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Psychometric Properties of a Neuropsychological Assessment Scale for Diagnosing Alzheimer's Disease in the Illiterate and Low-Educated Subjects in Iran

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Abstract

Objective: Because of changes in the population structure over time, dementia is one of the main concerns of the health systems worldwide. Screening for dementia in primary care settings, especially among high-risk populations, is essential. The aim of this study was to design, develop, and evaluate the reliability and validity of a diagnostic scale for Alzheimer's disease tailored to low-educated and illiterate populations.

Method: This study, conducted at Roozbeh Psychiatric Hospital and Yaadmaan Institute for Brain Cognition and Memory Studies, utilizes a mixed-methods approach for collecting, analyzing, and interpreting the data. Once the questionnaire was confirmed to be clear, appropriate, and consistently presented, it was administered to a purposive sample of 250 patients selected based on the study's specific inclusion criteria. These patients underwent a comprehensive neuropsychological assessment, which included the Behavioral Pathology in Alzheimer's Disease Rating Scale (BEHAVE-AD), The Katz Activities of Daily Living Scale (Katz ADL) and The Functional Assessment Staging Tool (FAST). The scale construction process was conducted in four phases.

Results: Confirmatory factor analysis showed that all questions significantly loaded on their respective factors, effectively measuring their intended constructs. The root mean square error of approximation (RMSEA) was less than 0.08, indicating a good model fit and supporting the scale's validity. The Adjusted Goodness of Fit Index (AGFI) and Goodness of Fit Index (GFI) were near 0.9, while the Comparative Fit Index (CFI), Normed Fit Index (NFI), Non-Normed Fit Index (NNFI), and Incremental Fit Index (IFI) exceeded 0.9. Correlational analysis with the FAST, Activities of Daily Living (ADL), and BEHAVE-AD scales confirmed significant relationships, validating the scale's convergent and divergent validity. The overall reliability, measured by Cronbach's alpha coefficient, was 0.96, indicating excellent internal consistency, with subdomain reliability coefficients ranging from 0.7 to 0.88.

Conclusion: The diagnostic scale for Alzheimer's disease demonstrates adequate fit and construct validity for assessing cognitive impairments in low-educated and illiterate patients across the 12 domains of orientation, judgment, abstract thinking, similarity, verbal fluency, repetition, working memory, visual-spatial skills, calculation, executive function, prosopagnosia, and naming. This culturally and linguistically adaptable assessment addresses gaps in diagnostic tools for low-literacy populations, enabling accurate evaluations of dementia and facilitating early diagnosis and treatment. The findings enhance existing knowledge by providing a reliable tool for early Alzheimer's diagnosis among low-literacy groups. However, further research is needed to validate the scale across diverse ethnic backgrounds and geographical locations to ensure its relevance and sensitivity to various contexts.

Key words: *Alzheimer; Cognitive Impairment; Diagnostic Test; Elderly; Literacy*

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Recent advancements in life expectancy and improvements in health conditions have led to a significant increase in the proportion of older individuals globally. Population aging is progressing more rapidly in developing countries than in developed ones. Two-thirds of individuals aged 60 and older reside in developing countries, which often lack sufficient support and infrastructure in their healthcare systems for the elderly (1). This aging population significantly affects these countries in terms of economic stability, workforce dynamics, and healthcare system demands. Specifically, As the number of dependent older individuals increases, the working-age population declines, resulting in a higher dependency ratio, which places financial burdens on social support systems and public welfare programs (2). Health issues among older adults represent some of the most significant challenges globally. Notably, the observed declines in mortality rates among the elderly are likely more related to a decrease in the lethality of chronic disabling diseases rather than a reduction in their overall incidence. As a result, many older individuals are living longer but with declining health, leading to what is referred to as the "expansion of morbidity." Among these health concerns, Alzheimer's disease (AD) is particularly prominent, posing significant challenges for the aging population (3), significantly increasing healthcare costs due to the extensive long-term medical care and hospitalizations required (4). This situation profoundly influences family structures as relatives often take on caregiving roles, leading to emotional and financial stress, while also affecting younger generations' educational and career opportunities (5). Additionally, there is a growing demand for professional caregivers and community resources, which are often insufficient, further compounding the challenges faced by families. As a result, social services are increasingly pressured to adapt and provide necessary support, highlighting the urgent need for comprehensive strategies to address the multifaceted impacts of cognitive impairments on individuals and the society (6).
Dementia includes various neurodegenerative disorders marked by progressive cognitive and functional decline (7). It is characterized by memory deficits and impairment in at least one other cognitive domain, such as executive functioning, language, visuospatial skills, or judgment, which can result in considerable challenges in daily activities (8). AD is the most prevalent cause of dementia (9).
Globally, the prevalence of cognitive impairment and dementia is on the rise (10). Several factors contribute to this trend, including early-life development, exposure to risk factors, insufficient cognitive stimulation, poor management of cardiovascular risks, low socioeconomic status, and a lack of awareness about dementia (11-13). The prevalence of dementia is notably higher among illiterate people (14). A UNESCO report highlights that, one in five adults globally remains illiterate, with more than half residing in South and West Asia (15). Literacy level plays a crucial role in psychological and neuropsychological evaluations. Education, particularly in reading and writing, leads to significant cognitive changes, influencing spatial perception, logical reasoning, and memory strategies (16). Cognitive screening is a vital strategy for detecting cognitive decline in its early stages, serving as one of the first steps in diagnosing dementia (17). It serves as an accessible and cost-effective tool for early detection. However, several challenges exist in utilizing this instrument effectively in primary care settings (18).
Various tools have been created to evaluate the cognitive status of the elderly, Cognitive assessment tools can be categorized based on their primary focus into specific cognitive functions and functional abilities. Specific Cognitive Functions include the Mini-Mental State Examination (MMSE), the Montreal Cognitive Assessment (MoCA), the Clock Drawing Test (CDT), the Memory Impairment Screen (MIS), the Category Fluency Test (CFT), the Rey-Osterrieth Complex Figure Test (ROCF), the Trail Making Test (TMT), and Addenbrooke's Cognitive Examination (ACE). Functional Abilities include the Barthel Index (BI), the Lawton Instrumental Activities of Daily Living (IADL) Scale, the Bayer-Activities of Daily Living Scale (B-ADL), and Functional Assessment Staging Test (FAST). Both categories are crucial for comprehensive cognitive assessments. Many of the specific cognitive function screening tools have not been validated across diverse socio-cultural, religious, and literacy levels. The MMSE is widely used and popular in dementia screening. It is quick to administer (19); however, its scores are significantly influenced by the educational level of the individual, and some of its items may not be appropriate for all cultural contexts (20, 21). The MoCA is also widely used and popular. It assesses a broader spectrum of cognitive domains compared to the MMSE (22); however, some parts of it require reading and understanding instructions, which may not be valid for use among illiterate populations (23). The CDT is another simple and concise cognitive screening tool that is adaptable to different cultures and languages. Despite its broad applicability, studies have shown that the CDT tends to overestimate cognitive decline in individuals with low literacy, particularly because they may feel uncomfortable using pen and paper to trace lines and write numbers (24). Similarly, the CFT, which requires examinees to generate as many words as they can within one minute that fit within a specific category, is quick and easy to perform, making it a useful tool for diagnosing dementia. However, Individuals with low literacy skills may have a more limited vocabulary due to less exposure to language development opportunities. Thus, literacy influences individuals' vocabulary size and affects their performance on this test (25). The MIS, a concise test that involves free and cued recall of a four-item word list, also shows promise, particularly because

