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Brief Assessment of Impaired Cognition (BASIC)—Validation of a new dementia case-finding instrument integrating cognitive assessment with patient and informant report

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Objectives: The aim of this study was to develop and validate a new brief and accurate case-finding instrument for dementia and cognitive impairment. Previous research indicates that combining cognitive tests with informant and/or patient report may improve accuracy in dementia case-finding. The Brief Assessment of Impaired Cognition (BASIC) integrates these three sources of information.

Methods: BASIC was prospectively validated in five memory clinics. Patients consecutively referred from general practice were tested at their initial visit prior to diagnosis. Control participants were primarily recruited among participating patients' relatives. Expert clinical diagnosis was subsequently used as gold standard for estimation of the classification accuracy of BASIC.

Results: A very high discriminative validity (specificity 0.98, sensitivity 0.95) for dementia (n = 122) versus socio-demographically matched control participants (n = 109) was found. In comparison, the MMSE had 0.90 specificity and 0.82 sensitivity. Extending the discriminative validity analysis to cognitive impairment (both dementia and MCI, n = 162) only slightly reduced the discriminative validity of BASIC whereas the discriminative validity of the MMSE was substantially attenuated. Administration time for BASIC was approximately 5 minutes compared with 10 to 15 minutes for the MMSE.

Conclusions: BASIC was found to be an efficient and valid case-finding instrument for dementia and cognitive impairment in a memory clinic setting.

KEYWORDS

BASIC, cognitive assessment, cognitive impairment, cognitive screening, dementia, diagnostic accuracy, discriminative validity, predictive validity

1 | INTRODUCTION

Brief case-finding and screening instruments are routinely used for identification of dementia. The standard instrument, Mini-Mental State Examination (MMSE)[1], however, lacks sensitivity to mild dementia[2], is substantially affected by education and age[3], and experience indicates that some patients may perceive certain items (eg, serial sevens) as difficult or confrontational. Since the publication of the MMSE more than 40 years ago, more refined instruments have been developed, but according to recent reviews, no single instrument is clearly superior to others[4-7]. Many cognitive tests and brief test batteries[8-13] have good psychometric properties but are relatively time-consuming. Most instruments belong to one of two subtypes: (a) brief cognitive tests or test batteries or (b) informant-directed tools. Combining cognitive tests with informant or patient report has been found to improve diagnostic accuracy in dementia case-finding[14-17], but very few instruments combine the two types of information[18,19]. A workgroup convened by Alzheimer's Association suggested that screening for dementia in primary care should include both cognitive assessment and informant report[20].

The aim of the present study was to develop and validate a new brief case-finding instrument for dementia, the Brief Assessment of Impaired Cognition (BASIC) in a memory clinic setting. The rationale for our study design, comparing a clinical sample referred from general practice to diagnostic evaluation to a cognitively intact control group, is the relative homogeneity of each group and the prospective availability of a relevant gold standard (expert clinical diagnosis). Among the possible risks of the study design is inflation of the classification accuracy of BASIC as cases and controls are readily separated compared with other clinical settings such as general practice or primary care where prevalence of dementia is lower, and the case mix more heterogeneous.

Key points

- The Brief Assessment of Impaired Cognition (BASIC) integrates brief cognitive assessment with both patient and informant report. Performance on the instrument is unaffected by education and only slightly affected by age and gender.
- A previous study investigating the utility of self-report and informant report found that self-report was more reliably correlated than with cognition earlier in the process of decline, whereas informant report became superior at later stages with loss of insight. The results of the present study substantiate the effectiveness and validity of integrating brief cognitive assessment with patient and informant report for case-finding of dementia and cognitive impairment.
- Although BASIC has promising diagnostic properties, a cross-validation of the instrument in a general practice setting is needed. Future studies should also examine the ability of BASIC to identify Alzheimer's disease dementia versus non-Alzheimer's dementia, as well as the instrument's ability to monitor cognitive decline during disease progression.

2 | METHODS

Based on focus group interviews with general practitioners and district nurses, specifications for the new instrument were defined: (a) It should be broadly applicable in general practice and memory clinics; (b) be easily administered by trained health care professionals; (c) have good discriminative validity; (d) be relatively free from educational, age, and gender bias; and (e) should not contain items that patients may perceive as unnecessarily confrontational. The instrument should be available for clinicians and noncommercial research without copyright restrictions.

