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THE PSYCHOMETRIC PROPERTIES OF ADCS - ACTIVITIES OF DAILY LIVING INVENTORY AND COMPARISON OF DIFFERENT ADL SCORES

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INTRODUCTION

Several multi-item activities of daily living (ADL) scales have been developed for assessment of functional status of patients with Alzheimer's Disease (AD) in the last few decades (McDowell and Newell, 1996). A disadvantage of the large number of scales is that scores of different ADL scales cannot be compared directly with each other. ADL scales which are used by McNamee's (Townsend's disability scale) and Hill's (Medicare Beneficiary definitions and Katz index of ADL) provide suitable tools for modelling the cost-effectiveness of different treatments in patients with Alzheimer's disease, since they report are empirical results about the relationship between the degree of functional impairment (healthcare costs) and the prevalence of institutionalisation (McNamee et al., 2001; Hill et al., 2006).

The IDEAL trial examines the efficacy of Exelon Patch with the ADCS - Activities of Daily Living Inventory (ADCS-ADL) (Galasko et al., 1997). This ADL instrument is not directly comparable to the ADL scales used by McNamee and Hill. However the use of the ADL scale from the IDEAL study to predict the prevalence of institutionalization with scales by Hill and McNamee would be desirable.

Because of the generic nature of the ADL construct, and considering the fact that these well validated ADL instruments identify the main physical impairments and functional disabilities in Alzheimer disease, we should expect high overlap in item content between different ADL instruments. The high overlap in item content between instruments, and the similar wording and scoring criteria makes it possible to pair each impairments with other. The intention of this study was to establish the link between these ADL scales in order to provide appropriate conditions for further economic analyses on the dataset provided by the IDEAL study.

OBJECTIVE

The aim of the present study was threefold: 1.) examine the psychometric properties (i. e. reliability and validity) of the ADCS–ADL for the mapping process; 2.) prepare three item domains (i.e. mapping) from the Galasko's ADCS-ADL which reflect the scores of Medicare Current Benificiary Survey, Katz index of ADL, and Townsend's disability scale; 3.) validate the mapping process with comparison of different ADL scores through the analysis of the empirical (IDEAL) dataset.

METHOD

Galasko's ADCS-Activities of Daily Living Inventory

The ADCS contained 23 items covering physical and mental functioning and independence in self-care. For each activities of daily living (ADL), an informant is first asked whether or not the patient attempted the activity during the past 4 weeks. If a patient did attempt the ADL, the informant is asked to choose the single most accurate

definition of the patient's level of performance from a set of descriptions. For each basic ADL (questions 1-5 and 6 A: eating, walking, toileting, bathing, grooming, selecting clothes), there is a forced choice of best response. All other ADL consist of a main question followed by subquestions (descriptors). The scores range from 0 to 78, with lower values indicating greater disability.

Galasko et al. (1997) reported good test-retest reliability (range from 0,41 to 0,70) of items over 1-2 months. Correlations between the ADCS items and the MMSE total score range from 0,28 to 0,70.

MCBS scale used by Hill et al

The Medicare Current Beneficiary Survey (MCBS) is a continuous, multipurpose survey of a nationally representative sample of aged, disabled, and institutionalised Medicare beneficiaries (Hill et al., 2006). MCBS collecting data on demographics, healthcare utilisation and costs, health insurance, medical conditions and functioning on activities of daily living. The sample (n=3.138) included both community and nursing home residents in the US: 34% in the community, 57% institutionalised and 9% residing in both settings during the year.

Hill et al. (2006) used retrospective cross-sectional data of the MCBS to estimate the relationship between the degree of functional impairment in patients with Alzheimer's disease and other dementias, and their healthcare costs and prevalence of institutionalisation. Three measures of functioning were used: the number of activities of daily living (ADLs) and independent activities of daily living (IADLs) impaired; an index summarising number and severity of ADL and IADL impairments; and Katz Index of ADLs. Patients were scored as impaired on an ADL or IADL if they needed any assistance performing the activity.

For ADLs, the scoring used was the following:

0 = no impairment,
1 = problem performing but no supervision or assistance needed,
2 = problem requiring supervision,
3 = problem with assistance needed, and
4 = unable to perform.

For IADLs, the scoring was the following:

0 = no impairment,
1 = problem performing but not requiring assistance,
2 = problem performing and assistance required, and
3 = unable to do the activity.

Scores by ADL and IADL were summed across ADLs and IADLs to create a summary index ranging from 0 to 42 points.

Katz index used by Hill et al

The Katz index of ADL (Katz et al., 1963) used by Hill et al was developed to measure the physical functioning of elderly and chronically ill patients. It assesses independence in

six activities: bathing, dressing, toileting, transferring from bed to chair, continence, and feeding. Through observation and interview, the therapist rates each activity on a three-point scale of independence. The six activities included in the index to lie in a hierarchical order from A to G class. Independence mean without supervision, direction, or active personal assistance, except specifically noted in the *Table 1*.

Table 1. Specific definitions of functional independence and dependence

Class A: independent in feeding, continence, transferring, going to toilet, dressing and bathing.
Class B: independent in all but one of these functions.
Class C: independent in all but bathing and one additional function.
Class D: independent in all but bathing, dressing and one additional function.
Class E: independent in all but bathing, dressing, going to toilet and one additional function.
Class F: independent in all but bathing, dressing, going to toilet, transferring and one additional function.
Class G: dependent in all six functions.
Other: dependent in at least two functions, but not classifiable as C, D, E, or F.

