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Neuropsychological Correlates of the Alzheimer's Questionnaire

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Abstract

Informant-based assessments of cognition and function are commonly used to differentiate individuals with amnestic mild cognitive impairment (aMCI) and Alzheimer's disease (AD) front those who are cognitively normal. However, determining the extent to which informant-based measures correlate to objective neuropsychological tests is important given the widespread use of neuropsychological tests in making clinical diagnoses of aMCI and AD. The aim of the current study is to determine how well the Alzheimer's Questionnaire (AQ) correlates with objective neuropsychological tests. The study utilized data from 300 individuals participating in a brain and body donation program. Individuals diagnosed with aMCI ($n = 83$) and AD ($n = 67$) were matched oil age, gender, and education to a control individual ($n = 150$). The average age for the entire sample was 83.52 ± 6.51 years with an average education level of 14.57 ± 2.55 years. Results showed that the AQ correlated strongly with the Mini-Mental State Exam ($r = -0.71$, $p < 0.001$) and the Mattis Dementia Rating Scale-2 ($r = -0.72$, $p < 0.001$), and moderate correlations were noted for the AQ with memory function (Rey Auditory Verbal Learning Test Delayed Recall, $r = -0.61$, $p < 0.001$) and executive function (Trails B, $r = 0.53$, $p < 0.001$). The findings of this study suggest that the AQ correlates well with several neuropsychological tests and lend further support to the validity of the AQ as a screening instrument for cognitive impairment.

Keywords

Alzheimer's disease; dementia; mild cognitive impairment; neuropsychology

INTRODUCTION

As the prevalence of Alzheimer's disease (AD) continues to increase [1], so too does the need for a brief and accurate informant-based screening tool for the detection of AD and amnestic mild cognitive impairment (aMCI). Informant-based questionnaires are commonly used in both clinical and research settings for the purpose of differentiating aMCI and AD individuals from those who are cognitively normal (CN) [2, 3]. The Informant Questionnaire

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on Cognitive Decline in the Elderly (IQCODE) and AD8 have demonstrated good diagnostic accuracy for AD and have been found to correlate well with other conventional cognitive screening tests, such as the Mini-Mental State Examination (MMSE) [4, 5]. However, these measures may not accurately identify aMCI individuals.

The Alzheimer's Questionnaire (AQ) is a 21-item, informant-based assessment designed for ease of use in the clinical setting that has demonstrated high sensitivity and specificity for both aMCI and AD [6, 7]. The concurrent validity of the AQ with other established measures of cognition was demonstrated by Malek-Ahmadi et al. [8] who found that the AQ correlates strongly with the Clinical Dementia Rating Sum of Boxes ($r = 0.79$) and moderately with the MMSE ($r = -0.56$) and Montreal Cognitive Assessment (MoCA) ($r = -0.46$).

Although the diagnostic accuracy and concurrent validity of the AQ have been established [6–8], the degree to which the AQ is associated with neuropsychological and cognitive screening tests has not been investigated. Since neuropsychological tests are utilized in making clinical diagnoses of aMCI and AD, determining the extent to which the AQ correlates with objective and specific measures of various cognitive domains is needed in order further validate its ability to detect cognitive changes associate with aMCI and AD. This study will determine the extent to which the AQ correlates with performance-based neuropsychological tests commonly used in clinical settings, as well as its correlation with other cognitive screening instruments.

METHODS

Study sample

Data from 300 individuals participating in the Banner Sun Health Research Institute (BSHRI) Brain and Body Donation Program were utilized for this study [9]. Participants in this program are recruited predominantly from the northwest region of the Phoenix, Arizona metropolitan area and are recruited from a variety of sources (clinic referral, community advertisement, talks in the community given by clinicians, word-of-mouth referral from current participants). Written informed consent, approved by the (BSHRI) Institutional Review Board, was obtained from all subjects. Each subject with aMCI or AD was matched on age, education, and gender to a CN individual, without replacement. When an exact match could not be found, a tolerance of ± 2 years was used for age and education in order to obtain an approximate match.

