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A Cluster Analysis of Activities of Daily Living From the Canadian Health and Disability Survey[1]

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ABSTRACT

The Canadian Health and Disability Survey, administered as a supplement to the Canadian Labour Force Survey in October 1983, collected data on potentially disabled persons by means of a screening questionnaire and a follow-up questionnaire for those screened-in. The data from the screening questionnaire, consisting of a set of activities of daily living, were used to group respondents according to identifiable characteristics. A description of the groups of respondents is provided along with an evaluation of the methods used in their determination. An incompletely ordered severity scale is proposed.

KEY WORDS: Disability scale; Discriminant analysis.

1. INTRODUCTION

Considerable efforts have been made to acquire a better understanding of the disabled population. These efforts have focussed on the development of a useful vehicle for capturing the potentially disabled population as well as the analysis of survey data for the purposes of gaining a better understanding of the various dimensions of disability and to develop useful measures of severity. Examples of papers which examine these issues are Dolson *et al.* (1984) and Raymond *et al.* (1981), among others. This paper chronicles the development of an exploratory technique in order to gain a better understanding of the disabled population in Canada. In particular, a cluster analysis based on results of several discriminant analyses was performed.

The next section presents information about the Canadian Health and Disability Survey. The third section describes the development of the clusters. Section 4 focusses on the characterization of the clusters. Some analysis of the behaviour of the derived clusters is given in Section 5. The paper concludes with some closing remarks.

2. BACKGROUND

In response to a need for data on disabled persons in Canada, Statistics Canada undertook a program to create a disability database. The Canadian Health and Disability Surveys (CHDS) were administered as supplements to the Canadian Labour Force Survey (LFS) in October 1983 and June 1984. In both cases, separate questionnaires were administered to children and to adults. In the October survey, the adult questionnaire was administered to everyone in the LFS sample (the frame includes about 97% of the Canadian population aged 15 or more). In June, the adult survey was restricted to those aged 15 to 64 from the six provinces with the smaller sample sizes in October (i.e. Newfoundland, Prince Edward Island, Nova Scotia, New Brunswick, Manitoba and Saskatchewan). Children from all provinces were surveyed in both October and June.

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This paper concentrates on work which utilized only the data from the adults questionnaire in October 1983. This survey obtained 92,945 adult respondents from approximately 47,000 households.

2.1 Questionnaire

2.1.1 Screening Section

The Labour Force Supplement included a screen which was used to identify respondents for a follow-up questionnaire. The screening section consisted of nineteen items - seventeen activities of daily living, an activity limitation item and an item about mental handicap. The activities of daily living (ADL's) are a set of activities which any person would perform during the course of his/her regular living pattern. The set used here was a modified version of those developed by the Organization for Economic and Co-operative Development (OECD) and has been utilized by several other countries.

The ADL's are presented in Table 1 with the questionnaire identification and the orientation of the specified activity. Two ADL's are related to hearing troubles, two to vision troubles, four to mobility troubles, one to speaking and being understood and the remaining eight to agility troubles.

Table 1

Activities of Daily Living

Questionnaire Item	Description	Orientation
A10	Walking 400 Metres	Mobility
A11	Walking up and down stairs	Mobility
A12	Carrying 5 kg. object for 10 metres	Mobility
A13	Moving from one room to another	Agility
A14	Standing for long periods	Mobility
A15	When standing, bending down to pick up object	Agility
A16	Dressing and undressing	Agility
A17	Getting in and out of bed	Agility
A18	Cutting own toenails	Agility
A19	Using fingers to grasp or handle	Agility
A20	Reaching	Agility
A21	Cutting own food	Agility
A22	Reading newsprint	Vision
A23	Seeing clearly a face across the room	Vision
A24	Hearing conversation with another person	Hearing
A25	Hearing conversation with two or more persons	Hearing
A26	Speaking and being understood	Speaking and being understood

An example of the wording of these questions in the screening section of the questionnaire is as follows: (A20) Does . . . . have any trouble reaching? The activity limitation item (A27) concerned limitation "in the kind or amount of activity he/she can do at home, at work or going to school because of a long-term physical condition or health problem". The final item in the screen section (A28) concerned mental handicap.