Townsend disability scale used by McNamee et al

The Medical Research Council Cognitive Function and Aging Study is a longitudinal study of health and well-being of the ageing UK population. The screening interview contained questions on orientation, socio-demography, social contacts, general health, memory, sleeping problems, ADL, smoking, drinking, cognition and medication (McGee et al., 1998; McNamee et al., 2001).

The Townsend disability scale (McGee et al., 1998) is a short index of activities that assesses physical ability in social terms and can be administered by a lay person (Townsend, 1979). The scale consists of nine questions or 'items': i. e. Are you able to Cut your own toe-nails; Are you able to Wash all over or bathe; Are you able to Get on a bus. Subjects report their level of difficulty. The valid responses — 'yes, with no difficulty', 'yes, with some difficulty' and 'no, needs help'—score 0, 1 and 2 respectively. The scale gives equal weighting to each item and ignores daily and seasonal effects. Items are worded without reference to a time period.

Townsend formed groups to interpret the scale (Townsend, 1979): a total score of 0 was regarded as indicating no disability, 1-2 being slightly affected, 3-6 having some disability, 7-10 having appreciable disability, 11-14 having severe disability and 15-18 having very severe disability. Although the groups were not validated, they do give an outline to assist interpretation.

Psychometrical analysis of the ADCS-ADL data

The IDEAL double blind study's dataset was available for quantitative analysis. This dataset contained items and scores of the ADCS-ADL inventory and also Mini-Menal Examination (MMSE) scores over 24 weeks. The dataset was first used to check the statistical properties of the ADCS-ADL measure, then was used to the support and validate the findings of the qualitative analyses (i.e. mappings). The psychometrical properties of the ADCS-ADL dataset should demonstrate the capability of the ADCS-ADL measure for mapping and for future economic analysis. To assess the psychometric properties of ADCS-ADL all subjects were evaluated at baseline and at 16 and 24 weeks (double-blind phase). Baseline data were used to test the main psychometric characteristics. The internal consistency of the ADCS - Activities of Daily Living Inventory was assessed using corrected item-total correlation and Cronbach's alpha coefficient. Spearman correlation between the item scores of ADCS and total score of MMSE was computed for the item-validity.

Mapping procedure

Based on the comparison of item content of different ADL scales we prepared three item domains from the Galasko's ADCS - Activities of Daily Living Inventory, which reflect the scores of ADL scales used by McNamee's and Hill's. These come from 3 mapping processes (one for each scale) where the items/impairments of the scales were paired with each other. Consequently three analyses were carried out:

1. Map ADCS-ADL to Hill's Medicare Current Beneficiary Survey
2. Map ADCS-ADL to Hill's Katz Index
3. Map ADCS-ADL to McNamee's Townsend disability scale

With this process the ADCS - Activities of Daily Living Inventory scores were translated to the corresponding ADL scales (Townsend's disability scale, Medicare Beneficiary definitions, and Katz index of ADL). The item content of different ADL instruments is very similar, which allows creating comparable equivalent forms. The procedure transforms the contents of one item to another component (see example on *Table 2*). The item-mapping method reflects on items whose difficulty calibrations clearly reflect the item content. The item types of Medicare Current Benificiary Survey, the Townsend's disability scale and Galasko's ADCS are multiple-choice with 3–5 options, ranging from no impairment to unable to do the activity. Corresponding items on the scales have been identified first then severity categories have been paired. Besides the item content we have considered the distribution of each item responses in the empirical (IDEAL) dataset when pairing different options.

Table 2. Sample of mapping procedure

Hill et al. (Medicare Beneficiary Definitions)	**IDEAL study (Galasko)**

Dressing	Dressing (item 6B)
0 = no impairment 1 = problem performing but no supervision or assistance needed	4 = dressed completely without supervision or physical help (frequency of item option: 64,7%)
2 = problem requiring supervision	3 = dressed completely with supervision, but without help (frequency of item option: 19,9%)
3 = problem with assistance needed	2 = needed physical help only for buttons, clasps, or buttoning (frequency of item option: 9,4%) 1 = dressed without help if clothes needed no fastening or buttoning (frequency of item option: 2,3%)
4 = unable to perform	0 = always needed help, regardless of the type of clothing (frequency of item option: 3,8%)

In this example it is seen that people with no problems with dressing on ADCS item 6B (option 4) can be mapped to the 0 (no impairment) and 1 (problem performing but no supervision or assistance needed) options of dressing item of Medicare Benificiary Definitions. “Dressed completely with supervision, but without help” was mapped to the “Problem requiring supervision”. Option 1 and 2 on the 6B item indicated problem that needed assistance, so both were mapped to option 3 of dressing item of Medicare Benificiary Definistions. “Always needed help” indicating that patients unable to do this activity, so it was mapped to option 4 (unable to perform) of dressing item of Medicare Benificiary Definistions.

