Comparison of the Clock Test and a questionnaire-based test for screening for cognitive impairment in Nigerians*

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Summary

Background: **Since it is projected that by 2020 seventy percent of the elderly will reside in developing countries, a reliable screening method for dementia and cognitive impairment in general in populations with diverse languages, culture, education and literacy will be needed. We sought to determine if the Clock Test, a screening test for dementia, was suitable for use in a Nigerian population.**

Study design: **Cross-sectional survey of 54 men and 12 women from Northern Nigeria. Researchers administered two dementia screening tools: a questionnaire-based test adapted for use in a Nigerian population and the Clock Test.**

Results: **Overall, 53.0% of the subjects had an abnormal Clock Test whereas 10.6% of the subjects had an abnormal questionnaire score. Only 9.1% of the subjects had abnormal scores on both tests. Subjects with more schooling had a greater probability of having a positive clock concept (understanding that a circle represented a clock). Of those with more than 6 years of schooling, 91.0% had a positive clock concept. Subjects with a negative clock concept were more likely to have an abnormal Clock Test (93.3%) than a questionnaire (26.6%).**

Conclusions: **The main finding of our study was the discrepancy between the results of the Clock Test and the questionnaire. Performance on the Clock Test appeared to have been heavily influenced by education level, indicating the test is not universally applicable across cultures. The questionnaire-based test appears to reduce the effects of illiteracy on assessing dementia in a Nigerian population. Larger studies should be done to control for how education affects the assessment of dementia.**

Key-words: ***Dementia, Clock test, Questionnaire, Nigeria, Screening.***

Résumé

Introduction: Puisque c'est prévu qu'en 2020 soixante dix pourcent des âgés resideront dans les pays en voie du développment, une méthode (de la selection) de dépistage d'une maladie de la démence et affaiblissement cognitif en général très fiable dans les populations des langues, cultures, éducation. et alphabetisations diverses seront donc nécessaire. Nous tâchons de décider si la pendule test, un test de dépistage pour la démence, était convenable pour l'utilisation dans la population nigériane.

Plan d'étude: Une étude section transversale de 54 hommes et 12 femmes du nord du Nigéria. Des chercheurs avaient administré deux instruments de dépistage pour la démence: un test de la base du questionnaire' adopté pour l'utilisation dans une population nigériane et le test à travers une pendule.

Resultats: Dans l'ensemble, 53,0% des sujets avaient eu le test à travers la pendule anormal 10,6 des sujets avaient eu score questionnaire anormal. Seulement 9,1% des sujets avaient eu des scores anormaux dans les deux tests. Des sujets très lettrés avaient une probabilité élevée d'avoir le concept positif de la pendule (avec la compréhension qu'un cercle représent une pendule). Pour ceux avec plus de 6 ans d'études, 91,0% avaient un concept positif d'une pendule. Des sujets avec le concept négatif de la pendule étaient plus probable d'avoir un test de la pendule anormale (93,3%) plus qu'un questionnaire (26,6%).

Conclusion: Le résultat le plus majeur de notre étude était le désaccord entre les résultats du test à travers la pendule et le questionnaire. La performance sur le test à travers la pendule semble être principalement influencée par le niveau d'éducation, ce qui montre que le test n'est pas applicable universellement en travers de toutes les cultures. Le test basé sur le questionnaire semble à reduire les effets d'analphabétisme au cours d'évaluation de la démence chez la population nigériane. Des études approfondies devraient être effectuées afin de controller comment l'éducation pourrait influencer l'évaluation de la démence.

Introduction

Over the past 50 years the decline in communicable diseases in developing regions of the world has been offset by increases in non-communicable diseases (e.g, obesity, cardiovascular disease, diabetes)[1]. In addition, the proportion of elderly persons is also increasing in devel-

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oping countries. Projections indicate that by the year 2020, there will be approximately one billion individuals over the age of 60 years worldwide and that 70% of the elderly will reside in developing countries[2]. An increased prevalence of age-related dementia and Alzheimer's disease is associated with an aging population.