it can be administered by trained non-specialists and has a strong correlation with Alzheimer's pathology. Nevertheless, this test requires a minimum level of education, which limits its applicability among illiterate populations (26). The ROCF is a Useful tool for individuals with language deficits as it relies on drawing rather than verbal responses and offers insights into the visual-spatial memory (27). However, Low literacy impacts the scores and its interpretation can be affected by cultural differences in drawing or art styles (28). The Trail Making Test (TMT) is a simple execution tool that requires minimal equipments (paper and pencil) and effectively measures attention and processing speed (29). However, it requires understanding of numbers and letters, creating barriers for illiterate individuals (30). The ACE is well-recognized and commonly used in clinical settings. It evaluates various cognitive domains such as attention, memory, language, and visuospatial skills (31). Although some of its components are not literacy-dependent, other parts of the test still require reading and writing, which can be a challenge for those with low literacy skills. Also, certain components of this test may reflect specific cultural knowledge (e.g., naming common objects or recalling local historical facts), which can disadvantage individuals from different cultural backgrounds (32).

There are other tools that directly or indirectly represent the cognitive status of patients by measuring their functional areas and activity level. One such tool is the FAST, which is commonly used to evaluate the stages of functional decline in patients with AD or other types of dementia, providing a framework for understanding the progression of the disease through various levels of care needed for activities of daily living (33). Another tool, the B-ADL, was developed as a brief, internationally applicable instrument to assess functional disabilities by determining the level of independence or dependence in performing daily activities. B-ADL is a reliable and valid tool for assessing the functional abilities of individuals (34, 35). The Barthel Index (BI) evaluates independence in essential self-care tasks like feeding, bathing, and mobility. It is used to measure a person's degree of independence, allowing caregivers and healthcare professionals to gauge how well individuals perform essential self-care tasks (36, 37). The Lawton IADL Scale measures the ability to perform more complex daily tasks. It evaluates tasks such as using the telephone, shopping, and managing medications. It helps to determine how well an individual can function in a community setting and maintain independence in everyday living (38, 39).

Functional assessment tools are particularly valuable because they tend to be free from cultural, social, and educational biases. Basic daily activities, such as dressing and bathing, are relatively consistent across different cultures, making these tests more universally applicable and easier to perform and helpful for identifying early functional decline in cognitively impaired individuals. However, they focus on functional abilities rather than on specific cognitive processes and domains. For example, while a patient may still be able to perform daily living tasks, they might struggle with underlying cognitive functions such as memory, executive function, or problem-solving —areas crucial for a comprehensive dementia assessment (40, 41). These tests are less sensitive to the early cognitive changes that are vital for Alzheimer's diagnosis. Many individuals may exhibit preserved functional abilities in the face of early cognitive decline, which is crucial for initiating timely interventions and diagnostic evaluations (42). As Alzheimer progresses, the individuals' ability to perform daily activities may mask early cognitive challenges. Functional assessments might not reveal critical changes in cognition that manifest as difficulties with planning, organizing, or remembering tasks (43).

Currently, one person is diagnosed with dementia every three seconds worldwide (44). Unfortunately, we still do not have a curative treatment for dementia. Since the progression of AD typically lasts about 10 to 15 years (45), it causes significant damage and costs for individuals, families, and societies. Early diagnosis, combined with prompt access to appropriate services and support, can significantly slow the disease progression. This enables individuals to manage their condition effectively, prolong their independence at home, and sustain a high quality of life for themselves, their families, and their caregivers (46).

Studies have found that 66% of individuals with dementia in the world live in low- and middle-income nations. Only a small percentage (10%) of globally available research data on dementia comes from these developing regions (47). A significant reason for this disparity is the lack of appropriate tools for diagnosing dementia in developing countries (48). On the other hand, most worldwide studies on dementia have utilized literacy-dependent tests, such as MoCA and MMSE. Therefore, illiterate and low educated individuals have not met the inclusion criteria for these studies and have been excluded. By excluding the hidden population, the research does not capture the full spectrum of the characteristics or effects of dementia, leading to a limited understanding of the condition across diverse populations. This creates a gap in our understanding of dementia's impact on diverse populations, particularly those who may not have the literacy skills needed for screening tests or assessments commonly used in research (49).

Socio-economic factors are often linked to the quality of healthcare infrastructure. In regions with limited healthcare facilities, particularly in rural areas, individuals face challenges such as insufficient access to services and long travel distances to receive care. These barriers can delay diagnosis and treatment, leading to increased costs. Additionally, the shortage of trained specialists in certain areas often forces reliance on general practitioners who may lack the necessary

expertise for comprehensive cognitive evaluations. This situation can exacerbate existing disparities, resulting in less thorough assessments for individuals in underserved regions. Addressing these disparities is crucial for promoting equitable healthcare and improving early diagnosis and treatment options for all populations (50, 51). Moreover, the cultural context significantly shapes cognitive development and symptom expression, highlighting the necessity for diagnostic tools that accommodate these variables. Recognizing the diverse cognitive styles, symptom expressions, and cultural norms that influence mental health is essential. However, cognitive assessments that are developed within specific cultural contexts can sometimes lead to cultural bias. For populations with different socio-cultural backgrounds, traditional assessments may not capture relevant cognitive skills or may misinterpret behaviors, skewing results (52). Considering these socio-economic influences, it is essential to develop a suitable assessment tool.