RESULTS OF THE PSYCHOMETRICAL ANALISYS OF ADCS-ADL INVENTORY

ADCS – Activities of Daily Living Inventory and Mini-Mental State Examination (MMSE) were administered to 1047 (359 men and 688 women) patients with probable Alzheimer’s Disease in the Exelon patch IDEAL study.

For the first visit (baseline), we calculated the distribution of responses of ADCS items (*Table 3*). Most of the item scores range from 0 to 3 (except 6B, 7, 13, 15, 16, 20, 23). The higher scores indicating greater independence. For each basic ADL (questions 1–5) there is a forced choice of best response. All other ADL consist of a main question followed by subquestions. The initial response to the main questions is „yes”, „no” or „don’t know”. The „no” and „don’t know” answers get 0 point. After a „yes” response subquestions are to be responded. Subquestions are arranged in hierarchical fashion, starting with the highest (most independent) level of ADL performance and ending with the lowest. This is the main reason, that distribution of 0 point does not show a linear trend comparing with 1, 2, or 3 points. Total score of ADCS Activities of Daily Living Inventory range from 3 to 78 (skewness: -0.49, kurtosis: -0,50; *Figure 1*).

All items in the ADCS had high corrected item-total correlation, with a high Cronbach's alpha coefficient of 0.91. These results confirm the internal consistency of the instrument.

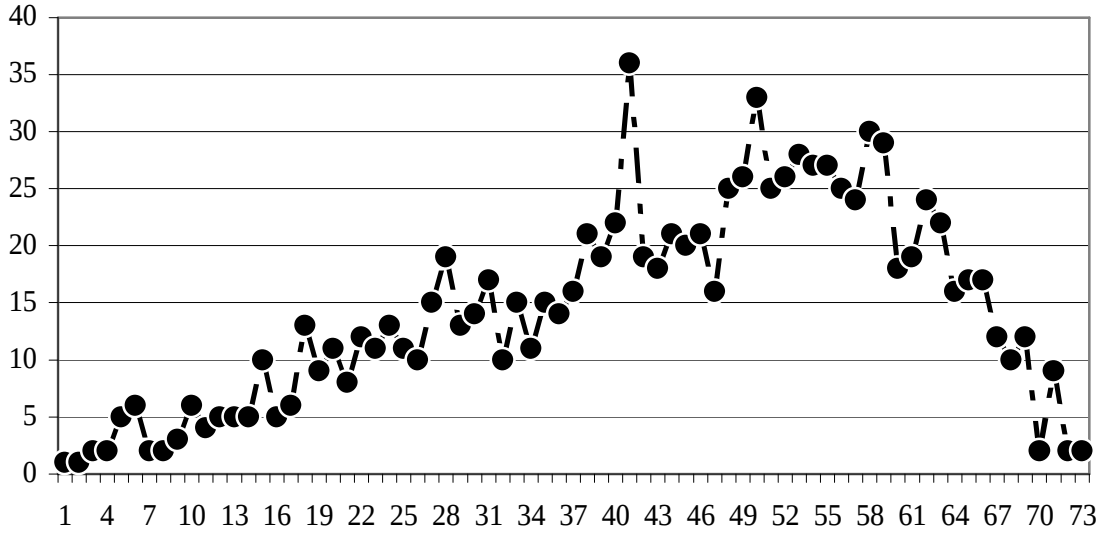
Most of the ADCS items show acceptable positive correlation with the total score of MMSE. These correlations are somewhat lower than reported by Galasko et al. (1997). The correlation between the total scores of ADCS and MMSE was 0,50 ($p<0,01$). This

correlation was lower between the Basic ADL (item 1 to 6) dimension of ADCS and MMSE (r=0,39; p<0,01). Instrumental ADL (item 7 to 23) of ADCS showed higher correlation with the MMSE (r=0,50; p<0,01).

Table 3. Metric properties of ADCS - Activities of Daily Living Inventory questions (**p<0,01)

ADCS questions	Distribution of points (%)						Corrected item total correlation	MMSE
	0	1	2	3	4	5		
1. eating	0,3	0,9	22,2	76,7			0,49**	0,27**
2. walking / mobility	1,7	1,1	14,9	82,3			0,46**	0,17**
3. toileting	1,5	3,2	12,1	83,2			0,54**	0,20**
4. bathing	5,4	13,5	28,4	52,7			0,62**	0,30**
5. grooming	7,5	7,9	26,8	57,7			0,63**	0,29**
6. A. selecting clothes	13,0	3,6	29,6	53,8			0,57**	0,30**
6. B. dressing	3,8	2,3	9,4	19,9	64,7		0,60**	0,28**
7. telephone use	16,4	4,0	22,6	29,0	17,8	10,1	0,61**	0,42**
8. watch television	27,2	35,9	26,2	10,7			0,49**	0,34**
9. conversation	14,3	6,9	22,3	56,5			0,41**	0,24**
10. clearing dishes from the table	19,0	1,8	15,8	63,4			0,55**	0,22**
11. finding personal belongings	17,2	10,2	38,4	34,2			0,49**	0,23**
12. getting/preparing beverages	16,7	12,6	11,9	58,7			0,69**	0,40**
13. meal or snacks	32,1	8,1	16,3	9,8	33,6		0,67**	0,35**
14. disposing of garbage	23,2	1,2	13,2	62,4			0,56**	0,23**
15. travelling / getting lost	11,0	1,9	36,1	26,6	24,5		0,57**	0,31**
16. shopping	36,0	4,0	17,7	16,6	25,7		0,62**	0,32**
17. keeping appointments	25,2	19,8	36,5	18,5			0,52**	0,38**
18. left alone	20,1	13,3	23,4	43,3			0,51**	0,29**
19. talking about current events	40,1	16,6	17,3	26,0			0,52**	0,32**
20. reading	71,7	20,7	7,5				0,36**	0,27**
21. writing	48,6	17,8	28,6	5,1			0,45**	0,27**
22. pastimes / hobbies / games	47,5	1,4	11,4	39,7			0,42**	0,27**
23. use of household appliances	33,5	0,5	7,4	25,2	33,3		0,70**	0,34**

