ASSessment of Activities of Daily Living in the Elderly

A Study of a Population of 76-Year-Olds in Gothenburg, Sweden

Ulla Sonn and Kerstin Halter Åberg

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ABSTRACT. The cumulative structure of personal daily activities (Katz’s Index of ADL) and four well-defined instrumental activities (cooking, transportation, shopping, and cleaning) have been studied in a population of 76-year-olds (N = 659) in Gothenburg, Sweden. Sixty-five percent of the population were independent, 22% were dependent in instrumental activities, and 13% were dependent in both instrumental and personal activities. No person was dependent in personal ADL and independent in instrumental ADL. The internal consistency and the coefficient of scalability were well above the acceptance level, which indicated an internal reliability and validity of the new scale. The frequency of personal and home-assistance care, type of accommodation, self-assessment of self-care and domestic activities were compared with the level of dependence in ADL and indicated external validity. This cumulative instrument of ADL can be used to describe and compare the level of disability in elderly populations and to define the need for personal assistance in home care among disabled persons.

Keywords: activities of daily living, elderly, disability, population studies, scalability, rehabilitation medicine.

Studies in Gothenburg, Sweden, have shown that the health and vitality of average 70-year-olds has increased during the past fifteen years (23). On the other hand, the number of people aged 80 and over will continue to increase and the incidence of diseases and disabilities will remain high. These groups also need more extensive social services and health care for each passing year. The relation between physical disability and age is well known in this age range (11, 22). Disability is often measured in terms of dependence or independence in personal daily life activities (P-ADL), for example feeding, dressing and bathing. In general population studies of elderly, attention should be paid to activities more typically experienced by old persons living in the community since that will be more relevant to a larger proportion of the elderly. Activities such as housekeeping, transportation, and shopping, have come to be termed “Instrumental Activities of Daily Living” (I-ADL) (12). Instrumental daily life activities have also been shown to be more useful as a means of detecting disability in a general population of elderly than personal ADL (7, 12).

However, the frequency of disability will also depend on how the separate daily life activities are defined. For example, Gomans-Hedström et al. (8) found that one third of a representative 70-year-old population were ADL-reduced, when asked if they had problems with their ADL, used technical aids or if they were dependent on personal help in any of the activities in P-ADL (bathing, dressing, going to the toilet, rising from chair/bed, and eating). If disability—in this study—had been defined only as dependence on personal help, the result would have been that only 4% of the population was disabled instead of one third of the population.

There is a cumulative scale of dependence in six items of personal ADL, exemplified in Katz’ Index of ADL (13, 14). Lawton & Brody (15) developed a Guttman scale of I-ADL, and Katz et al. (20) showed that two instrumental activities, namely shopping and transportation, can be ordered together with personal activities in a cumulative scale. In an earlier study, we have found that there was a cumulative relationship between certain well-defined instrumental activities (10). This sample was however rather small and included both aged and disabled persons, many of whom lived in rural districts. They were selected consecutively from persons who consulted an occupational therapist.

The purpose of this article is to study the cumulative structure of dependence in personal and instru-
Table 1. Number of persons distributed by type of accommodation and use of service

<table>
<thead>
<tr>
<th>Type of accommodation</th>
<th>Men</th>
<th>Women</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Own home</td>
<td>281 (94)</td>
<td>336 (94)</td>
<td>617 (94)</td>
</tr>
<tr>
<td>Service apartment/old peoples home</td>
<td>5 (2)</td>
<td>11 (3)</td>
<td>16 (2)</td>
</tr>
<tr>
<td>Nursing home/hospital</td>
<td>14 (5)</td>
<td>12 (3)</td>
<td>26 (4)</td>
</tr>
<tr>
<td>Use of services</td>
<td>32 (11)</td>
<td>48 (13)</td>
<td>80 (12)</td>
</tr>
<tr>
<td>Social service</td>
<td>70 (24)</td>
<td>100 (30)</td>
<td>176 (27)</td>
</tr>
</tbody>
</table>