The prevalence of dementia has been reported to be lower in less-developed regions of the world than in industrialized countries[3-5]. For example, the age-adjusted prevalence of dementia was found to be lower in a Nigerian population than in an African-American population (2.3% versus 4.8%, respectively)[6]. However, the 10/66 Dementia Research group has estimated that two-thirds or more of all individuals with dementia reside in developing countries[7]. Moreover, the mortality risk for individuals with dementia in developing countries has been estimated to be comparable to those in industrialized countries[8]. This underscores the need for a reliable screening method for dementia that is suitable for use in developing countries with diverse populations in regard to culture, education, literacy and language.

There are currently no definitive laboratory tests for dementia. The diagnosis of dementia is made through the combination of cognitive tests, neurological examinations, and brain scans, such as MRI. The most commonly used screening instrument for determining cognitive function is the Mini-Mental State Examination (MMSE)[9]. However, since this test has been criticized for being culturally insensitive and socio-economically and educationally-biased, it may not be suitable for use in a developing country such as Nigeria. Appreciating these limitations, Ogunniyi and coworkers modified the MMSE to assess cognitive function in elderly Nigerians[10]. When the instrument was tested in a pilot study in 250 cognitively-normal Nigerians, their scores were significantly different compared to those of 15 subjects with clinically-diagnosed dementia. It was determined that the modified MMSE had a sensitivity of 93% and a specificity of 83%.

Clock drawing has been used traditionally for the determination of constructional apraxia[11,12], which is recognized as an early disturbance in the development of dementia[11]. More recently, there has been an interest in applying clock drawing to the assessment of cognitive function in the elderly[13,14]. Tuoko and coworkers[15] developed a scoring method for the Clock Test to test its clinical utility for identifying dementia. In several trials, the Clock Test was reported to be highly correlated with other cognitive screening tests such as the MMSE[16-19].

Theoretically, the Clock Test should be independent of the education, ethnicity, or socioeconomic status of the subjects being tested since populations around the world are familiar with the clock face. For this reason, we compared the performance of healthy Nigerian adults using the modified MMSE screening test developed by Ogunniyi and coworkers[10] and which has been validated in a Nigerian population to the Clock Test as scored by Tuoko and associates[15]. Our specific goal was to determine whether the Clock Test is suitable to screen for dementia in a Nigerian population.

Materials and methods

Subjects

The study was conducted in 2002 at the Jos University Teaching Hospital (JUTH), a tertiary care center located in Jos, Nigeria, on a native population consisting of 54 men and 12 women living in the plateau state. The subjects ranged in age from 50 to 87 years and were recruited from family members accompanying patients to various clinics at JUTH and from the hospital staff. Subjects were excluded from the study if they could not comprehend instructions because of language barriers or if they had a previous diagnosis of dementia or loss of cognitive function (e.g., stroke). All 66 subjects participated voluntarily and gave informed consent. This study was approved by the Human Research Review Committee of the University of New Mexico School of Medicine and by the Ethics Review Committee of JUTH. All subjects were interviewed by the same person (MZ). The tests were administered in English. However, if a subject did not speak English then the test was translated and administered in Hausa, which is the predominant indigenous language of the region.

Cognitive function tests

The Clock Test

The Clock test consist of three components: Clock Drawing, in which the subject was given a sheet of paper with a round circle and asked to draw the numbers and hands of the clock to indicate 10 minutes past 11; Clock Setting, in which the subject was given a piece of paper containing five circles, each with clock face dashes but no numbers and told to fill in the hands for the time indicated by the administrator; and Clock Reading where the administrator presented a card with a clock drawn to a certain time and asked the patient to read the time.

The scoring of the Clock test followed the protocol outlined by Tuokko and associates[15] to determine whether the patient's performance met the criteria of an abnormal Clock Test. Scoring was based on objective principles and explicit criteria were applied. An error scoring system was used which takes into account the frequency of specific types of errors. The three subtests (drawing, setting, and reading) were scored individually and compared to a table to calculate a T-score for each subtest. T-scores provide an indication of how the subject performed compared to normal persons of similar age. If two out of the three subtests fell below the cutoffs, then the patient's test result was scored as abnormal (i.e., demonstrating signs of dementia).

The modifications made to the protocol were as follows. First, the clock circle used for the clock-drawing test was about twice as large as that stipulated by Tuokko and co-workers[15] in order to make it easier for the subject to see. The diameter of the clock face was 13 cm. Second, instead of measuring the misplacements of clock drawing with a ruler, a 12-segmented clock was superimposed on top of the drawn one. If the number lay outside the pie segment or on the line, the number would be scored as misplaced. Third, the methodology of not scoring any clock hands that were not within 1 cm of the clock center

was waived, so any hand location directed at or near the correct number location was considered valid.

