Dementia and Cognitive Impairment Prevalence and Associated Factors in Indigenous Populations

A Systematic Review

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Abstract: Population aging has been accompanied by worldwide growth in dementia. However, little is known about the prevalence of dementia and cognitive impairment not dementia in ethnically diverse populations, such as indigenous populations conceptualized as groups of persons who self-identify as indigenous and who are recognized as distinctive communities reproducing ancestral, historical, and territorial culture. This is particularly relevant in view of increasing life expectancy in indigenous populations and, consequently, in the number of elderly people, as well as the changes in their multimorbidity profile. In this study, a systematic review of the literature on the subject "cognitive impairment in indigenous elderly population" in the databases MEDLINE via PubMed, Lilacs, and Scopus showed that the prevalence of dementia in indigenous populations between 45 and 94 years old, originally from different countries, varied between 0.5% and 26.8% for age 60 and older, whereas the prevalence of cognitive impairment not dementia varied between 4.4% and 17.7%. Early onset of the disease, older age, low education level, and several poor health conditions were associated with prevalence rates and conversion from normal to any cognitive impairment. Cultural inadequacy of neuropsychological tests was the main factor reported in the selected studies, which makes the investigation of dementia a challenge in indigenous populations. These data reveal that the prevalence rates of dementia ranged from low to very high for those aged 60 years and older, with early onset of the disease and elevated mortality rate after initial diagnosis compared with the current global prevalence studies, suggesting that these individuals may be more vulnerable to cognitive disorders. Cognitive reserve and exposure to poor health status throughout life span may be considered in the interpretation of results.

Key Words: elderly, indigenous population, dementia, Alzheimer disease, vascular dementia, cognitive impairment

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Epidemiological studies have estimated that the prevalence of dementia in the world population varies between 5% and 7%, and it is higher in developing countries.[1–4] In illiterate elderly people, the prevalence is twice as high as in literate individuals.[3,4] Moreover, individuals with cognitive impairment not dementia (CIND), defined as people with lower cognitive performance than expected but who do not meet criteria for dementia, present high risk to develop dementia, showing an annual conversion rate of around 5% to 10%.[5] Nevertheless, it is not clear whether the percentage of dementia and CIND in ethnically diverse populations, such as indigenous people, is different from the general population. Indigenous people are defined as those who fulfill the following: "self-identification as indigenous people at the individual level and accepted by the community as their member; historical continuity with precolonial and/or presettler societies; strong link to territories and surrounding natural resources; distinct social, economic, or political systems; distinct language, culture, and beliefs; form nondominant groups of society; resolve to maintain and reproduce their ancestral environments and systems as distinctive peoples and communities."[6] The United Nations recognizes the "indigenous population" term as a question of identity whereby the fundamental criterion is self-identifcation.[6]

According to the World Health Organization, there are over 370 million indigenous people in developed and developing countries worldwide.[7] In Canada and Australia, the indigenous population has grown, and it will increase more in the coming years.[8,9] Given the poorer health status of indigenous people compared with the overall population, the World Health Organization has been mandating a special work plan and resolutions focused on promoting better health outcomes allied to human rights protection.[7]

The epidemiological disease profile of the indigenous population has been gradually changing from a scenario characterized by infectious and parasitic disorders to a current increase in rates of noncommunicable chronic diseases such as hypertension, diabetes, and respiratory diseases, as well as smoking.[8,10] Considering the strong relationship between aging, cardiovascular risk factors, low education, and dementia, an increase in its prevalence needs to be considered in the indigenous people.[11–13]

Several studies have reported higher dementia prevalence in Australian aboriginal people compared with the local overall population.[8] However, a more global overview about the prevalence of dementia in this population is mandatory to establish risk factors and to support international health policy-makers for indigenous people.

Thus, we aimed to describe the prevalence of dementia and CIND in indigenous populations from different countries based on a systematic review of the literature.

METHODS

Study Design and Inclusion and Exclusion Criteria

In this study, a systematic review of the literature on the subject "cognitive impairment in the indigenous elderly

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population" was undertaken, according to the PRISMA (Preferred Reporting Items for Systematic Reviews and Meta-Analyses) criteria.[14] To meet the proposed objectives, we included original articles, published in full in the indexed periodicals, with no time limit, which analyzed the prevalence of dementia and CIND in adults starting with 40-year-olds and with elderly indigenous people (60 y or older) evaluated by standardized and validated neuropsychological tests. Bibliographic review articles, update articles, editorials, letters to the editor, and articles published only in the form of abstracts were excluded. Articles covering cognitive assessment methods without showing data on the prevalence or frequency of cognitive changes in the indigenous population, and articles using tests that have not been validated in the literature, were also excluded. The inclusion and exclusion criteria were reviewed by 2 of the authors (A.P.d.C. and J.N.d.S.-T.). A third author resolved all disagreements.