Figure 1. Frequencies of ADCS - Activities of Daily Living Inventory total scores



We did not find significant differences between men and women comparing the different ADCS scores (Basic ADL, Instrumental ADL, Total ADL). Similarly to the baseline findings, internal consistencies of the ADCS-ADL scale were high at week 16 and 24 (*Table 4*).

Table 4. Descriptive statistics of ADCS - Activities of Daily Living Inventory in baseline, 16 and 24 week

	Basic ADL (item 1 to 6)		**Instrumental ADL** (item 7 to 23)		**Total ADL** (item 1 to 23)	
Baseline	*Mean*	*SD*	*Mean*	*SD*	*Mean*	*SD*
Females	18,61	4,13	30,95	12,80	49,56	16,05
Males	18,50	3,80	29,61	12,99	48,11	15,74
Total	18,57	4,02	30,49	12,88	49,06	15,95
Week 16						
Females	18,36	4,48	30,33	13,59	48,68	17,13
Males	18,52	3,89	29,42	13,49	47,94	16,37
Total	18,41	4,29	30,02	13,56	48,43	16,87
Week 24						
Females	18,28	4,62	30,59	13,66	48,87	17,32
Males	18,23	4,36	30,15	13,74	48,38	17,27
Total	18,26	4,53	30,44	13,68	48,71	17,29
Cronbach-alfa (Baseline)	0,84		0,89		0,91	
Cronbach-alfa (Week 16)	0,85		0,90		0,92	
Cronbach-alfa (Week 24)	0,86		0,90		0,92	

The present results suggest that the ADCS - Activities of Daily Living Inventory is a reliable and valid instrument. This scale has high internal consistency and was sensitive to functional changes in individuals with mild to moderate dementia severity as measured by a dementia screening measure (MMSE). The ADCS-ADL proves to be a reliable instrument for the proposed mapping processes.

RESULTS OF THE MAPPING

The following sections show the results of the mapping processes for each of the three ADL scales when translated to the ADCS-ADL scale used by Galasko.

Comparison of ADCS-ADL and Hill's Medicare Current Beneficiary Survey scale

Table 5. shows the results of our mapping procedure between the MCBS and the Galasko scales.

Table 5. Comparison of Medicare Benificiary definitions and Galasko's ADCS

Hill et al. (Medicare Beneficiary definitions)	**IDEAL study (Galasko)**
Bathing	**Bathing (item 4)**
0 = no impairment 1 = problem performing but no supervision or assistance needed	3 = bathed without reminding or physical help (frequency of item option: 52,7%)
2 = problem requiring supervision	2 = no physical help, but needed supervision/reminders to bathe completely (frequency of item option: 28,4%)
3 = problem with assistance needed	1 = needed minor physical help (e. g., with washing hair) to bathe completely (frequency of item option: 13,5%)
4 = unable to perform	0= needed to be bathed completely (frequency of item option: 5,4%)

As the transformation of item 3 on the Galasko's scale is ambiguous (0 or 1), we have prepared two scoring methods: $3 \rightarrow 1$ (creating equal distance) and $3 \rightarrow 0{,}5$ (using mean). We have used the same scoring method in the items below. The correlation between the two indexes generated by these two approaches was high: 0,997, and the two indexes shown very similar correlation with other scales and indexes. To keep the original item endorsment we decided to use the $3 \rightarrow 1$ method in our analysis.

Dressing	**Dressing (item 6B)**
0 = no impairment 1 = problem performing but no supervision or assistance needed	4 = dressed completely without supervision or physical help (64,7%)
2 = problem requiring supervision	3 = dressed completely with supervision, but without help (19,9%)
3 = problem with assistance needed	2 = needed physical help only for buttons, clasps, or buttoning (9,4%) 1 = dressed without help if clothes needed no fastening or buttoning (2,3%)
4 = unable to perform	0 = always needed help, regardless of the type of clothing (3,8%)

Eating	**Eating (item 1)**
0 = no impairment 1 = problem performing but no supervision or assistance needed	3 = ate without physical help, and used a knife (76,7%)
2 = problem requiring supervision	2 = used a fork or spoon, but not a knife, to eat (22,2%)
3 = problem with assistance needed	1 = used fingers to eat (0,9%)
4 = unable to perform	0 = {S} usually or always was fed by someone else (0,3%)