Both single and multiple domain aMCI cases were categorized as aMCI. Amnestic MCI cases were diagnosed using Petersen criteria [10] and were considered to be aMCI due to AD. The AD cases met N1NCDS-ADRDA criteria for a clinical diagnosis of probable or possible AD [11]. The CN cases were defined as having no limitations of activities of daily living by informant report, were within normal limits on neuropsychological testing, and did not receive a clinical diagnosis of any cognitive disorder. Informants for all individuals were a spouse/significant other, a child, or a friend with frequent and close contact to the individual.

Consensus diagnoses were made by the study physician and neuropsychologist based on neuropsychological testing results, neurological and physical exam findings, and interviews with the subject and an informant that assessed global cognition, functional status, and mood and behavioral status. The AQ was not utilized in making the consensus diagnoses and is utilized as a measure independent of diagnosis for research purposes, The AQ was administered and scored in a manner that was blinded from neuropsychological assessments in order to avoid bias.

Instruments

Alzheimer's questionnaire [7]—The AQ is a 21-item, informant-based dementia screening assessment designed for ease of use in a primary care setting. AQ items are divided into the following five domains: Memory, Orientation. Functional Ability, Visuospatial Ability, and Language. Items are posed in a yes/no formal with the count of 'yes' responses equaling the total AQ score (0–27). For the AQ, higher scores indicate greater impairment. Six items known to be predictive of a clinical AD diagnosis are weighted more heavily and are worth two points each.

Mini-mental state examination [12]—The MMSE is a brief, 30-poinl cognitive screening instrument that includes items measuring Orientation, Memory, Language, Attention, and Visuospatial functions.

Montreal cognitive assessment [13]—The MoCA is a brief, 30-point cognitive screening instrument that assesses cognitive domains including Attention and Concentration, Executive Functions, Memory, Language, Visuoconstructional Skills, Conceptual Thinking, Calculations, and Orientation.

Mattis dementia rating scale-2 (DRS-2) [14]—The DRS-2 is a widely-utilized, structured assessment of cognitive function. The instrument has five subscales: Attention, Initiation/Perseveration, Construction, Conceptualization, and Memory, with the subscales used to derive a total score. For this study, only the total score was used for the analyses.

Clock drawing test [15]—For this test, individuals are given a blank sheet of paper and asked to draw the face of a clock and to set the time to ten past eleven. A 10-point scoring system [15] was used which is based on three components: Integrity of Clock Face (0–2 points), Presence and Sequencing of Numbers (0–4 points), Presence and Placement of Hands (0–4 points).

Rey auditory verbal learning test (AVLT) [16]—A list of 15 words is read aloud to the individual, after which they are asked to recall as many words as possible in any order, for a total of 5 repeated trials. After the fifth trial, a new, distractor, 15-word list is read aloud to the individual, from which they recall as many words as possible. They are asked to recall the words they remember from the initial list after the distractor list and once more after a 20-minute delay. AVLT Total is the sum of the number of correctly recalled words for Trials 1–5. AVLT Delayed Recall is the number of correct words recalled after a 20-minute delay.

Brief visuospatial memory test-revised (BVMT-R) [17]—The BVMT-R is a test of visuospatial memory in which subjects are presented with a page containing six unique designs for 10 seconds. After the 10-second presentation, subjects are asked to draw the shapes on a blank page. Three such 10-second learning trials are administered, and after a del ay of 20 to 25 minutes, subjects are asked to draw the shapes again on a blank page. BVMT-R Total Score is the sum of points from the three learning trials while the BVMT-R Delayed Recall is the number of points from the delayed recall trial.

Trails A [18]—During this test, the individual is instructed to draw a line that connects circled numbers in consecutive order.

Trails B [18]—The individual is asked to draw a line that connects circled numbers and circled letters in consecutive order while alternating between numbers and letters (1 – A – 2 – B – 3 – C, etc.).