2.1 | The Brief Assessment of Impaired Cognition (BASIC) instrument

BASIC consists of four components: (a) patient-directed questions, (b) Supermarket Fluency, (c) Category Cued Memory Test (CCMT), and (d) informant-directed questions (Table 1). BASIC is inspired by existing, validated instruments[18,19,21] and includes elements from validated questionnaires[22,23]. According to previous research, memory tests based on controlled learning and cued recall[24-26] have high discriminative validity[5,27,28]. We have previously found that Supermarket Fluency may be less influenced by education and age compared with more commonly used animal fluency or lexical fluency tasks[29].

Prior to construction of BASIC, a preliminary version of the instrument was tested, and components and items with high discriminative validity for dementia were identified by repeated stepwise backwards binary logistic regression analyses utilizing the probability of the Wald statistic with case-control status as the dependent variable until a minimal set of highly discriminative items was identified. Excluded items were questions regarding orientation to time and place, and additional informant-directed questions regarding cognitive and neuropsychiatric symptoms. 1. The BASIC Record form, Informant report, Manual and CCMT stimulus card are available as (Supplementary Appendix A).

2.1.1 | Patient report

The participant is asked three questions regarding memory functioning from the Cognitive Function Instrument (CFI)[23]. Response options are "No," "To some extent," and "To a great extent."

2.1.2 | Supermarket Fluency

The participant is asked to name as many supermarket items as he or she can think of in 1 min[30]. An interval scoring algorithm is applied (Table 1).

TABLE 1 Brief Assessment of Impaired Cognition (BASIC)

Component	Description	Score Range
1. Patient-directed questions	• Compared with previously, do you feel that your memory has declined substantially? • Do you need more help from others to remember appointments, family occasions, or holidays? • Do you have more trouble recalling names, finding the right words, or completing sentences? Scoring: No = 2 points; To some extent = 1 point; To a great extent = 0 points.	0-6
2. Supermarket fluency	The patient is asked to name as many supermarket items as he or she can think of in 1 min. The number of items minus repetitions produced within 1 min is recorded. Scoring: 0-3 items = 0 points; 4-7 items = 1 point; 8-11 items = 2 points; 12-15 items = 3 points; 16-19 items = 4 points; ≥20 items = 5 points.	0-5
3. Category cued memory test	Four pictures are connected to specific semantic categories (banana ↔ fruit; cow ↔ animal; sofa ↔ furniture; bicycle ↔ means of transportation) by forced choice. After 2 min of distraction, the patient is asked to freely recall the objects. If one or more objects are not retrieved by free recall, the examiner provides the relevant semantic cue (eg, "There was also a fruit. Which fruit was it?"). Scoring: objects recalled by free recall = 2 points; items recalled by cued recall = 1 point; items not recalled = 0.	0-8
4. Informant-directed questions	Compared with a few years ago, how is your spouse/parent/relative/this person at: • Remembering things that have happened recently? • Recalling conversations a few days later? • Remembering what day and month it is? Scoring: Unchanged = 2 points; A bit worse = 1 point; Much worse = 0 points.	0-6
BASIC total score		0-25

Optimal cutoff score for case-finding of dementia = 19/20. Optimal cutoff score for case-finding of cognitive impairment = 20/21.

2.1.3 | Category Cued Memory Test

In this test, inspired by previous work by Buschke and colleagues,[21,24,25] the participant is asked to recall four pictures presented on an A4 stimulus card. The participant is asked to identify the object that best fits with a semantic cue given by the examiner (eg, "Which fruit do you see?" participant: "A banana"). When the objects have been categorized, the card is removed from sight, and patient-directed questions and Supermarket Fluency are administered providing approximately 2 minutes of distraction. The participant is then asked to recall the four objects. If one or more objects are not retrieved by free recall, the examiner provides the relevant semantic cue.

2.1.4 | Informant report

The informant is asked three questions from the Informant Questionnaire on Cognitive Decline (IQCODE)[22] regarding the cognitive functioning of the patient. Response options are "Unchanged," "A bit worse," and "Much worse." Informant report can either be administered by the examiner or self-administered.

The BASIC score is obtained by summing the scores of the four components into a composite score (range 0-25 points). In situations when reliable informant report cannot be obtained, a pro-rated BASIC score may be used (Supplementary Table 1).

2.2 | Participants

The study was carried out in accordance with the Code of Ethics of the World Medical Association for experiments involving humans (reference no. 17026283) and approved by the Danish Data Protection Agency (RH-2018-34). Written informed consent was obtained from all participants. The study involved a patient sample and a control sample both included between February and November 2018. Inclusion criteria for all participants were age ≥65 years and being fluent in Danish. Persons with impaired eyesight or hearing invalidating assessment were excluded.

