Dementia and Geriatric Cognitive Disorders Extra

Research Article

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Dementia and Cognitive Impairment in an Urban Multiethnic Indigenous Community from Amazonas

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Keywords
Cognition · Dementia · Indigenous people · Urban area

Abstract
Introduction: Studies about dementia in Indigenous communities are still scarce worldwide, especially in low-middle-income countries, limiting timely intervention in minority groups. Our research aimed to bridge this gap by determining the prevalence of dementia and mild cognitive impairment no dementia (CIND), and the associated factors, in a multiethnic Indigenous community in Manaus, Brazil. ***Methods:*** A cross-sectional observational study evaluated the cognitive and functional performances of 141 Indigenous individuals (aged 50 and above). A panel of dementia neurologist experts independently analyzed cognitive (Mini-Mental State Exam [MMSE], Brief Cognitive Screening Battery, verbal fluency), functional (Pfeffer questionnaire) performances, and depression symptoms (Geriatric Depression Scale) to classify participants as cognitively unimpaired, CIND, and dementia. ***Results:*** CIND rate was 11.3% and 12.8% for dementia. None of the participants classified as CIND had a prior diagnosis, and only three out of 18 participants with dementia had a diagnosis. Stratified analysis showed that age ($p = 0.017$) and lower education ($p = 0.047$) were associated with higher CIND and dementia. However, only age was significantly associated with dementia in the regression models (OR = 1.078; 95% CI: 1.011–1.149). Sex, living in extreme poverty, hypertension, diabetes, smoking, or excessive alcohol use was not linked to CIND or dementia. ***Conclusion:*** The Indigenous community of Manaus exhibited higher rates of dementia and CIND than national and global estimates. These findings may set the stage for additional research into the interplay of social, economic, biological, and behavioral factors affecting dementia risk in underrepresented groups such as Indigenous communities.

Introduction

Dementia remains one of the leading causes of disability and dependence in older people worldwide [1, 2]. In 2019, an estimated 57.4 million people were living with dementia, a number set to rise to 152.8 million cases by

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2050, with around 60% of cases occurring in low- and middle-income countries (LMIC) [1, 2]. In Latin America, estimated dementia prevalence ranges from 8.5% to 11% [3–6]. In Brazil, the overall prevalence of dementia in older adults aged >60 years was 5.8%, while the prevalence of cognitive impairment no dementia (CIND) was 8.1% [7].

In this context, the Indigenous population has become a focus of attention, a group known to experience worse health outcomes [8]. Globally, dementia disproportionately affects Indigenous populations [9], mainly owing to social, economic, and cultural barriers that restrict access to healthcare resources [9–11]. In addition, there is a high number of potentially modifiable risk factors associated with dementia in this population, such as hypertension, diabetes, low education, and unhealthy life habits, including sedentarism, tobacco use, and alcohol abuse [10, 11].

The prevalence of dementia ranges from 0.4 to 26.8% in Indigenous populations from Australia, the USA, and Canada [10]. In LMICs, a prevalence of 0.6% was found in a small community of Tsimane and Moseten Amerindian forager-horticulturalists from the Bolivian Amazon, possibly due to the subsistence living, physically active lifestyle, and low rates of cardiovascular diseases, diabetes, and obesity [12]. By contrast, in a rural Brazilian Indigenous community from Amazonas state, 43.3% of individuals aged ≥50 years had dementia or CIND, associated with age, low educational level (mean 1.3 years), and extreme economic poverty [13]. Variations in cognitive assessment tools and the criteria used to classify participants with dementia may partially explain these differences in prevalence [10, 12, 13]. Furthermore, the increased vulnerability to cognitive decline among Indigenous groups may be better explained by differences in risk and protective factors related to their social environment and living conditions rather than by the traditional risk factors identified in the general population.