Digit span forward [19]—Number sequences of increasing length are read aloud to the participant, after which the number series is repealed back to the examiner.

Digit span backward [19]—Number sequences are read aloud to the participant, after which the number series is repeated back to the examiner in reverse order.

Controlled oral word association test (COWAT) [20]—Individuals are given one minute to say out loud as many words as they can that begin with a specified letter.

Animal fluency [20]—For this test, individuals are given one minute to say out loud as many names of animals as they can.

Stroop color/word [21]—The individual is presented with 5 columns of the words “blue”, “red”, and “green” presented in random order. The words are printed in an ink that is incongruent with the actual word itself (e.g., the word “blue” is printed in red ink). The individual is then asked to identify the color of the ink of the printed word. There is a 45-second lime limit in which the individual must give as many correct responses as possible.

Judgment of line orientation (JLO) [22]—Individuals are asked to match a set of two lines, set at varying angles and lengths, to their respective reference lines located below each stimulus card.

Block design [23]—Subjects manipulate a set of colored blocks to create a design matching the stimulus design.

Boston naming test 30-item (BNT) [24]—The BNT consists of 30 line drawings of objects shown individually to the subject, who is asked to name the object.

Geriatric depression scale (GDS) [25]—The GDS is a 30-item depression screening questionnaire designed for older adults.

Statistical analysis

For the demographic variables, Chi-square analysis was used to examine the distribution of males and females among the three groups while the Kruskall-Wallis test was used to determine whether age and education differed significantly between groups. The Shapiro-Wilk test was used to determine whether the AQ and the individual neuropsychological variables were normally distributed. Since the neuropsychological variables and the AQ did not meet the assumption of normality, Spearman correlation analyses were carried out to assess the linear associations between the AQ and the neuropsychological measures. Correlation values were interpreted as weak (0.00–0.39), moderate (0.40–0.69), or strong (0.70–1.00). Data for DRS-2 and Block Design were only available from smaller subsets of the study sample (DRS-2, $n = 79$; Block Design, $n = 55$). In order to minimize the impact of floor and ceiling effects from the AD and CN groups on neuropsychological tests, the CN, aMCI, and AD groups were analyzed together. This also allowed for the relationship between the AQ and the individual cognitive tests to be assessed on a continuum of cognitive impairment.

The percentage of variance accounted by each cognitive test in AQ score was determined by using robust least median of squares regression models with AQ score as the outcome and cognitive test as the predictor. Each test was modelled independently in order to obtain a R^2 value that was unique to each of the tests.

The additional predictive value of the AQ in aMCI for a select subset of tests was assessed through a series of logistic regression models. The first series of models used only the cognitive test score as predictor with CN/aMCI as the outcome. A second series of models included the AQ score along with the cognitive test. Area under the curve (AUC) values between the first and second models were compared in order to determine if the AQ added a significant amount diagnostic accuracy when combined with a cognitive test. All models included the GDS score in order to account for the effect of depressive symptoms on cognitive performance.

Statistical analyses were carried out using Systat 12.0 (Systat, Inc., San Jose, CA).

RESULTS

The sample for this study ranged in age from 67 to 99 years, with a mean of 83.52 ± 6.51 and a mean educational level of 14.57 ± 2.55 years. The sample included 163 females and 137 males. Of the 300 subjects, 150 were classified as CN, 83 were classified as aMCI, and 67 were classified as AD. Demographic characteristics and results of the neuropsychological tests for each of the clinical groups are reported in Table 1. The groups were not significantly different in terms of age ($p = 0.99$) or education ($p = 0.33$). The Chi-square analysis indicated that there was no significant difference in the distribution of males and females among the three clinical groups ($p = 0.90$).

