Improving clarity and transparency in cognitive assessment: conversion of the Cambridge Cognition Examination to the International Classification of Functioning, Disability and Health.

Kirch, Sam; Gorus, Ellen; Brys, Charlotte; Cornelis, Elise; De Vriendt, Patricia

Published in:
European Geriatric Medicine

DOI:
10.1007/s41999-018-0066-y
10.1007/s41999-018-0066-y

Publication date:
2018

License:
Unspecified

Document Version:
Accepted author manuscript

Improving clarity and transparency in cognitive assessment: Conversion of the Cambridge Cognition Examination to the International Classification of Functioning, Disability and Health

Sam Kirch, Ellen Gorus, Charlotte Brys, Elise Cornelis, Patricia De Vriendt

Abstract

Background: A variety of screening, diagnostic and assessment tools have been developed for use in dementia research and care. However, there is no consensus which tool to use and moreover there is no transparency in communication between countries and disciplines.

Objective: To contribute to a more uniform assessment in dementia, the Cambridge Cognition Examination (CAMCOG), was converted to the International Classification of Functioning, Disability and Health (ICF).

Methods: In a qualitative design, CAMCOG-items and –scoring-system were converted to the ICF addressing 3 ICF-domains: global and specific mental functions and general tasks and demands. Construct and discriminative validity was checked in a sample of 25 cognitively healthy elderly (CHE), 25 persons with mild cognitive impairment (MCI) and 25 patients with mild Alzheimer's Disease (mAD).

Results: A significant correlation was observed between CAMCOG/ICF-CAMCOG ($r=-0.987$; $p < 0.01$). The Areas Under the Curve (AUC) of the ICF-CAMCOG were between 0.819 and 0.978; comparable with the original CAMCOG. Only a significant difference between the AUC of the CHE versus MCI (0.911 versus 0.819; $p = 0.0094$) was observed in favour of CAMCOG.

Conclusion: The clinical use of the ICF-CAMCOG looks promising offering a more detailed and interpretable scoring and may allow for better planning of resources to aid patients with dementia.

Introduction

Dementia is a clinical syndrome characterized by a progressive evolution of impairments of cognitive skills and the ability to function independently [1]. It is caused by many diseases of the brain, such as Alzheimer's disease (AD) - which is the most common cause - vascular dementia, frontotemporal dementia, and dementia with Lewy bodies (DLB) [2]. The prevalence of dementia is rising and - as stated by the World Health Organisation (WHO) in 2012 [3] - is becoming a crucial public health concern as it is one of the most common diseases in the elderly and a major cause of disability and mortality in later life.

Early detection of dementia is pivotal since this allows for better management of the disease and better outcomes of interventions. In this way, the concept of Mild Cognitive Impairment (MCI), which is considered as a transitional state between normal ageing and dementia and might be a prodromal stage of dementia, is interesting because MCI patients have an increased risk for developing dementia [4]. A systematic review showed conversion rates between 10.2% and 33.6% (after 1 year) and between 9.8% and 63% (after 2 years) [5]. Studies however applied different criteria, sampling (community versus clinic) and methodologies. The term MCI describes patients with cognitive deterioration of heterogeneous aetiology in the absence of significant functional impairment. Because of the heterogeneous aetiology and evolution,

boundaries between healthy aging, MCI and dementia are vague and thus hampering correct diagnosis.

Presently, the diagnosis is mainly based upon multiple assessment including cognitive, behaviour and functional measures, clinical judgment in a multidisciplinary approach. The evaluation of cognitive functioning in this process is of great importance. However, a variety of screening, diagnostic and assessment tools have been developed for use in dementia research and care [6] and there is no consensus what tool to use. There exist cognitive measures at different levels ranging from brief cognitive screening instruments such as the Minicog [7], Mini Mental State Examination (MMSE) [8], Montreal Cognitive Assessment (MOCA) [9] , etc. to more multi-functional batteries such as the Cambridge Cognition Examination (CAMCOG) [10], the Alzheimer's Disease Assessment Scale (Adascog) [11] , etc. The first are important to identify individuals for more in depth neuropsychological tests; they don't require extensive training and can be applied by a wide range of health professionals. The latter provide more in-depth assessment, but are more time consuming and need more specialised skills (such as trained psychologist) to perform and a more specific setting for application. However, screening tests produce a considerable rate of false negative results, often failing to detect subtle cognitive changes and therefore cannot replace neuropsychological testing. Next to standardised test batteries also an individual tailormade neuropsychological evaluation of memory, attention, visuoperception and construction, language abilities, executive functions, etc. can be performed as an in-depth examination of neuropsychological profile by means of tests specific to each cognitive domain [12]. Screening tests such as the Minicog, MMSE or Moca are freely available, while some test batteries are commercialised and therefore need to be bought. Tools used for the objectification of cognitive deficits differ enormously between countries, within countries and across clinical and research settings. Various aspects are responsible for this variability, such as the preference for home-made tests, local tradition and

the context of the assessment (e.g. GP practice, memory clinic, specialist clinic or a research centre).

As mentioned above, CAMCOG can be used in cognitive assessment. The CAMCOG takes about 30 minutes to administer, whereas an in-depth examination of neuropsychological functions easily takes up to 1.5-2.5 hours. The CAMCOG is the cognitive and self-contained part of the Cambridge Examination for Mental Disorders of the Elderly (CAMDEX) and is designed to detect cognitive impairments in older aged adults and for dementia screening [10]. It is used in different countries and has been translated and validated in several languages [13-15]. The CAMCOG consists of 59 items and several subscales: orientation, expressive and comprehensive language, memory, attention, praxis, calculation, abstraction, and perception. For each of these domains a subscale score can be calculated, as well as a total CAMCOG score with maximum 105. The original cut-off score of 79/80 showed a sensitivity of 92 % and a specificity of 96% for the diagnosis of dementia in the discrimination from normal controls [10]. The memory subscale score of 18/27 achieved a sensitivity of 78% and a specificity of 74% for in predicting conversion to AD from MCI with an accuracy of 0.83 [16]. Ballard et al. [17] found that the CAMCOG is effective in differentiating DLB from AD. The CAMCOG has also been found to be effective in differentiating dementia from depression [18].