Transferring in and out of chairs	**Regarding walking (or getting around in a wheelchair) (item 2)**
0 = no impairment 1 = problem performing but no supervision or assistance needed	3 = mobile outside of home without physical help (82,3%)
2 = problem requiring supervision	2 = mobile across a room without physical help (14,9%)
3 = problem with assistance needed	1 = transferred from bed to chair without help (1,1%)
4 = unable to perform	0 = required physical help to walk or transfer (1,7%)

Walking	**Did {S} get around (or travel) outside of his/her home (item 15)**
0 = no impairment	4 = alone, went at least 1 mile away from home (24,5%)
1 = problem performing but no supervision or assistance needed	3 = alone, but remained within 1 mile of home (26,6%)
2 = problem requiring supervision	2 = only when accompanied and supervised, regardless of the trip (36,1%)
3 = problem with assistance needed	1 = only with physical help, regardless of the trip (1,9%)
	0 = no or don't know (11%)
4 = unable to perform	**Alternative solution:** 0 = required physical help to walk or transfer (from item 2) (1,7%) This solution is not compatible with the scoring of 15th item.

Toileting	**Regarding bowel and bladder function at the toilet (item 3)**
0 = no impairment 1 = problem performing but no supervision or assistance needed	3 = did everything necessary without supervision or help (83,2%)
2 = problem requiring supervision	2 = needed supervision, but no physical help (12,1%)
3 = problem with assistance needed	1= needed physical help, and was usually continent (3,2%)
4 = unable to perform	0 = needed physical help, and was usually incontinent (1,5%)

Using the phone	**Did {S} use a telephone? (item 7)**
0 = no impairment	5 = made calls after looking up numbers in white or yellow pages, or by dialing directory assistance (10,1%)
1 = problem performing but no requiring assistance	4 = made calls only to well-known numbers, without referring to a directory or list (17,8%) 3 = made calls only to well-known numbers, by using a directory or list (29,0%)
2 = problem performing and assistance required	2 = answered the phone; did not make calls (22,6%)
3 = unable to do the activity	1 = did not answer the phone, but spoke when put on the line (4,0%)
	0 = no or don't know

Doing light housework (like washing dishes, straightening up, or light cleaning)	**Did {S} clear the dishes from the table after a meal or snack (item 10)**
0 = no impairment 1 = problem performing but no requiring assistance	3 = without supervision or help (63,4%)
2 = problem performing and assistance required	2 = with supervision (15,8%)
3 = unable to do the activity	1 = with physical help (1,8%)
	0 = no or don't know (19,0%)

Doing heavy housework (like scrubbing floors or washing windows)	**Did {S} dispose of garbage or litter in an appropriate place or container at home (item 14)**
0 = no impairment 1 = problem performing but no requiring assistance	3 = without supervision or help (62,4%)
2 = problem performing and assistance required	2 = with supervision (13,2%)
3 = unable to do the activity	1 = with physical help (1,2%)
	0 = no or don't know (23,2%)

Making meals	**Did {S} make him/herself a meal or snack at home (item 13)**
0 = no impairment 1 = problem performing but no requiring assistance	4 = cooked or microwaved food, with little or no help (33,6%)
2 = problem performing and assistance required	3 = cooked or microwaved food, with extensive help (9,8%) 2 = mixed or combined food items for a meal or snack, without cooking or microwaving (e. g., made a sandwich) (16,3)
3 = unable to do the activity	1 = obtained food on his/her own, without mixing or cooking it (8,1%)
	0 = no or don't know (32,1%)

Shopping	**Did {S} ever go shopping (item 16a)**
0 = no impairment 1 = problem performing but no requiring assistance	3 = without supervision or physical help (29,3%)
2 = problem performing and assistance required	2 = with supervision or physical help (30,3%)
3 = unable to do the activity	1 = not at all, or selected mainly random or inappropriate items (4,4%)
	0 = no or don't know (36%)

Managing money	**Did {S} usually manage to find his/her personal belongings at home (item 11)**
0 = no impairment 1 = problem performing but no requiring assistance	3 = without supervision or help (34,2%)
2 = problem performing and assistance required	2 = with supervision (38,4%) 1 = with physical help (10,2%)
3 = unable to do the activity	0 = no or don't know (17,2%) **Alternative solution:** Did {S} usually pay for items without supervision or physical help (16B item) (60,9%) This solution is not compatible with the scoring of 11th item.

Comparison of Katz index of ADL and Galasko's ADCS

Table 6. hows the results of our mapping procedure between the Katz index and the Galasko scales.

Table 6. Comparison of Katz index of ADL and Galasko' ADCS

Katz index (The index of independence in activities of daily living, or index of ADL)	**IDEAL study (Galasko)**
Bathing (sponge, shower or tube)	**Bathing (item 4)**
Independent: assistance only in bathing a single part (as back or disabled extremity) or bathes self completely.	3 = bathed without reminding or physical help (frequency of item option: 52,7%) 2 = no physical help, but needed supervision/reminders to bathe completely (frequency of item option: 28,4%) 1 = needed minor physical help (e. g., with washing hair) to bathe completely (frequency of item option: 13,5%)
Dependent: assistance in bathing more than one part of body; assistance in getting in or our of tube or does not bathe self.	0= needed to be bathed completely (frequency of item option: 5,4%)