Katz's Index of ADL was used with the exception of the item of continence and was supplemented by four instrumental activities, namely, cooking, transportation, shopping, and cleaning. Katz' Index is summarized in ADL grades from grade A, which means independent in all personal activities to grade G, which means dependent in all of these activities. Persons who cannot be classified in grade A to G are classified as "Others". Table II gives the definitions of the four instrumental activities (I-ADL) together with the definition of Katz' Index of ADL. "Partly dependent" is used to make it easier to dichotomize the assessment into independent or dependent to obtain the most perfect cumulative scale. "Partly dependent" in cleaning is assessed as independent, and "partly dependent" in shopping, transportation, and cooking is assessed as dependent in grade I. "Partly dependent" is assessed as independent in bathing, transfer, and continence, and independent in dressing, dressing, and feeding. People living together were assessed as independent if they performed the activity when alone and as dependent if another person was involved in the activity. The cumulative characteristics of the internal reliability and validity of the scale of P-ADL and I-ADL, can be studied in several ways. The proportion of persons who cannot be classified according to the cumulative ADL grades (Others) must not exceed 5% (14). 3. The coefficient of reproducibility can be measured by the scale analysis technique described by Guttman (9). It is a measure of both reliability, reproducibility and the internal validity of the scale (cumulant validity).

The coefficient of reproducibility

\[
\text{Coefficient of reproducibility} = 1 - \frac{\Sigma \text{of errors}}{\text{Number of persons} \times \text{Number of items}}
\]

The coefficient of reproducibility has been refined by Monti, into a more sensitive coefficient of scalability (11).

\[
\text{Coefficient of scalability} = 1 - \frac{\Sigma \text{of errors}}{\text{Maximum number of errors}}
\]

For calculation of the maximum number of errors, see (4, 10, 18).

A coefficient of reproducibility of 0.90 confirms the existence of a valid cumulative and unidimensional Guttman scale. If there is a skewness of the distribution of either of items or individuals, Mantel suggested the coefficient of scalability, which ought to be 0.65 or higher to confirm a valid Guttman scale. This method has been described in detail earlier together with the use of inter-observer reliability (4, 10). The internal consistency of the extended ADL scale was studied by using the Kuder Richardson formula 20 (K.R.20) for dichotomously scored items (19). Guidelines for reliability coefficients are for individuals at least 0.85 and for groups 0.65.

The external validity was studied in several ways. The distribution of persons by ADL categories and ADL grades was analyzed to show the discriminative validity. The concurrent validity was assessed by comparisons between the actual level of dependence and the type of accommodation (own home vs. sheltered accommodation) and between the level of dependence and the use of personal care and home help (12 months per month, 3 months per week, and daily assistance). In connection with the home visit, the probands received a self-assessment form, where the following questions were included:

- Comparing yourself with persons of your own age, what opinion do you have about your own situation concerning personal care (bathing, taking a shower, using the lavatory, dressing etc.), and domestic activities (shopping, washing, cleaning, cooking etc.)? When answering the self-assessment form, the subjects were asked to select from the following alternative responses: good, rather good, not so good, and bad. For 54 and 59 persons respectively, no self-assessment form was recorded about personal care and domestic activities. Comparisons were made between the extended ADL scale and the self-assessment of personal care and domestic abilities at the home visit.

Further, the extended ADL scale was compared with one of the following dimensions in the WHO handicap classification system (ICDHI) (23), the dimension of physical independence, in order to confirm the convergent validity. This classification system contains four levels of persons and not only their capability. Physical independence is classified in eight grades, ranging from grade

- fully independent
- slightly independent
- independent
- dependent
- severely dependent
- very severely dependent
- total dependence

The eight grades were divided into three groups (0-2, 3-4, and 5-6), when compared with the five categories of the extended ADL scale: independent, dependent in I-ADL, and dependent in I- and P-ADL. Eleven missing values were reported. The assessment according to the WHO classification was made by the same occupational therapists who had carried out the ADL assessments.

Fishers exact test was used for testing differences between men and women and dependence in ADL, type of living, and use of services. Only two-tailed tests were used. Values of \(p < 0.05\) were considered statistically significant. The results of the analyses are presented in Tables III and IV. The two-tailed significance level was 0.05. The comparison was made using the chi-square test. The results are presented in Table IV. The chi-square test was used for comparing the distribution of persons in the different groups (I, II, and III) with the expected distribution. The results of the chi-square test are presented in Table IV. The chi-square test was used for comparing the distribution of persons in the different groups (I, II, and III) with the expected distribution. The results of the chi-square test are presented in Table IV.
Table 1. Number of persons distributed by type of accommodation and use of service

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<tbody>
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<td>375</td>
</tr>
<tr>
<td>Service apartment/old peoples home</td>
<td>5</td>
<td>2</td>
<td>7</td>
</tr>
<tr>
<td>Nursing home/hospital</td>
<td>14</td>
<td>5</td>
<td>19</td>
</tr>
<tr>
<td>Use of services</td>
<td>32</td>
<td>11</td>
<td>43</td>
</tr>
<tr>
<td>Social service</td>
<td>70</td>
<td>24</td>
<td>94</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Use of service</th>
<th>n (%)</th>
<th>n (%)</th>
<th>n (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Handicapped transportation service</td>
<td>6</td>
<td>2</td>
<td>8</td>
</tr>
</tbody>
</table>