Therefore, for large-scale screening, particularly among individuals presenting with memory complaints, there is a need for a cost-effective, non-invasive screening tool that is compatible with diverse educational levels and cultural backgrounds, and can be implemented by trained primary healthcare providers. Assessing the cognitive function of older adults who are illiterate or have low levels of education presents unique challenges, as many cognitive tests require a certain level of educational background. Researchers highlight the critical need for developing cognitive ability testing instruments that are specifically tailored to the unique contexts of countries with low education levels (53). This study aims to develop and validate a culturally and linguistically adaptable Alzheimer's diagnostic scale that is specifically designed for the illiterate and populations with low literacy levels.

Materials and Methods

This study utilizes a mixed-methods approach for collecting, analyzing, and interpreting data. It was conducted at Roozbeh Psychiatric Hospital and Yaadmaan Institute for Brain Cognition and Memory Studies, both located in Tehran, the capital city of Iran. Roozbeh Hospital and the Yaadmaan Institute are the two main referral centers for patients from across the country for cognitive disorders and dementia. Roozbeh is an academic and governmental center, while Yaadmaan is a private institute. Purposeful sampling is justified for this study, which includes elderly patients over 60 years old diagnosed with dementia, specifically among individuals with low literacy levels or who are illiterate, and whose first language is Persian. Patients admitted to the Roozbeh Hospital and Yaadmaan Institute for an appointment with a neurologist were purposefully selected. The ages of the individuals were verified using their identification cards, while their levels of illiteracy were determined based on their highest year of education. Additional inclusion criteria included Persian as the first language and the absence of neurological disorders, severe medical conditions, motor impairments, as well as visual or hearing difficulties, which were confirmed through examinations by a neurologist. By implementing well-defined selection criteria and strategies to minimize bias, the study ensures that the findings are both valid and potentially generalizable to similar populations. Dementia was diagnosed according to the criteria outlined in the fifth edition of the Diagnostic and Statistical Manual of Mental Disorders (DSM-5) by an expert cognitive neurologist. Then, participants were selected through purposeful sampling and underwent a comprehensive neuropsychological assessment, which included the Behavioral Pathology in Alzheimer's Disease Rating Scale (BEHAVE-AD), The Katz Activities of Daily Living Scale (Katz ADL) and the Functional Assessment Staging Tool (FAST). The Ethics Committee of the Royan Research Institute, affiliated with the Academic Center for Education, Culture and Research (ACECR), has granted ethical approval for this study, the approval is documented under the ethical code number IR.ACECR.ROYAN.REC.1402.044.

Many clinical guidelines and research studies define dementia primarily in the context of older adults, often setting a common age threshold around 60 or 65 years (54). In Iran, the elderly is generally defined as individuals aged 60 and older (55). Literacy is another important consideration; according to the UNESCO, an individual is deemed literate if they can read and write a brief statement about everyday life with a clear understanding.

The national literacy agency in Iran uses the same definition. In this context, individuals with low literacy are those individuals who possess limited reading, writing, and comprehension skills (56). Educationally, low-literate is often more specifically defined as an individual who may not have completed primary education (57). For the purposes of this study, low literacy and low educational level are considered synonymous.

The absence of neurological disorders (like Multiple Sclerosis (MS), Epilepsy, Stroke) or severe medical disorders are often used as the inclusion criteria in clinical research to ensure that study participants do not have confounding factors that could influence the results (58). Moreover, the combined effects of motor, visual, and hearing impairments can lead to results that do not accurately reflect a participant's cognitive status. Participants with motor impairments may struggle with tasks that require fine motor skills, such as drawing, or manipulating objects. Participants with visual impairments may have difficulty in items that include visual stimuli, such as pictures. Hearing impairments can make it challenging for participants to understand verbal instructions or spoken components of tests (59). Alternative adjustments should certainly be considered

for potentially eligible participants with mild impairments. Offering one-on-one explanations or demonstrations tailored to individual needs can help clarify tasks for those with motor or cognitive challenges. It is also important to remind patients to bring their hearing aids and glasses if needed. Finally, we can provide visual aids and accommodations such as hearing amplification devices to further support participants (60).

Participants who do not answer more than 50% of the questions may be excluded from a study because a low response rate (less than 50%) could indicate insufficient data to perform a meaningful analysis. Incomplete data can lead to unreliable or invalid conclusions and raises concerns about the reliability of the data they provide (61).

The definition of expertise in neurology and geriatric medicine highlights the critical roles of formal education, clinical training, and practical experience, making this a key criterion for our expert inclusion (62). The interplay of clinical experience with the elderly and specialized knowledge in Alzheimer's and mild cognitive impairment (MCI) significantly enriches the quality and relevance of feedback provided during the scale construction process, ensuring that assessment tools effectively meet the needs of both clinicians and patients (63). The selection of experts was based on their qualifications, years of experience, and specialization in areas relevant to AD and MCI. We sought experts from diverse fields, including neurologists, geriatric psychiatrists, and specialists in geriatric medicine, to ensure a comprehensive perspective. Each candidate underwent interviews and assessments conducted by a qualified neurologist to evaluate their expertise and ensure alignment with the study's objectives.

The following definitions outline key concepts used in the study: Dementia is an overarching term that includes a range of symptoms impacting memory, thinking, and social abilities, significantly interfering with daily life. It includes several types, such as AD (64). Cognitive impairment refers to a general decline in cognitive function that impacts an elderly person's ability to think, remember, and make decisions. The severity of this impairment can range from mild to severe, and it may arise from various causes (65). MCI is a specific condition indicating noticeable cognitive decline that exceeds what is typical for a person's age, without being severe enough to significantly disrupt daily activities. MCI often serves as a precursor to more serious conditions, including AD and various types of dementia (66).

Inclusion Criteria:

- Being at the age of 60 or older
- Being illiterate or having a low level of education
- Not having neurological disorders or severe medical disorders
- Not having motor impairments, and Visual or auditory impairments that may hinder the testing process
- Using Persian as the first language

Exclusion Criteria:

- participants who did not answer more than 50% of the questions due to fatigue
- Participants who discontinue the assessment due to personal reasons

Expert inclusion Criteria:

- Expertise in neurology and geriatric medicine
- Clinical experience as a psychiatrist working with the elderly
- Specialized knowledge in AD and MCI

The scale construction process was conducted in four phases:

***Phase 1*:** In this initial phase, the preliminary version of the scale was developed. This involved creating a checklist of indicators based on existing texts, questionnaires, and interviews with patients. The checklist was informed by an understanding of the patients' cultural context and history, and it was specifically designed to assess cognitive impairments in illiterate or low-educated individuals. During this phase, redundant or overlapping items were identified and removed. To identify and remove redundant items several criteria were used; each item was required to present unique themes to avoid overlap, allowing similar items to be merged or removed. Expert reviews provided valuable insights into cognitive impairments, further aiding in the assessment of redundancy. Additionally, gathering feedback through patient interviews and focus groups helped to highlight any confusing or repetitive items (67).