Correlations between the AQ and the individual cognitive measures are shown in Table 2. Each cognitive test was grouped according to its respective domain of assessment (General Cognition: DRS-2, MoCA, MMSE, Clock; Memory: AVLT and BVMT; Executive Function:

Trails B, COWAT, Stroop Color/Word; Language: BNT and Animal Fluency; Attention: Trails A, Digit Span Forward, Digit Span Backward; Visuospatial: JLO and Block Design).

The AQ correlated strongly with DRS-2 Total ($r = -0.72$) and the MMSE (−0.71). The AQ showed a moderate correlation with the MoCA ($r = -0.68$) and a weak correlation with Clock Draw ($r = -0.32$). The AQ also demonstrated moderate correlations with measures of memory and executive function, as lower performance on the memory measures was associated with greater reported impairment on the AQ. For the measures of attention, the AQ correlated moderately with Trails-A, but demonstrated weak correlations with Digit Span Forward and Digit Span Backward. Both language measures also correlated moderately with the AQ. For visuospatial function, the JLO demonstrated a weak correlation with the AQ while Block Design demonstrated no correlation as the correlation value was not statistically significant. Measures of general cognition, memory, and executive function each accounted for a substantial proportion of variance in the AQ score.

Analyses showing the added diagnostic value of the AQ with select cognitive tests are shown in Table 4. For these analyses, we selected measures of general cognition delayed recall memory measures as they are often used independently to differentiate clinical groups while many of the other domain-specific cognitive tests are often used in a broader diagnostic framework and interpreted in relation to other tests. We chose to limit our analyses to CN versus aMCI cases as they would provide the most informative classification data given that aMCI/AD research has shifted toward identifying individuals in the pre-clinical stages of the disease. On its own, the AQ demonstrated good diagnostic accuracy for aMCI (AUC = 0.83, 95% CI: (0.77, 0.88)). When used in combination with different cognitive tests, the only test which showed significant benefit of the AQ's addition was the MMSE as the AUC value significantly improved.

The association statistics for the GDS as it was used in the logistic regression models are shown in Table 5. For all of the models, no significant association was present.

DISCUSSION

The results of this study demonstrate that the AQ, an informant-based assessment, correlates well with several performance-based neuropsychological and cognitive screening tests commonly used in clinical settings. The AQ correlates most strongly with the DRS-2, MMSE, and the MoCA. In the current study, the AQ demonstrated stronger correlations with the MoCA and MMSE than those reported previously (MMSE, $r = -0.56$; MoCA, $r = -0.46$) [8], possibly due to the larger sample size of the current study. The use of a larger sample size allows for more a precise interpretation of the AQ's correlation with performance-based neuropsychological and screening tests which strengthens its validity as an informant-based assessment that can be applied and utilized in clinical settings.

Other studies investigating the correlation between informant-based screening measures and objective cognitive tests have found that the AD8 is moderately correlated with the MMSE ($r = -0.41$, $r = -0.64$) [4, 26], while the reported correlation values for the IQCODE and MMSE have varied widely ($r = -0.37$ to $r = -0.78$) [5]. Galvin et al. [4] reported that the

AD8 demonstrated weak correlations with neuropsychological tests of specific domains such as memory (WMS Logical Memory, $r = -0.38$ and 10-Item Word List, $r = -0.39$) and language (Animal Fluency, $r = -0.05$ and BNT, $r = -0.02$); however, executive function measures (Trails-B, $r = 0.47$ and Digit Symbol, $r = -0.52$) demonstrated moderate correlations with the AD8. Jorm [5] reported on the findings of several studies showing weak correlations between the IQCODE and several neuropsychological measures (WMS Logical Memory, $r = -0.42$; AVLT, $r = -0.35$; Block Design, $r = -0.28$; and Digit Span, $r = -0.27$).

