The elderly at home: indices of disability

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SUMMARY The physical status of all people aged 75 and over living in and around Melton Mowbray was assessed by the responses to a series of questions on the activities of daily living that the respondents could perform. Three methods of producing an index of disability from these separate questions are investigated: principal component analysis, Guttman scaling, and a variation of Guttman scaling known as severity grading. All the methods produced very similar rankings of persons, confirming the suggestion of Bebbington¹ that the choice of scaling method is of little consequence. Two scales emerged: one measuring physical ability and the other the level of urinary and faecal incontinence.

Method

The original study was undertaken in Melton Mowbray, Leicestershire, where almost all the town and surrounding district is served by one 12-doctor general practice. The study population consisted of all those on the practice's computerised age-sex register who were 75 years and over on 31 December 1980. Of the total sample of 1329 persons, 50 (4%) died before interview; 13 (1%) could not be contacted; and 65 (5%) refused to be interviewed. The remaining elderly persons were given a personal interview, 1073 being interviewed in their own homes, 76 in hospital or homes for the elderly, and 51 in the pilot study. The population of Melton Mowbray is similar to that of England and Wales in terms of age, sex, social class distribution, and standardised mortality ratio, and further background information on the study has already been published.² The subsequent analyses were performed on the 1073 elderly persons resident in the community.

Physical status was determined using a method of assessing the ability to perform activities of daily living. This method is similar to that developed and validated by Katz.³ The activities of daily living assessed were transfer (from bed and chair), mobility around the home, bathing, dressing, feeding, getting to and from the toilet, and incontinence of urine and/or faeces. For the physical activities, questions were in the form: "Do you get in and out of a chair/in and out of bed/around the house, flat, home, ward/yourself to and from the toilet/without any help or appliances?" and "Do you bath/dress (including putting on shoes

and socks, stockings)/feed/yourself without any help or appliances?"

The possible responses to each question were: performs the activity alone; has help with the activity; uses an appliance; uses both help and an appliance; does not perform the activity.

Incontinence was assessed by the questions: "Do you have any difficulty in controlling your water/bowels?"

Responses were categorised as: no incontinence; occasional (once/twice a week); frequent (more than three times a week); catheter/colostomy/ileostomy.

Table 1 shows the breakdown for each of the physical activities into four categories: independent, uses help or appliances, uses help and appliances, does not perform this task. The incontinence variables are shown in Table 2, the categories here being: none, occasional, frequent, and appliance. (An appliance includes catheter, colostomy, and ileostomy.) Bathing was the activity that required most help, and assistance with getting to and from the toilet was the second most non-independent activity.

In order to achieve an ordering of severity through each variable, the physical activities were weighted from 0 (independent) to 3 (does not perform) and 0 (none) to 3 (appliance) for the incontinence variables. Two main methods were used to produce a scale of dependency: principal component analysis and Guttman scaling. The third scale produced, the severity grading, was a variant of Guttman scaling.

PRINCIPAL COMPONENT ANALYSIS

Principal component analysis (PCA) aims to reduce

Table 1 Categories of dependency of physical activities per cent (numbers in parentheses)

	Bed	Chair	Mobility	Bathing	Dressing	Feeding	Toilet
Independent	93 (998)	90 (962)	81 (870)	64 (689)	94 (1007)	99 (1060)	69 (732)
Uses help or appliances	6 (64)	10 (101)	18 (190)	30 (321)	6 (59)	1 (11)	30 (324)
Uses help and appliances	1 (9)	0 (5)	0 (6)	6 (59)	0 (0)	0 (0)	1 (13)
Does not perform	0 (1)	0 (5)	1 (7)	0 (4)	0 (6)	0 (1)	0 (4)
Missing	0 (1)	0 (0)	0 (0)	0 (0)	0 (1)	0 (1)	0 (0)
Total	100 (1073)	100 (1073)	100 (1073)	100 (1073)	100 (1073)	100 (1073)	100 (1073)

Table 2 Categories of severity of incontinence per cent (numbers in parentheses)

	Urine	Faeces
None	90 (963)	97 (1041)
Occasional	7 (71)	2 (20)
Frequent	2 (28)	0 (3)
Appliance*	1 (10)	1 (7)
Missing	0 (1)	0 (2)
Total	100 (1073)	100 (1073)

* Includes catheter/colostomy/ileostomy.

the dimensionality of multivariate problems by producing a transformation of the original items to a new (and smaller) set of uncorrelated scales. In order to do this, it makes comparisons between items but does not scale the weights within each item. The physical activities were also analysed with the weights 0 (independent), 2 (help/appliance/both), and 3 (did not perform) to see if different weights affected the scale.