Phase 2: A panel of ten distinguished experts conducted a comprehensive review of the draft checklist, including neurologists, geriatric psychiatrists, and geriatric medicine specialists, using the Lawshe criteria for evaluation. This criteria, used for evaluating expert reviews in this study, is a systematic method for assessing content validity. In this approach, a team of experts rates the contribution of specific items related to the study goals, categorizing each item as essential and useful, or non-essential and not required. Items that receive a consensus of essential ratings are deemed relevant and significant for the study's objectives. This method ensures that our expert reviews provide reliable and pertinent insights into AD (68, 69). The experts assessed whether each item effectively measured its intended construct, whether any items required revision, or whether any items should be removed. Based on their feedback, non-essential items were eliminated, and the checklist was refined to include only items that received

at least 80% approval from the panel. The rationale for an 80% approval threshold reflects a commitment to stakeholder consensus, quality assurance, and practical utility, ultimately supporting the creation of a reliable and effective assessment instrument. This indicates a strong consensus among the panel members and helps strike a balance between inclusivity and specificity, ensuring that only items deemed essential and valuable by a majority are retained (70). Instructions for administering the questionnaire were developed. To ensure clarity and validity, the revised checklist was pilot-tested with 10 patients to identify any ambiguities or misinterpretations. Revisions were made based on patient feedback and expert recommendations. These 10 patients were chosen according to specific inclusion criteria directly relevant to the study population. They received detailed instructions about the purpose of the pilot test and was informed that their feedback was crucial for improving the data collection tool, and completed the questionnaire in a controlled setting. After completing the questionnaire, participants filled out a feedback form that included open-ended questions about their experience, clarity of questions, and any terms or concepts that seemed ambiguous. Some participants found medical or technical terms confusing, which hindered their understanding of questions, especially in the part on similarities; therefore, we added an example to clarify the structure.

Phase 3: A small-scale feasibility test was conducted with 40 patients. During this phase, the frequency and percentage of responses for each item were analyzed, Cronbach's alpha for the entire scale was computed, and factor analysis was performed. The correlation coefficient of each item with the total scale score was calculated to determine its effectiveness. Items with high or low response frequencies, indicating reduced variance, were evaluated for potential exclusion. Any items with content or formatting issues were revised. After making necessary adjustments, the completed and last version of the questionnaire was prepared and reviewed again by experts. The Cronbach's alpha coefficient for the overall scale score was above 0.7, which is generally considered acceptable. Also, all items demonstrated balanced responses across the scale, suggesting they consistently measure the same underlying construct. As a result, all items were retained or adjusted for clarity and precision (71).

Phase 4: Once the questionnaire was confirmed to be clear, appropriate, and consistently presented, it was applied to a broader sample of 250 patients. The final phase involved analyzing the validity and reliability of the scale. Two reliability measures were assessed: internal consistency, and Cronbach’s alpha coefficient. Also, three validity indices were measured: content validity, construct validity, and convergent and divergent validity. The BEHAVE-AD and the Katz ADL were used to assess convergent validity, while the FAST was used for divergent validity. The sensitivity and specificity were assessed using the Receiver Operating Characteristic (ROC) curve to establish the optimal cutoff score. A sample of 250 can help ensure that the analysis has enough power (typically 0.80) to confidently reject the null hypothesis when it is indeed false. Additionally, a thorough evaluation of internal consistency was performed with Cronbach's alpha. A sample size larger than 200 is generally deemed sufficient for obtaining stable reliability estimates. Furthermore, a sample of 250 patients not only improves representation of the target population, but also enhances the generalizability of the findings. By selecting 250 patients for scale validation, the study establishes a robust foundation for comprehensive psychometric analyses, ensuring both reliability and validity, while also enhancing the overall representativeness of the results (72).

Data Analysis

Descriptive statistics were utilized to present comprehensive information about the research variables and demographic data. This included key metrics such as the mean, standard deviation, frequency, and percentage. To evaluate content validity of the constructed questionnaire, the Lawshe method was employed in the form of the Content Validity Ratio (CVR) and Content Validity Index (CVI). For assessing construct validity, confirmatory factor analysis was conducted; while concurrent validity was evaluated through the Pearson correlation coefficient between the results of the developing scale and those of FAST, Katz ADL, and BEHAVE-AD. Internal consistency was assessed using Cronbach's alpha. The sensitivity and specificity analysis is conducted using the ROC curve. The optimal cutoff point is determined based on Youden’s Index. Many studies consider thresholds of at least 80% for sensitivity and 70% for specificity to be acceptable (73). The implications for scale application can be observed in clinical contexts and screening programs (74).

Tools

BEHAVE-AD

It is a specialized tool designed to evaluate a variety of behavioral disturbances based on caregiver reports. This 25-item scale evaluates seven symptom categories: delusions (seven items), hallucinations (five items), activity disturbances (three items), aggressiveness (three items), sleep-wake disturbances (one item), affective disturbances (two items), and anxieties and phobias (four items). Each item is evaluated using a four-point rating scale. The reliability and validity of BEHAVE-AD have been established through three studies involving both outpatient and nursing home populations, demonstrating strong inter-rater reliability and solid construct validity (75). The Persian translation of BEHAVE-AD, compiled and published by Noroozian, shows high concurrent validity with the Neuropsychiatric Inventory Questionnaire (NPI-Q) (Pearson correlation coefficient, $r = 0.77$, $P < 0.01$) and good construct validity with the MMSE ($r = -0.34$, $P < 0.01$). The inter-rater reliability

index for BEHAVE-AD demonstrated a robust range, varying from 0.88 to 0.99, confirming the scale's validity and reliability for assessing Behavioral and Psychological Symptoms of Dementia (BPSD) in Alzheimer's patients (76).