The external validity was studied in several ways. The distribution of persons by ADL categories and ADL grades was analyzed to show the distribution validity. The concurrent validity was assessed by comparing the actual level of dependence and the type of accommodation (own home vs. sheltered accommodation) and between the level of dependence and the use of personal care and home help (1–2 times per month, 3–10 times per week and daily assistance). In connection with the home visit, the probands received a self-assessment form, where the following questions were included: Comparing yourself with persons of your own age, what opinion do you have about your own situation concerning personal care (bathing/taking a shower, using the lavatory, dressing etc.) and domestic activities (shopping, washing, cleaning, cooking etc.). When answering the self-assessment form, the subjects were able to select from the following alternative responses: good, rather good, not so good, and bad. For 34 and 59 persons, respectively, no self-assessment form was recorded about personal care and domestic activities. Comparisons were made between the extended ADL scale and the self-assessment of personal care and domestic activities.

Katz' Index of ADL was used with the exception of the item of continence and was supplemented by four instrumental activities, namely, cooking, transportation, shopping, and cleaning. Katz' Index is summarized in ADL-grades from grade A, which means independent in all personal activities to grade G, which means dependent in all of these activities. Persons who cannot be classified according to ADL scale due to other reasons are classified as "Others". Table II gives the definitions of the six instrumental activities (I-ADL) together with the definition of Katz' Index of ADL. "Partly dependent" is used to indicate that the task is still performed. More elaborate equipment is needed to obtain the perfect scale of performance. "Partly dependent" in cleaning is assessed as independent, and "partly dependent" in shopping, transportation, and cooking is assessed as dependent (I-II). "Partly dependent" is assessed as independent in bathing, transfer, and continence, and as dependent in shopping, dressing, and feeding (II). People living together were assessed as independent if they performed the activity when alone and as dependent if another person was involved in the activity. The cumulative characteristics of the internal reliability and validity of the scale of P-ADL and I-ADL can be studied in several ways.

1. The proportion of persons who cannot be classified according to the cumulative ADL grades (Others) must not exceed 5% (6-14).

The coefficient of reproducibility can be measured by the scale analysis technique described by Gunzburg (9). It is a measure of both the reliability and the internal validity of the scale (construct validity).

The coefficient of reproducibility is calculated as:

\[
R = \frac{\text{Number of persons} \times \text{Number of items}}{\text{Number of errors}}
\]

The coefficient of reproducibility has been refined by Montel, into a more sensitive coefficient of scalability (11).

\[
R = \frac{\text{Number of errors}}{\text{Maximun number of errors}}
\]

For calculation of the maximum number of errors, see (4, 10, 13). A coefficient of reproducibility of 0.90 confirms the existence of a valid cumulative unidimensional Guttman scale. If there is a skewness of the distribution either of items or of individuals, Montel suggested the coefficient of scalability, which ought to be 0.60 or higher to confirm a valid Guttman scale. This method has been described in detail earlier together with several inter-observer reliability tests (4, 10). The internal consistency of the extended ADL scale was studied using the Kuder Richardson formula 20 (K.R.20) for dichotomously scored items (13). Guidelines for reliability coefficients are for individuals at least 0.85 and for groups 0.65.

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Further, the extended ADL scale was compared with one of the dimensions in the WHO handicap classification system (ICIDH-23), the dimension of physical independence, in order to confirm the convergent validity. This classification system is a scale of the persons and not our own capability, physical independence is classified in eight grades, ranging from grade


The eight grades were divided into three groups (0, 2–3, 4–9), when compared with the three categories of the extended ADL scale: independent, dependent in I-ADL, and dependent in I- and P-ADL. Eleven missing values were registered. The assessment according to the WHO classification was made by the same occupational therapists who had carried out the ADL assessments.