However, the problem with the CAMCOG – but also with other cognitive evaluation tools - is that it does not conform in describing and organizing cognitive functions. Each assessment tool uses its own definition of the different cognitive functions adopted in the tool and puts them in its own framework. This confusion in language and the fact that there is no single measure that comprehensively covers all aspects of cognitive functioning results in a weakening of the dementia research and practice. A more clear and congruent terminology may allow for more accurate diagnosis, more transparent communication between disciplines, clinicians, researchers and countries and for better planning of resources to aid patients with

MCI and dementia. In order to provide a common framework that counters the above mentioned problems, the International Classification of Functioning, Disability and Health (ICF) can be used, since the ICF is seen as the current reference framework in describing human functioning, developed in 2001 by the World Health Organization [19]. The ICF serves as a comprehensive framework of human functioning and disability as well as a classification system based on a bio-psycho-social model. The ICF framework offers a unified and standardized language for describing and organizing information to be understood by health professionals, policy makers, researchers and patients. In accordance with the WHO's policy, the ICF thereby complements and completes the International Classification of Disease, 10th version (ICD-10). The ICF framework organizes information in two major parts. Part 1 covers Functioning and Disability and consists of the components "body functions" (coded b), "body structures" (coded s) and "activities and participation" (coded d). Part 2 deals with Contextual factors and is formed by the components "environmental factors" (coded e) and "personal factors", the latest not yet coded in the ICF, because of the significant social and cultural differences. Examples are race, education, gender, etc. Each ICF component consists of multiple domains, and each domain consists of categories which are the units of classification. The ICF uses an alphanumeric coding system, hierarchically organized in maximum four levels, each level representing a specific level of precision. The hierarchic structure of the ICF classification allows either a general or a very detailed description of human functioning.

The ability (or disability) in all ICF-categories are quantified using the same generic scale 0-4 scale with qualifier (0) representing no problem (0-4%), qualifier (1) mild problem (5-24%), qualifier (2) moderate problem (25-49%), qualifier (3) severe problem (50-95%) and qualifier (4) complete problem (96-100%). Other possible scores are: not specified (8), and not applicable (9). The WHO provided the ICF qualifier with percentage values.

The WHO adopted the ICF framework in 2001 and since it has been utilized extensively. The ICF framework has already made a considerable impact on the way in which data concerning human functioning and disability are conceptualized, collected and processed [20] for instance the emphasis on people's disabilities shifted to their level of functioning. Several researchers agreed upon the necessity of an adoption of the ICF language in the gerontological research community [21, 22]. For instance, extensive work has been carried out on ´content comparison studies´. The aim of these `content comparison studies` was to gain a deeper understanding of the content and to increase the conceptual understanding of these tools by linking them to the ICF. Bladh et al. [23] conducted a ´content-comparison study´ to link the content of four fear of falling rating scales to the ICF. All meaningful concepts of the items in these rating scales were identified and linked to the most appropriate ICF categories. Furthermore, the content of 18 physical activity questionnaires for the elderly using the ICF as a reference were compared [24]. And more recently, a systematic review linked all the existing frailty tools to the ICF [25].

Also in the domain of cognitive evaluation, some 'linking' work had been done, for instance the conversion and the (re) calibration of the Mini-Mental State Examination (MMSE) to the ICF terminology and scoring system [26]. The conversion of the MMSE to ICF-MMSE was done by content comparison and subsequent translation of the scoring system using automatic algorithms. The ICF-MMSE provided a transparent language and a more detailed scoring system than the original MMSE with the same psychometrical value.

These studies demonstrated that it is possible to adapt existing measurement instruments to the ICF-categories and to convert the original scoring system of tools to the ICF scoring system, providing thus better assessment by improving the communication and understanding between health professionals, e.g. creating a common language and standard definitions.

The aim of this study was to convert the CAMCOG to the ICF standard by means of content comparison and subsequently translating the scoring system into the ICF scoring. In order to evaluate the translation and conversion, we set out to check the face validity, construct validity and discriminative validity of the ICF-CAMCOG compared to the original CAMCOG.

Methods

The Conversion of the CAMCOG to the ICF-CAMCOG consists of a qualitative and a quantitative study. Firstly, the mapping of the CAMCOG items to the ICF codes has been done by using the linking rules published by Cieza [27], to link items or concepts to the ICF framework in a standardized manner. The qualitative study involved three phases: (1) identification of each meaningful concept and the most appropriate ICF category, (2) translation of the scoring system which led to a 'pilot' version of the ICF-CAMCOG and has been tested in a (3) pilot study with 5 cases.

Phase 1

Firstly, we identified the underlying meaningful concepts within each item of the CAMCOG. For the identification of the underlying meaningful concepts, we considered the specific cognitive functions tested in the CAMCOG and its description or definition in the literature (step 1). Next, each meaningful concept identified in step 1, was linked to the most appropriate ICF-category (step 2).

Phase 2

Subsequently, based on the translation of the CAMCOG items to the ICF-categories, the CAMCOG scoring system was converted to the qualifiers of the ICF-scale. For the translation of the CAMCOG scoring system, we developed rationale for each category.

This has been performed by a team of health professionals (clinical psychologist, occupational therapist and neuropsychologist), all qualified and experienced in gerontological/geriatric research and clinical practice. All decisions were unanimously taken after open discussion until consensus was reached.

Phase 3

In Phase 3, we conducted a pilot study (n=5) including cases from two cognitively healthy older persons; one patient with MCI and two diagnosed with mild AD to check the face validity of the ICF-CAMCOG. Hence, we examined if the total CAMCOG-score corresponds to the ICF-CAMCOG score (0-4) and if the total score, sub scores and the scores of each ICF-category of the ICF-CAMCOG provided an accurate and expected image of the cognitive state of the person.

Phase 4

Finally, the CAMCOG scoring system was translated into the ICF scale, taking into account the weight of each domain. Based on the translation process, algorithms were developed for each domain.

In the quantitative study, we evaluated the construct validity and discriminative validity of the ICF-CAMCOG in a sample of healthy older adults, patients with MCI and mild AD.

For the construct validity of the ICF-CAMCOG, the correlation between the total scores of the ICF-CAMCOG and the original CAMCOG was analysed with a Pearson's correlation coefficient.

To evaluate the discriminative validity of the ICF-CAMCOG, a receiver operating characteristic (ROC) curve method was used. We conducted a receiver operating characteristic

(ROC) curve for both the CAMCOG and ICF-CAMCOG and both were compared in order to check whether the translation was done appropriately.

Participants and Data Collection

This study was carried out based on available data from an ongoing study in older persons (aged 65 years or more), conducted at the Vrije Universiteit Brussel and Universitair Ziekenhuis Brussel (Brussels, Belgium). In total, we included 75 participants who were either cognitively normal or presented with MCI or mild AD.

Group 1 (n = 25) were cognitively healthy community-dwelling older participants, volunteers, recruited through advertisement. All participants were evaluated with Mini-Mental State Examination (MMSE) [8], the memory part (10-word list learning task memory) of the Alzheimer´s Disease Assessment Scale cognitive subscale (ADAScog) [11], Geriatric Depression Scale [28], basic activities of daily living (ADL) according to Katz et al. [29], and instrumental ADL according to Lawton et al. [30]. Exclusion criteria for this group were a diagnosis of MCI and dementia or any objective functional or cognitive deficit which could be suggestive for the diagnosis of MCI or AD. They were selected carefully (including adjustment for educational level and taking into account premorbid learning), to ensure that no mild cognitive problem was present. All participants were interviewed and tested in their native language (which was in this case Dutch).