One outpatient memory clinic from each of the five administrative regions of Denmark took part in the data collection. Further inclusion criteria for the patient sample were (a) a relevant informant (eg, relative) present at the examination and (b) referred from general practice for diagnostic evaluation. Other referrals (eg, second opinion and genetic counseling) were excluded. Patients were consecutively included at their initial memory clinic visit and administered a preliminary version of BASIC before diagnosis was available. Patients further underwent an extensive diagnostic work-up including a clinical interview involving accompanying informants, neurological and physical examination, brief cognitive tests and activities of daily living-scales, laboratory screening tests, and structural neuroimaging. Additional investigations such as lumbar puncture or positron emission tomography with ^{18}F-labeled fluorodeoxyglucose (^{18}F-FDG PET) neuroimaging were performed according to clinical indication. After completion of the diagnostic work-up, a multidisciplinary staff meeting led by senior specialists in neurology, psychiatry, or geriatrics blinded to BASIC results established a consensus diagnosis. Dementia was diagnosed according to National Institute of Aging and Alzheimer's Association (NIA-AA) workgroup criteria,[31] and clinical research criteria were used for specific subtypes of dementia disorders[32-34]. Mild cognitive impairment (MCI) was diagnosed according to revised Petersen criteria[35].

The control sample was recruited among participating patients' relatives (mainly spouses) and volunteers from ongoing research projects at the involved memory clinics. Accompanying relatives were informed about the study and asked if they would like to participate as healthy controls. Candidates for inclusion completed a comprehensive questionnaire

including medical history and use of medication and alcohol. Candidates with a history of neurological or psychiatric disease or alcohol consumption above recommended national levels were excluded. Remaining candidates were assessed with the MMSE and the 15-item Geriatric Depression Scale (GDS-15)[36]. Further exclusion criteria for the control sample were MMSE <24, and/or GDS-15 ≥6.

2.3 | Procedure

This was a prospective validation study in which patients were assessed with the preliminary version of BASIC at their initial memory clinic visit prior to diagnosis. In most cases, diagnosis was established 1 to 3 months later. At each site, the preliminary BASIC was administered by trained nurses or physicians. Administration was standardized across memory clinics. Informants concurrently completed a brief questionnaire containing the informant-directed questions. Control participants served as their own informants. Age, gender, and postsecondary education (type and approximate length of education exceeding compulsory education) were registered for all participants. Moreover, total years of education was registered for control participants.

2.4 | Data analysis

The significance of group differences on continuous variables was determined using the independent samples t-test. The significance of group differences in gender distribution was determined using the Pearson χ^2 test. Effect sizes were calculated as Hedges' g[37]. Discriminative validity was assessed by calculating sensitivity, specificity, and likelihood ratios using the clinical diagnosis of dementia as gold standard. The optimal balance between sensitivity and specificity for discrimination between groups was determined by Youden's J[38]. Receiver operating characteristic (ROC) curves for BASIC and MMSE were constructed, and the areas under the curve (AUC) were compared using the nonparametric approach by DeLong et al[39] for correlated ROC curves. Predictive validity was calculated according to Bayes' classical theorem[40]. Positive predictive validity (PPV) is essentially the proportion of individuals who screen positive at a given cutoff score and are later assigned a diagnosis of dementia, whereas negative predictive validity (NPV) is the proportion screening negative and being without dementia. PPV can also be interpreted as an estimate of the probability of dementia for individuals scoring positive according to a given cutoff, whereas NPV may work as an estimate of the probability of being without dementia for individuals scoring negative according to the cutoff. Possible effects of socio-demographical variables on BASIC performance were estimated by linear regression analysis with plots of residuals as model control. Associations between continuous variables were assessed using the Pearson product-moment correlation coefficient. Internal consistency of BASIC was determined by coefficient alpha as an approximation of scale reliability. Pro-rated BASIC score estimates were obtained by linear regression rounding the result to the closest integer.

An online clinical research calculator was used to calculate 95% confidence intervals (CI) for sensitivity, specificity, PPV, and NPV (www.vassarstats.net/clin1.html). For comparison of ROC curves, MedCalc statistical software was used (www.medcalc.org). All other analyses were performed with SPSS statistical software (version 19.0, SPSS Inc., Chicago, Ill., USA).