Dressing	Dressing (item 6B)
Independent: gets clothes from closets and drawers; puts on clothes, outer garments, braces; manages fasteners; act of tying shoes is excluded.	4 = dressed completely without supervision or physical help (64,7%)
	3 = dressed completely with supervision, but without help (19,9%)
	2 = needed physical help only for buttons, clasps, or buttoning (9,4%)
	1 = dressed without help if clothes needed no fastening or buttoning (2,3%)
Dependent: does not dress self or remains partly undressed.	0 = always needed help, regardless of the type of clothing (3,8%)

Going to toilet	Bowel and bladder function at the toilet (item3)
Independent: gets to toilet; gets on and off toilet; arranges clothes; cleans organs of excretion; (may manage own bedpan used at night only and may or may not be using mechanical supports).	3 = did everything necessary without supervision or help (83,2%)
	2 = needed supervision, but no physical help (12,1%)
Dependent: uses bedpan or commode or receives assistance in getting to and using toilet.	1 = needed physical help, and was usually continent (3,2%)
	0 = needed physical help, and was usually incontinent (1,5%)

Transfer	Regarding walking (or getting around in a wheelchair) (item 2)
Independent: moves in and out of bed independently and moves in and out of chair independently (may or may not be using mechanical supports)	3 = mobile outside of home without physical help (82,3%)
	2 = mobile across a room without physical help (14,9%)
	1 = transferred from bed to chair without help (1,1%)
Dependent: assistance in moving in or out of bed and/or chair; does not perform one or more transfers.	0 = required physical help to walk or transfer (1,7%)

Continence	Bowel and bladder function at the toilet (item3)
Independent: urination and defecation entirely self-controlled.	3 = did everything necessary without supervision or help (83,2%)
	2 = needed supervision, but no physical help (12,1%)
Dependent: partial or total incontinence in urination or defecation; partial or total control by enemas, catheters, or regulated use of urinals and/or bedpans.	1 = needed physical help, and was usually continent (3,2%)
	0 = needed physical help, and was usually incontinent (1,5%)

Feeding	Eating (item 1)
Independent: gets food from plate or its equivalent into mouth; (precutting of meat and preparation of food, as buttering bread, are excluded from evaluation).	3 = ate without physical help, and used a knife (76,7%)
	2 = used a fork or spoon, but not a knife, to eat (22,2%)
	1 = used fingers to eat (0,9%)
Dependent: assistance in act of feeding: does not eat at all or parental feeding.	0 = {S} usually or always was fed by someone else (0,3%)

Comparison of Townsend's disability scale and Galasko' ADCS

Table 7. shows the results of our mapping procedure between the Townsend's disability scale and the Galasko scales.

Table 7. Comparison of Townsend's disability scale and Galasko' ADCS

Townsend's disability scale (used by McNamee et al.)	IDEAL study (Galasko)
Cut your own toe-nails	**Grooming (item 5)**
0 = no difficulty	3 = cleaned and cut fingernails without help (frequency of item option: 57,7%)
	2 = brushed or combed hair without physical help (frequency of item option: 26,8%)
1 = some difficulty	1 = kept face and hands clean without physical help (frequency of item option: 7,9%)
2 = needs help	0= needed help for grooming of hair, face, hands, and fingernails (frequency of item option: 7,5%)
Wash all over or bathe	**Bathing (item 4)**
0 = no difficulty	3 = bathed without reminding or physical help (52,7%)
1 = some difficulty	2 = no physical help, but needed supervision/reminders to bathe completely (28,4%)
	1 = needed minor physical help (e. g., with washing hair) to bathe completely (13,5%)
2 = needs help	0= needed to be bathed completely (5,4%)

Get on a bus	**Did {S} get around (or travel) outside of his/her home (item 15)**
0 = no difficulty	4 = alone, went at least 1 mile away from home (24,5%)
1 = some difficulty	3 = alone, but remained within 1 mile of home (26,6%)
	2 = only when accompanied and supervised, regardless of the trip (36,1%)
2 = needs help	1 = only with physical help, regardless of the trip (1,9%)
	0 = no or don't know (11%)

Go up and down stairs	**Regarding walking (or getting around in a wheelchair) (item 2)**
0 = no difficulty	3 = mobile outside of home without physical help (82,3%)
	2 = mobile across a room without physical help (14,9%)
1 = some difficulty	1 = transferred from bed to chair without help (1,1%)
2 = needs help	0 = required physical help to walk or transfer (1,7%)

Do the heavy housework	**Did {S} dispose of garbage or litter (item 14)**
0 = no difficulty	3 = without supervision or help (62,4%)
1 = some difficulty	2 = with supervision (13,2%)
2 = needs help	1 = with physical help (1,2%)
	0 = no or don't know (23,2%)

Shop and carry heavy bags	**Did {S} ever go shopping (item 16A)**
0 = no difficulty	3 = without supervision or physical help (29,3%)
1 = some difficulty	2 = with supervision or physical help (30,3%)
2 = needs help	1 = not at all, or selected mainly random or inappropriate items (4,4%)
	0 = no or don't know (36%)