Prior to administering the Clock test, the eyesight of every subject was tested using a Snellen eye chart. For subjects who were not able to read 20/20 or better, they were given reading glasses of different strengths. Those who could read better with the reading glasses were allowed to use them when performing the Clock test.

The questionnaire-based test

For comparison to the Clock test, a questionnaire-based dementia test developed and validated for Nigerian subjects by Hendrie and associates [5] was administered. The test consisted of 16 verbal questions that the interviewer posed to the subject. The Nigerian dementia test was scored by assigning a value of 1 for a correct answer, and a 2 for an incorrect answer. Subjects were asked to guess rather than leave any question blank. According to Ogunniyi and associates [10], a score of 21 or higher is regarded as an abnormal test and indicative of dementia. Subjects were asked to guess only when they gave a response of "I don't know" to a question and were not prompted to answer one way or another. The interpreter was trained to refrain from prompting subjects and the subjects' relatives, if present during the test, not allowed to cue the subject. All testing sessions were supervised by a physician (MZ or MO).

Statistical analysis

Contingency tables were formulated using SAS Version 8.2 to address three questions: how many people met the criteria for an abnormal test based on cutoffs, do the tests give the same result when compared, and is there an age dependency or age distribution for either test? To determine which aspects of the Clock Tests and the parameters of clock drawing were the most sensitive without compromising specificity, Receiver Operating Characteristic Curves (R.O.C. curves) were created using Stata Version 6.0.

Results

Description of subjects

Table 1 is a summary of the characteristics of the subjects that included 54 men and 12 women (n = 66). About one-third of the subjects (n = 23) had received more than 6 years of formal schooling, another third (n=22) had less than 6 years of schooling, and the remainder (n=21) had no schooling at all. For the male subjects, there was an even distribution of professions between farming, trading, teaching and civil service. There was also an even distribution of male subjects across the three educational categories. The female subjects were primarily traders, teachers and civil servants with no clear distribution across educational categories.

The Clock Test

The number of subjects who had normal and abnormal tests is summarized in Table 2. Twenty-eight of the men (52 %) and seven of the women (58 %) had abnormal Clock Tests. Overall, 35 of the subjects (53%) had an abnormal Clock Test. The number of subjects with abnormal Clock Tests was inversely related to schooling (Table 3). Only 35 % (n =8) of the individuals with greater than 6 years of education had abnormal tests while 81% (n=17) of the individuals with no schooling had abnormal Clock Tests.

The questionnaire

Four of the men (7%) and 3 of the women (25%) were classified as having an abnormal score on the question-