Search Strategy

The search was conducted from January to September 2015 in the electronic database MEDLINE via PubMed, Lilacs, and Scopus. To ensure that the largest possible number of articles on the theme were included, a manual search for studies was conducted in the bibliographical references of the publications that were found in the digital search and also in gray literature (conference proceedings and governmental reports). We used the PICO strategy to search the articles,[15] and the purpose was to answer the following question: "What is the prevalence of dementia and cognitive impairment in indigenous populations?" With this strategy, the following terms were used: Participants (P) = elderly indigenous population descriptors for Indians; Intervention (I) = cognitive impairment—descriptors dementia, cognitive impairment, Alzheimer disease and vascular dementia; Comparison (C) = there is no comparison; Outcome (O) = prevalence. To select the descriptors, we used the tools MeSH (Medical Subject Headings Section) of PubMed/MEDLINE and DeCS (Descriptors in Health Sciences) of the BVS Portal, as well as combinations of synonyms from previous readings. For details about the terms used in each database, see Table 1.

Selection, Data Extraction, and Quality of Articles

Initially, the articles were identified by title and abstract, and those that did not meet the inclusion and exclusion criteria were rejected. Those that were duplicated in the database were also excluded. Next, the articles were fully and selectively read to choose those that indeed met the purposes of the research.

Authors performed the data extraction twice, and all disagreements were resolved. The data extracted were: (1) prevalence of dementia and CIND, or percentage of indigenous people with low cognitive performance as a primary outcome variable; (2) sociodemographic data (age, sex, ethnicity); (3) sample size; (4) neuropsychological tests used; and (5) study design (cross-sectional or longitudinal).

Age-standardized prevalence rates were extracted from the selected studies when participants below 60 years old were included. The quality of selected studies was assessed using the criteria established in "Strengthening the Reporting of Observational Studies in Epidemiology (STROBE),"[16] which is composed of a checklist with 22 items regarded as essential for the transparent communication of observational studies. The assessment of the quality of the articles was made twice by the authors, in a blinded manner. Given the heterogeneity between the studies selected regarding age, cognitive assessment, and control of confounding factors, no meta-analysis was conducted.

RESULTS

Research Results

The search in the databases resulted in a total of 143 articles, and 7 studies recovered from the articles selected references, conference proceedings, governmental reports, related publications in the database or in journal databases (eg, Scielo) totaling 150 records (Fig. 1). Initial sorting eliminated 6 articles that were duplicated in the database and 127 articles that did not meet the inclusion and exclusion criteria. Of the 17 articles selected, 4 were excluded after they were fully read, because they did not show a percentage of elderly indigenous people with cognitive change (Fig. 1). Therefore, in all, 13 articles were analyzed to compose the current literature review (6 from the database search and 7 from the manual search; Fig. 1).

Characteristics of the Studies

Eleven of the 13 studies included in the systematic review were cross-sectional studies, published predominantly in the past 8 years, with samples composed of Australian, American, Brazilian, and Canadian indigenous participants. In one of the Brazilian studies, the samples were composed of the local community in the river bank of the Amazon Forest that was descendent of indigenous groups and that was historically linked to indigenous territories and surrounding natural resources reproducing several elements of the indigenous ancestral environment.[17] The participants in the studies were mostly women aged 45 years or older with a low level of education (Table 2).

TABLE 1. Databases and Search Descriptors

Database	Search Descriptors
MEDLINE/ PubMed	(((((((("Aged"[Mesh]) AND "African Continental Ancestry Group"[Mesh]) OR "American Native Continental Ancestry Group"[Mesh]) OR "Asian Continental Ancestry Group"[Mesh]) OR "European Continental Ancestry Group"[Mesh]) OR "Oceanic Ancestry Group"[Mesh]) OR "Inuits"[Mesh]) AND indigenous population AND "Prevalence"[Mesh]) AND ("Dementia, Vascular"[Mesh] OR "Alzheimer Disease"[Mesh] OR "Dementia"[Mesh] OR "Delirium, Dementia, Amnestic, Cognitive Disorders"[Mesh])
LILACS	("AGED")[Descritor de assunto] AND ("INDIGENOUS POPULATION"[Descritor de assunto] AND ("PREVALENCE") [Descritor de assunto] AND ("DEMENTIA") [Descritor de assunto] OR ("ALZHEIMER DISEASE")[Descritor de assunto] OR ("DEMENTIA, VASCULAR")[Descritor de assunto]
SCOPUS	"AGED" AND "INDIGENOUS" AND "PREVALENCE" AND "DEMENTIA" AND "COGNITIVE IMPAIRMENT" OR "ALZHEIMER DISEASE" OR VASCULAR DEMENTIA"