3 | RESULTS

Of 442 participants assessed, four dropped out prior to diagnosis, and 10 were excluded. Reasons for exclusion were (a) age < 65 years (nine participants) and (b) GDS-15 ≥ 6 (one control participant). Thus, 428 participants (293 cases and 135 controls) were eligible for inclusion. In the patient sample, 57% of the participants were diagnosed with dementia, 14% with MCI, and 29% with other, mainly neurological or psychiatric conditions. To minimize the possible impact of socio-demographic variables on the discriminative validity analyses, we selected three socio-demographically matched subsamples through stepwise exclusion of participants until statistically significant differences in age, education, and gender between the subsamples were suspended: (a) a dementia-only sample (n = 122), (b) a cognitively impaired sample including patients with dementia or MCI (n = 162), and (c) a matched control sample (n = 109). The dementia-only sample was a subsample of the cognitively impaired sample. Socio-demographic and cognitive characteristics of the matched samples are summarized in Table 2.

TABLE 2 Socio-demographic and cognitive participant characteristics

	Cognitively Impaired (Dementia or MCI)	Dementia	Controls
Number	162	122	109
Age (years)	75.7 (4.89)	76.2 (4.91)	75.1 (4.84)
Postsecondary education (years)	2.3 (1.51)	2.3 (1.49)	2.7 (1.49)
Gender (female/male)	83/79	72/50	65/44
MMSE	23.9 (4.44)	22.8 (4.27)	28.7 (1.54)
BASIC	14.6 (3.96) [a]	13.6 (3.58) [b]	23.4 (1.62)
CCMT	5.9 (2.13) [a]	5.5 (2.22) [b]	7.7 (.55)
Supermarket fluency	2.8 (1.41) [a]	2.5 (1.34) [b]	4.7 (.69)
Patient-directed questions	3.8 (1.46) [a]	3.8 (1.53) [b]	5.2 (.98)
Informant-directed questions	2.2 (1.69) [a]	1.8 (1.50) [b]	5.8 (.53)

Ages and scores are reported as mean and standard deviation.

[a]Cognitively impaired sample vs control sample comparison: $P < .001$ (two tailed).

[b]Dementia sample vs control sample comparison: $P < .001$ (two tailed).

Abbreviations: CCMT, Category Cued Memory Test; MMSE, Mini-Mental State Examination.

The distribution of diagnoses in the dementia sample was 55% Alzheimer's disease, 16% vascular dementia, 7% Lewy body dementia, 7% frontotemporal dementia, 4% mixed dementia, 4% dementia not otherwise specified, 3% Parkinson's disease dementia, 2% alcohol-related dementia, and 2% other causes of dementia. Significant differences with large effect sizes were present between the control and dementia samples on BASIC (t (229) = 26.61, P < .001, g = 3.50), Supermarket Fluency (t (229) = 15.50, P < .001, g = 2.04), CCMT (t (229) = 10.28, P < .001, g = 1.35), patient-directed questions (t (229) = 8.52, P < .001, g = 1.12), and informant-directed questions (t (229) = 26.46, P < .001, g = 3.47) (Table 2).

3.1 | Reliability

Coefficient alpha for BASIC (11 items) was .75.

3.2 | Discriminative validity

Using the AUC as a general index of discriminative validity, BASIC (AUC = 0.99) was highly accurate in differentiating patients with dementia from control participants (Figure 1). In comparison, the MMSE had an AUC of 0.92.

Pairwise comparison of ROC curves revealed that BASIC had significantly higher classification accuracy than the MMSE (z = 3.87, P < .001). Discriminative validity statistics for BASIC for identification of dementia at six different cutoff scores are presented in Table 3.

A cutoff score of 19/20 on BASIC provided optimal discrimination between the dementia and control group with very high specificity (0.98) and sensitivity (0.95). By comparison, in this sample the MMSE had high specificity (0.90) but moderate sensitivity (0.82) at an optimal cutoff score of 26/27, and very high specificity (1.00) but low sensitivity (0.53) at the commonly applied cutoff score of 23/24.

We repeated the discriminative validity analysis in the cognitively impaired sample (dementia and MCI). As expected, a differential reduction in discriminative validity was found. However, BASIC (AUC = 0.98) remained relatively accurate in differentiating between people with and without cognitive impairment whereas the discriminative validity of the MMSE (AUC = 0.86) was substantially attenuated (Figure 2).