Precarious living conditions in rural communities have driven many Indigenous people to migrate to urban areas. These conditions include limited access to essential services such as education and healthcare, economic pressures exacerbated by insufficient federal welfare programs [14], and environmental degradation due to illegal activities like mining and logging [15]. Disputes over traditional lands are primarily motivated by the pursuit of natural resources within Indigenous territories, particularly through illegal mining, agribusiness, energy production, and large-scale infrastructure projects [15]. These conditions are rooted in the historical and ongoing impacts of colonization, which have led to land dispossession, cultural disruption, and socioeconomic marginalization [16]. These factors collectively contribute to the migration of Indigenous communities from their ancestral lands to urban areas in search of better living conditions [14, 16]. In the process of resettling in the urban areas, Indigenous people typically undergo significant changes in lifestyle [17, 18] and eating habits [19], contributing to the rise in cardiovascular disease risks, such as hypertension, dyslipidemia, sedentarism, obesity, alcohol abuse, and tobacco use [20, 21]. Changes in the sociodemographic and health profile of urban Indigenous communities increase their vulnerability to dementia risk factors [22]. However, little is known about the prevalence of dementia and risk factors in urban Indigenous communities in LMICs. Such knowledge is essential for determining the true impact of dementia in these minority groups, identifying their healthcare needs, and allowing risk reduction, early detection, and timely interventions in the "new era of Alzheimer's disease treatment" [23]. The objective of the present study was to determine dementia and CIND rates and the associated factors in an urban multiethnic Indigenous community in Manaus, Amazonas, Brazil.

Methods

Study Design and Ethical Aspects

A cross-sectional study was conducted between August 2021 and January 2022 in a multiethnic urban Indigenous community in Manaus, Amazonas state, Brazil. The study was approved by the local Research Ethics Committees (CEP #4.252.377 and 4.396.738), and all participants (or their family caregivers) signed the consent form.

Participant Recruitment and Sample Selection

The urban Indigenous community of Manaus comprised 341 homes with 1,290 dwellers (data provided by the Indigenous leadership of the community). Eligible community members were aged ≥50, self-identified as Indigenous, and resided in the urban setting (n = 167). Of this group, 26 individuals did not compose the final sample for the following reasons: not speaking/understanding Portuguese (n = 3), being out of the city (n = 5), severe visual deficit (n = 2), refusal to participate (n = 10), residing in urban area <6 months (n = 1); and death between recruitment and data collection (n = 5). After applying these criteria, 141 Indigenous participants were included in the study.

In collaboration with Indigenous community leaders, systematic house-to-house visits covering the 27.65 km^2 of the Indigenous community ensured equal inclusion probability for individuals aged 50 or above in our study. Communication regarding the study and upcoming researcher visits was proactively disseminated in the community. This outreach involved video announcements recorded by Indigenous leaders and shared across various social media platforms. An Indigenous-certified nursing assistant, a community member, and an undergraduate nursing student from the Indigenous community contributed to participant recruitment and data collection activities.

Cognitive and Functional Assessment

Global cognition was evaluated using the Mini-Mental State Exam (MMSE), which assesses orientation, immediate memory, attention and calculation skills, delayed recall, language, and visuospatial ability. Each of the 30 items in these categories scores 1 point for a correct response, giving a total score range of 0 to 30 [24, 25]. Declarative memory was assessed through the Brief Cognitive Screening Battery (BCSB), a verbal test that utilizes a set of ten-line drawings to evaluate incidental recall, immediate recall, learning, and delayed recall. Participants identify the drawings, which are subsequently removed. They then recollect the drawings to measure incidental memory. To assess immediate memory and learning, the drawings were shown twice, each for 30 s, followed by recall. After an interference task (verbal fluency test – numbers of animals in 1 min), the delayed recall was evaluated by asking participants to remember the drawings. Each correct recall scores 1, accumulating 10 points in every memory category [26]. These tests were validated for individuals with low and heterogeneous educational backgrounds [24, 27–29] and have been extensively used in previous studies involving Indigenous populations from Brazil [13, 30].

The Pfeffer Functional Activities Questionnaire (PFAQ) was administered to assess functionality based on the perspectives of a family member or companion in daily direct contact with the participant. The PFAQ comprises seven questions examining the participant's abilities relating to daily activities. These activities include personal finance management, shopping unaided, the ability to heat water and turn off the stove, meal preparation, maintaining current event awareness, engaging with and understanding media content (such as radio, TV, books, and magazines), and remembering appointments. Each activity was rated on a three-point scale, with 0 denoting complete autonomy and three indicating dependence. The scores of each completed task were aggregated to determine the overall score, ranging from 0 to 21. A higher score represents a lower functionality level, indicating a decreased ability to perform daily activities independently [31].