Group 2 (n = 25) were patients from the geriatric day hospital, diagnosed with amnestic MCI according to the criteria, as defined by the International Working Group on MCI [4]. They all underwent the same multidisciplinary evaluation as the healthy controls, but also completed with standard laboratory blood testing, physical and neurological testing and CT scan of the brain.

Group 3 (n = 25) were patients from the geriatric day hospital, diagnosed with mild AD, who met the DSM-IV [31] as well as the NINCDS-ADRDA [32] criteria for possible AD. They all underwent the same multidisciplinary evaluation as the healthy controls, completed with standard laboratory blood testing and CT scan of the brain.

For the 3 groups, the original CAMCOG [10] was completed.

Statistical analysis

Statistical analysis was performed using the Statistical Package for Social Sciences (SPSS) version 21. Parametric statistical analyses were used. The significance level was set a priori at $p < 0.05$.

Differences between groups (healthy persons, MCI, mild AD) and between scores (CAMCOG vs. ICF-CAMCOG) were computed by one-way ANOVA with Bonferroni post hoc tests or Chi-square.

Conversion of the CAMCOG to the ICF-CAMCOG was verified by computing Pearson's correlation coefficient to analyse the correlation between scores on CAMCOG and ICF-CAMCOG and to investigate the impact of the developed algorithms.

The construct validity of the ICF-CAMCOG was verified by computing a Pearson's correlation coefficient to analyse the correlation between the total scores of the ICF-CAMCOG and the total score of the original CAMCOG.

To analyse the discriminative ability of the ICF-CAMCOG compared to the original CAMCOG, a receiver operating characteristic (ROC) curve was performed. Both were compared to determine the difference by using the method of DeLong et al. [33] in MedCalc (version 14.8.1.0) (MedCalc Software, Mariakerke, Belgium).

Ethics

All participants gave informed consent for the clinical study from which data were derived and for which the local Ethical Committee UZ Brussel was responsible (B.U.N.143201523678). All data were collected in accordance with the Declaration of Helsinki. All material and data can be requested from the corresponding author via email.

Results

Qualitative study:

Phase 1

As shown in Table 1, the majority of the items of the CAMCOG (54/59) were mapped to ICF-categories of the component Body functions (coded b). Five items were mapped to the component Activities and Participation (coded d). Three major ICF domains were addressed: global mental functions, specific mental functions and general tasks and demands, divided over 15 categories (for definitions, see Supplementary Material S1).

Phase 2

Table 1 shows the rationale developed for each ICF-category. All decisions concerning the rationale were made after considering the generic scale from (0) no problem to (4) complete problem provided by the WHO, the number of items of each ICF-category, and the common sense of the three health professionals. In case of too many CAMCOG scores, multiple scores were unified in one ICF-score, while some ICF-scores were skipped in case of too few CAMCOG scores. For example in the case of too many CAMCOG scores, for the new categories ‘orientation in time‘ (b1140) and ‘sustaining attention‘ (b1400), two scores in the CAMCOG (0/5 and 1/5) were taken together in one scores. Or in the case of too few CAMCOG scores, an example is that for the new category ‘orientation to others‘ (b11421), three ICF-qualifiers were skipped, because this category only consists of two scores (1/1 and 0/1).

Table 1. Translation of the CAMCOG to the ICF

CAMCOG items / ICF-category	**Original score** **Weight in CAMCOG**	**Raw ICF score**	**Weighted ICF score**
CAMCOG:1,2,3,4,5	5/5	0	0
orientation in time – ICF:b1140	4/5	1	1.2
	3/5	2	2.4
	2/5	3	3.6
	1/5 and 0/5	4	4.8
	Weight in CAMCOG: 4.8%		
CAMCOG items: 6,7,8,9,10	5/5	0	0
orientation in place – ICF:b1141	4/5	1	1.2
	3/5	2	2.4
	2/5	3	3.6
	1/5 and 0/5	4	4.8
	Weight in CAMCOG: 4.8%		
CAMCOG item: 59	1/1	0	0
orientation to others- ICF:b11421	0/1	4	0.9
	Weight in CAMCOG: 0.9%		
CAMCOG items: 37,38a	7/7	0	0
sustaining attention- ICF:b1400	6/7	1	1.65
	5/7 and 4/7	2	3.3
	3/7 and 2/7	3	4.9
	1/7 and 0/7	4	6.6
	Weight in CAMCOG: 6.6%		

CAMCOG item: 26	6/6	0	0
long-term memory – ICF:b1441	5/6	1	1.4
	4/6	2	2.85
	3/6 and 2/6	3	4.3
	1/6 and 0/6	4	5.7
	Weight in CAMCOG: 5.7%		
CAMCOG items: 19,20,21,22,23,25,	35/35, 34/35 and 33/35	0	0
27,28,29,30,31,32,33,34,35,36,52,57	32/35 to 23/35	1	8.4
retrieval of memory –ICF:b1442	22/35 to 16/35	2	16.8
	15/35 to 5/35	3	25.2
	4/35 to 0/35	4	33.6
	Weight in CAMCOG: 33.6%		
CAMCOG item: 58	6/6	0	0
visuospatial perception –	5/6	1	1.4
ICF:b1565	4/6	2	2.85
	3/6 and 2/6	3	4.3
	1/6 and 0/6	4	5.7
	Weight in CAMCOG: 5.7%		
CAMCOG items: 53,54,55,56	8/8	0	0
abstraction – ICF:b1640	7/8 and 6/8	1	1.9
	5/8 and 4/8	2	3.8
	3/8 and 2/8	3	5.7
	1/8 and 0/8	4	7.6
	Weight in CAMCOG: 7.6%		

CAMCOG item: 44	3/3	0	0
organization and planning	2/3	1	0.56
ICF:b1641	1/3	2	1.1
	0/3	4	2.8
	Weight in CAMCOG: 2.8%		
CAMCOG items:	8/8	0	0
11,12,13,14,15,16,17,24	7/8 and 6/8	1	1.9
reception of spoken language –	5/8 and 4/8	2	3.8
ICF: b16700	3/8 and 2/8	3	5.7
	1/8 and 0/8	4	7.6
	Weight in CAMCOG: 7.6%		
CAMCOG items: 39,40	2/2	0	0
reception of written language –	1/2	2	0.95
ICF:b16701	0/2	4	1.9
	Weight in CAMCOG: 1.9%		
CAMCOG items: 18	6/6	0	0
expression of spoken language –	5/6	1	1.43
ICF: b16710	4/6	2	2.85
	3/6 and 2/6	3	4.28
	1/6 and 0/6	4	5.7
	Weight in CAMCOG: 5.7%		
CAMCOG items: 50,51	2/2	0	0
simple calculation – ICF: b1720	1/2	2	0.95
	0/2	4	1.9
	Weight in CAMCOG: 1.9%		