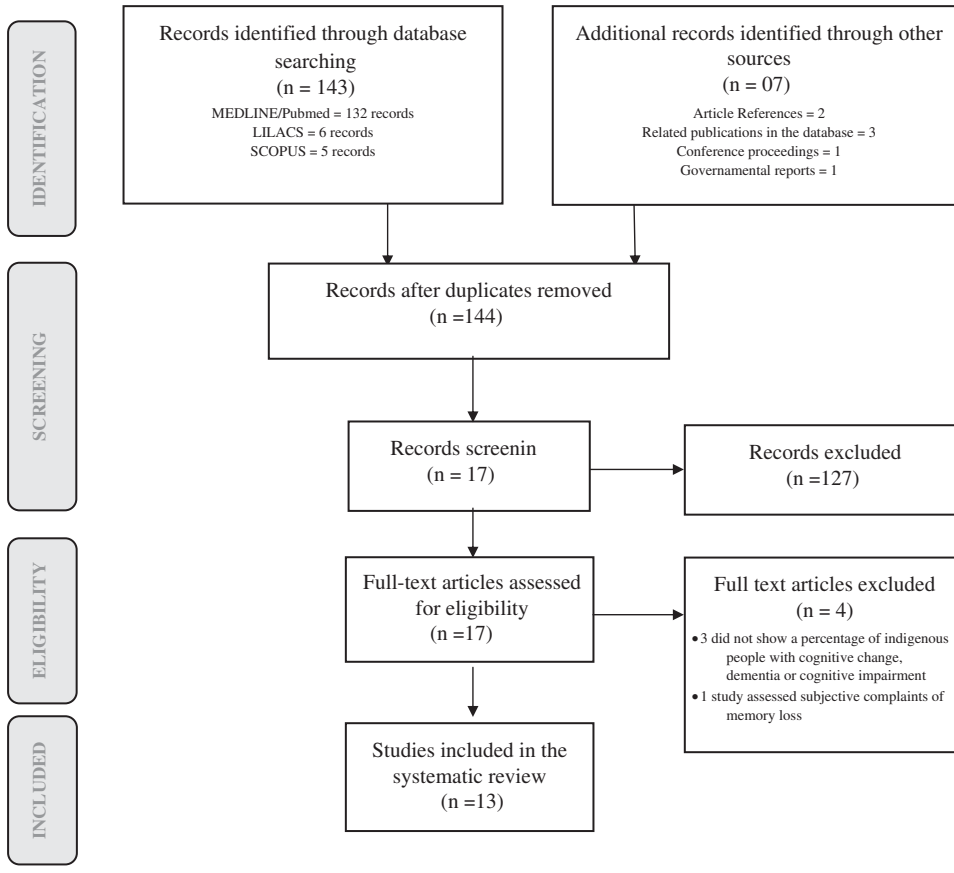

FIGURE 1. Diagram flow of records and studies included in the systematic review.

Prevalence of Dementia and CIND in the Indigenous People

The prevalence of dementia observed in the studies varied between 0.4% and 26.8%, whereas the prevalence of CIND varied between 4.4% and 17.7%. Alzheimer disease (AD) was the most common subtype of dementia reported in 3 of the selected studies.[19,27,28] One study did not report the prevalence of dementia. Instead, the authors showed that 27.4% of the indigenous sample showed cognitive performance below the cutoff scores in the neuropsychological assessment[20] (Table 2).

Factors Associated With Dementia in Indigenous People

Among nonmodifiable factors, age, sex, and genotype were the variables investigated as factors associated with dementia in indigenous people. Five of the selected studies showed that high prevalence rates or low cognitive performance were associated with elevated age.[17,19,27,28] More than half of the studies reported early onset of cognitive impairment (dementia or CIND)—that is, before 65 years of age.[9,17,20,21,23–28] The incidence rate ratios of indigenous to nonindigenous were higher for the younger age groups (45 to 64 y).[26] One study showed a sex effect on cognitive performance.[20] Women performed better than men even when education and health conditions were controlled in the analysis.[20] APOE-ϵ4 was also analyzed in 2 cross-sectional studies, but no significant associations were found.[19,20]