Trained research nurses with expertise in Indigenous health and cognitive aging performed the cognitive and functional evaluation through individual interviews conducted in the participant's house. Interviews were delivered in Portuguese, the primary language among the Manaus urban Indigenous community.

Cognitive Status Classification

A panel of neurologist experts in dementia independently analyzed cognitive and functional data to classify participants as cognitively normal (CN), CIND [32–34], and dementia. CIND is a comprehensive term capturing those who are cognitively impaired but may not meet the full criteria for mild cognitive impairment [32–34]. This diagnosis includes those who have self-reported or externally observed significant cognitive decline, and demonstrated cognitive test scores at least 1.5 standard deviations below the norm, and no substantial impairment of daily activities, as reported by a physician or informant. Crucially, these individuals should not meet the clinical threshold for dementia. Following recommendations for low education and illiterate individuals and Indigenous groups, the following score cutoffs were adopted: (a) MMSE ≤18 points for illiterate, ≤23 for 1–4 years of education, ≤25 for 5–8 years, ≤26 for 9–11 years, and ≤27 points for >11 years of formal education [13, 24, 30]; (b) delayed recall on BCSB ≤5 [13, 26, 30, 35]; (c) verbal fluency ≤8 animals or fruit items [13, 27, 30]; and PFAQ ≥5 [31]. Participants were categorized based on cognitive and functional assessments. Those with scores above the cutoff on the MMSE and either the BCSB or verbal fluency were classified as CN. CIND classification was assigned to participants with MMSE and either BCSB or verbal fluency scores below the cutoff. Finally, if MMSE and either BCSB or verbal fluency results fell below the threshold and PFAQ scores exceeded the cutoff, a dementia classification was assigned as shown in Figure 1.

Potential Confounders and Covariates

This study analyzed potential confounders and covariates linked to Indigenous people's cognitive decline and health outcomes [11, 22]. These factors included age, sex, educational attainment, marital status, per capita monthly income, extreme poverty (monthly per capita income divided by 30 <USD 2.15 per day) [36], household