CAMCOG items: 47,48,49	5/5	0	0
mental function of sequencing	4/5	1	1.2
complex movements – ICF: b176	3/5	2	2.4
	2/5	3	3.6
	1/5 and 0/5	4	4.8
	Weight in CAMCOG: 4.8		
CAMCOG items: 41,42,43,45,46	6/6	0	0
undertaking a simple task –	5/6	1	1.43
ICF:d210	4/6	2	2.85
	3/6 and 2/6	3	4.28
	1/6 and 0/6	4	5.7
	Weight in CAMCOG: 5.7%		

Phase 3

The pilot study confirmed our expectation that the ICF-CAMCOG sub scores were higher with increasing severity in cognitive decline, e.g. case 1 (healthy person), the score 'no problem' (0) was observed in all ICF-categories. In case 3 (MCI), the score 'mild problem' (1) is getting more prominent. On the contrary, in case 4 (mild AD) the scores ''moderate problem' (2), 'severe problem' (3) were seen. The calculated ICF-means, ICF-median and ICF-mode for each case were higher with increasing cognitive deterioration, which is most apparent for case 1, case 3 and 5. In case 1 (healthy person), the ICF-mean, ICF-median and ICF-mode were 0, which indicates no problem in all 15 ICF-categories. In case 3 (MCI), ICF-mean was 0.73 and the ICF-median was 1, which shows that the frequency of the ICF-qualifier 'mild problem' (1) increased. The ICF mean (1.13), ICF-median (1) and ICF-mode

(2) of case 5 (mild AD) were higher than in case 1 and case 3. This indicates that in case 5, the ICF-qualifier 'moderate problem' (2) was most prominent.

Phase 4

In this phase, an ICF based version of the scoring system of the ICF-CAMCOG was created. The 'weight' of each domain in the original CAMCOG was taken into account. Therefore, we adopted the original weight of the CAMCOG items and domains in the total ICF-CAMCOG score, e.g. 5/105= 4.8% for the domain b1140 'orientation in time'. Table 1 shows the 'converted' weighted ICF-CAMCOG rating scale and the weight of the domains in the original CAMCOG converted to the ICF-CAMCOG. The ICF-CAMCOG scores were expressed in a total sum score ranging from 0 (no problem) to 100 (complete problem), thus higher scores representing worse performance.

Quantitative study:

Study population characteristics

Table 2 shows the characteristics and demographics of the participants. Gender proportions were similar for healthy older adults, MCI and mild AD ($\chi 2$ (2) = 4.333, $p > .05$). The age of the 3 diagnostic groups was not significantly different ($F(2,72) = .263$), $p > .05$).

The mean total GDS score was significant different between the three groups ($F(2,72) = 6.712$, $p < .05$), however Bonferroni post hoc comparisons indicated that only the healthy persons differed significantly from the mild AD group ($p < .01$). There was a significant difference between the three groups for the mean total ADL score ($F(2,72) = 4.946$, $p < .05$), however, Bonferroni post hoc tests showed that only the healthy persons differed significantly from the MCI group ($p < .01$). The mean total i-ADL score was significant different between the three groups ($F(2,72) = 31.23$, $p < .05$), however only the healthy persons from the MCI

group ($p < .001$) and the healthy persons from the mild AD group ($p < .001$) differed significantly from each other.

There was a significant difference between all of the three diagnostic groups of the mean total MMSE score ($F(2,72) = 52.7$, $p < .05$; Bonferroni post hoc tests, $p < .001$), the mean total CAMCOG score ($F(2,72) = 66.67$, $p < .05$; Bonferroni post hoc tests, $p < .001$) and the mean CAMCOG memory section score ($F(2,72) = 51.05$, $p < .05$; Bonferroni post hoc tests, $p < .001$). The mean total ICF-CAMCOG score differed significantly between all of the three diagnostic groups ($F(2,72) = 59.01$, $p < .05$; Bonferroni post hoc tests, $p < .01$).

Table 2. Demographic and cognitive measures of study population

	Healthy persons (n=25)	MCI (n=25)	Mild AD (n=25)	Significance
Mean age, years	79.7 (71-88; 4,6)	80.7 (68-90; 4.8)	80.3 (69-91; 5.5)	
Male/female	9/16	14/11	7/18	
Mean MMSE scores/30*	28.8 (26-30; 1.25)	26.2 (21-29; 2.56)	21.84 (16-29; 3.11)	A3, B3, C3
GDS	1.9 (0-6; 1.66)	2.71 (0-7; 1.829)	4.28 (0-11; 3.22)	C2
b-ADL (Katz)	6.1 (6-7; 0.27)	7.52 (6-15; 2.16)	7.20 (6-15; 1.97)	A2
i-ADL (Lawton)	26.6 (22-27; 1.03)	20.28 (9-27; 5.1)	19.16 (12-26; 3.46)	A3,C3
Mean CAMCOG scores/105*	95.4 (87-103; 4.7)	85.8 (73-93; 5.4)	73.4 (55-92; 9.4)	A3, B3, C3
Mean CAMCOG memory section/27*	22.4 (19-26; 1.98)	18.2 (11-24; 3.0)	12.5 (5-23; 4.85)	A3, B3, C3
Mean ICF-CAMCOG/100*	13.32 (1-26; 5.6)	20.87 (13-37; 6.6)	37.27 (13-56; 10.6)	A2, B3, C3

Figures in parentheses indicate range and sd.

Mci = mild cognitive impairment; ad = alzheimer's disease; mmse = mini-mental state examination; gds = geriatric depression scale; b-adl = basic activities of daily living; i- adl = instrumental activities of daily living.

*$p < 0.001$, significant between all groups (anova-bonferroni post hoc test).

Differences between healthy persons and mci: a; differences between mci and mild ad: b; differences between healthy persons and mild ad: c; level of significance: 1 $p < 0.05$, 2 $p < 0.01$, 3 $p < 0.001$.

Distribution of ICF domain scores within the diagnostic groups

In table 3, the distribution of ICF-scores for each separate domain within the diagnostic groups is shown. In general, ICF-CAMCOG sub scores were higher with increasing severity in cognitive decline. As expected, the scores 'no problem' (0) and 'mild problem' (1) were mainly seen in healthy persons (0=74%; 1=20%) and persons with MCI (0=58%; 1=30%). On the other hand, the scores 'moderate problem' (2), 'severe problem' (3) were mainly observed in mild AD patients (2=22%; 3=11%). This tendency is most apparent for b1442 (retrieval of memory) going from 0% scores > 1 in the healthy persons to 88% in the mild AD group. This tendency is also seen for b1400 (sustaining attention) going from 0% scores > 1 in the healthy persons to 56% in the mild AD group.