Like the AD8 and IQCODE, the AQ demonstrated some weak correlations with several neuropsychological tests examining specific domains; however, several moderate correlations were also noted, particularly with measures of memory and executive function. Given that decreased memory and dual processing skills are hallmark features that direct a clinician to a diagnosis of AD, these results suggest that the AQ is accurately assessing AD-specific cognitive declines. Weak correlations' between informant-reported measures and domain-specific neuropsychological tests may be expected to some extent given that informant-based measures often contain items spanning several cognitive domains. Thus, the lack of overlap in the constructs measured by broad informant-based and domain-specific neuropsychological measures may explain weak correlations between these assessment types. Additionally, as some of these domains, such as visuospatial, are not typically expected to have significant involvement in AD, one would expect the AQ to have lower correlations with these domains than the domains with declines more strongly associated with AD, such as memory and executive function.

There was considerable heterogeneity in the amount of variance accounted for in each neuropsychological test by the AQ as it accounted for most variability in the memory and executive function domains. Even with a relatively large amount of variance accounted for in these domains, a fair amount of variance remained unaccounted for. Since the AQ is an informant-based screening measure, it is inevitable that other sources of variability that underlie cognitive impairment, such as age and education, will not be captured. Within the context of screening one would not expect the AQ to fully predict impairment in specific domains nor would it be expected that the AQ be completely concordant with a specific diagnosis. The weak and moderate correlations with domain-specific neuropsychological tests may also be due to structure of the measure, as some AQ domains contain more items than others and are thus represented more heavily than others within the AQ total score. The AQ contains several items relating to memory, orientation, and functional ability, but only a few items relating to language and visuospatial domains. This might explain the moderate correlations found for the neuropsychological tests of memory and executive function and the weak correlations with visuospatial tests. However, the imbalance of items within the AQ is due to its initial conceptualization as an instrument designed to detect symptoms associated with aMCI and AD [6, 7], which tend to be concentrated in the areas of memory and executive function.

Another important consideration is that the AQ relies heavily on reported functional status in activities of daily life. Difficulties noted by family members may not emerge on neuropsychological instruments administered in a more controlled testing environment,

which may impact the strength of the correlations between the AQ and neuropsychological measures. However, the moderate and strong correlations in this study provide evidence that informant-reported symptoms on the AQ correspond well to the results of performance-based cognitive assessments. It is interesting to note that the AQ did not significantly improve diagnostic accuracy when combined with other cognitive tests. The exception to this was the MMSE where the AUC value improved significantly when the AQ was added to die prediction model. Given that the MMSE is still one of the most widely-used cognitive screening instruments, using the AQ in conjunction with the MMSE may helpful in accurately identifying aMCI cases. Although the addition of the AQ did not significantly improve the diagnostic accuracy of the other instruments, having information from the AQ may be helpful in cases where individuals are demonstrating impairment in daily function but are performing within normal limits on cognitive tests [27]. Rizk-Jackson et al. [28] found that functional decline among cognitively normal individuals may precede cognitive decline in the process of converting to aMCI. Juva and Sulkava [29] reported a case-study in which an individual demonstrated significant functional impairment, but whose cognitive testing was within normal limits. They also note that cognitive screening measures may be insensitive cognitive changes in atypical presentations of AD and that these measures may not be able to detect impairment in individuals with high levels of education.

While the large sample size was able to add strength to the correlations, one weakness of the study is the ethnically homogenous sample with a majority of participants in the study identifying as while. It is therefore unclear if these results are generalizable to more ethnically diverse populations. Another potential limitation lies in the cross-sectional design of the study as it is unclear whether longitudinal changes in the AQ correspond with longitudinal changes in the neuropsychological tests.

The results of this study provide further evidence to support the validity of the AQ as an instrument for detecting cognitive impairment associated with aMCT and AD. In particular, the AQ demonstrated moderate correlations with memory and executive function measures which shows that the AQ can reasonably assess cognitive impairment demonstrated on standard neuropsychological measures. Given the AQ's ease of use and short duration of administration, the results of this study also demonstrate that it could provide a great deal of value to general and geriatric practitioners who desire a screening instrument that is highly predictive of aMCI and AD.