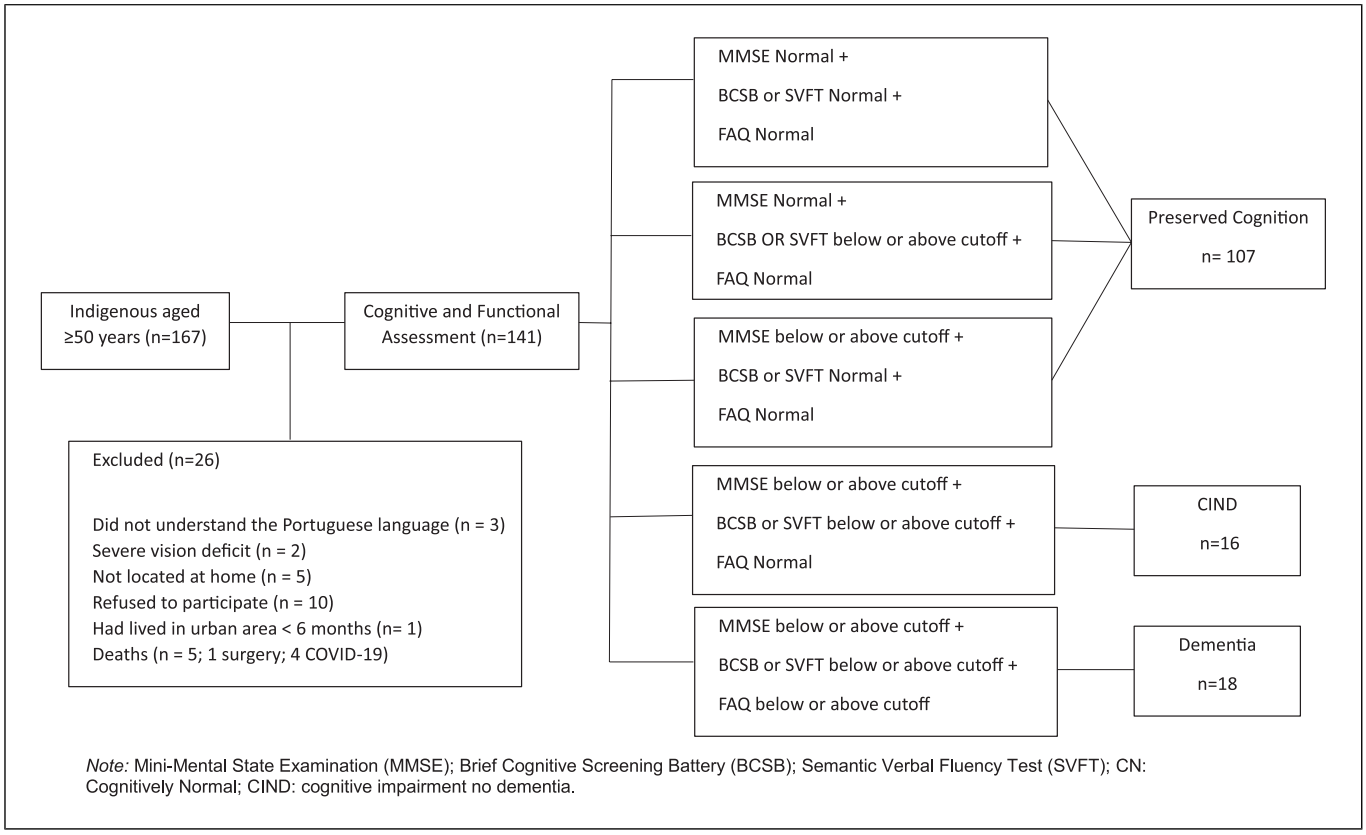

Fig. 1. Flow diagram for classifying participants. MMSE, Mini-Mental State Examination; BCSB, Brief Cognitive Screening Battery; SVFT, Semantic Verbal Fluency Test; CN, cognitively normal; CIND, cognitive impairment no dementia.

size, years living in the urban area, employment, and retirement status. Self-reported health conditions such as diabetes, hypertension, cardiovascular disease, and psychiatric disorders, as well as lifestyle habits, including smoking and excessive alcohol use (CAGE score ≥2), were taken into account. The study also considered body mass index, subjective memory decline (7-item memory complaint score >3) [37], depressive symptoms (15-item Geriatric Depression Scale score) [38], physical activity level, and reading habits.

Data Analysis

Numerical variables were presented as means and standard deviations, including their minimum and maximum values, while categorical variables were reported as absolute and relative frequencies. The normality of the data was assessed using the Shapiro-Wilk test. For non-normal variables, the Kruskal-Wallis test, followed by pairwise post hoc analysis, was used to compare the three groups (CN, CIND, and dementia), while one-way ANOVA was employed for the normally distributed variable (body mass index). For categorical variables, group comparisons were performed using Pearson's chi-squared test and Fisher's exact test. Associations between potential risk factors (such as age, sex, education, income levels, hypertension, diabetes, smoking, and excessive alcohol use) and rates of CIND and dementia were assessed through multinomial logistic regression. Data analysis was conducted using IBM SPSS Statistics® (version 21), with a significance level set at ≤5% and a 95% confidence interval.

Results

Participant Characteristics

The sample was primarily composed of individuals from Baré ethnicity (21%), followed by Kokama (15%) and Tukano (11%). Most participants were women between the age of 50 and 90, married, and with a lower

Table 1. Participants' characteristics in the total sample and comparisons between CN, CIND, and dementia