The Katz ADL

This scale is a widely utilized assessment tool that evaluates an individual's independence in performing six essential daily activities: bathing, dressing, toileting, transferring, continence, and feeding. This informant-rated questionnaire consists of six items, each scored as either "Yes" (1 point) or "No" (0 points) regarding the individual's ability to perform these tasks independently. A score of 6 indicates full function, 4 indicates moderate impairment, and 2 or less indicates severe impairment (77). The scale is noted for its sensitivity to cognitive impairments, ease of use, and international applicability. Each item was selected for its relevance to daily life activities and its ability to discriminate between varying levels of cognitive function. the Katz ADL scale is considered a reliable and valid tool for evaluating the functional status of older adults, making it a valuable resource in clinical and research settings (78, 79). The reliability of the Persian translation of the Katz ADL was assessed by Azad. The Cronbach's alpha coefficient in the initial phase (0.787) and in the subsequent phase (0.787) indicates that the Katz assessment index is acceptable. Also, in the test-retest, the overall score for the Katz index was 0.888, indicating highly desirable reliability (80).

FAST

It is a clinical tool specifically designed to assess the progression of AD. It categorizes the disease from the absence of deficits through various stages, including pre-clinical subjective deficits and MCI, ultimately leading to the advanced stages of AD (81). The psychometric properties and validity of the Persian version of the Functional Assessment Staging Tool (I-FAST) were rigorously evaluated in a study conducted by Noroozian among elderly outpatients in Iran. The results indicated that the I-FAST achieved a sensitivity of 92.2% and a specificity of 98.0% in distinguishing between normal cognitive function and MCI. Moreover, when differentiating AD from MCI, the I-FAST demonstrated an impressive sensitivity of 99.0% and a specificity of 93.7%. The I-FAST exhibits strong psychometric properties, effectively distinguishing between MCI, normal elderly individuals, and those diagnosed with AD. It is regarded as a sensitive and accurate tool for assessing individuals at risk for MCI and Alzheimer's, demonstrating minimal influence from the educational background, cultural factors, and language differences when compared to the MMSE (82).

Results

Description of Participants

The study sample consisted of 250 individuals. A total of 114 participants in the study were women, and 136 were men. The mean age of participants in this study was 75.79 years, and the standard deviation was 7.81. The age range was between 67 and 85 years. There were 165 illiterate individuals and 85 individuals with low education. The first language of all participants was Persian. Among the participants, 153 individuals were monolingual, 76 had Turkish as their second language, and 21 had Kurdish as their second language.

Checklist Scoring

Completion of the checklist took approximately 30 minutes for the patients participating in the practical examination designed to assess its validity and reliability. The total score was calculated by summing the scores across 12 distinct domains, with higher scores indicating a higher level of cognitive function among patients.

Validity

When assessing the content validity of a tool, one of the most effective approaches is to utilize expert judgments by determining the CVR. The CVR was employed through three main stages: first, a panel of qualified experts was selected to ensure informed evaluations; second, these experts assessed and rated the essentiality of each item; and third, the CVR for every component was determined using a specific formula to measure content validity objectively (83). The panel of experts (n = 10) identified the second version of the checklist as essential for effective implementation. The CVR was calculated for all questions, with item scores ranging from 0.80 to 1.00. By comparing these ratios with the accepted values from the content validity ratio table and the Lawshe method (where the minimum acceptable value for this number of experts is 0.62) (84), the content validity of the questionnaire items was deemed adequate and acceptable. Based on feedback from experts regarding the prosopagnosia domain, one of the images was removed at the recommendation of three specialists. Additionally, in the abstract thinking domain, two proverbs were replaced because five specialists indicated that understanding and interpreting them required a high level of literacy. In the visual-spatial domain, one of the shapes was eliminated due to a consensus among all experts regarding its complexity and the necessity for advanced drawing skills. All of these limitations that negatively impacted the content validity index were revised. Consequently, the final version of the checklist with 12 domains called the "Noroozian brief Cognitive Screening Scale (NBCSS)" was developed. The CVI for the questionnaire items was 0.9 to 1, which are higher than acceptable values (the least acceptable being 0.79). Therefore, the CVI for this questionnaire is considered acceptable. It can further be said that the questionnaire items have adequate content validity.