The PCA was performed on the 1071 people living in the community with complete data on all the variables, and this resulted in two significant components which explained about 52% of the variability. The first component weighted heavily on the physical activities, that is, transfer from bed and chair, mobility around the home, bathing, dressing, feeding, and getting to and from the toilet. The second component, on the other hand, was heavily weighted on incontinence of urine and faeces.

When PCA was performed separately for the subgroups of persons who did and did not have stairs, the first two components consistently weighted the

same variables although further components did not. Thus two scales were realised, the first measuring physical activity and the second incontinence.

A simplified scoring method for these scales was constructed by rounding the standardised coefficients produced by the PCA. These simplified scales can be written as:

Physical activity scale = $1 \times \text{CHAIR} + 1 \times \text{BED}$
 $+ 0.5 \times \text{MOBILITY} + 1 \times \text{DRESS} + 0.25 \times \text{TOILET}$

Incontinence scale = $1 \times \text{URINE} + 2 \times \text{FAECES}$

The two activities of feeding (most respondents independent) and bathing (most respondents dependent) did not contribute to the physical activity scale.

There was good correlation between the simplified scales and the full scale produced by PCA, as can be seen from Table 3 (0.97 for physical activity scales and 0.94 for incontinence scales). The scale using weights 0,2,3 for the physical activities had a product moment correlation coefficient of 0.95 with the full PCA score and the simplified PCA score, demonstrating that different internal weighting has little effect on the overall scale.

Table 3 Product moment correlation coefficients between the physical activity scales and incontinence scales produced by the three methods

	(i)	(ii)	(iii)	(iv)	(v)	(vi)
Physical activity scales						
(i) Simplified PCA	1.00					
(ii) Guttman	0.94	1.00				
(iii) Severity grading	0.89	0.93	1.00			
Incontinence scales						
(iv) Simplified PCA	0.24	0.24	0.26	1.00		
(v) Guttman	0.28	0.28	0.30	0.92	1.00	
(vi) Severity grading	0.27	0.26	0.29	0.95	0.96	1.00

(N = 1071)

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GUTTMAN SCALING

The basic principle of Guttman scaling is to attempt to place items in order of severity. This is performed by grading items from easy to hard so that a person who cannot perform a particular task should not be able to perform a harder task. Since Guttman scales should be unidimensional, that is, they should measure one single underlying object, the physical ability items and incontinence items were treated separately so that two scales were again produced.

As Guttman scaling requires a person to 'pass' or 'fail' an item at each stage, the method used by Bebbington¹ was used to reduce the nine multicategory items to 18 two-category items. The physical activity items were turned into two items by the following questions:

- (1) This task needs help/appliance or is not done?
(Yes = "pass", No = "fail")
- (2) This task is not done at all?
(Yes = "pass", No = "fail")

Thus "passing" an item implies dependency of some sort, and the resulting scale will be ordered in the same way as the PCA scales, 0 implying total independence.

The incontinence items were treated similarly:

- (1) Is there any incontinence?
(Yes = "pass", No = "fail")
- (2) Is there an appliance?
(Yes = "pass", No = "fail")

When all the physical activities were included the coefficients of reproducibility and scalability were 0.96 and 0.49. This low coefficient of scalability casts doubt on whether these items form a valid scale. Guttman scaling was therefore tried on the physical activities omitting feeding and bathing, the two activities that did not appear in the PCA scale of physical activity. Table 4 shows the order of items produced by the Guttman scaling for the physical activities without feeding and bathing. The coefficient of reproducibility

was found to be 0.98 with the corresponding coefficient of scalability 0.72, confirming that these items form valid scales.