	Total sample (n = 141)		CN (n = 107)	CIND (n = 16)	Dementia (n = 18)	p value
	n	mean (±SD)	mean (±SD)	mean (±SD)	mean (±SD)	
Age (years)	141	61.9 (±9.2)	61.1 (±8.5)	60.1 (±7.2)	68.4 (±12.1)	**0.037**[a]
Education (years)	141	5.7 (±4.4)	6.2 (±4.3)	5.6 (±4.4)	2.9 (±3.8)	**0.005**[a]
Years living in urban area	128	31.5 (±20.4)	31.1 (±20.5)	36.4 (±18.4)	30.2 (±22.2)	0.761[a]
Household size (people, n)	141	4.4 (±2.6)	4.5 (±2.8)	3.7 (±1.8)	4.3 (±1.5)	0.613[a]
Monthly income per capita (USD)[c]	141	84.3 (±74.8)	89.2 (±76.4)	56.5 (±43.5)	82.7 (±87.7)	0.267[a]
Body mass index	139	28.1 (±18.5)	28.1 (±5.3)	30.1 (±5.9)	26.4 (±5.4)	0.154[b]
Geriatric Depression Scale	137	5.2 (±2.8)	5.0 (±2.7)	5.3 (±3.1)	6.2 (±2.9)	0.344[a]
	n	n (%)	n (%)	n (%)	n (%)	p value[d]
Female (%)	141	82 (58.2)	64 (59.8)	9 (56.3)	9 (50.0)	0.727
Marital status	141					0.057
Single		30 (21.3)	22 (20.6)	4 (25.0)	4 (22.2)	
Married		54 (38.3)	46 (43.0)	6 (37.5)	2 (11.1)	
Widowed		25 (17.7)	15 (14.0)	2 (12.5)	8 (44.4)	
Divorced/separated		10 (7.1)	9 (8.4)	0 (0.0)	1 (5.6)	
Legal partner		22 (15.6)	15 (14.0)	4 (25.0)	3 (16.7)	
Extreme poverty (% yes)	141	80 (56.7)	55 (51.4)	12 (75)	13 (72.2)	0.075
Currently employed (% yes)	141	48 (34.0)	41 (38.3)	2 (12.5)	5 (27.8)	0.106
Retired (% yes)	141	62 (44)	45 (42.1)	6 (37.5)	11 (61.1)	0.276
Diabetes (% yes)	141	15 (10.6)	13 (12.1)	1 (6.3)	1 (5.6)	0.586
Hypertension (% yes)	140	58 (41.1)	43 (40.2)	8 (50.0)	7 (38.9)	0.742
Cardiovascular diseases (% yes)	141	7 (5.0)	6 (5.6)	0 (0.0)	1 (5.6)	0.624
Psychiatric disorder (% yes)	139	9 (6.5)	7 (6.7)	0 (0.0)	2 (11.1)	0.416
Subjective memory complaint (% score >3)	141	122 (86.5)	90 (84.1)	15 (93.8)	17 (94.4)	0.330
Smoking (% yes)	141	76 (53.9)	55 (51.4)	7 (43.8)	14 (77.8)	0.080
Excessive alcohol use (% yes)	141	43 (30.5)	30 (28.0)	6 (37.5)	7 (38.9)	0.529
Engagement in physical activity (% yes)	141	67 (47.5)	51 (47.7)	8 (50.0)	8 (44.4)	0.947
Engagement in reading (% yes)	141	76 (53.9)	63 (58.9)	7 (43.8)	6 (33.3)	0.091

SD, standard deviation. [a]Kruskal-Wallis. [b]One-way ANOVA. [c]Quoted exchange rate per USD = BRL 5.28. [d]Pearson's chi-squared test and Fisher's exact test. Bold indicates p value <0.05. Cardiovascular diseases = coronary obstruction or cardiomegaly or arrhythmia or breath.

level of education (15% of participants had no formal education, while the rest had education ranging from 0 to 18 years), as shown in Table 1. Over half of the participants lived in extreme poverty (Table 1). The most common chronic conditions observed were hypertension, smoking, and potential alcohol abuse disorder (Table 1).

Dementia and CIND and Associated Factors

The CIND rate was 11.3% for individuals aged 50 and older, 9.7% for those aged 60 and older, and 10.2% for those aged 65 and older. Similarly, the dementia rate was 12.8% for individuals aged 50 and older, 18.1% for those aged 60 and older, and 18.4% for those aged 65 and older. Interestingly, none of the participants classified as CIND had a

Table 2. Rates of CN, CIND, and dementia (n = 141) for overall sample and stratified by age, education, and sex