In regard to the modifiable factors, decreased education level[17,19,20,28] and health conditions were associated with high rates of dementia.[22,28] Poor mobility, head injury, analgesic medications, and low body mass index (BMI), measured after the follow-up period of 6.7 years, were associated with cognitive impairment (CIND or dementia) in indigenous people.[28] In that same period, stroke, head injury, analgesic medication, low BMI, and higher systolic blood pressure were associated with decline from normal at the beginning of the study to CIND or dementia at the follow-up period.[28] During this period, 77% of the participants who were initially diagnosed with dementia and 43% with CIND died.[28] Another study showed that 38% of the American Indians died after an average follow-up period of 2.4 years.[22]

DISCUSSION

The review of the selected studies after a systematic search of the literature revealed that indigenous people showed very diverse prevalence of dementia or CIND ranging from low to very high prevalence rates with early onset of the disease and elevated mortality rate after initial diagnosis. Data were obtained from study samples composed of indigenous people between 45 and 94 years of age who were natives from Canada, the United States, Australia, and Brazil.

Prevalence rates of dementia varied between 0.5% and 26.8% for those aged 60 years and older,[9,18–21,27] and

TABLE 2. Characteristics and Results of the Studies Included in the Systematic Review

		Sample						Prevalence	
References	Study Design	Indigenous Population Sample Size	Country of Origin	Sex (% F)	Age Range Mean (± SD)	Education Range (y) Mean (± SD) (% Illiterate)	Cognitive Assessment	Dementia	CIND
Hall et al[18]	Cross-sectional	198	Canada	51.5	≥ 65 NA	0-11 NA (47)	DSM-III-R CSI'D' based on CAMDEX MMSE CARE DSR East Boston Memory Test	4.2%*	NA
Galasko et al[19]	Cross-sectional	2029	United States of Guam	62.0	≥ 65 73.8 (6.0)	NA 9.4 (4.0) (0)	DSM-IV CASI CERAD Word list Digit Span Boston Naming Clock drawing Block design category fluency Digit-Symbol substitution Odd-Man Out Trailmaking Grooved Pegboard	12.2%†	4.4%†
Jervis et al[20]	Cross-sectional	137	United States	71.4	≥ 60 69.8 (6.4)	0-18 10.5 (2.6) NA	MMSE MDRS	10.9%‡ for MMSE	27.4%‡ for MDRS
Smith et al[21]	Cross-sectional	363	Australia	55	≥ 45 60.9 (11.9)	0-12 NA (40)	KICA DSM-IV	12.4% 26.8% in those ≥ 65 y	8% 13.4% in those ≥ 65 y
Mehta et al[22]	Longitudinal	162	United States	68	≥ 65 78.2 (7.0)	NA 11.1 (3.5) NA	MMSE Neuropsychological battery from NACC	0.5%	NA
British Columbia Provincial Health Officer[23]	Cross-sectional	357	Canada	56.9	≥ 60 NA	NA	Clinical diagnosis	0.6%*	NA
Caixeta et al[24]	Cross-sectional	108	Brazil	68.5	≥ 60 72.4 (8.7)	0 0 (100)	MMSE	6.4%	NA
Cotter et al[25]	Cross-sectional	1668	Australia	NA	≥ 45	NA	Clinical diagnosis ACAP database	0.4%-6.3%	NA
Jacklin et al[9]	Cross-sectional	129,774	Canada	NA	≥ 60	NA	Clinical diagnosis ICP-9	7.5%*	NA
Li et al[26]	Cross-sectional	11 646	Australia	56.1	≥ 45 (median, 72 y)	—	Clinical diagnosis ICD-10 ICPC ACAP database	6.5%*	NA
Brucki et al[17]	Cross-sectional	163	Brazil	50.3	≥ 50 62.3 (9.2)	0-11 0.8 (1.55) (32.5)	MMSE BCSB	4.9% 12.3% in those ≥ 65 y	6.1% 7.7% in those ≥ 65 y
Radford et al[27]	Cross-sectional	336	Australia	59.5	≥ 60 66.6 (6.3)	NA NA (0.9)	KICA MMSE RUDAS	21.0%*	17.7%*
Lo Giudice et al[28]	Longitudinal	363	Australia	55.0	≥ 45 65.4 (10.3)	NA NA (40.0)	KICA DSM-IV ICD-10	7.3% 21.0% in those ≥ 65 y	14.3%§