The order of items for the incontinence scale are shown in table 5. The coefficients of reproducibility and scalability for this scale were 0.99 and 0.72, again suggesting that these items form a unidimensional scale.

After the Guttman procedure has produced the ordering and verified the validity, the actual scale is formed as an additive index. An alternative scale can be found by using the rank of the 'easiest' task that the person cannot manage. These are called severity grading scales and are shown in tables 4 and 5. Of the respondents 61% were fully independent in all the physical activities (omitting feeding and bathing) and had a grading of 0 on the physical activity severity grading scale; 89% were fully continent and had a score of 0 on the incontinence severity grading scale.

COMPARISONS OF THE SCALES

The simplified PCA scale, the Guttman scale, and the severity grading scale were compared by calculating the product moment correlation coefficient between pairs of scores for both the physical activity and incontinence scales.

These correlations are shown in table 3. The correlations between the physical activity scales and the incontinence scales are reassuringly low (of the order of 0.25), indicating that the two scales are measuring different disabilities. The correlation coefficients between the three sets of physical activity scales were in each around 0.90, confirming that these scales are measuring similar disabilities.

All three methods were found to be robust as similar results emerged from separate analyses for men and women and for two random halves of the sample.

Discussion

In a community survey of this size it is impractical to use clinical assessment to ascertain the "functional

Table 4 *Order of items in the physical activity scale produced by Guttman scaling and the severity grading scale.*

Item	Severity grading scale
Independent in all tasks	0
Cannot manage unaided	
Toilet	1
Mobility	2
Chair	3
Bed	4
Dress	5
Did not perform	
Mobility	6
Dress	7
Chair	8
Toilet	9
Bed	10

(N = 1071)

Note: "Cannot manage unaided" included "did not perform".

Table 5 *Order of items in the incontinence scale produced by Guttman scaling and the severity grading scale*

Item	Severity grading scale
Fully continent	0
Has some incontinence of:	
Urine	1
Faeces	2
Has an appliance for:	
Urine	3
Faeces	4

(N = 1071)

Note: "Has some incontinence of" includes "has an appliance for".

status" of an elderly person. The activities of feeding, bathing, dressing, mobility, transfer from bed and chair, and toileting were those used by Katz³ in developing his index of independence in activities of daily living. Comparison with other studies of disability in the elderly is difficult as other workers have chosen different sets of activities from those defined by Katz³ (Harris,⁴ McDonnell *et al*,⁵ Hunt,⁶ and Garrad and Bennett.⁷) It was therefore decided, in the present study, that reversion back to Katz's original assessments based on the six functions was more acceptable than any of the methods used in subsequent studies.

With regard to the wording of the questions asked, Dunt *et al*⁸ maintain that the measurement of performance of activities of daily living should reflect "usual" (measured by "Do you . . .?") rather than "optimal" performance ("Can you . . .?"). Thus all questions relating to physical activities began with the phrase "Do you . . .?" and concluded with ". . . on your own?". As Dunt *et al*⁸ also showed that measures of activities of daily living rarely take into account the different situations—without physical aids or personal assistance, with aids only and with both aids and assistance—these distinctions between help and aids were allowed for in the possible responses mentioned previously.

Three methods of producing a scale of disability have been investigated. Two scales emerged, one measuring physical activity and the other incontinence, a high score indicating greater disability. All three methods produced very similar scales which were highly correlated with each other. This confirms the findings of Bebbington¹ that the choice of scaling method for scoring disability seems to be of little consequence. However, Bebbington reached this conclusion for assessment of disabled populations whereas this paper used data from a community survey of the elderly.

The first method of scaling used was PCA and this gave the lowest weight to the activity of getting to and from the toilet. This reflects the fact that, after bathing, it was the activity that most respondents had

difficulty with. Of the five activities that formed the physical activity scale, getting to and from the toilet is unique in involving not only whole body movements (of which mobility in and around the house and getting out of a chair and bed consist) and fine movements (which dressing involves) but also the element of time. The other four activities can take the respondent as long as is necessary, but this is not true for getting to the toilet.

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