It should be noted that the survey was concerned with long-term conditions or health problems – those that had lasted or were expected to last more than six months (excluding pregnancy). An individual was screened in if he/she had trouble with at least one of the ADL's, the activity limitation item or had a mental handicap. (Proxy responses were required for mentally handicapped individuals).

2.1.2 Follow-up Section

The follow-up section of the questionnaire was completed for individuals selected by the screening section. This section included an item which sought to determine if the respondent was completely unable to perform the ADL('s) he/she had trouble with. Other segments of the follow-up questionnaire pertained to: nature of the disability (related to trouble seeing or reading, trouble hearing, trouble speaking and being understood, and mobility); problems related to the ability to work or the workplace itself; obstacles to education and availability of special educational facilities; problems related to local and long-distance travel; and problems in current residence and special facilities. The information in the follow-up questionnaire, given above, could be used to analyze the cluster characteristics, or to develop a severity index (see Lazarus; 1985a, 1985b).

3. CLUSTERS

This section presents a description of the procedures used in the development of the clusters. The clustering procedures employed were developed specifically for this application. Technical details concerning the methods used are given in Sections 3.2 and 3.3. All computations were performed using SAS.

3.1 Methodology

This section summarizes the methodology used to derive the final clusters. The clustering procedure consisted of two steps:

a) a divisive step, where the 12,907 individuals were sequentially partitioned using PROC CANDISC.
b) an agglomerative step, where the partition was collapsed.

For the divisive step, the following procedure was employed iteratively. First, the starting point put all the observations into a single cluster. Each step subdivided each of the current clusters into two groups. For each of the current clusters, a canonical correlation analysis was performed by taking each non-constant variable as a grouping variable and using all other non-constant variables as explanatory variables. The cluster was then split into two, based on the discriminant analysis with the largest F-value. In this way the determinant of the between-sums-of-squares matrix is maximized.

For the agglomerative step, subjective criteria were used, based on the magnitude of the F-value, the size of the groups and the plots of the points. Collapsing was accomplished in the reverse order of splitting, for the most part.

For the divisive step, data based on both unweighted and weighted covariances were used separately. The results were essentially the same. It was decided to continue without the sampling weights because of the added complexity which would be incurred by their inclusion. Furthermore, the weights were not expected to be important with respect to the characteristics of the clustered individuals. Inclusion of weights is necessary for evaluation and analysis.

3.2 Description

The cluster analysis was a procedure which grouped together those screened in respondents with similar but not necessarily identical "profiles". For our purposes, a respondent's profile consisted of the responses to the seventeen ADL's (yes, has trouble/no, does not have trouble), responses to the major activity limitation item (positive/negative), and the mental handicap item in the screening section of the questionnaire.

Table 2 details the final clusters. The symbols U and Z demonstrate how the groups are defined. The symbol U means that the group is defined through that variable being one, i.e. 100% by definition. The symbol Z is used when the defining screening section item is zero, i.e. 0% by definition. Note that six of the nineteen screening items are not used explicitly in the process of classifying respondents. These are A11, A13, A18, A20, A23 and A24.

4. CLUSTER CHARACTERIZATION

This section explores the ways and means of identifying the clusters. The concepts of "trouble orientation" and "umbrella" group are introduced and the clusters are ranked according to the severity of disability.

4.1 Trouble Orientation

Threshold values were established to assist in the cluster classification process. The values were chosen by ordering the clusters according to orientation and locating an obvious gap in the E(NADL) for the orientation, where E(NADL) referred to the average number of troubles among ADL's A10 - A26. In general, a cluster was recognized as having trouble with an activity orientation when the E(NADL) for a particular orientation exceeded the established threshold value. For example, for mobility orientation, E(NADL) was computed for activities A10, A11, A12 and A14. The E(NADL) for each cluster over each orientation may be found in Table 3.