Table 3. ICF score distribution over diagnostic groups

Parameter:		Healthy persons					MCI					Mild AD				
Qualifier:		0	1	2	3	4	0	1	2	3	4	0	1	2	3	4
Global mental functions																
b1140	n	22	2	1	0	0	11	7	5	1	1	5	7	10	1	2
	%	88	8	4	0	0	44	28	20	4	4	20	28	40	4	8
b1141	n	24	1	0	0	0	18	6	1	0	0	7	11	4	3	0
	%	96	4	0	0	0	72	24	4	0	0	28	44	16	12	0
b11421	n	25	n.a	n.a.	n.a.	0	24	n.a.	n.a.	n.a	1	25	n.a.	n.a.	n.a.	0
	%	10	n.a	n.a.	n.a.	0	94	n.a.	n.a.	n.a	4	100	n.a.	n.a.	n.a.	0
Specific mental functions																
b1400	n	23	2	0	0	0	13	9	2	1	0	4	7	9	5	0
	%	92	8	0	0	0	52	36	8	4	0	16	28	36	20	0
b1441	n	15	7	3	0	0	15	7	1	2	0	5	4	7	9	0
	%	60	28	12	0	0	60	28	4	8	0	20	16	28	36	0
b1442	n	3	22	0	0	0	0	18	7	0	0	0	3	17	5	0
	%	12	88	0	0	0	0	72	28	0	0	0	12	68	20	0
b1565	n	8	10	2	4	1	8	5	5	6	1	2	7	3	13	0
	%	32	40	8	16	4	32	20	20	24	4	8	28	12	52	0
b1640	n	6	16	3	0	0	6	18	1	0	0	3	13	4	5	0
	%	24	64	12	0	0	24	72	4	0	0	12	52	16	20	0
b1641	n	23	2	0	n.a.	0	14	10	1	n.a	0	8	10	5	n.a.	2
	%	92	8	0	n.a.	0	56	40	4	n.a	0	32	40	20	n.a.	8
b16700	n	18	7	0	0	0	14	11	0	0	0	6	18	1	0	0
	%	72	28	0	0	0	56	44	0	0	0	24	72	4	0	0
b16701	n	25	n.a.	0	n.a.	0	25	n.a.	0	n.a	0	25	n.a.	0	n.a.	0
	%	10	n.a.	0	n.a.	0	100	n.a.	0	n.a	0	100	n.a.	0	n.a.	0
b16710	n	21	3	1	0	0	16	8	1	0	0	14	7	3	0	1
	%	84	12	4	0	0	64	32	4	0	0	56	28	12	0	4
b1720	n	23	n.a.	2	n.a.	0	19	n.a.	5	n.a	1	17	n.a.	8	n.a.	0
	%	92	n.a.	8	n.a.	0	76	n.a.	20	n.a.	4	68	n.a.	32	n.a.	0
b176	n	25	0	0	0	0	18	6	1	0	0	15	8	2	0	0
	%	10	0	0	0	0	72	24	4	0	0	60	32	8	0	0
General tasks and demands																
d210	n	19	3	3	0	0	17	6	2	0	0	11	3	8	2	1
	%	76	12	12	0	0	68	24	8	0	0	44	12	32	8	4
Total	**n**	**28**	**75**	**15**	**4**	**1**	**217**	**111**	**32**	**11**	**4**	**147**	**98**	**81**	**43**	**6**
	%	**74**	**20**	**4**	**1**	**<1**	**58**	**30**	**9**	**2**	**1**	**39**	**26**	**22**	**11**	**2**

Mci=mild cognitive impairment; ad=alzheimer's disease; n=number; %=prevalence within diagnostic group; b1140=orientation to time; b1141=orientation to place; b11421=orientation to others; b1400=sustaining attention;b1441=long-term memory; b1442=retrieval of memory; b156=visuospatial perception; b1640=abstraction; b1641=organization and planning; b16700=reception of spoken language; b16701=reception of written language; b16710=expression of spoken language; b1720=simple calculation; b176=mental function of sequencing complex movements; d210=undertaking a simple task;0=no problem;1=mild problem;2=moderate problem;3=severe problem;4=complete problem; n.a. = not applicable .

In addition figure 1 shows the total CAMCOG and ICF-CAMCOG scores across diagnostic groups. The ICF-CAMCOG total scores were labelled with a qualifier according to the WHO guidelines as ‘no problem’ (total score from 0% to 4%, n = 3), ‘mild problem’ (total score from 5% to 24%, n = 42), ‘moderate problem’ (total score from 25% to 49%, n = 27), ‘severe problem’ (total score from 50% to 95%, n = 3) and ‘complete problem’ (total score from 96% to 100%, n = 0). In analogy to the total scores on the original CAMCOG scale, mild problem ICF-CAMCOG performance was seen both in healthy persons and MCI patients, moderate problems in MCI and mild AD patients.