*Age-standardized rates.
†Estimated based on the number of participants alive at the prevalence day (n = 1984).
‡Percentage of individuals whose test performance was 2 SDs below the mean.
§Estimated based on the number of followed-up participants (n = 189).
BCSB indicates Brief Cognitive Screening Battery; CASI, Cognitive Assessment Screening Instrument; CAMDEX, Cambridge Mental Disorders of the Elderly Examination; CERAD, Consortium to Established to Establish a Registry for Alzheimer's Disease; CIND, cognitive impairment not dementia; F, female; MMSE, Mini-Mental State Examination; MDRS, Mattis Dementia Ratting Scale; NA, not applicable; KICA, Kimberley Indigenous Cognitive Assessment.

ranged from 4.4% to 17.7%[17,19,21,27,28] for CIND. AD was the most common subtype of dementia.[19,27,28] One of the selected studies did not calculate the prevalence of dementia, but it showed that 10.9% to 27.4% of the indigenous population had lower cognitive performance than the cutoff established by the Mini-Mental State Examination (MMSE) and Mattis Dementia Ratting Scale (MDRS).[20] In recent years, the global prevalence of dementia recorded in the general population aged over 60 years has varied between 5% and 7% in most countries of the world, with higher prevalence in Latin American countries (8.5%) and lower prevalence in the Sub-Saharan Africa region (2% to 4%).[1–4] Another systematic review study that used the Delphi method of consensus identified worldwide prevalence between 3% and 9%.[29] In addition to varying in view of the socioeconomic characteristics of the country, the prevalence of dementia is higher in women and in older people.[2,29] In the current review, approximately 30% of the selected studies reported higher rates of dementia compared with these global and regional prevalence rates. Although the factors explaining the prevalence of dementia among indigenous populations are unknown, a potential explanation is related to the cognitive reserve and health conditions over the course of life.

With regard to the cognitive reserve, there is evidence that some people may tolerate brain changes associated with age or pathologic changes such as those that occur in AD better, keeping brain functionality.[30,31] Cognitive reserve has been associated with the employment of preexisting or compensatory cognitive processing brain mechanisms to manage present brain damage.[30,31] Among the factors associated with cognitive reserve are educational level, occupational activity, and execution of leisure activities during the aging process. Elderly people with 8 or less years of schooling or low occupational activity during their lives have approximately twice the risk of developing dementia when compared with elderly people with more years of study or who were included in work activities for longer periods of time.[30–32] Neuroimaging and neuropathologic findings revealed that AD patients with higher education, leisure activities, and occupational attainment tolerate more AD pathology than those with lower cognitive reserve.[32–35] According to the theoretical model of cognitive reserve, neuropathologic hallmarks of brain damage allied to clinical signs of cognitive impairment may also vary as a function of cognitive reserve.[30] Patients with a mild burden of AD pathology and lower cognitive reserve might exhibit clinical signs of severe dementia, whereas those with higher cognitive reserve might appear to be clinically normal. Interestingly, in the current review, several cases of dementia and CIND were detected early from those aged 45 years. Furthermore, indigenous populations at younger age groups, ranging from 45 to 64 years, showed higher incidence rates compared with nonindigenous populations at the same age range.[26] The percentage of indigenous people with little or no formal education was highly significant, and no formal education among Australian aboriginal people was associated with dementia.[36] Altogether, these findings suggest that low cognitive reserve because of low educational level in indigenous populations may explain earlier clinical signs of cognitive impairment compared with nonindigenous general populations. Even so, other factors associated with cognitive reserve, such as occupational activities, need to be accurately investigated in future studies, as the education level may not represent the best indicator of optimal cognitive functioning.[30]

It is necessary to consider that the level of education is significantly related to performance in some cognitive tests, but it is not related to the ability to solve daily problems—that is, it is not related to a limitation in functional intelligence.[37–41] In this sense, the assumption that people with low education are to a certain extent "cognitively limited" may be wrong. Actually, cognitive performance in neuropsychological tests reflects knowledge and skills that are more developed in regard to a certain historical and sociocultural context.[38] In view of this, cultural adaptation of neuropsychological instruments considering cognitive skills predominantly used in the daily context of indigenous life is essential to understanding the cognitive skills of learning and information management, and, consequently, to identifying pathologic cognitive impairment.