The facts were used to test differences between men and women and dependence in ADL, type of living, and use of services. Only two-sided tests were used. Values of \( p \leq 0.05 \) were considered statistically significant.
Table II. Definitions of four instrumental activities and six personal activities included in Katz's Index of ADL and of independent, partly dependent, and dependent

<table>
<thead>
<tr>
<th>Activity</th>
<th>Independent</th>
<th>Partly dependent</th>
<th>Dependent</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Shopping</strong></td>
<td>gets to the store, manages stairs or other obstacles, takes out groceries, pays for them and carries them home</td>
<td>performs the activity when necessary</td>
<td>does not perform the activity or needs assistance with some part of the activity</td>
</tr>
<tr>
<td><strong>Cleaning</strong></td>
<td>performs the activity but together with another person</td>
<td>performs the activity when necessary</td>
<td>gets assistance in cleaning the house or assistance very seldom</td>
</tr>
<tr>
<td><strong>Transportation</strong></td>
<td>gets assistance in taking the car to doctor or assistance very seldom</td>
<td>performs the activity when needed</td>
<td>performs the activity but together with another person</td>
</tr>
<tr>
<td><strong>Cooking</strong></td>
<td>does not perform the activity</td>
<td>does not perform the activity</td>
<td>does not perform the activity</td>
</tr>
<tr>
<td><strong>Bathing</strong></td>
<td>gets to the kitchen, prepares the food, manages the stove</td>
<td>does not prepare dinner-food or only heating up prepared food</td>
<td>does not perform the activity</td>
</tr>
<tr>
<td><strong>Dressing</strong></td>
<td>means sponge bath, tub bath, or shower</td>
<td>means getting all needed clothing from the closet and drawers and getting dressed, includes using fasteners and putting on a brace, if worn</td>
<td>means getting all needed clothing from the closet and drawers and getting dressed, includes using fasteners and putting on a brace, if worn</td>
</tr>
<tr>
<td><strong>Toileting</strong></td>
<td>means going to the 'toilet room' for bowel and urine elimination, cleansing self after elimination, and arranging clothes</td>
<td>means going to the 'toilet room', cleans self and arranges clothes without assistance. (May use support object such as cane, walker, or wheelchair, and may manage a night bedpan or commode, emptying it in the morning)</td>
<td>means going to the 'toilet room', cleans self and arranges clothes without assistance. (May use support object such as cane, walker, or wheelchair, and may manage a night bedpan or commode, emptying it in the morning)</td>
</tr>
<tr>
<td><strong>Transfer</strong></td>
<td>moves in and out of bed in and in out of chair</td>
<td>moves in and out of bed in and out of chair with assistance. (May use support object such as a cane or walker)</td>
<td>does not get out of bed</td>
</tr>
<tr>
<td><strong>Continence</strong></td>
<td>controls urination and bowel movement completely by self</td>
<td>has occasional accidents</td>
<td>supervision helps keep urine or bowel control, or catheter is used, or is inconsistent</td>
</tr>
</tbody>
</table>

Table III. Number of persons distributed by index grade. Errors of scale marked with circles (independent +, dependent —)

<table>
<thead>
<tr>
<th>No. of persons</th>
<th>N=659</th>
<th>Feeding</th>
<th>Transfer</th>
<th>Going to toilet</th>
<th>Dressing</th>
<th>Bathing</th>
<th>Cooking</th>
<th>Transporting</th>
<th>Cleaning</th>
<th>Shopping</th>
<th>Sum of modal category frequencies</th>
</tr>
</thead>
<tbody>
<tr>
<td>450</td>
<td>9</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>653</td>
</tr>
<tr>
<td>7</td>
<td>1</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>632</td>
</tr>
<tr>
<td>5</td>
<td>1</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>629</td>
</tr>
<tr>
<td>8</td>
<td>1</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>605</td>
</tr>
<tr>
<td>44</td>
<td>1</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>573</td>
</tr>
<tr>
<td>1</td>
<td>2</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>541</td>
</tr>
<tr>
<td>1</td>
<td>2</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>529</td>
</tr>
<tr>
<td>1</td>
<td>1</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>499</td>
</tr>
<tr>
<td>1</td>
<td>1</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>451</td>
</tr>
<tr>
<td>1</td>
<td>1</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>510</td>
</tr>
<tr>
<td>2</td>
<td>1</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>511</td>
</tr>
</tbody>
</table>

| Sum of modal category frequencies | 653 | 632 | 629 | 605 | 573 | 541 | 529 | 499 | 451 | 510 | 511 |

* A non-scale type is designated x.