TABLE 3 Classification accuracy of BASIC and MMSE for dementia at different cutoff scores

	Cutoff	Sensitivity (95% CI)	Specificity (95% CI)	LR+	LR−
BASIC	17/18	0.89 (0.82-0.94)	1.00 (0.96-1.00)	N/A	0.11
	18/19	0.93 (0.86-0.96)	0.99 (0.95-1.00)	101.89	0.07
	19/20[a]	0.95 (0.89-0.98)	0.98 (0.93-1.00)	52.30	0.05
	20/21	0.98 (0.94-1.00)	0.95 (0.90-0.98)	21.64	0.02
	21/22	0.99 (0.95-1.00)	0.88 (0.81-0.93)	8.39	0.01
	22/23	1.00 (0.96-1.00)	0.80 (0.72-0.86)	5.00	0.00
MMSE	23/24[b]	0.53 (0.43-0.63)	1.00 (0.96-1.00)	N/A	0.47
	26/27[a]	0.82 (0.73-0.88)	0.90 (0.82-0.95)	8.20	0.20

[a]Optimal cutoff score for discrimination between dementia group and control group.

[b]Commonly applied cutoff score for MMSE.

Abbreviations: CI, confidence interval; LR+, positive likelihood ratio; LR−, negative likelihood ratio; MMSE, Mini-Mental State Examination.

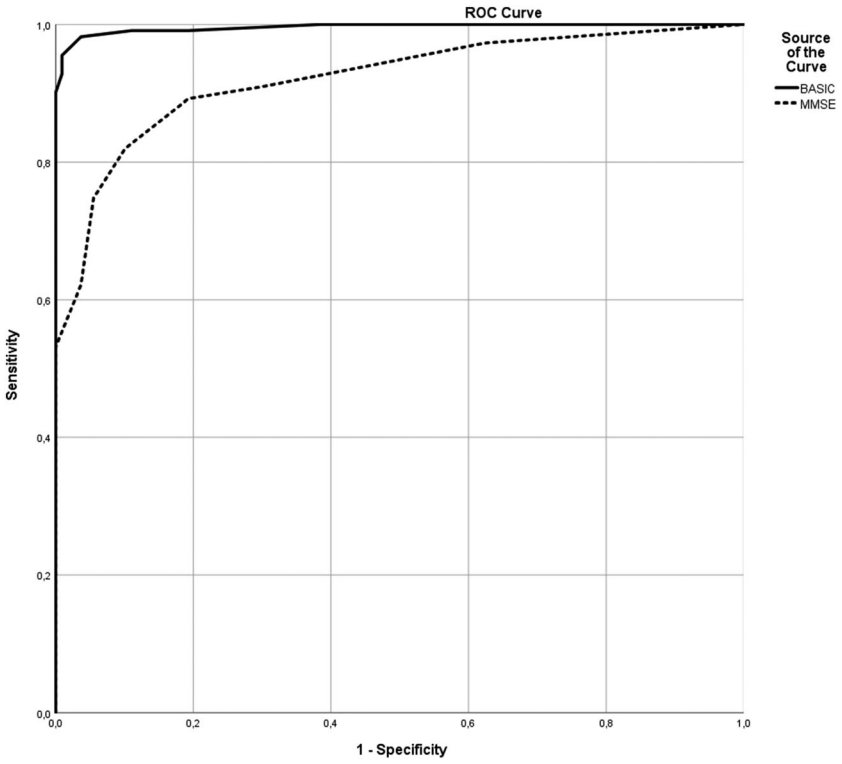

FIGURE 1 Receiver operating characteristics of BASIC as a case-finding tool for dementia. Areas under the ROC curve (AUC): BASIC = 0.99 (95% CI 0.98-1.00); MMSE = 0.92 (95% CI 0.88-0.96). Abbreviations: MMSE = Mini-Mental State Examination; CI = confidence interval.