The poor health status in the course of life of the indigenous population is another relevant factor to be considered in the interpretation of dementia prevalence in these people. One of the reviewed studies showed that age, head injury, stroke, poor mobility, analgesic medications, low BMI, and higher systolic blood pressure were associated with cognitive impairment or conversion from normal to CIND and dementia.[28] In addition, high mortality after dementia diagnosis was reported.[22,28] The acculturation of the native population has led to significant changes in their lifestyle and an increase in consumption of processed and shop-bought foods in the detriment of traditional foods[42] contributing to the onset of cerebrovascular risk factors.[36,42] Epidemiological and neuropathologic findings have associated vascular risk factors with AD and vascular dementia.[43] Although little evidence is available, higher rates of hypertension, diabetes, and dyslipidemia, known factors associated with cerebrovascular diseases, have been reported in indigenous compared with nonindigenous people.[7,8,10,36] In addition, unhealthy behaviors such as smoking and alcohol abuse are other potential elements increasing vulnerability and influencing health among indigenous people.[36] Overall, the complex and interrelated factors such as income, education, living conditions, employment, stress, and social support constitute social determinants of health capable of influencing mortality, morbidity, and therefore vulnerability to cognitive impairment among indigenous populations.

The most relevant limitation indicated by the selected studies was the degree of validity of the neuropsychological tests in relation to their lack of cultural adaptation to the indigenous population. Although the instruments used were validated and were regarded as a reference for the diagnosis of dementia, we can question whether the diagnostic accuracy of these instruments may have been influenced by sociocultural characteristics of the indigenous population. One of the studies developed a dementia screening interview for the indigenous population composed of cognitive assessment and informant interview based on items from the Cambridge Mental Disorders of the Elderly Examination and MMSE adapted for detecting cognitive impairment in populations with very different cultural and linguistic identities showing high sensitivity and specificity rates for clinical diagnosis of dementia.[18] Four studies used modified versions of traditional neuropsychological assessment such as the MMSE,[17,20,24] Consortium to Establish a Registry for Alzheimer's Disease,[19] and MDRS[20] to minimize cultural bias related to the cognitive assessment. However, any psychometric measure was performed to analyze the validity properties of those modified instruments. Other authors used

the Cognitive Assessment Screening Instrument (CASI) and the Brief Cognitive Screening Battery that are relatively easy tests of episodic memory that show low influence of education level.[17,19] The CASI was validated in populations with little or no formal education, showing high sensitivity for the diagnosis of dementia.[44] In 3 of the selected studies, the researchers used a test that was especially created for the local indigenous population [Kimberley Indigenous Cognitive Assessment (KICA)], with validated psychometric properties of sensitivity and specificity among Aboriginal Australians from urban and remote regions.[27,45,46] The KICA provides information on cognitive assessment, general health care perceptions, activities of daily living, and behavioral and psychological symptoms reported by both participant and informant.[45] KICA's authors reported that the instrument could be used in participants with visual and verbal impairment without compromising the evaluation.[45] Instruments that were less sensible to education level and preferably adapted to the regional indigenous characteristics should be considered to diminish the culture effect of cognitive assessment. Given that the critical issue in the neuropsychological tests is related to their inadequacy to evaluate individuals with low education level, it is hypothesized that the rates reported in the studies may be overestimated (the lower cognitive performance may not represent their real cognitive ability). However, the rates may also be underestimated when we consider not only the cultural inadequacy of the test but also their insensitivity for a certain cognitive domain. For example, MMSE is a global measure of cognitive function, and it is not very sensitive for specific domains such as executive function, which is a relevant function in some subtypes of dementia. Studies on the prevalence of dementia face great obstacles, such as the absence of a diagnostic test that may be accepted as a "gold standard" and the difficulty of using tracking instruments validated in other countries that may have very different accuracies depending on cultural and social factors and the need to adapt items or modify cutoff scores.[35] International Networks in the investigation of dementia in indigenous populations may represent an interesting strategy to discuss those obstacles, to propose solutions, and to conduct more global epidemiological studies. Lastly, it is necessary to mention that the selected studies show the percentage of indigenous persons with cognitive impairment or dementia based on randomized nonpopulation samples predominantly circumscribed by the socioeconomic context of developed countries. Only 2 studies were conducted in a developing country.[17,24] Therefore, studies of world prevalence emphatically report that the percentage of people affected by dementia varies significantly depending on the country and its level of social and economic development.[2–16,18–25] In this sense, the prevalence range in this research may not reflect the real global and regional percentage of cognitive impairment in this population.

In general terms, this systematic review showed that, in the 20 years since the first evidence of the prevalence of cognitive impairment in elderly indigenous populations, very few studies have been conducted on the theme, and most have been conducted in developed countries. The need for evidence in different regions of the world, especially in emerging countries, to overcome limitations related to the cultural adaptation of cognitive instruments is relevant to guiding treatment and prevention of indigenous health problems in a scenario of aging populations and changing multimorbidity profiles.