Activities of daily living in the elderly

VII. Of those who lived in their own homes, 69% were independent, 23% were dependent in I-ADL, and 8% were dependent in both I- and P-ADL. The corresponding results for those who lived in service apartments or in old peoples' homes were 12, 26 and 62%. All persons who lived in nursing homes or hospitals were dependent in I- and P-ADL. Thirty-one persons belonged to the most dependent ADL grades (Grades 7, 8, and 9), two thirds of them lived in some type of sheltered accommodation, and one third lived in their own homes. They received support from their
Table II. Definitions of four instrumental activities and six personal activities included in Katz' Index of ADL and of independent, partly dependent, and dependent

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<th>Dependent</th>
</tr>
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<td>Shopping</td>
<td>gets to the store, manages stairs or other obstacles, takes out groceries, pays for them and carries them home</td>
<td>performs the activity when necessary</td>
<td>does not perform the activity or needs assistance with some part of the activity</td>
</tr>
<tr>
<td>Cleaning</td>
<td>performs housekeeping, vacuum-cleaning, washing floors</td>
<td>performs the activity when necessary</td>
<td>does not perform the activity or gets assistance with some part of the activity regularly</td>
</tr>
<tr>
<td>Transportation</td>
<td>gets to the stop for public transportation, gets on and gets off by bus, tram, or train</td>
<td>performs the activity when needed</td>
<td>performs the activity but together with another person</td>
</tr>
<tr>
<td>Cooking</td>
<td>gets to the kitchen, prepares the food, manages the stove</td>
<td>does not prepare dinner-food or only heating up prepared food</td>
<td>does not perform the activity</td>
</tr>
<tr>
<td>Bathing</td>
<td>means sponge bath, tub bath, or shower</td>
<td>receives no assistance (gets in and out of tub by self if tub is usual means of bathing)</td>
<td>receives assistance without assistance except for help with laying in or out of bed</td>
</tr>
<tr>
<td>Dressing</td>
<td>means getting all needed clothing from closets and dressers and getting dressed; includes putting on and taking off of clothes, and exercising, including putting on clothes</td>
<td>gets clothes and gets dressed without assistance</td>
<td>receives assistance in bathing only one part of the body (such as back or a leg)</td>
</tr>
<tr>
<td>Transfer</td>
<td>means moving in and out of bed, in chair or on chair; may move up and down of chair without assistance</td>
<td>moves in and out of bed or chair without assistance</td>
<td>does not get out of bed</td>
</tr>
<tr>
<td>Continence</td>
<td>means the function of controlling elimination from the bladder and bowel</td>
<td>controls urination and bowel movements completely by self</td>
<td>has occasional accidents</td>
</tr>
<tr>
<td>Feeding</td>
<td>means the basic process of getting food from plate or equivalent into the mouth</td>
<td>needs food without assistance</td>
<td>gets food without assistance or has occasional accidents</td>
</tr>
<tr>
<td>Pivotal to all</td>
<td>receives assistance in feeding or in feeding or in being fed partly or completely through tube or with intravenous fluid</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Partly dependent is assessed as dependent in cooking, shopping and transportation and as independent in cleaning. Partly dependent is assessed as dependent in toileting, transfer, and continence and as independent in bathing, dressing, and feeding</td>
<td>receives assistance in feeding or in being fed partly or completely through tube or with intravenous fluid</td>
<td></td>
<td></td>
</tr>
</tbody>
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Table III. Number of persons distributed by index grade. Errors of scale marked with circles (independent +, dependent -)

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<th>Bathing</th>
<th>Cooking</th>
<th>Transportation</th>
<th>Cleaning</th>
<th>Shopping</th>
</tr>
</thead>
<tbody>
<tr>
<td>N = 659</td>
<td></td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>+</td>
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</table>

Sum of modal category frequencies: 653 632 629 603 573 541 529 499 451 510 511

* A non-scale type is designated x.

Activities of daily living in the elderly

VII. Of those who lived in their own homes, 69% were independent, 23% were dependent in I-ADL, and 8% were dependent in both I- and P-ADL. The corresponding results for those who lived in service apartments or in old people’s homes were 12, 26 and 62%. All persons who lived in nursing homes or hospitals were dependent in I- and P-ADL. Thirty-one persons belonged to the most dependent ADL grades (Grades 7, 8, and 9), two thirds of them lived in some type of sheltered accommodation, and one third lived in their own homes. They received support from their...
relatives and assistance from the social service or service from hospital, such as day-care or similar facilities. Only 7% of the independent persons received some form of regular assistance compared with about 90% of the persons who were dependent in one or two activities and 100% of those who were dependent in three or more activities (Table VII). Twenty-seven percent of the study population used the Handi-cap Transportation Service. Of those, only 49% of the women and 24% of the men were dependent in transportation as defined in the extended ADL scale.