Clusters were labelled as follows. If a cluster had trouble with an activity, the corresponding letter was included in the label. Two clusters, containing individuals who had trouble speaking and being understood or were mentally handicapped, were "special". Clusters which had neither mobility nor agility troubles exceeding the established values were so designated with an N. For example, HMA1 and HMA2 refer to clusters with a large proportion having hearing, mobility and agility problems, but no particular problem with vision. Alternatively, VN1 refers to a cluster with the exact opposite set of problems.

4.2 Umbrella Groups

Clusters with similar orientation patterns became members of specified "umbrella" groups, where they could be better compared using E(NADL) within the umbrella. Table 4 shows the clusters according to the "umbrella" groups to which they belong.

Table 2
Cluster Analysis Results

Cluster	A10	A11	A12	A13	A14	A15	A16	A17	A18	A19
1	*U*	92.7	79.9	59.7	89.8	85.5	*U*	62.7	86.8	60.1
2	*U*	77.0	63.1	16.0	77.0	55.6	*Z*	11.2	46.5	31.0
3	*U*	85.1	66.5	19.4	75.8	*U*	*Z*	15.8	49.6	26.5
4	*U*	65.6	36.7	6.4	55.9	*Z*	*Z*	4.5	21.5	17.7
5	*Z*	18.7	18.2	3.4	25.6	24.6	4.9	6.9	21.7	20.7
6	*Z*	36.3	23.2	4.8	49.5	*U*	11.8	16.6	28.4	21.1
7	*Z*	9.2	5.3	0.3	10.8	*Z*	1.1	0.9	4.4	7.1
8	*U*	94.7	88.6	67.3	93.9	89.0	*U*	74.7	94.7	84.0
9	*U*	92.9	82.1	55.4	89.3	91.1	*U*	58.9	87.5	30.4
10	*U*	95.7	81.0	55.7	91.9	93.8	*U*	*U*	85.2	33.3
11	*U*	92.2	71.7	21.1	83.7	74.1	*U*	*Z*	59.0	28.9
12	*U*	91.9	71.3	25.0	81.3	*U*	*Z*	16.9	58.1	31.9
13	*U*	61.0	48.8	4.3	55.5	*Z*	*Z*	4.9	32.3	14.0
14	*U*	91.3	*U*	23.6	81.4	*U*	*Z*	16.8	40.2	*U*
15	*U*	93.6	*U*	29.9	84.0	*U*	*Z*	19.3	56.1	*Z*
16	*U*	74.9	*Z*	10.9	65.7	*U*	*Z*	12.9	32.8	16.4
17	*U*	66.7	58.3	12.5	37.5	*Z*	*Z*	0.0	37.5	20.8
18	*U*	74.0	55.5	7.5	59.5	*Z*	*Z*	10.4	29.5	*U*
19	*U*	79.6	*U*	11.5	60.8	*Z*	*Z*	2.9	14.6	*Z*
20	*U*	59.0	*Z*	2.7	45.6	*Z*	*Z*	2.2	10.4	*Z*
21	*Z*	14.7	12.6	1.9	19.4	13.9	5.5	4.7	22.2	11.5
22	*Z*	26.5	40.9	7.0	41.4	59.1	*U*	32.1	47.4	35.8
23	*Z*	29.0	26.1	2.1	43.3	*U*	*Z*	13.0	19.0	13.5
24	*Z*	2.4	2.4	0.0	2.0	*Z*	*Z*	0.4	7.7	3.3
25	*Z*	35.6	*U*	2.4	32.9	*Z*	*Z*	3.1	8.5	18.0
26	*Z*	13.5	*Z*	0.3	16.8	*Z*	*Z*	1.8	4.2	9.1
27	*Z*	17.0	13.7	0.3	*U*	*Z*	*Z*	2.4	6.2	5.4
28	*Z*	10.3	6.9	0.0	*Z*	*Z*	*Z*	0.1	7.8	*U*
29	*Z*	38.7	26.3	0.6	*Z*	*Z*	*Z*	2.2	10.9	*Z*