REFERENCES

1. Custodio N, Herrera-Perez H, Lira D, et al. Prevalence of frontotemporal dementia in community-based studies in Latin America: a systematic review. *Dement Neuropsychol*. 2013;7:27–32.
2. Prince M, Bryce R, Albanese E, et al. The global prevalence of dementia: a systematic review and metaanalysis. *Alzheimers Dement*. 2013;9:63–75.
3. Nitrini R. Dementia incidence in middle-income countries. *Lancet*. 2012;380:1470.
4. Nitrini R, Caramelli P, Herrera E Jr, et al. Incidence of dementia in a community-dwelling Brazilian population. *Alzheimer Dis Assoc Disord*. 2004;18:241–246.
5. Mitchell AJ, Shiri-Feshki M. Rate of progression of mild cognitive impairment to dementia—meta-analysis of 41 robust inception cohort studies. *Acta Psychiatr Scand*. 2009;119:252–265.
6. United Nations. Indigenous people, indigenous voice: permanent forum on indigenous issues; 2007. Available at: http://www.un.org/esa/socdev/unpfii/documents/5session_factsheet1.pdf. Accessed January 10, 2015.
7. World Health Organization. Indigenous people's health: health and human rights; 2007. Available at: http://www.who.int/hhr/activities/indigenous_peoples/informationsheetenglishrev.pdf?ua = 1. Accessed March 18, 2015.
8. Flicker L, Holdsworth K. Aboriginal and torres Strait islander people and dementia: a review of the research—a report for Alzheimer's Australia. Available at: https://fightdementia.org.au/sites/default/files/Alzheimers_Australia_Numbered_Publication_41.pdf. Accessed March 18, 2015.
9. Jacklin KM, Walker JD, Shawande M. The emergence of dementia as a health concern among First Nations populations in Alberta, Canada. *Can J Public Health*. 2012;104:e39–e44.
10. Ferreira MEV, Matsuo T, Souza RKT. Demographic characteristics and mortality among indigenous peoples in Mato Grosso South State, Brazil. *Cad Saude Publica*. 2011;27:2327–2339.
11. Anstey KJ, von Sanden C, Salim A, et al. Smoking as a risk factor for dementia and cognitive decline: a meta-analysis of prospective studies. *Am J Epidemiol*. 2007;166:367–378.
12. Peters R, Poulter R, Warner J, et al. Smoking, dementia and cognitive decline in the elderly, a systematic review. *BMC Geriatr*. 2008;8:36.
13. Qiu C, Fratiglioni L. A major role for cardiovascular burden in age-related cognitive decline. *Nat Rev Cardiol*. 2015;12:267–277.
14. Moher D, Liberati A, Tetzlaff J, et al. Preferred reporting items for systematic reviews and meta-analyses: the PRISMA statement. *Ann Intern Med*. 2009;151:264–269.
15. Santos CMC, Pimenta CAM, Nobre MRC. The PICO strategy for the research question construction and evidence search. *Rev Lat Am Enfermagem*. 2007;15:508–511.
16. von Elm E, Altman DG, Egger M, et al. The strengthening the reporting of observational studies in epidemiology (STROBE) statement: guidelines for reporting observational studies. *Lancet*. 2007;370:1453–1457.
17. Brucki SMD, Nitrini R. Cognitive impairment in individuals with low educational level and homogeneous sociocultural background. *Dement Neuropsychol*. 2014;8:345–350.
18. Hall KS, Hendrie HC, Brittain HM, et al. The development of a dementia screening interview in two distinct languages. *Int J Meth Psych Res*. 1993;3:1–28.
19. Galasko D, Salmon D, Gamst A, et al. Prevalence of dementia in Chamorros on Guam: relationship to age, gender, education, and APOE. *Neurology*. 2007;68:1772–17781.
20. Jervis LL, Beals J, Fickenscher A, et al. Performance on the Mini-Mental State Examination and Mattis Dementia Rating Scale among older American Indians. *J Neuropsychiatry Clin Neurosci*. 2007;19:173–178.