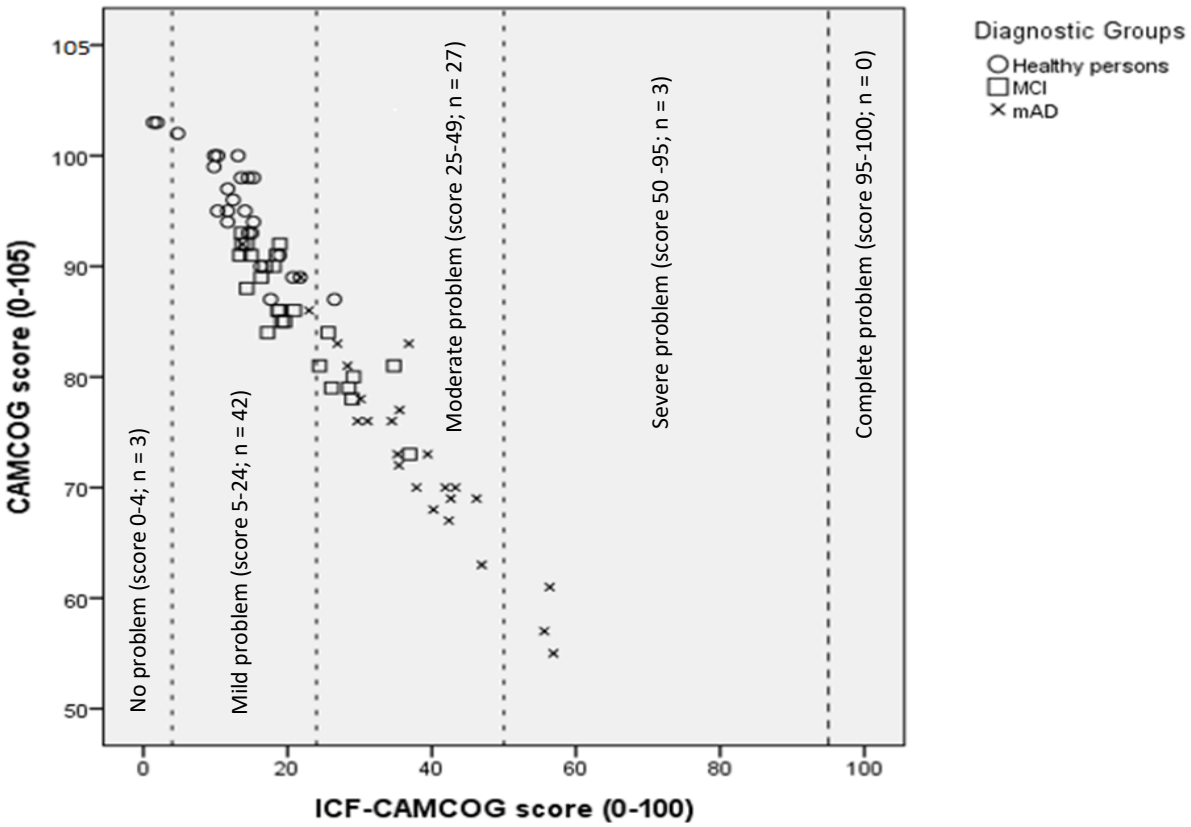

Fig. 1. CAMCOG total scores and total scores on the weighted ICF-CAMCOG across diagnostic groups

Construct validity

The overall correlation between the total scores on the CAMCOG and total scores on the ICF-CAMCOG ($r = -0.967$; $p < 0.01$) was high. Furthermore, the results indicated a highly significant correlation between the CAMCOG domains and the ICF-categories of the ICF-CAMCOG. The highest correlation was found between the CAMCOG domain 'orientation: place' and the ICF-category 'orientation in place' (b1141) ($r = -1$; $p < .01$) and between the CAMCOG domain 'calculation' and the ICF-category 'simple calculation' (b1720) ($r = -1$; $p < .01$). The lowest correlation was found between the CAMCOG memory section score and the ICF-category 'retrieval of memory' (b1442) ($r = -.880$; $p < .01$) and between the CAMCOG praxis section score and the ICF-category 'undertaking a simple task' (d210) ($r = -.759$; $p < .01$).

Discriminative validity

Table 4 shows the results of the computed ROC curves for the CAMCOG and the ICF-CAMCOG with optimal cut-offs, sensitivity specificity and AUC. The ROC curve for the CAMCOG demonstrated AUC values between 0.877 and 0.986. The ICF-CAMCOG was found to have an AUC between 0.819 and 0.978. There were no significant differences between the AUC for the discrimination between MCI and mild AD, nor for the differentiation between the healthy group and the mild AD group. However, there was a significant difference observed between the CAMCOG and the ICF-CAMCOG for the differentiation between the healthy group and the MCI group (respectively .911 and .819; p .0094).

Table 4. Discriminative validity of the CAMCOG and the ICF-CAMCOG between healthy persons, patients with MCI and mild AD

	Groups	Optimal Cut-off	Sensitivity	Specificity	AUC
Indices					
CAMCOG	HP vs. MCI	91.5	84%	76%	0.911
	MCI vs. mAD	83.5	88%	72%	0.877
	HP vs. mAD	88	92%	92%	0.986
ICF-CAMCOG					
	HP vs. MCI	16.32	76%	80%	0.819
	MCI vs. mAD	29.42	80%	92%	0.904
	HP vs. mAD	21.74	96%	96%	0.978

Hp: healthy persons; mci: mild cognitive impairment; mad: mild alzheimer's disease; auc: area under the curve.

Discussion

Since the WHO launched the ICF framework in 2001 [19], several studies have been conducted in order to relate, compare or adapt existing assessment tools to the ICF or develop new tools based on the ICF in order to contribute to a more uniform and standardized assessment policy. Although a lot of work has been carried out, most assessment tools in the field of gerontology are not in accordance with the ICF language. To the best of our knowledge, this is the first study which converts the original CAMCOG into a ICF-CAMCOG. This has been done by means of content comparison and subsequently translating the scoring system. We evaluated the translation by checking the face validity, construct validity and the discriminative validity of the new ICF-CAMCOG and compare the results to the original one.

Therefore, we maintained the structure of the original CAMCOG, and translated the items and convert the scores to the ICF language. The advantage of this type of 'content comparison' with the ICF framework is the use of an external and independent reference to which all instruments can be linked and compared. However, starting from and maintaining the original structure of the CAMCOG implicates that one adopts the rationale of the instrument. Consequently, a disadvantage is that any limitations of the original CAMCOG will still be present in the converted ICF-CAMCOG, for example the lengthy administration time (25-30 minutes) and that even normal ageing is associated with significantly poorer scores [34].

The results of the study demonstrate that it was possible to successfully link all 59 CAMCOG items to ICF-categories. The original CAMCOG does not cover entirely all available ICF domains and categories, hence only provides an indication of the cognitive functioning of a person on a restricted number of domains. For the 59 items in the CAMCOG, 3 major ICF domains were addressed: global mental functions, specific mental functions and general tasks and demands, divided over 15 categories. Since for most CAMCOG items, more than one possible category was available, choices had to be made among available ICF categories. A clear example is, 'undertaking a simple task' (d2100) or 'undertaking a single task independently' (d2102) can be both used for the CAMCOG praxis item. This problem of 'overlapping ICF codes' is considered as a major difficulty for the linkage of the original assessment tool item to the ICF-categories [20]. To counter this problem of 'overlapping ICF codes', we identified for each CAMCOG item its specific underlying meaningful concept based on the description or definition, found in the literature, of the specific cognitive function tested in this item. To link each meaningful concept to the appropriate ICF-category, we considered the definitions and examples given of each ICF-category by the WHO in the ICF.

The linkage of the CAMCOG items to the ICF-categories facilitated an increased conceptual understanding and provided a structured content description with a better visibility of the cognitive domains covered by the instrument.

Furthermore, the findings of our study demonstrated that the ICF-CAMCOG has good construct validity. There was a high overall correlation between totals scores on the CAMCOG and total scores on the ICF-CAMCOG. In addition, the results indicated a high correlation between the original CAMCOG domains and the ICF-categories of the ICF-CAMCOG. These results confirm that the conversion reflected faithfully the original CAMCOG.

The major advantage of the ICF-scoring system of the new ICF-CAMCOG tool is that it provides a quantification of the limitation in a given ICF-category. The extent of the observed impairment can be labelled in a statement as ‘no problem’, ‘mild problem’, ‘moderate problem’, ‘severe problem’ and ‘complete problem’, resulting in a five-point scale. It is important to note that these ICF labels provide a judgment concerning the ICF-category under question, but are no exact clinical diagnosis. For instance, a participant with an CAMCOG score of 101/105, failing in recalling 4 words (ICF-category ‘retrieval of memory’ (b1442)), will have a ‘mild problem’ in ‘retrieval of memory’, which is logical considering the fact that memory impairment is frequently seen one of the first signs in dementia. As seen in the results, diagnostic groups are divided over the qualifiers as expected, respecting the widely used cut-off value of 79/80 of 105 on the CAMCOG.