Cluster	A20	A21	A22	A23	A24	A25	A26	A27	A28	Size
1	63.7	42.2	38.6	27.1	73.3	*U*	23.4	94.4	6.3	303
2	35.3	11.8	*U*	50.8	71.7	*U*	9.6	85.0	1.6	187
3	34.6	5.9	*Z*	3.4	63.7	*U*	2.5	88.7	1.1	355
4	16.4	1.9	*Z*	1.6	57.9	*U*	2.6	73.3	1.0	311
5	17.7	8.4	*U*	46.3	59.6	*U*	12.8	55.7	7.9	203
6	24.9	3.5	*Z*	1.4	50.9	*U*	4.2	71.3	1.0	289
7	4.6	0.6	*Z*	1.3	60.5	*U*	5.6	26.3	1.6	1,770
8	78.4	*U*	32.6	16.7	1.2	*Z*	32.2	96.3	9.8	245
9	50.0	*Z*	*U*	30.4	5.4	*Z*	10.7	100.0	5.4	56
10	55.2	*Z*	*Z*	0.5	0.0	*Z*	2.4	89.0	1.9	210
11	45.8	*Z*	*Z*	1.8	0.6	*Z*	3.0	90.4	0.6	166
12	39.4	7.5	*U*	45.6	4.4	*Z*	5.0	93.1	1.9	160
13	20.7	5.5	*U*	42.7	1.2	*Z*	6.7	78.0	4.3	164
14	34.4	1.5	*Z*	1.0	0.9	*Z*	1.3	89.4	1.2	187
15	66.3	16.6	*Z*	2.1	2.1	*Z*	5.9	92.0	1.6	677
16	20.7	0.7	*Z*	0.0	0.4	*Z*	2.0	82.3	0.4	458
17	16.7	20.8	*Z*	0.0	0.0	*Z*	*U*	91.7	33.3	24
18	29.5	12.1	*Z*	0.0	0.0	*Z*	*Z*	82.1	1.2	173
19	19.4	1.0	*Z*	0.5	0.2	*Z*	*Z*	73.5	1.0	582
20	8.0	0.0	*Z*	0.7	0.4	*Z*	*Z*	66.7	0.6	857
21	9.7	7.1	*U*	41.1	2.6	*Z*	8.7	55.3	9.2	618
22	41.9	19.5	*Z*	1.4	1.4	*Z*	7.0	76.3	4.7	215
23	18.1	1.9	*Z*	0.8	0.7	*Z*	1.2	66.6	0.4	1,164
24	0.8	2.0	*Z*	0.0	0.0	*Z*	27.2	62.2	*U*	246
25	23.7	1.4	*Z*	0.3	0.0	*Z*	1.4	*U*	*Z*	295
26	7.3	1.2	*Z*	0.7	0.5	*Z*	1.9	*U*	*Z*	1,923
27	2.4	0.3	*Z*	0.3	0.3	*Z*	0.3	*Z*	*Z*	371
28	11.8	8.3	*Z*	0.0	0.5	*Z*	0.5	*Z*	*Z*	204
29	18.0	1.6	*Z*	6.5	5.7	*Z*	8.5	*Z*	*Z*	494