	Total	CN	CIND	Dementia	p value
	n	n (%) [95% CI]	n (%) [95% CI]	n (%) [95% CI]	
Age range					
50–59 years	69	55 (79.7) [70.2 to 89.2]	9 (13) [5.1 to 20.9]	5 (7.2) [1.1 to 13.3]	
60–69 years	42	33 (78.6) [66.2 to 91]	5 (11.9) [2.1 to 21.7]	4 (9.5) [0.6 to 18.4]	**0.017**[b]
70–79 years	25	17 (68) [49.7 to 86.5]	2 (8) [−2.6 to 18.6]	6 (24) [7.3 to 40.7]	
80+ years	5	2 (40) [−2.9 to 82.9]	0 (0) [0.0 to 0.0]	3 (60) [17.1 to 102.9]	
Education[a]					
0	21	14 (66.7) [46.5 to 86.9]	1 (4.8) [−4.3 to 13.9]	6 (28.6) [9.3 to 47.9]	
1–5	60	41 (68.3) [56.5 to 80]	10 (16.7) [7.2 to 26.1]	9 (15) [5.9 to 24.0]	
6–10	32	27 (84.4) [71.8 to 96.9]	3 (9.4) [−0.71 to 19.5]	2 (6.3) [−2.1 to 14.7]	**0.047**[b]
11–15	26	24 (92.3) [82.0 to 102.5]	1 (3.8) [−3.5 to 11.1]	1 (3.8) [−3.5 to 11.1]	
≥16	2	1 (50) [−19.3 to 119.3]	1 (50) [−19.3 to 119.3]	0 (0.0) [0.0 to 0.00]	
Sex					
Female	82	64 (78) [69.0 to 86.9]	9 (11) [4.2 to 17.7]	9 (11) [4.2 to 17.7]	0.727[b]
Male	59	43 (72.9) [61.5 to 84.2]	7 (11.9) [3.6 to 20.1]	9 (15.3) [6.1 to 24.4]	

CN, cognitively normal; CIND, cognitive impairment no dementia; CI, confidence interval. [a]Years of education. [b]Pearson's chi-squared test and Fisher's exact test. Bold indicates p value <0.05.

prior diagnosis, and only three out of 18 participants with dementia had a diagnosis. Stratified analysis showed that younger age groups (50–59) had higher rates of CIND, while dementia rates were higher in older groups (≥70 years; p = 0.017) (Table 2). Dementia rates were higher in low-education groups (less than 5 years of education) (Table 2). There was no significant difference in CIND and dementia rates between male and female participants (p = 0.727) (Table 2). In the logistic regression model, higher age was associated with a higher dementia rate, but not in the CIND group (Table 3). Other sociodemographic variables such as education, sex, living in extreme poverty, hypertension, diabetes, smoking, or excessive alcohol use were not linked to CIND or dementia (Table 3).

Discussion

Examining cognitive and functional performance data from an urban, multiethnic Indigenous community, 11.3% of participants aged 50 years and older were classified as CIND, and 12.8% as having dementia, based on the expert consensus diagnosis approach. Higher estimates were observed among Indigenous participants aged 70 years and older. Notably, only one in six individuals classified with dementia reported a previous diagnosis. These findings indicate a high prevalence of CIND and dementia, with early symptom onset in a Brazilian urban Indigenous community.

Compared to previous studies in the overall Brazilian population, where dementia prevalence ranges from 2.0% to 7.1% [7, 39, 40], the Indigenous participants in our study showed higher rates of CIND and dementia. In a nationally representative sample, Bertola et al. [7] found a prevalence of 5.8% for dementia and 8.1% for CIND in Brazilian individuals aged 60 years and older, with the highest rates in those 80 years and older. In our study, 9.7% of participants aged 60 and older had CIND, and 18.1% had dementia. Similar to Bertola et al. [7], we found higher dementia estimates in older age groups. However, for CIND, the highest rates were detected in individuals aged 50–59 years, suggesting early onset of symptoms. Bertola et al. [7] also found higher CIND and dementia prevalence in females, while we did not find significant sex differences.

In our study, dementia rates were higher across all age groups (12.8% for ages 50+, 18.1% for ages 60+, and 18.4% for ages 65+) compared to those reported for Aboriginal Australians from Kimberley (12.4% for ages ≥45 years) [41], from a rainforest riverside community in Mamirauá and Amanã in Amazonas, Brazil (4.9% for ages ≥50 years) [30], the Cree tribe in Northern Manitoba (4.2% for ages ≥65 years) [42], the rural Karajá tribe in Brazil (6.4% for ages ≥65 years) [43], the Tsimane community in the Bolivian Amazon (1.2% for ages ≥80

Table 3. Logistic regression model for cognitive status, sociodemographic variables, and modifiable risk factors for dementia