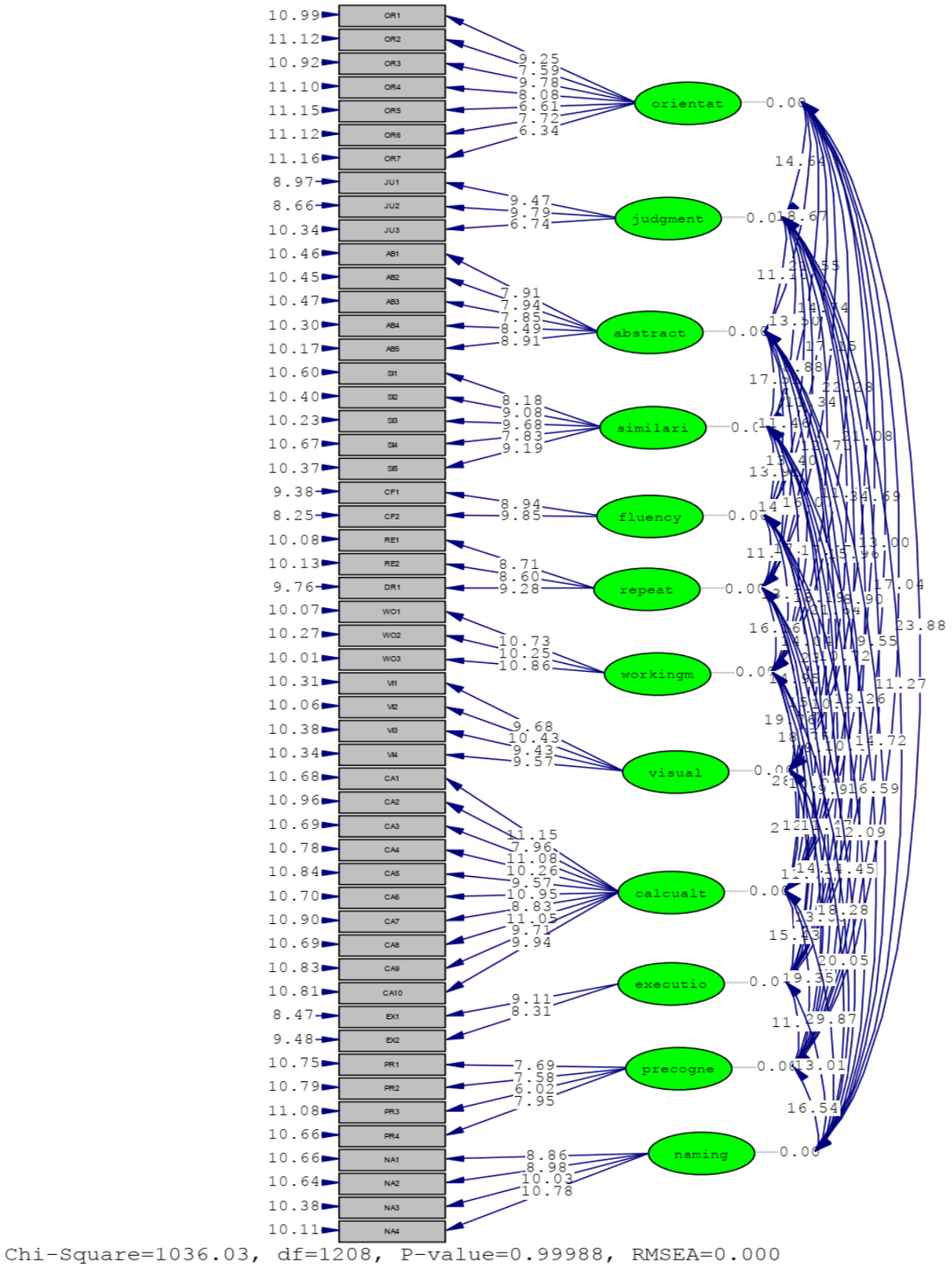

Figure 1. Confirmatory Factor Analysis Assessing Construct Validity of the Alzheimer's Diagnostic Scale

The purpose of the confirmatory factor analysis was to identify factor weights, as illustrated in Figure 1. The 0.3 cutoff is often based on established conventions in the field of social sciences and psychology. It is a commonly accepted threshold indicating a moderate correlation between a variable and its underlying factors (85). All factor weights for the items exceeded 0.3, indicating statistical significance. A factor loading of 0.4 indicates that approximately 16% of the variance in the observed variable can be attributed to the underlying factor. This level of variance is often seen as sufficient for meaningful interpretation and practical significance in research findings (86). As shown in figure 1, Factor loadings exceeding 0.40 were deemed significant for all survey questions. Furthermore, the value of 1.96 is associated with the standard normal distribution and corresponds to a 95% confidence level. In hypothesis testing, this value represents the cutoff for determining whether an observed effect is statistically significant (87). The obtained values for the significance of the factor loadings are all above 1.96, indicating that all questions have significant factor loadings on their respective factors and that they accurately measure their intended constructs.

Table 1. Fit Indices of the Measurement Model for Assessing Construct Validity of the Alzheimer's Diagnostic Scale

Fit Index	Acceptable Range	Observed Value
X^2		1036.03
Df		1208
X^2/df	3 <	0.85
Root Mean Square Error Of Approximation (RMSEA)	0 < 0.08	0.000
The Goodness of Fit Index (GFI)	> 0.9	0.86
Adjusted Goodness of Fit Index (AGFI)	> 0.9	0.84
Comparative Fit Index (CFI)	> 0.9	0.97
Normed Fit Index (NFI)	> 0.9	0.93
Non-Normed Fit Index (NNFI)	> 0.9	0.97
Incremental Fit Index (IFI)	> 0.9	0.97

Table 1 presents the goodness of fit indexes, which validate the proposed theoretical model. Notably, the root mean square error of approximation (RMSEA) is below the threshold of 0.08, indicating a good fit. Additionally, both AGFI and the GFI are approaching 0.9. Values exceeding 0.9 suggest an acceptable model fit, further supporting the robustness of the theoretical model (88), and in this study, the CFI, NFI, NNFI, and IFI indices are all higher than 0.9. Considering the fit indices, the model fits the data, it can be concluded that the diagnostic scale for AD demonstrates adequate construct validity.

Table 2. Correlation of the Alzheimer's Diagnostic Scale with BEHAVE-AD and ADL for Evaluating Convergent Validity

	Orientation	Judgment	Abstract Thinking	Similarity	Verbal Fluency	Repetition	Working Memory	Visual-Spatial	Calculation	Executive Function	Prosopagnosia	Naming
Behave-AD	-0.41**	-0.44**	-0.39**	-0.45**	-0.45**	-0.45**	-0.46**	-0.44**	-0.49**	-0.33**	-0.34**	-0.39**
ADL	-0.59**	-0.51**	-0.41**	-0.51**	0.50**	0.58**	0.54**	0.54**	0.54**	0.56**	0.48**	0.55**

ADL: Activities of Daily Living

Table 2 shows the results of the convergent and divergent validity. Correlational analysis was performed between the job, ADL and Behave-AD scales and the Alzheimer's diagnostic scale to evaluate their validity. Convergent validity refers to the degree to which different measures or indicators that are intended to assess the same latent variable yield similar results, and it was assumed that the correlations between the two

scales will be positive and in the same direction. In divergent validity, it was assumed that the correlations will be negative and inversely related. As indicated by the results in Table 2, the correlation of the ADL and Behave-AD scales with all dimensions of the Alzheimer's scale is positive and significant, suggesting that the Alzheimer's diagnostic scale has convergent validity. Additionally, in this study, the Functional Assessment Staging Tool (FAST) was utilized to examine divergent validity. The correlation between the FAST and all dimensions of the Alzheimer's scale is negative and insignificant, with a Pearson correlation coefficient of -0.788. This indicates that the Alzheimer's diagnostic scale also has divergent validity. FAST evaluates functional impairment in elderly individuals diagnosed with AD. As individuals progress to higher stages on the FAST scale, the severity of AD increases, resulting in a lower score in our scale. Conversely, a higher score on our scale signifies superior cognitive function, which is inversely related to the higher stages of the scale.

Reliability

Table 3. Correlation Matrix of Factors in the Alzheimer's Diagnostic Scale: Assessing Internal Consistency

	1	2	3	4	5	6	7	8	9	10	11	12
1. orientation	1											
2. Judgment	0.89	1										
3. Abstract Thinking	0.94	0.78	1									
4. Similarity	0.98	0.85	0.92	1								
5. Verbal Fluency	0.99	0.76	0.86	0.96	1							
6. Repetition	0.99	0.85	0.89	0.91	0.91	1						
7. Working Memory	0.98	0.84	0.90	0.92	0.97	0.98	1					
8. Visual-spatial	0.97	0.76	0.91	0.91	0.96	0.92	0.96	1				
9. Calculation	0.99	0.84	0.90	0.90	0.92	0.93	0.99	0.94	1			
10. Executive Function	0.99	0.80	0.88	0.86	0.90	0.96	0.99	0.91	1	1		
11. Prosopagnosia	0.99	0.81	0.96	0.81	0.90	0.94	0.99	0.94	0.99	0.99	1	
12. Naming	0.99	0.77	0.85	0.88	0.88	0.91	0.94	0.95	0.98	0.99	0.99	1

Table 3 displays the findings of the correlations among the factors of the Alzheimer's diagnostic scale. The correlational analysis revealed significant associations between these factors. The positive correlations among them indicate a high level of internal consistency within the scale. The P-value for all correlation coefficients is 0.01, indicating statistical significance at this level.