Table 3

Average Number of Troubles by Orientation

Cluster	Hearing	Vision	Mobility	Agility	Total
1	1.733	0.657	3.624	5.841	11.855
2	1.717	1.508	3.171	2.170	8.566
3	1.637	0.034	3.274	2.543	7.488
4	1.579	0.016	2.582	0.710	4.887
5	1.596	1.463	0.625	1.211	4.895
6	1.509	0.014	1.091	2.152	4.766
7	1.605	0.013	0.253	0.246	2.117
8	0.012	0.493	3.772	7.203	11.480
9	0.054	1.304	3.643	4.480	9.841
10	0.000	0.005	3.686	5.256	8.947
11	0.006	0.018	3.476	3.319	6.819
12	0.044	1.456	3.445	2.838	7.783
13	0.012	1.427	2.653	0.884	4.976
14	0.009	0.010	3.727	3.178	6.924
15	0.021	0.021	3.776	2.941	6.759
16	0.004	0.000	2.406	1.964	4.374
17	0.000	0.000	2.625	2.083	4.708
18	0.000	0.000	2.890	1.890	4.780
19	0.002	0.005	3.404	0.494	3.905
20	0.004	0.007	2.046	0.233	2.290
21	0.026	1.411	0.467	0.852	2.756
22	0.014	0.014	1.088	3.498	4.614
23	0.007	0.008	0.984	1.688	2.687
24	0.000	0.000	0.068	0.352	0.482
25	0.000	0.003	1.685	0.587	2.273
26	0.005	0.007	0.303	0.258	0.573
27	0.003	0.003	0.310	1.170	1.486
28	0.005	0.000	0.172	1.285	1.462
29	0.057	0.065	0.650	0.418	1.190

4.3 Severity

One area of analytic interest is the development of an index of severity of disability. The notion has been considered previously by Raymond et al, among others.

The index of severity would be useful in as much as it would allow for simple comparisons of disability among the screened-in respondents. The use of E(NADL) to draw such comparisons presumes that the orientations are self-weighting, noting, for example, that two ADL's are devoted to hearing troubles while four are devoted to mobility troubles. Also, the multidimensional nature of severity of disability is hidden by a single score such as E(NADL).

Table 4

Ordering of Clusters by "Umbrella" Groups

Umbrella Group	Cluster	Sample Count	*E*(NADL)	ID
HV (Hearing/Vision)	2	187	8.566	HVMA1
	5	203	4.895	HVN1
H (Hearing)	1	303	11.855	HMA1
	3	355	7.488	HMA2
	4	311	4.829	HM1
	6	289	4.760	HA1
	7	1,770	2.120	HN1
V (Vision)	9	56	9.841	VMA1
	12	160	7.783	VMA2
	13	164	4.976	VM1
	21	618	2.756	VN1
S (Special)	17	24	4.708	SMA1
	24	246	0.482	SN1
MA (Mobility/Agility)	8	245	11.480	MA1
	10	210	8.947	MA2
	11	166	6.819	MA4
	14	187	6.924	MA3
	15	677	6.759	MA5
M (Mobility)	16	458	4.374	M2
	18	173	4.780	M1
	19	582	3.905	M3
	20	857	2.290	M4
A (Agility)	22	215	4.614	A1
N (Neither)	23	1,164	2.687	N1
	25	295	2.273	N2
	26	1,923	0.573	N6
	27	371	1.486	N3
	28	204	1.462	N4
	29	494	1.190	N5

Table 4 presents an ordering of clusters according to "severity" within umbrella groups. This within group ordering better reflects the notion that severity is multidimensional than would an overall ordering.

5. CLUSTER CHARACTERISTICS

The principal components technique was used to examine the behaviour of the resulting clusters. Raymond et al also employed principal components; the main difference being that analysis here is based upon group means rather than individuals.

5.1 Methodology

We considered a subset of screened in cases, where more information per case is available. In particular, we added the responses to questions of the form: (B101) Is . . . completely

unable to walk 400 metres without resting? This line of questioning was used for each of the ADL'S, A10-A26. Thus, 11,412 of the original 12,907 individuals who were screened in were usable. The other 1,495 were dropped because of non-response problems. These "completely unable" items were coded with "1" when the individual indicated that he/she was completely unable to perform the specified ADL, otherwise , a "0" was coded.

The means were obtained for the nineteen screening items and seventeen follow-up items for each cluster. The means for the completely unable items were then multiplied by the ratio of the overall average number of ADL's to the overall average of completely unable items in order to scale them consistently and to avoid the scaling problems associated with principal components analysis.