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Table 1

Demographic Characteristics and neuropsychological data

	CN	aMCI	AD	Total	*p*-value
n	150	83	67	300	–
Age	83.45±6.49	83.59±6.66	83.56±6.44	83.52±6.51	0.99
Education	14.57±2.50	14.88±2.62	14.18±2.58	14.57±2.55	0.33
Gender (M/F)	82/68	44/39	38/29	164/136	0.90
GDS	4 [1, 7]	3 [2, 7]	5 [2, 8]	–	0.18
AQ	0 [0, 2]	10 [3, 13.75]	22 [19, 27]	–	–
MMSE	29 [27, 30]	27 [24, 28]	19 [14, 22]	–	–
MoCA	26 [24, 28]	21.50 [19, 23]	14 [9.75, 18.25]	–	–
DRS-2	140 [134, 141]	128 [126, 134]	102 [70, 123]	–	–
Clock Draw	10 [9, 10]	9 [8, 10]	8 [5, 9]	–	–
AVLT Total	40.50 [33, 50]	27 [21, 31]	19 [15, 23]	–	–
AVLT Delayed Recall	8 [5, 11]	2 [0, 3]	0 [0, 0]	–	–
BVMT-R Total	16 [11, 22]	8 [5, 10]	4 [1, 5.25]	–	–
BVMT-R Delayed Recall	7 [5, 9]	3 [1, 4]	0 [0, 1]	–	–
Trails B	93 [73, 123]	159 [119.25, 221]	300 [219, 300]	–	–
Stroop Color/Word	30 [23, 37]	21 [15.25, 29]	15 [8, 24.50]	–	–
COWAT	36 [31, 45]	29 [23, 39]	24 [15, 37.25]	–	–
Trails A	37 [30, 46.50]	52 [40, 62]	74.50 [55, 123]	–	–
Digit Span Forward	8 [6, 9]	8 [6, 9]	7 [5.25, 8]	–	–
Digit Span Backward	6 [5, 8]	5 [4, 6]	4 [3, 5]	–	–
BNT	27 [25, 28]	25 [23, 27]	21 [17, 23]	–	–
Animal Fluency	17 [14, 20]	13 [11, 16]	8 [6, 12]	–	–
Block Design	29 [24, 34]	26 [16, 32]	20 [16, 24]	–	–
JLO	24 [20, 27]	21 [18, 23.75]	20 [16, 24]	–	–

Mean±standard deviation. Median [interquartile range].

Table 2

Correlation values for neuropsychological tests with the AQ

Domain	Test	Correlation with AQ	*p*-value	R^2
General Cognition				
	MMSE	−0.71	<0.001	0.63
	MoCA	−0.68	<0.001	0.57
	DRS-2	−0.72	<0.001	0.71
	Clock Draw	−0.38	<0.001	0.31
Memory				
	AVLT Total	−0.62	<0.001	0.44
	AVLT Delayed Recall	−0.61	<0.001	0.43
	BVMT-R Total	−0.61	<0.001	0.41
	BVMT-R Delayed Recall	−0.65	<0.001	0.49
Executive Function				
	Trails B	0.53	<0.001	0.52
	Stroop Color/Word	−0.51	<0.001	0.32
	COWAT	−0.27	<0.001	0.11
Attention				
	Trails A	0.52	<0.001	0.41
	Digit Span Forward	−0.21	<0.001	0.06
	Digit Span Backward	−0.37	<0.001	0.18
Language				
	BNT	−0.44	<0.001	0.14
	Animal Fluency	−0.56	<0.001	0.41
Visuospatial				
	Block Design	−0.24	0.08	–
	JLO	−0.28	<0.001	0.11

R^2 value derived from least median of squares regression model; R^2 for Block Design could not be derived to a large number of missing AD cases.