Table 4. Cronbach's Alpha Reliability Coefficients for Dimensions and Overall Scores of the Alzheimer's Diagnostic Scale

Factor	Number of Questions	Reliability Coefficient
Orientation	7	0.71
Judgment	3	0.70
Abstract Thinking	5	0.70
Similarity	5	0.71

Verbal Fluency	2	0.79
Repetition	3	0.70
Working Memory	3	0.83
Visual-spatial	4	0.77
Calculation	10	0.88
Executive Function	2	0.70
Prosopagnosia	4	0.70
Naming	4	0.71
Overall Scale	52	0.96

The reliability of the Alzheimer's diagnostic scale was assessed using Cronbach's alpha coefficient. As shown in Table 4, the overall reliability coefficient is 0.96, which is considered excellent. Furthermore, the reliability coefficients for the subdomains were as follows: orientation 0.71, judgment 0.70, abstract thinking 0.70, similarities 0.71, verbal fluency 0.70, executive functions 0.88, spatial perception 0.77, active memory 0.70, repetition 0.79, face recognition 0.70, and naming 0.71. The results indicate that the Cronbach's alpha coefficient demonstrated both significance and excellence.

A ROC curve was generated to evaluate the sensitivity and specificity of the diagnostic test, yielding a specificity of 81.48 and a sensitivity of 88.14. To further evaluate the test's ability to distinguish between clients with and without AD, we employed Youden's index. The formula for Youden's index was as follows: (specificity + sensitivity − 1) (89). According to this, the score achieving the highest sum of sensitivity and specificity is identified as the cutoff. A score of 56 demonstrated the greatest sensitivity and specificity, thus it is designated as the cutoff point.

Table 5. Determination of Cutoff Points for the Alzheimer's Diagnostic Scale to Distinguish MCI from the Normal Population

Less than	NBCSS Detection	FAST Result for Mild Patients		Sensitivity %	Specificity %	Positive Predictive Value %	Negative Predictive Value %	Accuracy %
		Normal	Mild					
90	Normal	4	0	100	14.81	65.15	100	67.14
	Mild	23	43					
89	Normal	6	0	100	22.22	67.19	100	70.00
	Mild	21	43					
88	Normal	6	0	100	22.22	67.19	100	70.00
	Mild	21	43					
87	Normal	7	4	90.70	25.93	66.10	63.64	65.71
	Mild	20	39					
86	Normal	8	4	90.70	29.63	67.24	66.67	67.14
	Mild	19	39					
85	Normal	8	4	90.70	29.63	67.24	66.67	67.14
	Mild	19	39					
84	Normal	8	5	88.37	29.63	66.67	61.54	65.71

	Mild	19	38					
83	Normal	8	9	79.07	29.63	64.15	47.06	60.00
	Mild	19	34					
82	Normal	9	11	74.42	33.33	64.00	45.00	58.57
	Mild	18	32					
81	Normal	10	11	74.42	37.04	65.31	47.62	60.00
	Mild	17	32					
80	Normal	13	11	74.42	48.15	69.57	54.17	64.29
	Mild	14	32					
79	Normal	14	11	74.42	48.15	69.57	54.17	64.29
	Mild	13	32					
78	Normal	17	11	74.42	62.96	76.19	60.71	70.00
	Mild	10	32					
77	Normal	21	11	74.42	77.78	84.21	65.62	75.71
	Mild	6	32					
76	Normal	22	11	74.42	81.48	86.49	66.67	77.14
	Mild	5	32					
75	Normal	22	15	65.12	81.48	84.85	59.46	71.43
	Mild	5	28					

MCI: Mild Cognitive Impairment

Table 5 shows that a score of 76 demonstrated the greatest sensitivity and specificity, thus it is designated as the cutoff point for diagnosing MCI.

Discussion

This study aims to develop and validate an Alzheimer's diagnostic scale specifically designed for low-educated and illiterate populations, with a focus on ensuring its reliability and sensitivity across diverse linguistic and cultural contexts. Additionally, it aims to address gaps in current cognitive screening practices. Our commitment is to developing a comprehensive assessment tool designed to evaluate specific cognitive processes and domains that are sensitive to preliminary cognitive decline in AD diagnosis.

For this purpose, the 12-domain scale was developed based on a comprehensive review of the literature and subsequently applied to a sample of 250 subjects. The 12 cognitive domains selected for assessment are supported by research, emphasizing their importance in cognitive functioning and cultural relevance. These domains facilitate a comprehensive evaluation of essential skills for learning and daily interactions. For example, the assessment of visual-spatial perception as a cognitive ability is emphasized (90). Also, calculating abilities are reflective of a broader cognitive development (91). Additionally, working memory plays a crucial role in performing everyday tasks (92). Orientation is especially important for the elderly concerning dementia (93). Adapting these assessments to reflect cultural contexts ensures their relevance and applicability to the specific participants being studied. Each domain has implications in both educational and everyday contexts, reflecting skills necessary for functioning effectively within specific cultural environments. Based on this analysis, the reliability of the questionnaire was assessed using Cronbach's alpha and internal consistency. A higher average correlation suggests greater internal consistency. Validity was evaluated through divergent and convergent validity measures, content validity and construct validity. The ADL and Behave-AD scales were used to examine convergent validity, while the FAST measure was utilized to assess divergent validity. Correlational analysis revealed a positive and significant correlation between the ADL and Behave-AD scales and all dimensions of the Alzheimer's scale. In contrast, the FAST measure showed a negative and insignificant correlation with all dimensions of the Alzheimer's scale. The process of content validity included an expert panel that reviews the items for relevance, clarity, and comprehensiveness. The experts ensured that the test

accurately assesses its intended objectives, minimizing the risk of construct under-representation.

