of the activities of daily living (ADL) index for institutionalized older adults. *Jpn J Hygiene* 55: 538-546
- Dunlop DD, Hughes SL, Manheim LM (1997) Disability in activities of daily living: Patterns of change and a hierarchy of disability. *Amer J Public Health* 87: 378-383
- Hayashi C, Komazawa T (1983) *Theory of quantification and data analysis*. Asakura publishers, Inc., Tokyo, 89-136
- Hosokawa T, Tsubono Y, Tsuji I, Maesawa M, Nakamura R (1994) Assessment of functional status with an extended ADL scale (1) A general population sample of community elderly. *Jpn J Rehab Med* 31: 399-408
- Kawaminami K, Fujita T, Minowa M, Koyano W (2000) Development of a scale for subjective QOL common to patients with intractable diseases. *Jpn J Public Health* 47: 990-1003
- Keith RA, Granger CV, Hamilton BB, Sherwin FS (1987) The Functional Independence Measure: a new tool for rehabilitation. In Eisenberg MG, Grzesiak RC eds. *Advances in clinical rehabilitation*. vol 2. New York: Springer, 6-18
- Kempen GIJM, Suurmeijer JPBM (1990) The development of a hierarchical polychotomous ADL-IADL scale for noninstitutionalized elders. *Gerontologist* 30: 497-502
- Klein MR, Bell B (1982) Self care skills: behavioral measurement with Klein-Bell ADL scale. *Arch Phys Med Rehab* 63: 335-338
- Koyano W, Shibata H, Nakazato K, Haga H, Suyama Y (1991) Measurement of competence: reliability and validity of the TMIG index of competence. *Arch Gerontol Geriatr* 13: 103-115
- Lawton MP, Brody EM (1969) Assessment of older people: self-maintaining and instrumental activities of daily living. *Gerontologist* 9: 179-186
- Mahoney FI, Barthel WD (1965) Functional evaluation: The Barthel Index. *Maryland State Med J* 14: 61-65
- Nunnally JC, Bernstein IH (1994) *Psychometric theory*. 3rd ed. McGraw-Hill, 118-120
- Ranberg AK, Christensen K, Jeune B, Skytthe A, Vasegaard L, Vaupel JW (1999) Declining physical abilities with age: a cross-sectional study of older twins and centenarians in Denmark. *Age and Ageing* 28: 373-377
- Sato S, Demura S, Kobayashi H, Goshi F, Minami M, Nagasawa Y, Yamaji S (1999) Characteristics of ADL

ability on partially dependent older adults: Comparison among different ambulatory activities levels. *Appl Human Sci* 18: 169-174

Shoening HA, Iversen IA (1968) Numerical Scoring of Self-care Status: A Study of Kenny self-care evaluation. *Arch Phys Med Rehab* 49: 221-229

Tsuchiya K, Imada H, Okawa T (1992) Activities of daily living. Ishiyaku Publishers, Inc., Tokyo, 37-52

Winograd CH, Lemsky CM, Nevitt MC, Nordstorm TM, Stewart AL, Miller CJ, Bloch DA (1994) Development of

a physical performance and mobility examination. *J Amer Geriatr Soc* 42: 743-749

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