Independent variables	CIND			Dementia		
	OR	95 CI%		OR	95 CI%	
		min	max		min	max
Extreme poverty	0.310	0.086	1.113	0.516	0.150	1.775
Education (years)	0.966	0.833	1.121	0.878	0.732	1.053
Sex (male)	1.659	0.470	5.853	0.981	0.259	3.718
Age (years)	0.981	0.915	1.053	**1.078**	**1.011**	**1.149**
Hypertension	0.611	0.203	1.843	1.087	0.342	3.454
Diabetes	2.527	0.295	21.668	2.560	0.279	23.465
Smoking	2.021	0.573	7.132	0.349	0.086	1.423
Excessive alcohol use	0.682	0.199	2.339	0.515	0.139	1.915

OR, odds ratio; CI, confidence interval. Nagelkerke R^2 0.235; reference category dependent variables: cognitively normal; reference category independent variables: yes.

years) [12], and First Nations populations in Alberta, Canada (0.75% age-standardized) [44], the Aboriginal Australians from Torres Strait Islanders (13.4% for ages ≥60 years) [45], American Indians from the Northern Plains (14.6% for ages ≥60 years) [46], and Chamorro's Indigenous people from Guam (12.2% for ages ≥65 years) [47]. Conversely, the dementia rates in our study were lower than those reported for Aboriginal Australians from Torres Strait Islanders (14.2% for ages ≥45 years) [48].

Regarding CIND, the rates were higher across all age groups in our study (11.3% for ages 50+, 9.7% for ages 60+, and 10.2% for ages 65+) compared to those reported for Indigenous people from Kimberley in the north of Western Australia (8% for ages ≥45 years) [41], Mamirauá and Amanã in Brazil (6.1% for ages ≥50 years) [30]. In contrast, Jervis et al. [46] reported higher rates (27.4% for ages ≥60 years) among Northern Plains American Indians and those reported for Aboriginal Australians and Torres Strait Islander residents (17.7% for ages ≥60 years) [45] and the Tsimane (7% for ages ≥80 years) and Moseten (9.8% for ages ≥80 years) from rural Bolivia [12] compared to the current study's CIND rates.

Variations in dementia prevalence might be attributable to methodological factors, such as case classification, cognitive screening protocols, cutoff scores, and age-standardized analyses [45, 46, 48, 49]. Nevertheless, socioeconomic and lifestyle factors, particularly in urban areas, may also shape these disparities by influencing exposure to risk and protective elements. Studies indicate that lower dementia prevalence is typically associated with Indigenous populations residing in rural areas [12, 30, 43]. These groups often maintain healthy diets with limited access to ultra-processed foods, subsist on physically intensive activities like fishing, hunting, and foraging, and dwell in reserves or riverbank settlements [12, 30, 43]. Indigenous Bolivians manifesting the lowest dementia prevalence are emblematic of this lifestyle [12].

Similar to our study, higher dementia rates often correlate with Indigenous communities in urban locations or remote areas that are unsuitable for subsistence agriculture [46, 47]. Limited access to fresh fruits, vegetables, or legumes and a higher reliance on foods high in refined carbohydrates can predispose Indigenous people to cardiovascular diseases [22, 46, 47, 50]. Despite their migration for improved living conditions and healthcare access, often escaping harsh circumstances, urbanization has adversely affected cardiovascular mortality rates [51–55]. Lifestyle changes, healthcare neglect, and dietary habit alterations are key contributors [51–55]. Moreover, Indigenous people living in urban areas regularly face discrimination, exclusion, and challenges in maintaining their cultural identity in the metropolitan areas, factors that may lead to unhealthy coping mechanisms such as alcohol abuse and tobacco [51–53]. In our study, although the frequencies of diabetes, hypertension, excessive alcohol consumption, tobacco use, and extreme poverty were high, no association with CIND or dementia was observed. It is worth highlighting that the study participants lived in the same geographic area and were

exposed to similar poor living conditions with limited access to healthcare resources. When each individual is directly or indirectly exposed to similar risk factors, the lack of variability in the exposure factor can limit the detection of its isolated influence [56]. Measures that combine social, psychosocial, socioeconomic, sociodemographic, local, regional, and cultural aspects might better reflect their potential synergetic influence [56] on brain health and cognition.