Principal components were obtained using the nineteen screening section and seventeen follow-up item means as variables, using the "clusters" as observations and weighting according to cluster size. The clusters were then ordered according to each of the first four principal component scores.

The final stage involved the pooling of cluster cases according to "umbrella" group membership and finding the means of the first four principal component leadings for each of the eight "umbrella" groups, where the weights were the numbers of members in the "umbrella" groups.

5.2 Results

We present the results in two stages. In the first stage, we examine the principal components and attempt to label them according to the scores. We also explore the "umbrella" group construct in terms of the principal component means. In the second stage, we examine the ordering of the clusters according to the first four principal components.

5.2.1 Components

The first four principal components for the nineteen screening section items and the seventeen follow-up items explained just over seven-eighths of the total variance and appeared to be most useful for our purposes.

The loadings of the first principal component are positive on all but four items (A24, A25 and B241 are hearing oriented, A28 is mental handicap). The negative loadings are close to zero. This first component appears to be an overall measure of strength. The first principal component explained nearly 66% of the total variance and is denoted as "OVERALL".

There are negative loadings on A10, A11, A12, A14 and A15 of the second component. The loading for A15 is nearly zero, however. Loadings are positive for ADL's with an agility-trouble orientation as well as for hearing-trouble and vision-trouble orientations. It appears then that this component polarizes mobility trouble against agility, hearing and vision troubles. The second component is labelled "AHV/M".

The third principal component has positive loadings for mobility and hearing oriented ADL's and negative loadings for agility and vision oriented ADL's. This third component is denoted "MH/AV".

The fourth principal component has positive loadings for mobility and vision oriented ADL's and negative loadings for agility oriented ADL's. This fourth component is designated "MV/A".

5.2.2 Mean Loadings

Table 5 presents the average differences of the principal component scores from the mean scores over all 11,412 individuals, for each of the eight "umbrella" groups. We can

Table 5
Average Differences of Principal Component Scores from Mean Scores

Umbrella Group	Sample Count	Differences PRIN1 (Overall)	PRIN2 (AVH/M)	PRIN3 (MH/AV)	PRIN4 (MV/A)
Hearing/Vision	346	0.68	1.26	0.61	1.06
Hearing	2741	−0.33	0.54	0.81	−0.25
Vision	888	0.30	0.69	−0.76	1.27
Special	151	−1.02	−0.04	−0.47	−0.06
Mobility/Agility	1311	3.31	−0.33	−0.21	−0.33
Mobility	1893	0.30	−0.80	0.18	0.33
Agility	195	−0.19	0.31	−0.80	−0.78
Neither	3887	−1.11	−0.16	−0.41	−0.22

now check to see if the incomplete ordering presented earlier is consistent with the results from the principal components analysis. We note the following observations are taken from Table 5.

i) The mobility/agility "umbrella" group has the highest difference on the first principal component "overall", while the "umbrella" group "neither" has the lowest difference. The difference for the hearing/vision group is positive as is the mean for the vision group. The hearing group difference is negative, however, evidence that individuals with hearing-oriented troubles tend not to have other disabilities. There may be an in−clination to draw the same kind of conclusion with respect to agility-oriented troubles. It is observed that the mobility/agility and mobility groups have positive differences while the agility "umbrella" group has a negative difference. However, in this case, the result is somewhat ambiguous because the agility-oriented ADL's included speaking trouble (A26), a so-called "special" trouble area and it is clear indeed that the special "umbrella" group has a negative difference for the first principal component.

ii) The second component set mobility-oriented troubles (-) against agility, hearing and vision-oriented troubles (+). Positive differences are recorded for the hearing/vision, hearing, vision and agility "umbrella" groups while negative differences are associated with the mobility/agility, mobility and neither groups, as expected. The difference for the special groups is nearly zero.

iii) The third component set mobility-oriented and hearing-oriented troubles (+)against agility-oriented and vision-oriented troubles (−). Again, the results are consistent.

iv) The fourth principal component set mobility and vision-oriented troubles (+) against agility-oriented troubles (−). The results are again consistent with the umbrella-group construct.