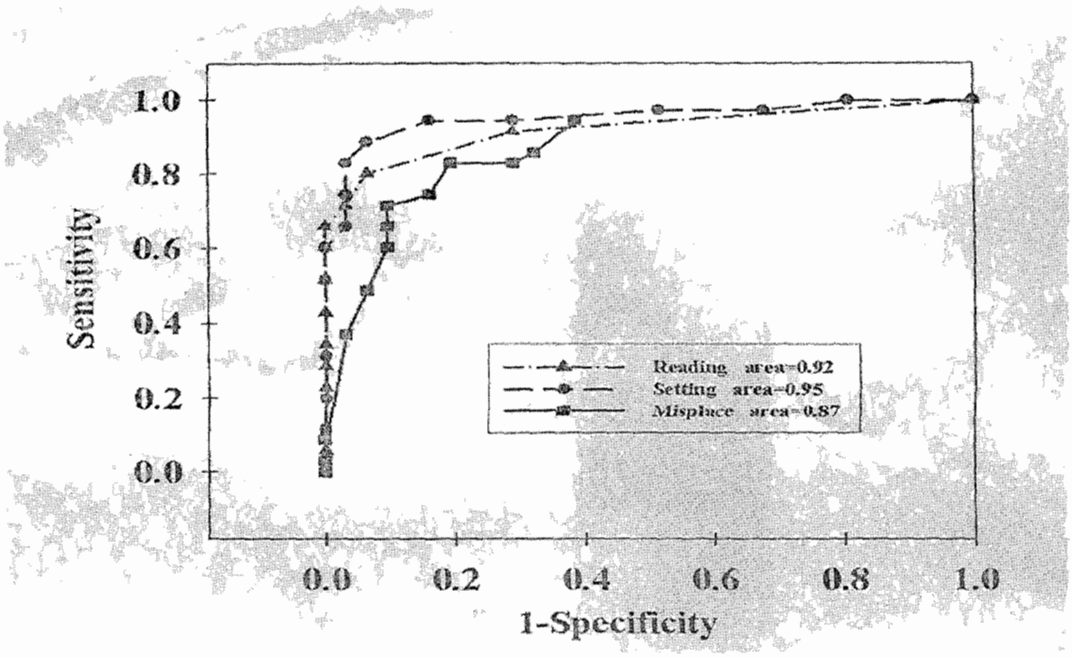

Figure 1 *Receiver operator characteristic curve (R.O.C. curve) for 3 components of the Clock Test: reading, setting and misplacements. The overall score of the Clock test served as the reference.*

Table 1 Summary of the characteristics of the subjects

	Male (n=54)	Female (n=12)
Mean age (yrs)	64.3 ± 9.0	60.3 ± 10.0
Range (yrs)	(50-87)	(50-81)
Education	(n)	(n)
> 6 yrs	22	1
≤ 6 yrs	14	8
No schooling	18	3
Occupation*		
Housework	0	2
Farming	14	0
Trading	13	5
Artisan	1	0
Teacher	14	4
Civil Servant	14	4
Other	11	1

**The total number of responses to the inquiry regarding occupation exceeds the total number of subjects for both the males and females because some subjects reported having two occupations.*

Table 2 Number of subjects exceeding cutoff criteria for dementia for the Clock Test and the questionnaire based test

	Male (n=54)	Female (n=12)
Questionnaire	4 (7.4%)	3 (25.0%)
Clock test	28(51.9%)	7 (58.3%)
Both	4 (7.4%)	2 (16.7%)
Neither	26(48.1%)	4 (33.4%)
Total	62	16

Table 3 Education level and performance of Nigerian subjects on the Clock test and questionnaire based test

	> 6 years (n=23)	≤ 6 years (n=22)	no schooling (n=21)	total (n=66)
Category	**Number of subjects per category**			
Clock test abnormal	8	10	17	35
Clock test normal	15	12	4	31
Questionnaire abnormal	2	1	4	7
Questionnaire normal	21	21	17	59
Positive Clock concept	21	20	10	51
Negative Clock concept	2	2	11	15
Positive Clock concept				
Clock test abnormal	7	8	6	21
Clock test normal	14	12	4	30
Questionnaire abnormal	1	1	1	3
Questionnaire normal	20	19	9	48
Negative Clock concept				
Clock test abnormal	1	2	11	14
Clock test normal	1	0	0	1
Questionnaire abnormal	1	0	3	4
Questionnaire normal	1	2	8	11

Table 4 Comparing Clock Test results with questionnaire results (n =66)

	Clock test abnormal*	Clock test normal
Questionnaire abnormal	6	1
Questionnaire normal	29	30

Percent of agreement = 54.6%
Confidence limits = 41.8% - 66.9%
**Abnormal tests for both the Clock test and the questionnaire denote a designation of dementia based on individual test cutoffs. Normal tests denote a designation of normal cognitive abilities based on individual test cutoffs.*

Table 5 Relationship between age and test performance

	Age < 63 yrs (n=32)	Age ≥ 63 yrs (n=34)
[1]Clock test abnormal*	10	25
Clock test normal	22	9
[2]Questionnaire abnormal	3	4
Questionnaire normal	29	30

Clock test: $\div^2 = 11.83$ *and* $P = .0006$
Questionnaire: $\div^2 = .097$ *and* $p = .75$
**Abnormal tests for both the Clock test and the questionnaire denote a designation of dementia based on individual test cutoffs. Normal tests denote a designation of normal cognitive abilities based on individual test cutoffs.*

naire (Table 2). Thus, only 10.6% (n=7) of all subjects had an abnormal questionnaire score. The number of subjects that had an abnormal questionnaire test was relatively constant across educational divisions (Table 3). Only two of the subjects who had 6 years or more of education (8.7%) exceeded the cut-off of 21, whereas 4 of the subjects (19%) with no schooling had an abnormal questionnaire test.