Table 3

Within-group correlation values for neuropsychological tests with the AQ

Domain	Test	CN	aMCI	AD
General Cognition				
	MMSE	0.15	−0.82	−0.34
	MoCA	−0.28	0.37	−0.12
	DRS-2	−0.31	−0.26	−0.61
	Clock Draw	0.29	0.30	−0.37
Memory				
	AVLT Total	−0.22	0.12	−0.03
	AVLT Delayed Recall	−0.04	0.46	−0.02
	BVMT-R Total	−0.48	−0.17	−0.34
	BVMT-R Delayed Recall	−0.60	0.31	−0.05
Executive Function				
	Trails B	0.09	−0.29	0.41
	Stroop Color/Word	−0.34	−0.55	−0.3l
	COWAT	−0.39	0.20	0.03
Attention				
	Trails A	−0.01	0.35	0.23
	Digit Span Forward	0.03	−0.19	−0.36
	Digit Span Backward	−0.13	0.06	−0.30
Language				
	BNT	0.10	0.20	−0.30
	Animal Fluency	−0.25	−0.23	0.09
Visuospatial				
	Block Design	0.05	−0.20	***
	JLO	0.04	−0.06	−0.20

Table 4

Additional diagnostic accuracy of select cognitive tests with AQ in aMCI cases

	Test only	Test with AQ	*p*-value
AQ	AUC = 0.83 95% CI: (0.77, 0.88)	na	na
DRS-2 Total	AUC = 0.90 95% CI: (0.80, 0.96)	AUC = 0.94 95% CI: (0.86, 0.99)	0.46
MMSE	AUC = 0.79 95% CI: (0.73, 0.85)	AUC = 0.88 95% CI: (0.83, 0.92)	0.02
MoCA	AUC = 0.87 95% CI: (0.80, 0.92)	AUC = 0.9095% CI: (0.85, 0.95)	0.43
AVLT Delayed Recall	AUC = 0.94 95% CI: (0.90, 0.97)	AUC = 0.97 95% CI: (0.94, 0.99)	0.13
BVMT-R Delayed Recall	AUC = 0.87 95% CI: (0.82, 0.91)	AUC = 0.91 95% CI: (0.86, 0.94)	0.21

AUC, Area Under the Curve; 95% CI, 95% Confidence Interval; AQ, Alzheimer's Questionnaire; DRS-2, Dementia Rating Scale; MMSE, Mini-Mental State Exam; MoCA, Montreal Cognitive Assessment; AVLT, Auditory Verbal Learning Test; BVMT-R, Brief Visuospatial Memory Test.

Table 5

Association statistics for the GDS covariate in the diagnostic accuracy models

	Test only	Test with AQ
AQ	OR = 1.01 95% CI: (0.94, 1.09) *p* = 0.77	na
DRS-2 Total	OR = 1.08 95% CI: (0.86, 1.37) *p* = 0.49	OR = 1.06 95% CI: (0.82, 1.38) *p* = 0.65
MMSE	OR = 1.05 95% CI: (0.98, 1.11) *p* = 0.17	OR = 1.01 95% CI: (0.93, 1.09) *p* = 0.83
MoCA	OR = 1.00 95% CI: (0.92, 1.08) *p* = 0.98	OR = 0.99 95% CI: (0.90, 1.09) *p* = 0.79
AVLT Delayed Recall	OR = 0.98 95% CI: (0.90, 1.06) *p* = 0.61	OR = 0.93 95% CI: (0.84, 1.02) *p* = 0.13
BVMT-R Delayed Recall	OR = 1.05 95% CI: (0.98, 1.13) *p* = 0.14	OR = 1.02 95% CI: (0.94, 1.11) *p* = 0.59

OR, Odds Ratio; 95% CI, 95% Confidence Interval; p, *p*-value; AQ, Alzheimer's Questionnaire; DRS-2, Dementia Rating Scale; MMSE, Mini-Mental State Exam; MoCA, Montreal Cognitive Assessment; AVLT, Auditory Verbal Learning Test; BVMT-R, Brief Visuospatial Memory Test.