The social injustices and cultural changes the Indigenous have historically experienced during urbanization and interactions with non-Indigenous communities could contribute to their vulnerability to dementia in those residing in metropolitan areas [57]. Our findings provide the foundation for more complex study designs, and measurement approaches to test the hypothesis that prolonged exposure to this multitude of elements might have a cumulative impact on dementia risk in Indigenous groups.

Study Limitations and Strengths

A limitation of this study is the relatively small sample size. However, it is important to note that the sample accurately represents the entire urban Indigenous community from Manaus, Amazonas. This comprehensive representation ensures that the findings reflect the broader community despite the limited number of participants. Future research with larger sample sizes could further validate these results and provide more generalizable insights. In addition, the cognitive assessment was not conducted using a culturally sensitive tool. Although the tests employed were validated for low-educated populations [24, 27–29] and have been used in previous studies with Brazilian Indigenous [13, 30], they may not fully capture the cognitive nuances of these groups. Future research utilizing the recently validated cognitive tool for the Brazilian Indigenous population [58] can provide additional insights and enhance our understanding of dementia prevalence among urban Indigenous groups. The validity of dementia diagnoses would be improved by having participants who scored near or below the cutoff points undergo a face-to-face reevaluation by a comprehensive expert. Future studies should consider this approach to improve the accuracy of diagnosis classification. Furthermore, the absence of biological markers for clinical diagnosis confirmation represented another limitation related to ethical limits in collecting biological measures from particular groups and cultural barriers in Brazil. Moreover, we excluded three eligible participants who spoke languages other than Portuguese. It is essential to acknowledge that in multiethnic communities, the members share the Indigenous identity but not necessarily the same language. In our study, 14 Indigenous languages were identified, and not having available interpreters for them was a limitation. In future multiethnic studies, it is essential to assess the different languages spoken in the Indigenous community and find potential interpreters among community members to increase inclusivity and representativeness. Future research should focus on building enduring partnerships and active community engagement to promote sustainable and trustful connections with Indigenous communities to overcome those barriers. Our study was among the first to establish the prevalence of cognitive impairment in Brazil's multiethnic urban Indigenous community. It highlighted the prevailing health and living conditions marked by high levels of cardiovascular diseases, extreme poverty, and illiteracy – factors likely to contribute to cognitive decline in this community.

Conclusion

The prevalence of dementia and CIND among urban-dwelling Indigenous inhabitants of Amazonas was significantly high relative to the overall Brazilian population and Indigenous communities in other South American LMICs. These findings may set the stage for additional research into the interplay of social, environmental, economic, biological, and behavioral factors affecting dementia risk in underrepresented groups such as Indigenous communities. This can also lead to further studies on interventions to enhance brain health knowledge and awareness of risk factors within the community and among health professionals who cater to this demographic.

Acknowledgments

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Statement of Ethics

The study was submitted to and approved by the Research Ethics Committee of the Escola de Enfermagem da Universidade de São Paulo (EEUSP), under permit no. 4.252.377 and by the National Board for Research Ethics (CONEP), under permit no.

4.396.738 and CAAE 30393320.3.0000.5392. Study participants agreed to take part in the study by signing the written free and informed consent form. For three vulnerable participants, written informed consent was obtained from the patient's legal guardians. All human subjects provided informed consent. The findings presented were not preregistered.

Conflict of Interest Statement

The authors declare that there is no financial/personal interest or opinions and declare no conflict of interest.

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Author Contributions

C.C.B. was responsible for the study design conceptualization, methodology, formal analysis, investigation, resources, data curation, writing – original draft, review, and editing, and project administration. B.J.A.P.B. and S.M.D.B. were involved in methodology, formal analysis, data curation, and writing – original draft. N.N.T. was involved in study design conceptualization, methodology, investigation, resources, and writing – original draft. R.L.S. was involved in investigation, resources, data curation, and writing – original draft. J.N.S.-T. oversaw all stages of the study. All the authors read the final draft of this manuscript and agreed to its publication.

Data Availability Statement

The data that support the findings of this study and de-identified data are not publicly available due to containing information that could compromise the privacy of research participants but are available with corresponding author J.N.S.-T. through e-mail talaricoj@uiowa.edu upon reasonable request.

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