The results of reliability assessments showed that the scale has high internal consistency, indicating the existence of significant associations between factors of the scale. Examination of correlations among the factors showed coefficients in the range of $0.7 \leq \alpha < 0.9$. This indicates that the scale reliably measures the construct and suggests that it is of high quality for use in clinical assessments (94). To assess the reliability of the Alzheimer's diagnostic scale, Cronbach's alpha coefficient was computed, which was found to be significant. The high reliability of the items suggests that the scale accurately reflects the cognitive impairment of the patient and provides stable outcomes over time. The current findings align with the studies conducted by Park and Jeong (95), demonstrating that the present scale possesses sufficient concurrent validity and reliability as a testing instrument for measuring dementia, similar to the MMSE and MoCA. Unlike the MMSE and MoCA, it exhibited high sensitivity in screening for dementia, irrespective of the literacy status. This finding is consistent with another study that demonstrated the CDT has a high reliability (ranging from 0.82 to 0.94) in assessing multiple cognitive domains.

These results indicate that our scale has significant and acceptable validity. Based on the confirmatory factor analysis, the obtained values for the significance of the factor loadings are all above 1.96 and the model fits the data. Therefore, it can be concluded that the diagnostic scale for AD demonstrates adequate construct validity, and this indicates that the questions have been accurately selected and the processes of development of the tool have been appropriately carried out. This finding suggests that this scale is similar to the MIS, a brief test that employs free and cued recall of a four-item word list. Factor analytic studies have demonstrated significant construct validity for the MIS, supporting its effectiveness as a reliable measure of memory impairment (96).

The findings demonstrate strong content validity and that the scale covers relevant aspects of cognitive impairment. These findings are consistent with Hindmarch and colleagues's study that showed significant content validity for the B-ADL, validated through expert review, pilot testing, and alignment with relevant theoretical frameworks. proper content validity contributes to the scale's effectiveness in evaluating individuals with cognitive impairment (34).

Results of convergent and divergent validity assessments indicate that the Alzheimer's diagnostic scale has significant convergent and divergent validity. These findings agree with the findings by Zegarra-Valdivia and colleagues where they discuss the CFT as a useful screening tool for AD. Both forms of validity are confirming that the CFT is a reliable and effective tool for assessing cognitive function, especially in clinical settings, such as for screening AD (97).

Our findings showed sensitivity rates ranging from 85% to 92% among illiterate and low-literate populations, which indicate a high sensitivity to screening Alzheimer among these groups, while cognitive assessment tools like the MMSE, MoCA, and CDT can vary significantly in populations with low education levels or illiteracy. Among populations with low levels of education or illiteracy, the sensitivity of the MMSE tends to be lower, typically around 50% to 75% (98). The MoCA generally shows better sensitivity in these populations compared to the MMSE. Its sensitivity can range from 70% to 85% among low-educated and illiterate individuals (99). Also, the CDT often performs better than the MMSE in illiterate and low-educated populations due to its pictorial nature and minimal language dependence. Sensitivity rates can vary widely but typically range from 70% to 90%, depending on the scoring methods used and the instructions provided (100). The statistical improvements observed highlight the distinctiveness of our scale in effectively assessing cognitive impairment in the illiterate and low-literate population.

A cutoff score was established, and the sensitivity and specificity were calculated, suggesting a score of 56. This score reliably distinguishes individuals with AD from those without it. In line with the current study, Nishiwaki and colleagues reported sensitivity and specificity values of 0.77 and 0.87, respectively, for the CDT (101). In another study, the findings show that while the MMSE is extensively utilized, it demonstrates imperfect sensitivity and specificity, as well as a limited ability to differentiate between individuals with MCI and healthy controls (102). The cutoff score of 76 for diagnosing MCI effectively differentiates between normal cognition and MCI. This aligns with insights from the study by Ding which emphasizes the importance of cognitive testing in distinguishing MCI from normal aging and early dementia (103).

To build upon our initial findings, we propose several follow-up studies aimed at enhancing the validation and applicability of our cognitive assessment scale. One key area of focus will be testing the scale with a broader demographic population. By including diverse ethnic backgrounds and geographical locations, we can better understand the scale's effectiveness across different populations. This approach will help ensure that the tool is relevant and sensitive to the needs of various contexts. Additionally, we recommend conducting longitudinal studies to evaluate the predictive validity of the scale over an extended period. These studies will allow us to monitor cognitive changes in individuals who are at risk for AD, providing valuable insights into how well the scale can predict the onset of cognitive impairment. By evaluating the scale's performance in diverse settings and over extended periods, we aim to strengthen its reliability and utility in clinical practice.

Limitation

The current study has a few limitations. This tool is not free from cultural and social biases because of using culture and religion-related proverbs, questions and pictures. However, we intend to have some of these questions removed in the short form of the scale in the future. Another limitation is the use of purposeful sampling, which arose from challenges in accessing a diverse group of elderly individuals meeting the inclusion criteria. This could potentially affect the generalizability of the study's results.

Conclusion

In conclusion, the findings indicate that the scale developed in this research is a reliable and valid tool for effectively detecting dementia. It proves to be consistent and accurate, irrespective of the participant's education, background, or literacy status. It addresses the limitations of existing tests and is appropriate for use in countries with a high illiteracy rate. This scale reflects high quality, and its results can be trusted, especially when utilized for critical decisions such as evaluation, diagnosis and treatment. This scale serves as a vital bridge to improved healthcare access and awareness for rural and underserved populations. it has the potential to significantly enhance healthcare access and improve Alzheimer's diagnosis. By integrating the scale into telehealth platforms, healthcare providers can conduct remote assessments, enabling timely diagnoses without the burden of extensive travel. Training local healthcare workers to utilize the scale ensures effective cognitive evaluations during routine check-ups in mobile clinics, promoting early detection. Furthermore, community outreach programs can leverage the scale to raise awareness about Alzheimer's, serving as a practical tool for self-assessment among community members. Collecting data on cognitive health trends through the scale can provide valuable insights to policymakers regarding dementia prevalence, guiding targeted resource allocation to areas of greatest need. Additionally, the scale empowers caregivers to monitor cognitive changes in their loved ones, facilitating earlier and more informed discussions with healthcare providers. Overall, this scale not only enhances diagnostic accuracy and fosters early intervention, but also addresses healthcare disparities and promotes a proactive approach to cognitive health, making it an essential resource for policymakers and healthcare practitioners alike.

Moreover, this scale is a useful and practical tool that addresses the growing demand for dementia screening, particularly in the rapidly aging populations of Asian countries with cultural similarities to our own. By integrating this scale into community health practices, we can ensure that more individuals receive the support they need in a timely manner, thereby enhancing the quality of care for those affected by Alzheimer's.

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Conflict of Interest

None.

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