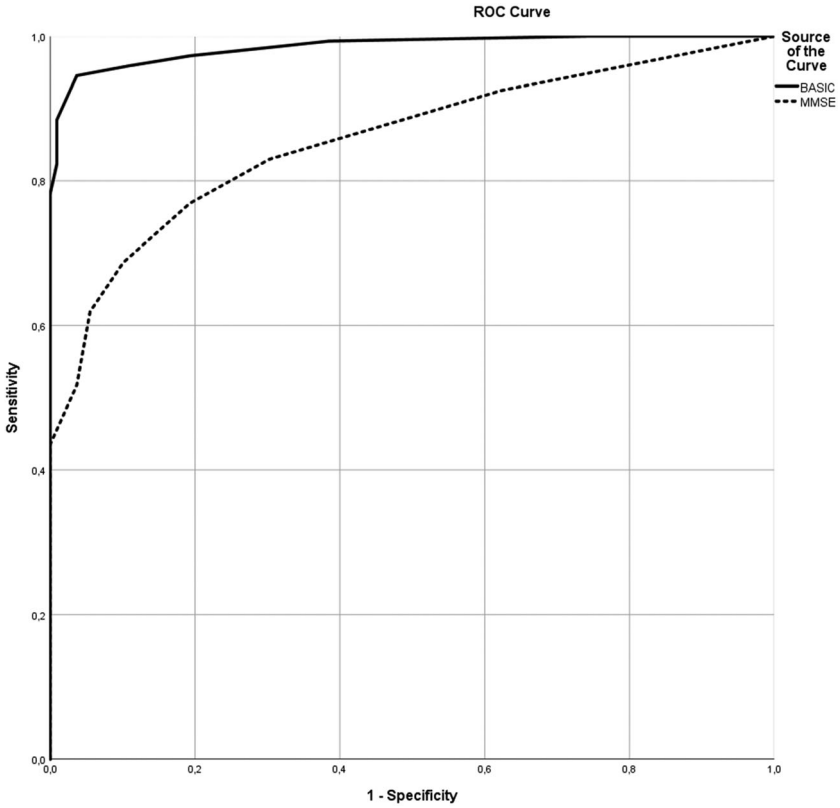

FIGURE 2 Receiver operating characteristics of BASIC as a case-finding tool for cognitive impairment. Areas under the ROC curve (AUC): BASIC = 0.98 (95% CI 0.97-1.00); MMSE = 0.86 (95% CI 0.81-0.90). Abbreviations: MMSE = Mini-Mental State Examination; CI = confidence interval.

Again, BASIC had significantly higher classification accuracy than the MMSE (z = 5.64, P < .001). A cutoff score of 20/21 on BASIC provides the optimal discrimination between the cognitively impaired group and the control group with high specificity (0.95) and sensitivity (0.95) (Supplementary Table 2). By comparison, the MMSE had moderate specificity (0.81) and sensitivity (0.76) at the optimal cutoff of 27/28, and very high specificity (1.00) but low sensitivity (0.43) at cutoff 23/24. The discriminative validity of pro-rated BASIC scores for dementia (AUC = 0.97) and cognitive impairment (AUC = 0.96) were high, although the full BASIC instrument performed significantly better than pro-rated scores (z = 3.27, P = .001, and z = 3.71, P < .001).

3.3 | Construct validity

Moderate correlations were found between the complete BASIC and the MMSE (r = .72, P < .001) (Supplementary Table 3). Also, significant correlations were found between BASIC and its four components. The weakest, but still robust, correlations were seen between patient-directed questions and other components of BASIC.

3.4 | Face validity

Interviews with five patient-informant dyads immediately after completion of BASIC indicated that questions and instructions were easily understood, and the instrument was perceived as relevant and non-confrontational. Interviews with six nurses involved in the data collection indicated that the instrument was easy to use and favorably received by patients and relatives.

3.5 | Impact of socio-demographic variables

Age and gender had a statistically significant but numerically small impact on BASIC score in the control sample, whereas years of education had no significant effect (Supplementary Table 4). Women slightly outperformed men by 0.7 points on BASIC. Years of education had a statistically significant but numerically small impact on Supermarket Fluency (unstandardized beta = .05, P = .005) but not on any of the other three BASIC components. Neither age nor gender had a statistically significant impact on any single BASIC component. Predicted BASIC scores for control participants were estimated by combining unstandardized beta coefficients from the regression model with the age, gender, and education of control participants using this formula: 26.181 − age × 0.058 + gender × 0.706 + total years of education × 0.036 (gender coded as female = 2, male = 1). Mean predicted score for the control sample was 23.2. The effect of age was −0.06 point per year accounting for approximately half a point difference between the predicted scores of, eg, a 70-year-old and an 80-year-old. We tentatively computed socio-demographically adjusted scores for the dementia sample based on a crude algorithm (one point was subtracted from the scores of women <75 years of age, and one point was added to the scores of men ≥80 years of age). This tentative adjustment, however, had no effect on classification accuracy.

4 | DISCUSSION

The present study developed and validated BASIC as a new, brief case-finding instrument for dementia in a memory clinic setting. The results indicate that the instrument has high discriminative validity in this setting and is easy to use, favorably received by patients and relatives, and can be administered in approximately 5 minutes. In comparison, the MMSE can be administered in 10 to 15 minutes. The present results substantiate that integrating brief cognitive testing, patient report, and informant report into one instrument produces higher discriminative validity than applying each element separately[14-17]. We recommend that the complete instrument is used as default option, but if reliable informant report cannot be obtained, pro-rated BASIC scores may be used. BASIC appears to be unaffected by education, and the impact of age and gender is too small to necessitate socio-demographical adjustment of observed scores in the examined age range.