Comparison of the Clock test to the questionnaire

Only 7 % (n=4) of men and 17 % (n=2) of women had abnormal scores by both tests, while 48 % (n=26) of men and 33 % (n=4) of women were determined to have normal scores by either test (Table 2). The Nigerian questionnaire predicted far fewer individuals as having abnormal results than did the Clock test (35).

The two tests were then compared to determine the level of agreement in their conclusions (Table 4). The percent of agreement was 54.6% and the 95% confidence limits were 41.8%-66.9%, indicating that there is a 95% chance that the population percent agreement is between 41.8% and 66.9%.

Age relationship with cognitive assessment

Numbers of abnormal results were calculated for specific age groups for both the Clock Test and the questionnaire (Table 5). Due to the small number of subjects tested in this study, the population was divided into just two groups: individuals less than 63 years of age and individuals greater than or equal to 63 years of age. For the Clock Test, 25 subjects 63 years of age or older (37.9%) had an abnormal test while only 10 subjects younger than age 63 (15%) had an abnormal test. (chi square= 11.8, $p < 0.001$), indicating an association between age and abnormal results according to the Clock Test.

For the Nigerian dementia questionnaire, only 4 subjects age 63 years or older (6%) were found to have an abnormal test while only 3 subjects less than 63 years of age (4.5%) had an abnormal test (chi square= 0.097, $p = 0.75$). We conclude that according to the Nigerian questionnaire there is no association between age and abnormal results

Components of the Clock Test

We wanted to determine if performance on individual components of the Clock Test was associated with abnormal results. To analyze the relationships between the specific components of the Clock Tests (clock drawing, clock setting and clock reading) and the individual measures of mistakes in clock drawing, Receiver Operating Characteristic (R.O.C.) curves were constructed using the results of the Clock test as the standard and the areas under the curve were calculated (Fig. 1). The closer the area under the curve is to unity, the better a test is at gaining sensitivity without losing specificity. We did not use a gold standard test to compare the components of the Clock test, as is normally done with R.O.C. curves. We used the overall Clock test results as our standard and compared it against the subsets of the Clock test. The additions graph, scored by counting additional numbers added to the clock, was not analyzed since every subject scored a zero, indicating that none of them had any errors on that measurement of clock drawing errors. The tests with the highest values for the area under the R.O.C. curves were the clock setting (0.95), the clock reading (0.92) and the misplacements portion of the clock drawing section (0.87). The clock setting therefore proved to be more accurate in predicting true positive results without detecting false positives, and more effective in detecting abnormal performance than were the other components of the test, as classified by the Clock Test criteria.

Clock concept

A subject was considered to have a negative clock concept if they did not understand that a circle represented a clock and that the numbers must be arranged in a circular fashion as opposed to a line or other arrangement. Subjects with more years of schooling had a greater probability of having a positive clock concept (Table 3). Twenty-one of the subjects with greater than 6 years of schooling (91.3%) and 20 of the subjects with 6 years or less of schooling (91.0%) had a positive clock concept. Of those subjects who declared having no formal education, only 10 had a positive clock concept (47.6%). Comparing the clock concept variable to test results (Table 3) showed that 93.3% of the subjects (n=14) with negative clock concepts had an abnormal Clock Test, while only 26.6% of those subjects (n=4) had an abnormal questionnaire test. The subjects with positive clock concepts also fared better on the questionnaire, since only 5.9% (n=3) had abnormal questionnaire tests and 41.2% (n=21) had an abnormal Clock Test.

Of the 15 subjects with negative clock concepts, there were 14 with abnormal Clock tests. Eleven of the 14 who had an abnormal Clock test had no formal education, whereas only 3 out of those 11 had an abnormal questionnaire test (Table 3). Of the subjects who had a positive clock concept, only one had an abnormal questionnaire result whereas six had an abnormal Clock test result (Table 3). In the positive clock concept group there was also a direct relationship between the extent of schooling and

having a normal Clock Test (Table 3): subjects with less schooling were less likely to have a normal Clock Test since only 4 out of the 21 subjects in the "no schooling" category had a normal test and 14 subjects who had greater than 6 years of education had normal tests.