Prepare and cook a hot meal	**Did {S} make him/herself a meal or snack at home (item 13)**
0 = no difficulty	4 = cooked or microwaved food, with little or no help (33,6%)
1 = some difficulty	3 = cooked or microwaved food, with extensive help (9,8%)
2 = needs help	2 = mixed or combined food items for a meal or snack, without cooking or microwaving (e. g., made a sandwich) (16,3%)
	1 = obtained food on his/her own, without mixing or cooking it (8,1%)
	0 = no or don't know (32,1%)

Reach and overhead shelf	**Did {S} clear the dishes from the table after a meal or snack (item 10)**
0 = no difficulty	3 = without supervision or help (63,4%)
1 = some difficulty	2 = with supervision (15,8%)
2 = needs help	1 = with physical help (1,8%)
	0 = no or don't know (19%)

Tie a good knot in a piece of string	**Dressing (item 6B)**
0 = no difficulty	4 = dressed completely without supervision or physical help (64,7%)
1 = some difficulty	3 = dressed completely with supervision, but without help (19,9%)
2 = needs help	2 = needed physical help only for buttons, clasps, or buttoning (9,4%)
	1 = dressed without help if clothes needed no fastening or buttoning (2,3%)
	0 = always needed help, regardless of the type of clothing (3,8%)

VALIDATION OF THE MAPPING - COMPARISON OF DIFFERENT ADL SCORES IN THE EMPIRICAL DATASET

Based on the item-mapping procedure we have prepared two indexes and a classification in our empirical dataset, which reflect the Medicare Beneficiary Definitions and the Townsend's disability scale, and the Katz Index of ADL. The different ADCS domains (basic, instrumental, total) showed high correlation with the Medicare Benificiary Definitions Index and the Townsend's disability Index (*Table 8*). These results support the validity of the ADL instruments, and the indexes. The Medicare Beneficiary Definitions Index ($r=-0,43$; $p<0,01$) and Townsend's disability scale Index ($r=-0,41$; $p<0,01$) have showed somewhat lower correlation with the MMSE, than the ADCS.

Table 8. Correlation between indexes and the ADCS-ADL scale

	Medicare Beneficiary Definitions Index	**Townsend's disability scale Index**
Basic ADL (item 1 to 6)	-0,81**	-0,79**
Instrumental ADL (item 7 to 23)	-0,90**	-0,87**
Total ADL (item 1 to 23)	-0,93**	-0,90**

**p<0,01

Descriptive statistics of hierarchical classification of patients in eight groups by type and number of ADL impairments are shown in *Table 9*. Most of the patients (90,1%) were fully independent on all ADLSs (class A), and only 0,5% of patients were in the most impaired categories (classes F and G). Mean total score of ADCS - Activities of Daily Living Inventory was highest in class A, and lowest in class G. The means of total score of ADCS - Activities of Daily Living Inventory in the different classes support the hierarchical order of the classification. The same hierarchical order can be seen at the Medicare Beneficiary Definitions Index and the Townsend's disability scale Index.

Table 9. Descriptive statistics of hierarchical classification of patients

Impairment	**Frequency**	**Percent**	**ADCS – Activities of Daily Living Inventory**	**Medicare Beneficiary Definitions Index**	**Townsend's disability scale Index**
Katz class A	943	90,1	51,78	18,02	4,75
Katz class B	59	5,6	27,73	27,86	10,86
Katz class C	16	1,5	22,19	31,44	13,75
Katz class D	3	0,3	13,67	35,00	15,00
Katz class E	5	0,5	14,00	34,60	15,40
Katz class F	4	0,4	7,50	39,00	16,75
Katz class G	1	0,1	3,00	41,00	18,00
Katz class other	16	1,5	25,25	30,54	11,15

Comparing our results with the Hill et al. study, we can see a very different prevalence rate in the Katz' classes. Most of the persons (90,1%) get into class A (*Table 10* - IDEAL study (base case)). For this reason we have tried to prepare an alternative algorithm to get more adequate prevalence (*Appendix 1*). This alternative algorithm does not give different prevalence rate in the Class E-G, and the Class other, so further study is needed to clarify these differences.

Table 10. Prevalence of Katz hierarchical ADLs in the IDEAL and Hills et al. study with the base case and the new algorithm

Katz hierarchical ADLs (%)	IDEAL study (base case)	IDEAL study (new algorithm)	Full-year community (n=1070) Hill et al. 2006.	Partial-year nursing home (n=295) Hill et al. 2006.	Ful-year nursing home (n=1773) Hill et al. 2006.	All patients (n=3138) Hill et al. 2006.
Class A	90,1	78,1	41	8	3	19
Class B	5,6	14,4	13	11	4	8
Class C	1,5	3,2	7	6	7	7
Class D	0,3	1,3	7	7	5	6
Class E	0,5	0,6	5	12	8	7
Class F	0,4	0,6	10	17	18	15
Class G	0,1	0,2	9	33	50	32
Class Other	1,5	1,5	8	6	5	6

DISCUSSION

Our data show very good internal consistency for the ADCS - Activities of Daily Living Inventory. The very high Cronbach alfa (0,91) value indicate the redundancy of the items/impairments. The expected substantial correlation (r=0,50) between the ADCS - Activities of Daily Living Inventory and the Mini Mental State Examination confirms the construct validity of ADCS instruments. Since the relatively long (23 items) and comprehensive ADCS - Activities of Daily Living Inventory contains all important ADL domains (i. e. basic mobility, self-care, houshold activities, community activities, social activities, and cognitive activities) we have had the possibility to pair each impairment from the different instruments (i. e. ADCS, Townsend's disability scale, Medicare Beneficiary definitions) with each other. Based on the comparison of item content of different ADL scales we have prepared three item domains from the ADCS - Activities of Daily Living Inventory, which reflect the scores of ADL scales used by McNamee's and Hill's. We have showed the detailed comparison process of items from different ADL instruments.