21. Smith K, Flicker L, Lautenschlager NT, et al. High prevalence of dementia and cognitive impairment in indigenous Australians. *Neurology*. 2008;71:1470–1473.
22. Mehta KM, Yaffe K, Pérez-Stable EJ, et al. Race/ethnic differences in AD survival in US Alzheimer's Disease Centers. *Neurology*. 2008;70:1163–1170.
23. British Columbia Provincial Health Officer. *Pathways to Health and Healing: 2nd Report on the Health and Well-being of Aboriginal People in British Columbia: Provincial Health Officer's Annual Report 2007*. Victoria, BC: Ministry of Healthy Living and Sport; 2009.
24. Caixeta L, Reis G. Dementia prevalence in indigenous population from Brazilian Amazon (abstract only). Presented at the 15th Congress of the European Federation of Neurological Societies. *Eur J Neurol*. 2011. pp. 344–620. Budapest, Hungary.
25. Cotter PR, Condon JR, Barnes T, et al. Do Indigenous Australians age prematurely? The implications of life expectancy and health conditions of older Indigenous people for health and aged care policy. *Aust Health Rev*. 2012;36:68–74.
26. Li SQ, Guthridge SL, Aratchige PE, et al. Dementia prevalence and incidence among the Indigenous and non-Indigenous populations of the Northern Territory. *Med J Aust*. 2014;200: 465–469.
27. Radford K, Holly A, Mack HA, et al. Prevalence of dementia in urban and regional aboriginal Australians. *Alzheimers Dement*. 2015;11:271–279.
28. Lo Giudice D, Smith K, Fenner S, et al. Incidence and predictors of cognitive impairment and dementia in Aboriginal Australians: a follow-up study of 5 years. *Alzheimers Dement*. 2015;18:S1552–S5260.
29. Ferri CP, Prince M, Brayne C, et al. Global prevalence of dementia: a Delphi consensus study. *Lancet*. 2005;366:2112–2117.
30. Stern Y. Cognitive reserve in ageing and Alzheimer's disease. *Lancet Neurol*. 2012;11:1006–1012.
31. Stern Y. What is cognitive reserve? Theory and research application of the reserve concept. *J Int Neuropsychol Soc*. 2002;8:448–460.
32. Farfel JM, Nitrini R, Suemoto CK, et al. Very low levels of education and cognitive reserve: a clinicopathologic study. *Neurology*. 2013;81:650–657.
33. Stern Y, Alexander GE, Prohovnik I, et al. Inverse relationship between education and parietotemporal perfusion deficit in Alzheimer's disease. *Ann Neurol*. 1992;32:371–375.
34. Stern Y, Alexander GE, Prohovnik I, et al. Relationship between lifetime occupation and parietal flow: Implications for a reserve against Alzheimer's disease pathology. *Neurology*. 1995;45:55–60.
35. Scarmeas N, Zarahn E, Anderson KE, et al. Association of life activities with cerebral blood flow in Alzheimer disease—implications for the cognitive reserve hypothesis. *Arch Neurol*. 2003;60:359–365.
36. Smith K, Flicker L, Dwyer A, et al. Factors associated with dementia in Aboriginal Australians. *Aust N Z J Psychiatry*. 2010;44:888–893.
37. Ostrosky-Solis F, Ardila A, Rosselli M, et al. Neuropsychological test performance in illiterate subjects. *Arch Clin Neuropsychol*. 1998;13:645–660.
38. Rosselli M, Ardila A. The impact of culture and education on non-verbal neuropsychological measurements: a critical review. *Brain Cogn*. 2003;52:326–333.
39. Souza-Talarico JN, Caramelli P, Nitrini R, et al. The influence of schooling on working memory performance in elderly individuals without cognitive decline. *Dement Neuropsychol*. 2007;1:276–281.
40. Ardila A, Ostrosky F, Mendoza V. Learning to read is much more than learning to read: a neuropsychologically based reading program. *J Int Neuropsychol Soc*. 2000;6:789–801.
41. Cornelious SW, Caspi A. Everyday problem solving in adulthood and old age. *Psychol Aging*. 1987;2:144–153.
42. Sharma S. Assessing diet and lifestyle in the Canadian Arctic Inuit and Inuvialuit to inform a nutrition and physical activity intervention programme. *J Hum Nutr Diet*. 2010;23:5–17.
43. Knopman DS, Roberts R. Vascular risk factors: imaging and neuropathologic correlates. *J Alzheimers Dis*. 2010;20:699–709.
44. Liu HC, Chou P, Lin KN, et al. Assessing cognitive abilities and dementia in a predominantly illiterate population of older individuals in Kinmen. *Psychol Med*. 1994;24:763–770.
45. LoGiudice D, Smith K, Thomas J, et al. Kimberley Indigenous Cognitive Assessment tool (KICA): development of a cognitive assessment tool for older indigenous Australians. *Int Psychogeriatr*. 2006;18:269–280.
46. Lo Giudice D, Strivens E, Smith K, et al. The KICA Screen: the psychometric properties of a shortened version of the KICA (Kimberley Indigenous Cognitive Assessment). *Australas J Ageing*. 2011;30:215–219.