The concurrent validity is also shown by the relationship between the observers’ ADL assessments and the probands’ self-assessments of their personal care and domestic activities (Figs. 1 and 2). Eighty-one percent of those who noted bad or not so good about how they managed P-ADL were also dependent in P-ADL, while 7% of those who noted good or rather good were dependent in P-ADL. Seventy-one percent were independent and felt good or rather good about how they managed personal care compared with others of the same age. Eighty-four percent of those who noted not so good or bad about how they managed domestic activities were dependent in I-ADL. Twenty-four percent were dependent in I-ADL and still felt that they managed the domestic activities well or rather well.

The extended ADL scale was also related to the WHO classification of physical independence, which is shown in Fig. 3. Ninety-four percent of those who were assessed as independent (class 0–2) in the WHO classification were also assessed as independent by the ADL scale, and all but 6% who were assessed as dependent in the WHO classification were assessed as dependent in the ADL scale. Those persons who were classified in classes 3-4 were generally situation-dependent. They were dependent in I-ADL and those who were dependent in P-ADL were dependent in bathing. Those persons who were classified in groups 5-8 were dependent more frequently and were dependent in more critical situations in P-ADL, such as dressing, going to the toilet and transfer. Those who were dependent in I-ADL in this group were dependent in cooking.

**DISCUSSION**

One important limitation of Katz’s Index of ADL is that improvements in grade A and dependence in I-ADL cannot be detected. This is why a cumulative extension of this ADL scale is valuable. The former study of the cumulative structure of personal and instrumental ADL (10) was carried out in a small population (n=85) while this study concerns a general population (n=659) of elderly people in Gothenburg.

The items chosen for this ADL scale are essential to most people and concern important activities of daily living. They are defined with the purpose of describing different levels of disability. Since the instrumental activities are more complex, they could be useful for detecting dysfunctions earlier than if only personal ADL are assessed.

The interview methodology may imply an over- or underestimate of the ADL capacity. Visiting subjects in their homes provides an opportunity to combine the interview with observations, and the persons who carried out the interviews in this study were occupational therapists who were trained to analyseabilities in the elderly.

In this study, the item of continence was excluded to avoid too many systematic errors of scale. Incompletely described ADL categories are not included in the tabulation.
relatives and assistance from the social service or service from hospital, such as day-care or similar facilities. Only 7% of the independent persons received some form of regular assistance compared with about 90% of the persons who were dependent in one or two activities and 100% of those who were dependent in three or more activities (Table VII). Twenty-seven percent of the study population used the Handicap Transportation Service. Of those, only 49% of the women and 24% of the men were dependent in transportation as defined in the extended ADL scale.

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The extended ADL scale was also related to the WHO classification of physical independence, which is shown in Fig. 3. Ninety-four percent of those who were assessed as independent (class 0–2) in the WHO classification were also assessed as independent by

Table V. Distribution of male and female subjects categorized as independent and dependent in I-ADL and dependent or P-ADL

<table>
<thead>
<tr>
<th>ADL-category</th>
<th>Men n (%)</th>
<th>Women n (%)</th>
<th>Total n (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Independent</td>
<td>190 (63)</td>
<td>236 (66)</td>
<td>426 (62)</td>
</tr>
<tr>
<td>Dependent in I-ADL</td>
<td>62 (21)</td>
<td>83 (23)</td>
<td>145 (22)</td>
</tr>
<tr>
<td>Dependent in P-ADL</td>
<td>48 (16)</td>
<td>40 (11)</td>
<td>88 (13)</td>
</tr>
<tr>
<td>Dependent only in P-ADL</td>
<td>0 (0)</td>
<td>0 (0)</td>
<td>0 (0)</td>
</tr>
<tr>
<td>Total</td>
<td>300 (100)</td>
<td>359 (100)</td>
<td>659 (100)</td>
</tr>
</tbody>
</table>

NS=not significant.

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Table VI. Distribution of persons by type of accommodation and level of independence and dependence

<table>
<thead>
<tr>
<th>Type of accommodation</th>
<th>ADL-category</th>
<th>Own home n (%)</th>
<th>Service apartment/old people's home n (%)</th>
<th>Nursing home/hospital n (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Own home</td>
<td>Service apartment/old people's home</td>
<td>Nursing home/hospital</td>
<td></td>
</tr>
<tr>
<td>Independent</td>
<td>424 (69)</td>
<td>2 (12)</td>
<td>0 (0)</td>
<td></td>
</tr>
<tr>
<td>Dependent in I-ADL</td>
<td>141 (23)</td>
<td>4 (26)</td>
<td>0 (0)</td>
<td></td>
</tr>
<tr>
<td>Dependent in P-ADL</td>
<td>52 (8)</td>
<td>10 (16)</td>
<td>28 (46)</td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>617 (100)</td>
<td>16 (16)</td>
<td>26 (42)</td>
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</tr>
</tbody>
</table>