Discussion

The main purpose of the present study was to compare the performance of healthy Nigerian subjects on two different dementia screening instruments: the Clock Test and the Nigerian dementia questionnaire that was specifically developed for a Nigerian population. Our intent was not to estimate the prevalence of dementia in this population. It is important to understand that the Clock Test and the dementia questionnaire were originally intended to detect cognitive impairment and that the diagnosis of dementia requires second-stage assessment involving neuropsychiatric tests, clinical examination, basic investigations and interviews with close relations. The main finding of the present study was the great discrepancy between the results of the Clock Test and the questionnaire in the Nigerian setting. The Clock Test results appeared to have been greatly influenced by the educational level of the subjects, indicating that the test is not universally applicable across cultures. The questionnaire-based test identified 10% of the subjects as having dementia, a value that is higher than the 2.3% reported Hendrie and colleagues [6], but similar to values reported by other investigators for populations in northern Nigeria [20].

The results obtained using the Clock Test support the contention of Ainslie and colleagues [21] that the Clock Test, particularly the Clock Drawing component, is affected by the education level in non-demented elderly persons. They argued that the effectiveness of the test was influenced by a low education level, since the mean scores of the well educated non-demented subjects were significantly better than mean scores of the poorly educated non-demented subjects. In our study population, 60% of the subjects had less than six years of schooling and many of them had none at all. Subjects that had no schooling were more likely to score positive on the Clock Test (81%, n=17) than on the questionnaire (19%, n=4). This finding is in accord with that of Ainsle and colleagues [21] who found that drawing ability is affected by education in non-demented elderly persons. We found that many subjects in our study had difficulty carrying out the tasks associated with the Clock Test that required writing with a pencil. On the other hand, the questionnaire-based test requiring verbal responses was less influenced by the educational or literacy level of the subjects.

Even though many subjects performed poorly overall on the Clock Test, there were particular aspects of the test on which they performed well. Every subject scored perfectly on the "additions" portion of the Clock Drawing subtest which accounted for extra figures being added to the clock face. Since all of the subjects scored perfectly, (no irrelevant words, lines or figures added to the clock face), this indicates that, in general, the patients had a good sense of the elements that make up a clock face .

Another factor to be considered in interpreting the results of our study was that since the majority of the subjects interviewed were in the age range of 50-80 years, they were adolescents in the colonial period when education was less widely available in the country. Perhaps the Clock Test would be more relevant for assessing dementia in the future for Nigerians who grew up in the post-colonial period when there was greater access to schooling.

Our study had several limitations. First, the small subject size (n=66) limits the conclusions we can make regarding the ability of the two tests to assess dementia. Second, we made adjustments to the Clock Test that could have altered its accuracy. For example, we were more lenient with the scoring on parts of the Clock Drawing in relation to the prescriptions of Tuokko and colleagues [15]. A third limitation of the present study was that some subjects did not understand that a circle represented a clock and that the clock face must be arranged in a circular fashion, rather than linearly or in some other arrangement. This division of some patients into a negative clock concept category complicated the data since there was no way to determine whether a patient's limitations were due to their lack of formal education or because they were actually demented. Some patients within the negative clock concept category wore a watch, suggesting that they were familiar with clocks and perhaps at one time did understand the nature of a clock. In future studies of this kind it would be useful to include: 1) a memory-testing component in the Clock Test, such as asking subjects to recall the time shown previously because memory is a major function affected by dementia in about three-fourths of cases; and 2) the Community Screening Instrument for Dementia (CSID).

Conclusion

The results of our comparison of the Nigerian questionnaire and the Clock Test indicate that the questionnaire-based test appears to reduce the effects of illiteracy on assessing dementia, whereas a more formal written test like the Clock Test may be heavily influenced by one's level of education. It would be useful to test the dementia questionnaire on a larger population in northern Nigeria while at the same time taking into account schooling, employment history and other forms of informal education (travel, fluency in multiple languages, etc.) in order to control for how education affects the assessment of dementia. The components of the Clock Test that were the most sensitive for screening for dementia (Clock Setting, Reading and the misplacements portion of Clock Drawing) should also be further tested for their reliability in assessing dementia in a Nigerian population. The rates of dementia in the Nigerian population may have important implications in understanding dementia. If the Nigerian population were found to have lower rates of dementia compared to comparable populations in industrialized countries, this would provide an opportunity to inquire into environmental or

other modifiable factors (e.g., diet) that might influence the incidence, prevalence or progression of the disease in an underdeveloped region of the world.

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