The inclusion of patient report in BASIC may seem problematic as previous research has shown that patients with dementia lose insight with the progression of illness[41,42]. However, a prospective study investigating the utility of the CFI found that self-report was more reliably correlated than partner report with cognition earlier in the process of decline, whereas partner report became superior at later stages with development of anosognosia[23].

BASIC was validated in memory clinics using expert clinical diagnosis of dementia as gold standard. An excellent discriminative validity with a specificity of 0.98 and a sensitivity of 0.95 for dementia versus socio-demographically matched control participants was found. In comparison, the MMSE had a specificity of 0.90 and a sensitivity of 0.82. At the commonly applied 23/24 cutoff for MMSE, we found a sensitivity for dementia of only 0.53 which is lower than previously reported[43,44], possibly reflecting the fact that our sample was characterized by relatively mild dementia. Comparison of ROC curves confirmed that BASIC had significantly higher classification accuracy than MMSE. In a general practice setting, it may be relevant to identify patients with suspected cognitive impairment (not necessarily meeting criteria for dementia) for referral to specialist diagnostic services. We therefore extended the discriminative validity analysis to cognitive impairment (including both dementia and MCI). In this analysis, the discriminative validity of BASIC was only slightly reduced (AUC decreased from 0.99 to 0.98). In comparison, the discriminative validity of the MMSE diminished substantially (AUC decreased from 0.92 to 0.86).

Optimal cutoff scores for separation of patients with dementia or cognitive impairment from control participants are presented. However, optimal group separation is not the main question when evaluating the performance of an individual patient. In a clinical context, it is important to consider the probability of dementia and the probability of being cognitively intact associated with a given cutoff score. For this purpose, we present PPV and NPV estimates for a range of scores below and above the optimal cutoff (Table 4 and Supplementary Table 5).

TABLE 4 Predictive validity estimates at different cutoff scores and base rates of dementia

		Base Rate 5%		Base Rate 10%		Base Rate 25%		Base Rate 50%	
	Cutoff	PPV (95% CI)	NPV (95% CI)	PPV (95% CI)	NPV (95% CI)	PPV (95% CI)	NPV (95% CI)	PPV (95% CI)	NPV (95% CI)
BASIC	17/18	1.00 (0.96-1.00)	0.99 (0.99-1.00)	1.00 (0.96-1.00)	0.99 (0.98-0.99)	1.00 (0.96-1.00)	0.97 (0.94-0.98)	1.00 (0.96-1.00)	0.90 (0.84-0.95)
	18/19	0.84 (0.77-0.90)	1.00 (0.99-1.00)	0.92 (0.85-0.96)	0.99 (0.98-1.00)	0.97 (0.92-0.99)	0.98 (0.95-0.99)	0.99 (0.94-1.00)	0.93 (0.87-0.97)
	19/20[a]	0.74 (0.66-0.80)	1.00 (0.99-1.00)	0.85 (0.78-0.91)	0.99 (0.99-1.00)	0.95 (0.89-0.98)	0.98 (0.96-0.99)	0.98 (0.93-1.00)	0.95 (0.89-0.98)
	20/21	0.54 (0.47-0.60)	1.00 (1.00-1.00)	0.71 (0.63-0.77)	1.00 (0.99-1.00)	0.88 (0.81-0.93)	0.99 (0.98-1.00)	0.96 (0.90-0.98)	0.98 (0.93-1.00)
	21/22	0.31 (0.26-0.36)	1.00 (1.00-1.00)	0.48 (0.42-0.55)	1.00 (0.99-1.00)	0.74 (0.66-0.80)	1.00 (0.98-1.00)	0.89 (0.83-0.94)	0.99 (0.94-1.00)
	22/23	0.21 (0.18-0.25)	1.00 (1.00-1.00)	0.36 (0.31-0.41)	1.00 (0.99-1.00)	0.63 (0.55-0.69)	1.00 (0.98-1.00)	0.83 (0.76-0.89)	1.00 (0.95-1.00)
MMSE	23/24[b]	1.00 (0.92-1.00)	0.98 (0.97-0.98)	1.00 (0.92-1.00)	0.95 (0.93-0.96)	1.00 (0.92-1.00)	0.86 (0.83-0.90)	1.00 (0.92-1.00)	0.68 (0.60-0.75)
	26/27[a]	0.30 (0.25-0.36)	0.99 (0.98-0.99)	0.48 (0.41-0.55)	0.98 (0.97-0.99)	0.73 (0.64-0.81)	0.94 (0.90-0.96)	0.89 (0.81-0.94)	0.83 (0.75-0.89)

[a]Optimal cutoff score for discrimination between dementia group and control group.