5.2.3 The Scales

Table 6 shows the ranks of the clusters according to the first four principal component scores and E(NADL). Recall that the component loadings are for 11,412 cases and utilize follow-up information as well as screening section information while the E(NADL) scale is based on 12,907 cases and uses screening information only.

The cluster ranking according to principal components was done as follows. The component representing overall strength (OVERALL) ranked clusters from highest to lowest scores. The ranking of clusters on AHV/M tended to put clusters with mobility-oriented troubles at the bottom end as opposed to clusters with agility, hearing or vision oriented troubles

which were ranked higher up on this scale. The ranking of clusters on MH/AV tended to put clusters with mobility or hearing troubles at or near the bottom of the scale while clusters with agility or vision-oriented troubles were ranked higher. Finally clusters with agility-oriented troubles were ranked higher on MV/A than the others. Given the bipolar nature of components 2, 3 and 4, it was necessary to make an arbitrary decision as to a trouble orientation scale. As cluster 8 had shown itself to be highly severe according to the *E*(NADL) scale, it was determined that cluster 8 should be similarly ranked along the other scales.

For most clusters, the rankings fluctuate over a wide range. This reflects the nature of the criteria upon which the scales were based. The first principal component, which provides an overall measure of strength, may be the most suitable candidate for ranking the clusters. Firstly, it incorporates the screening section information used in the development of the *E*(NADL) measure. As a result, the rank orderings provided by the OVERALL and *E*(NADL) scales are quite similar. The additional follow-up information used in the construction of

Table 6

Cluster Rank According to Alternative Scales

Cluster	ID	PRIN1 (Overall)	PRIN2 (AHV/M)	PRIN3 (MH/AV)	PRIN4 (MV/A)	*E*(NADL)
2	HVMA1	9	4	27	28	5
5	HVN1	22	2	22	25	12
1	HMA1	3	3	24	6	1
3	HMA2	10	14	28	10	7
4	HM1	16	15	29	20	13
6	HA1	20	8	25	3	15
7	HN1	29	7	26	9	24
9	VMA1	2	6	4	23	3
12	VMA2	4	10	7	27	6
13	VM1	13	11	11	29	11
21	VN1	23	5	2	26	20
8	MA1	1	1	1	1	2
10	MA2	5	20	13	4	4
14	MA3	6	24	16	7	8
11	MA4	7	23	17	8	9
15	MA5	8	28	20	18	10
18	M1	14	26	19	21	14
16	M2	15	25	18	17	18
19	M3	11	29	23	24	19
20	M4	18	27	21	22	22
22	A1	17	9	3	2	17
23	N1	21	17	6	5	21
25	N2	19	22	10	16	23
27	N3	24	19	15	12	25
28	N4	28	12	9	11	26
29	N5	25	16	12	15	27
26	N6	26	18	8	14	28
17	SMA1	12	21	14	19	16
24	SN1	27	13	5	13	29

this component leads us to believe that OVERALL is better than other scales such as *E*(NADL). It is worth noting that the ranking was done on all 29 clusters and depicted in Table 6 on an "umbrella" group basis. The "umbrella" group information was not incorporated into the principal components analysis, however.

6 CLOSING REMARKS

A clustering technique was employed to group screened-in individuals according to similar screening section profiles. The clusters were then ordered according to the information contained in the screening section of the questionnaire (the incomplete ordering based on *E*(NADL) and presented in Table 4) and finally according to information contained in the screening and follow-up sections of the questionnaire (the OVERALL scale presented in Table 6). This last scale is deemed presently to be the most suitable of those considered here. However, it could be argued that no single index of severity exists and in fact the severity index should be defined as a 4-dimensional scale corresponding to our principal components.

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