The ADL scale, and all but 6% who were assessed as dependent in the WHO classification were assessed as dependent in the ADL scale. Those persons who were classified in classes 3–4 were generally situation-dependent. They were dependent in I-ADL and those who were dependent in P-ADL were dependent in bathing. Those persons who were classified in groups 5–8 were dependent more frequently and were dependent in more 'critical' situations in P-ADL, such as dressing, going to the toilet and transfer. Those who were dependent in I-ADL in this group were dependent in cooking.

DISCUSSION

One important limitation of Katz' Index of ADL is that improvements in grade A and dependence in I-ADL cannot be detected. This is why a cumulative extension of this ADL scale is valuable. The former study of the cumulative structure of personal and instrumental ADL (10) was carried out in a small population (n=85) while this study concerns a general population (n=659) of elderly people in Gothenburg.

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The interview methodology may imply an over- or underestimate of the ADL capacity. Visiting subjects in their homes provides an opportunity to combine the interview with observations, and the persons who carried out the interviews in this study were occupational therapists who were trained to analyse disabilities in the elderly.

In this study, the item of continence was excluded to avoid too many systematic errors of scale. Incom
tinence is quite common among elderly women (17), and this item will not fit into a one-dimensional activity scale. Continence is a physiological function rather than an activity, and according to the WHO criteria for Impairments, Disabilities and Handicaps, continence is classified as an impairment (23).

Most elderly people in general populations are expected to be independent in personal ADL. According to an assessment of the personal activities as in Katz’ Index of ADL in this 76-year-old population, 43% were classified as independent compared with 65% when the instrumental activities were added. The subjects were distributed over all grades, and there was a cumulative structure between the instrumental and the personal categories, which confirms an improved discriminative validity of the extended ADL instrument.

Several studies have shown the prevalence of disability in I-ADL (1, 3, 6, 8, 11, 22). In all these studies the highest percentage of personal help concerned housework as is the case in this study, where cleaning was the most frequent need. People living together often perform the instrumental activities together, that is, that they are voluntarily dependent on each other. It is important that an ADL instrument should detect the change from voluntary to involuntary dependence.

There were only 15 errors of scale concerning P-ADL but 53 concerning I-ADL. Instrumental activities represent complex tasks made up of many components. They may be sex-linked and influenced by cultural and environmental factors to a higher degree than the personal activities. To minimize the number of systematic errors, further studies should be performed to improve the definitions of the items, to test the instrument on persons with different diagnoses and in different age-groups.

Coefficients of reproducibility and scalability showed that the extended ADL scale had internal reliability and validity in a general elderly population when the item of continence was excluded. The item ‘washing’, used in the former study (10) was excluded in the present study, as the definition of the activity was indistinct, and ‘shopping’ has been ranked second to ‘cleaning’ to fit into the cumulative scale. Environmental factors may affect the order of these items as the distance from the home to shopping centres will differ in rural and urban areas.

Forty-nine percent of the women who had Handicap Transportation Service (HTS) were dependent regarding transportation in the ADL scale. For men the figure was 24%, which may partly be due to the higher incidence of mobility disorders for women (2). Explanations of the fact that independent persons are using the HTS could be difficulties in using public transportation or distance to the bus stop, etc. Other difficulties are getting on to the bus-tram-or-train and passing along the bus when it is moving. Lundgren-Lindquist et al. (14) have shown that among 79-year-olds 20% of the women and 6% of the men had difficulties in a test situation. The difficulties in the real-life situation may be assumed to be worse.

One-third of those who were dependent in grades 7, 8, or 9, were living in their own homes. All of these needed assistance several times a day and also often at night as they were dependent in going to the toilet. This support was either given by the social services system or mostly by close relatives. The activity ‘going to the toilet’ should be seen as a ‘critical item’, for persons returning home after hospital treatment.

Seventy percent of the persons classified as independent in the ADL scale, had personal help, which could be explained by the fact that these persons were dependent in areas not measured with this scale. Two percent were dependent in the ADL scale and had no assistance and these persons were dependent only in transportation.

The concurrent validity was also confirmed by the strong agreement between self-assessment of personal care, domestic activities and level of dependence in ADL. Very few were over-optimistic or underestimated their capacity.