The computed indexes (Townsend's disability scale, Medicare Beneficiary definitions) and the classification (Katz index of ADL) has shown a very high convergence with the original ADCS instrument. The high convergence makes it probable, that the different ADL instruments identify accurately the main physical impairments and functional disabilities in Alzheimer's disease, however the scoring, the number of items and their content are somewhat different.

LIMITATITON OF MAPPING PROCEDURE

Limitations of these analysis were the following:

1. Sometimes there was no clear transformation rule on matching the content of one item to another. This problem arose mainly when the item types of ADL scales were dissimiler (i. e.: multiple choice items with 3 versus 5 options). Therefore it is supposed, that distribution of the item-score was little bit biased when we paired multiple choice items with different item scores ranges (i. e: 3 and 5 options).
2. In some cases the identification of the corresponding item was problematic, since the ADL scales item were not matching exactly (i. e.: continence item in the Katz Index).
3. ADCS Activities of Daily Living Inventory has the following answers: „no", „don't know" and „yes". The „no" and „don't know" answers get 0 point. Other ADLS scales have no „don't know" answers, or not scored with 0 point.
4. Another limitation of the work was that there is no empirical evidence about the "real" correlation between of different ADL scales. The exact and quantitative analysis of the relationship of the different ADL scales would require a survey with each scale on the same patient population. Such data were not available; therefore the mapping procedure was mainly based on a qualitative approach.

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APPENDIX 1
COMPARISON OF KATZ INDEX OF ADL AND GALASKO' ADCS WITH A NEW ALGORITHM

Katz index (The index of independence in activities of daily living, or index of ADL)	**IDEAL study (Galasko)**
Bathing (sponge, shower or tube)	**Bathing (item 4)**
Independent: assistance only in bathing a single part (as back or disabled extremity) or bathes self completely.	3 = bathed without reminding or physical help (frequency of item option: 52,7%)
	2 = no physical help, but needed supervision/reminders to bathe completely (frequency of item option: 28,4%)
Dependent: assistance in bathing more than one part of body; assistance in getting in or our of tube or does not bathe self.	1 = needed minor physical help (e. g., with washing hair) to bathe completely (frequency of item option: 13,5%)
	0= needed to be bathed completely (frequency of item option: 5,4%)
Dressing	**Dressing (item 6B)**
Independent: gets clothes from closets and drawers; puts on clothes, outer garments, braces; manages fasteners; act of tying shoes is excluded.	4 = dressed completely without supervision or physical help (64,7%)
	3 = dressed completely with supervision, but without help (19,9%)
	2 = needed physical help only for buttons, clasps, or buttoning (9,4%)
Dependent: does not dress self or remains partly undressed.	1 = dressed without help if clothes needed no fastening or buttoning (2,3%)
	0 = always needed help, regardless of the type of clothing (3,8%)

Going to toilet	Bowel and bladder function at the toilet (item3)
Independent: gets to toilet; gets on and off toilet; arranges clothes; cleans organs of excretion; (may manage own bedpan used at night only and may or may not be using mechanical supports).	3 = did everything necessary without supervision or help (83,2%)
	2 = needed supervision, but no physical help (12,1%)
Dependent: uses bedpan or commode or receives assistance in getting to and using toilet.	1 = needed physical help, and was usually continent (3,2%)
	0 = needed physical help, and was usually incontinent (1,5%)

Transfer	Regarding walking (or getting around in a wheelchair) (item 2)
Independent: moves in and out of bed independently and moves in and out of chair independently (may or may not be using mechanical supports)	3 = mobile outside of home without physical help (82,3%)
	2 = mobile across a room without physical help (14,9%)
Dependent: assistance in moving in or out of bed and/or chair; does not perform one or more transfers.	1 = transferred from bed to chair without help (1,1%)
	0 = required physical help to walk or transfer (1,7%)

Continence	Bowel and bladder function at the toilet (item3)
Independent: urination and defecation entirely self-controlled.	3 = did everything necessary without supervision or help (83,2%)
	2 = needed supervision, but no physical help (12,1%)
Dependent: partial or total incontinence in urination or defecation; partial or total control by enemas, catheters, or regulated use of urinals and/or bedpans.	1 = needed physical help, and was usually continent (3,2%)
	0 = needed physical help, and was usually incontinent (1,5%)

Feeding	Eating (item 1)
Independent: gets food from plate or its equivalent into mouth; (precutting of meat and preparation of food, as buttering bread, are excluded from evaluation).	3 = ate without physical help, and used a knife (76,7%)
	2 = used a fork or spoon, but not a knife, to eat (22,2%)
Dependent: assistance in act of feeding: does not eat at all or parental feeding.	1 = used fingers to eat (0,9%)
	0 = {S} usually or always was fed by someone else (0,3%)