Overall, the clinical use of the ICF-CAMCOG looks promising and equivalent to the original one, since it can discriminate between the 3 diagnostic groups with a high accuracy [35]. However, the ability of the original CAMCOG to discriminate between healthy persons and patients with MCI was significantly better than that of the ICF-CAMCOG, while the others were comparable. This indicates that the translation was done in a reliable way, not losing the capacities of the original CAMCOG.

In this study, the original CAMCOG scores of 75 subjects were all successfully converted to ICF-CAMCOG scores. During linkage process, the 59 items of the CAMCOG were distributed to 15 ICF-categories. Each new category contains different numbers of items of the CAMCOG. The new ICF-category 'retrieval of memory' (b1442) consists of 18 items of several subscales of the CAMCOG (language expression: naming and definitions; memory: new learning, remote and recent; perception: visual recognition). This finding of a generalized memory category contradicts neuropsychological and neuroanatomical evidence that indicated that memory is composed of distinct interrelated systems and multiple functions [36, 37]. Due to the generalized and large category, some precision and important information could get lost. This can be seen as a shortcoming of the linkage process and as a shortcoming of the ICF-category 'retrieval of memory' (b1442), defined by the WHO.

Some limitations concerning the sample should be discussed. Firstly, we didn't perform a power calculation. Secondly, it can be noted the GDS score was significantly different in the healthy vs. AD group. However, the patient groups (both MCI and AD) were diagnosed based on multidisciplinary evaluation. Any suspicion of a major clinical depression was ruled out before including the data of the participant in this particular study. But off course persons could show some depressive symptomatology. This mirrors also clinical reality where there is a high comorbidity between cognitive problems and depressive symptoms. Thirdly, there was no significant difference for i-ADL between the MCI and AD group. This probable reflect the fact that the i-ADL (in this case the Lawton Scale) is not a good tool to differentiate between these 3 conditions. Although commonly used, these instruments like the Lawton scale are not sensitive enough to detect mild limitations in functioning. Another difficulty is that most ADL-assessment tools do not distinguish between motor and processing skills, while only functional loss due to cognitive deficits has to be considered for the diagnosis of cognitive problems [38].Another shortcoming of the current study could be that one can argue that the evaluation

of the discriminative validity is a circular reasoning/argumentation. This can be seen as a major weakness for the evaluation of the discriminative validity. However, we didn't want to state firm conclusions on the discriminative power, but rather evaluate whether translation has been done reliable meaning that discriminative power should be comparable.

The present study is a step towards a more uniform and standardized assessment policy in accordance with the ICF framework and towards a new ICF-CAMCOG. This adaptation improves the interdisciplinary communication and understanding, since it provides a structured content description, with better visibility of the domains covered by the instrument. The ability of the new ICF-CAMCOG to quantify limitation in a given ICF-category and the more detailed scoring appears to be a major advantage of the new ICF-CAMCOG. Overall, the clinical use of the ICF-CAMCOG looks promising. However, future improvements of the ICF-CAMCOG are needed: firstly remove redundant content (e.g. the frequently matched categories), and thus accounting for the length of the tool, and secondly add content since it was clear that the CAMCOG did not cover all potentially meaningful categories. Finally, further prospective evaluation with an independent gold standard is needed for validation and to establish its clinical usefulness.

References

1 Burns A, Lliffe S: Dementia. BMJ 2009;338:75.

2 Holmes C: Dementia. Medicine 2008;36:467-470.

3 World Health Organization and Alzheimer's Disease International: Dementia: A Public Health Priority. Geneva, World Health Organization, 2012.

4 Windblad B, Palmer K, Kivipelto M, Jelic V, Fratiglioni L, Wahlund LO, Nordberg A, Backman L, Albert M, Almkvist O, Arai H, Basun H, Blennow K, De Leon M, DeCarli C, Erkinjuntti T, Giacobini E, Graff C, Hardy J, Jack C, Jorm A, Ritchie K, van Duijn C, Visser P, Petersen RC: Mild cognitive impairment – beyond controversies, towards a consensus: report of the international working on mild cognitive impairment. J Intern Med 2004;256:240-246.

5 Ward A, Tardiff S, Dye C, Arrighi HM: Rate of Conversion from Prodromal Alzheimer's Disease to Alzheimer's Dementia: A Systematic Review of the Literature. Dementia Geriatric Cognitive Disorders Extra 2013;3:320-332.

6 Sheehan B: Assessment scales in dementia. Ther Adv Neurol Disord 2012;5:349-358.

7 Borson S, Scanlan JM, Chen PJ: The Mini-Cog as a screen for dementia: Validation in a population-based sample. J Am Geriatr Soc 2003;51:1451–1454.

8 Folstein, MF, Folstein, SE, McHugh, PR: "Mini-mental state": a practical method for grading the cognitive state of patients for the clinician. Journal of Psychiatric Research 1975;12:189–198.

9 Nasreddine ZS, Phillips NA, Bédirian V, Charbonneau S, Whitehead V, Collin I, Cummings JL, Chertkow H: "The Montreal Cognitive Assessment, MoCA: a brief screening tool for mild cognitive impairment". J Am Geriatr Soc. 2005;53:695–699. doi:10.1111/j.1532-5415.2005.53221.x. PMID 15817019.

10 Roth M, Tym E, Mountjoy CQ, Huppert FA, Hendrie H, Verma S, Goddard R: CAMDEX: A standardized instrument for the diagnosis of mental disorder in the elderly with special reference to the early detection of dementia. The British Journal of Psychiatry 1986;149:698-709.

11 Rosen WG, Mohs RC, Davis KL: A new rating scale for Alzheimer's disease. Am J Psychiatry. 1984;141:1356-1364.

12 Costa A, Bak T, Caffarra P, Caltagirone C, Ceccaldi M, Collette F, Crutch S, Della Sala S, Démonet JF, Dubois B, Duzel E, Nestor P, Papageorgiou SG, Salmon E, Sikkes S, Tiraboschi P, van der Flier WM, Visser PJ, Cappa SF: The need for harmonisation and

innovation of neuropsychological assessment in neurodegenerative dementias in Europe: consensus document of the Joint Program for Neurodegenerative Diseases Working Group. Alzheimers Res Ther. 2017;9:27.

13 Andersen K, Lolk A, Nielsen H: Prevalence of very mild to severe dementia in Denmark. Acta Neurol Scand 1997;96:82-87.

14 Derix MM, Hofstede AB, Teunisse S: The Dutch version of the Cambridge Examination for Menal Disorders of the Elderly with automatic data processing. Gerontol Geriatr 1991;22:143-150.