The WHO classification is a taxonomy rather than an instrument for assessing the daily life activities, designed for a variety of applications. However, there is a correlation between independence and dependence in the extended ADL scale and the WHO classification of physical independence, which confirms the convergent validity to some extent. Further studies should be performed to compare the ADL scale with another valid and reliable ADL instrument to improve convergent validity.

This extended ADL scale is easy to administer because of its simplicity. The cumulative structure of instrumental and personal ADL provides information not only about a single item, but also about other items included in the scale. The activities included are well defined and cover central activities of the daily life, making it easier to discover disabilities in an elderly population at an early stage. The activities that can be assessed by means of this instrument are not only essential to people in general. Any restrictions of them due to impairment or disability will lead to loss of independence.

This study has shown that this cumulative ADL instrument is reliable and valid for assessing levels of dependence both in personal and instrumental ADL in a general population of elderly persons. However, establishment of reliability and validity is always an ongoing process. The extended ADL scale provides information that is valuable in planning individual or group programs for elderly persons. It can also be used in research to describe and compare the level of disability in elderly populations, to evaluate the quality of life, and probably to predict the need for care among elderly and disabled persons in the future.

Acknowledgements

The population studies were made possible through grants from the Swedish Council for Planning and Coordination of Research, the Swedish Medical Research Council, the Swedish Council for Building Research, the Bank of Sweden Tercentenary Foundation, the Gothenburg Medical Services Administration, the Gothenburg Administration of Social Services, and the Gothenburg Administration of Sports and Leisure.

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REFERENCES

STANDARDIZATION OF GRIP STRENGTH MEASUREMENTS

Effects on Reproducibility and Peak Force

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From the1 Department of Rehabilitation Medicine, 2 Department of Biomedical Physics and Technology, 3 Department of Epidemiology and Biostatistics, Faculty of Medicine and Allied Health Sciences, Erasmus University Rotterdam, 3000 DR Rotterdam, The Netherlands

ABSTRACT. The aim of our study was to test grip strength and assess the effects of various degrees of standardization on reproducibility and level of peak force. Sixteen healthy persons and eight subjects with an impaired hand function have been tested using a strain-gauge dynamometer. We compared four measurement protocols: (A) the subject is free to assume a comfortable arm position; (B) the subject is also free to assume a comfortable arm position but in addition a challenging stimulus to exceed a previous maximal effort, is given; (C) the arm was held in a predescribed and partly fixed position, as recommended by the American Society of Hand Therapists; (D) the position of the dynamometer is standardized using two reference points on the hand and on the dynamometer. We found high test-retest reliabilities for each measurement protocol without any significant difference. However, significant differences in strength level. With measurements according to protocol B the highest peak values were noted. Since the measurement protocol B combined good reliability with realistic peak forces, this procedure seems most suitable for grip strength measurements.

Key words: reliability, hand, strength, standardization.

Motivation may also influence test results and their reproducibility. Bohnann (1) compared the results of fake efforts to those of sincere efforts. He found intra-trial variation coefficients of less than 8% for maximal efforts, whereas submaximal efforts resulted in variation coefficients usually exceeding 8%. The administration of a challenge to exceed previous efforts may help to obtain maximal efforts and might therefore improve test-retest reliability.

Test-retest correlation coefficients of grip strength have been reported by several authors (2, 4, 6, 7, 8) (Table I), but those are not very helpful in order to establish confidence limits of strength values. Furthermore, no studies about the effect of standardization on grip strength measurements could be found. The aim of the present study was to assess the effects of various degrees of standardization on reproducibility and level of peak force of grip strength measurements.

MATERIAL AND METHODS

We studied 16 healthy subjects and 8 subjects with impaired hand function (Table I). A strain-gauge dynamometer was used (9), with an accuracy of 5% in the range of 2–500 N. We compared four measurement protocols:

A. The subject is free to assume a comfortable arm position during the test.

B. A recorder (Hewlett Packard model 1750A) with a non-numerical scale and two recording pens is attached to the amplifier. One pen is used to monitor the signal produced by the dynamometer, the other pen is set by the observer to a strength level 10% higher than that of a preceding (maximal) effort, thus challenging the subject with a visual stimulus to exceed his previous effort. The subject is free to assume a comfortable arm position.

C. The forearm is stabilized in a groove, the wrist is flexed in neutral position with a velcro strap. The elbow is in 90° of flexion, the shoulder is in adduction and neutral rotation (the position recommended by the American Society of Hand Therapists). The dynamometer is suspended from the ceiling with a cord in order to eliminate the weight of the dynamometer.

D. The position of the dynamometer in the hand is stand-