[b]Commonly applied cutoff score for MMSE.

Abbreviations: CI, confidence interval; MMSE, Mini-Mental State Examination; NPV, negative predictive validity; PPV, positive predictive validity.

Predictive validity estimates are affected by the base rate of dementia in the given setting. In a high base rate setting, such as a memory clinic (base rate 50% or higher), neither PPV nor NPV for BASIC seems to be a challenge. But in a low base rate setting, PPV is relatively attenuated due to a higher proportion of false positive cases. For instance, in a 5% to 10% base rate setting, a BASIC cutoff score of 18/19 instead of 19/20 may be considered in order to ensure a high PPV. The fact that the case mix in general practice and primary care differs from memory clinics is likely to affect the performance of BASIC in these settings. To clarify this, further validation is needed.

Among the strengths of the present study is the prospective design with patients referred from general practice being undiagnosed at the time of testing. As BASIC had no influence on subsequent clinical diagnosis, the risk of circular evidence was low. The fact that the conditions of interest—dementia and cognitive impairment—are clinically defined conditions seems to justify the use of expert clinical diagnosis (rather than, eg, biomarker-based algorithms) as gold standard. Another strength is the geographical distribution of the sample involving all administrative regions in Denmark.

Among the limitations of the study is the fact that the results apply primarily to a memory clinic setting.

Our sample is probably representative for patients referred from general practice at their initial memory clinic visit, but not necessarily for other patient groups or settings. Thus, the generalizability of the findings to general practice or primary care is unknown, and future studies are needed to cross-validate BASIC in these settings. The items that constitute BASIC were selected in order to optimize the discriminative validity of the instrument in the current sample, but it is possible that an item analysis based on a more heterogeneous sample may have identified a different combination of discriminative items.

Reliability has not been properly assessed using a test-retest design. Coefficient alpha is presented as an approximation of scale reliability, but there is not necessarily a strong association between internal consistency and the temporal stability of an instrument composed of relatively independent items. Further, because BASIC is a short scale (11 items), alpha may not be an optimal reliability measure. However, previous research indicates that the components of BASIC are reliable[25,30]. Except for the interval scoring of Supermarket Fluency, the BASIC composite score was based on summing up unweighted component scores. Although more refined methods may have been used, the high intercorrelation between most BASIC components makes unweighted summations of components a valid and straightforward method that is easily applied in a clinical setting[45].

Although we aimed at creating an instrument relatively free of impact from socio-demographic variables, a further refinement of BASIC would require analyses of differential item or test functioning. For instance, it is possible that Supermarket Fluency in other populations may show differential functioning depending on, eg, gender role. However, in a recent cross-cultural study of middle-aged and elderly Europeans, no influence of gender on Supermarket Fluency was found[46]. Future studies should examine the ability of BASIC to identify Alzheimer's disease dementia versus non-Alzheimer's dementia, as well as the instrument's ability to monitor cognitive decline during disease progression.

5 | CONCLUSION

The present study suggests that BASIC meets criteria for an accurate, time-saving, and easy-to-use routine case-finding instrument. The instrument appears to be sensitive and highly specific for identification of dementia and cognitive impairment in patients referred for diagnostic evaluation in a memory clinic. By making BASIC available for clinicians and noncommercial research without copyright restrictions, we hope to facilitate quicker and more accurate identification of dementia and cognitive impairment in clinical settings enabling a higher proportion of patients with dementia to receive a timely diagnosis providing access to care and management. It is important to note, though, that BASIC can never substitute a full clinical evaluation. A diagnosis of dementia or cognitive impairment cannot be based solely on a brief case-finding instrument.

Data Availability Statement

The data that support the findings of this study are available on request from the corresponding author. The data are not publicly available due to privacy or ethical restrictions.

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AUTHORS' CONTRIBUTIONS

Gunhild Waldemar, Frans Boch Waldorff, Kasper Jørgensen, and Ann Nielsen designed the study. Ann Nielsen and Kasper Jørgensen coordinated the data collection. Kasper Jørgensen and T. Rune Nielsen developed the BASIC, analyzed the data, and drafted the initial version of the manuscript. All authors contributed to revision and editing of the article.

CONFLICTS OF INTEREST

The authors have no conflicts of interest.

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SUPPORTING INFORMATION

Additional supporting information may be found online in the Supporting Information section at the end of the article.

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