15 Greifenhagen A, Kurz A, Wiseman M, Haupt M, Zimmer R: Cognitive assessment in Alzheimer´s disease: What does the CAMCOG assess? Int J Meth Psychiatr 1994;9:743-750.

16 Gallagher D, Mhaolain AN, Coen R, Walsh C, Kilroy D, Belinski K, Bruce I, Coakley D, Walsh JB, Cunningham C, Lawlor BA: Detecting prodromal Alzheimer´s disease in mild cognitive impairment: utility of the CAMCOG and other neuropsychological predictors. Int J Geriatr Psychiatry 2010;25:1280-1287.

17 Ballard CG, Ayre G, O´Brien J, Shagal A, McKeith IG, Ince PG, Perry RH: Simple standardized neuropsychological assessments aid in the differential diagnosis of dementia with Lewy bodies from Alzheimer´s disease and vascular dementia. Dement Geriatr Cogn Disord 1999;10:104-108.

18 Heinik J, Werner P, Mendel A, Raikher B, Bleich A: The Cambridge cognitive examination (CAMCOG): Validation of the Hebrew version in elderly demented patients. Int J Geriat Psychiatry 1999;14:1006-1013.

19 World Health Organization: International Classification of Functioning, Disability and Health. Geneva, World Health Organisation, 2001.

20 Jelsma J: Use of the International Classification of Functioning, Disability and Health: a literature review. J Rehabil Med 2009;41:1-12.

21 Jette AM: Towards a Common Language of Disablement. J Gerontol A Biol Sci Med Sci 2009;64:1165-1168.

22 Freedman VA: Adopting the ICF Language for Studying Late-life Disability: A field of dream? J Gerontol A Biol Sci Med Sci 2009;64:1172-1174.

23 Bladh S, Nilsson MH, Carlsson G, Lexell J: Content analysis of 4 fear of falling rating scales by linking to the International Classification of Functioning, Disability and Health. PM R 2013;5:573-582.

24 Eckert KG, Lange MA: Comparison of physical activity questionnaires for the elderly with the International Classification of Functioning, Disability and Health (ICF) – an analysis of content. BMC Public Health 2015;15:249-260.

25 Azzopardi RV, Vermeiren S, Gorus E, Habbig AK, Petrovic M, Van Den Noortgate N, De Vriendt P, Bautmans I, Beyer I, Gerontopole Brussels Study Group: Linking Frailty Instruments to the International Classification of Functioning, Disability, and Health: A Systematic Review. JAMDA 2016:17:1066.

26 De Vriendt P, Gorus E, Bautmans I, Mets T: Conversion of the Mini-Mental State examination to the International Classification of Functioning, Disability and Health Terminology and Scoring System. Gerontology 2012;58:112-119.

27 Cieza A, Geyh S, Chatterij S, Kostanjsek N, Üstün, B, Stucki G: ICF linking rules: an update based on lessons learned. J Rehabil Med 2005;37:212-218.

28 Yesavage JA, Brink TL, Rose TL, Lum O, Huang V, Adey MB, Leirer VO: Development and validation of a geriatric depression screening scale: a preliminary report. J Psychiatr Res 1983;17:37-49.

29 Katz S, Ford AB, Moskowitz RW, Jackson BA, Jaffe MW: Studies of illness in the aged. The index of ADL: a standardized measure of biological and psychosocial function. JAMA 1963;185:914-919.

30 Lawton MP, Moss M, Fulcomer M, Kleban MH: A research and service oriented multi-level assessment instrument. J Gerontol 1982;37:91-99.

31 American Psychiatric Association: Diagnostic and Statistical Manual of Mental Disorders, ed 4. Washington, American Psychiatric Association, 2000.

32 McKhann G, Drachman D, Folstein M, Katzman R, Price D, Stadlan EM: Clinical diagnosis of Alzheimer´s disease: report of the NINCDS-ADRDA work group under the auspices of Department of Health and Human Services Task Force on Alzheimer´s Disease. Neurology 1984;34:939-944.

33 DeLong ER, DeLong DM, Clarke-Pearson DL: Comparing the areas under two or more correlated receiver operating characteristic curves: a nonparametric approach. Biometrics 1988;44:837-845.

34 Athey RJ, Porter RW, Walker RW: Cognitive assessment of a representative community population with Parkinson´s disease (PD) using the Cambridge Cognitive Assessment –Revised (CAMCOG-R). Age and Ageing 2005;34:268-273.

35 Hanley JA, McNeil BJ: The meaning and use of the area under a receiver operating characteristic (ROC) curve. Radiology 1982;143:29-36.

36 Squire LR: Memory systems of the brain: A brief history and current perspective. Neurobiology of Learning and Memory 2004;82:171-177.

37 Tulving E: How many memory systems are there? American Psychologist 1985;40:385-398.

38 De Vriendt P, Mets T, Petrovic M, Gorus E: Discriminative power of the advanced activities of daily living (a-ADL) tool in the diagnosis of mild cognitive impairment in an older population. Int Psychogeriatr. 2015;27:1419-1427.

S1: Supplementary material: Definitions of ICF- categories in the CAMCOG

b1140 orientation in time: mental functions that produce awareness of day, date, month and year.

b1411 orientation in place: mental functions that produce awareness of one's location, such as one's immediate surroundings, one's town or country.

b11421 orientation to others*:* mental functions that produce awareness of one's own identity and of individuals in the immediate environment.

b1400 sustaining attention: mental functions that produce concentration for the period of time required.

b1441 long-term memory: mental functions that produce a memory system permitting the long-term storage of information from short-term memory and both autobiographical memory for past events and semantic memory for language and facts.

b1442 retrieval of memory: specific mental functions of recalling information stored in long-term memory and bringing it into awareness.

b1565 visuospatial perception: mental function involved in distinguishing by sight the relative position of objects in the environment or in relation to oneself.

b1640 abstraction: mental functions of creating general ideas, qualities or characteristics out of, and distinct from, concrete realities, specific objects or actual instances.

b1641 organization and planning: mental functions of coordinating parts into a whole, of systematizing; the mental function involved in developing a method of proceeding or acting

b16700 reception of spoken language: mental functions necessary for decoding spoken messages to obtain their meaning.

b16701 reception of written language: mental functions of decoding writing messages to obtain their meaning.

b16710 expression of spoken language: mental function necessary to produce meaningful spoken language.

b1720 simple calculation: mental functions of computing with numbers, such as addition, subtraction, multiplication and division.

b176 mental function of sequencing complex movements: specific mental functions of sequencing and coordinating complex, purposeful movements.

d210 undertaking a simple task: preparing, initiating and arranging the time and space required for a simple task; executing a simple task with a single major component, such as reading a book, writing a letter, or making one's bed.