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ORIGINAL ARTICLE

The impact of education as a proxy for lifestyle habits on reducing the association with dementia prevalence in the Southern Region of Brazil

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Abstract

Objectives: This study aimed to investigate the prevalence of dementia among older adults from Florianópolis, in the Southern Region of Brazil.

Methods: Data were originally drawn from the Epifloripa Aging Cohort Study, a representative and community-based survey designed to evaluate older people's health. This cross-sectional study was conducted in two phases: the community-screening phase, in which the Mini-Mental State Examination and a multifunctional scale were administered to older subjects and close informants, respectively; and the hospital-diagnosis phase, when the Cambridge Examination and the National Institute on Aging criteria were used. Adjustment for screening accuracy was made in order to estimate dementia prevalence.

Results: Of 1184 subjects evaluated in the community, 243 were screened for the diagnosis phase, in which 47 were identified with dementia, resulting in a crude prevalence of 4.5% (95% CI: 3.241–5.758) and an estimated prevalence of 9.2% (95% CI: 7.446–10.954). Dementia was associated with older ages, lower education levels, and the presence of stroke. Mild alcohol use (in comparison with no alcohol use), community-group practice, internet use and a higher level of physical activity, rather than education, decreased the odds ratio for dementia. Education was directly associated with these lifestyle habits.

Conclusions: Prevalence was lower than that in previous studies in the country, and multivariate analysis reinforced the importance of lifestyle in preventing cognitive disorders in the older population.

KEYWORDS
dementia, education, lifestyle, older people, prevalence

1 | INTRODUCTION

Dementia prevalence throughout the world varies from 2.0%, in the West Sub-Saharan Africa region, to 8.5%, in Latin America. It has doubled every 5.5 years in North America, Latin America and Asia, and every 6.7 years in Southeastern Asia and Australasia, and it has been 19%–29% lower in men than in women.[1] Indeed, a relevant meta-analysis on the global prevalence of dementia has affirmed that low- and middle-income countries are primarily responsible for the projected increase in the total number of people with dementia in the next few decades.[2]

Among developing countries, dementia prevalence tends to be higher in Latin America and lower in India and sub-Saharan Africa, with intermediate rates in China.[3–5] While age has a robust effect, females show a weak predominance; low education is consistently associated, and Alzheimer's Disease represents 60% of total cases.[3] Corroborating these findings, a review of Latin-American studies intriguingly observed higher rates at younger ages when compared to those for developed countries and suggested the effect of low cognitive reserve anticipating dementia symptoms.[6,7] Another review of Latin-American and Caribbean countries found higher rates in women, rural residents, and subjects with low education levels.[8]

Particularly in Brazil, three recent studies conducted in the most affluent state, São Paulo, in the Southeastern Region, and using two different diagnostic criteria and designs (one- or two-phase), found high dementia prevalence rates (≥ 60 years old), from 12.5 to 17.5%,[9–11] and again higher rates at younger ages and association with low education. In other words, by using different methods, the three studies converged and reinforced the findings observed in the continental region.

On the other hand, it is imperative that the investigation on dementia in the Brazilian population extend beyond the borders of São Paulo state, where almost all clinical and representative prevalence studies have been carried out, thus leading to a broader perspective of how dementia cases are distributed in the country. This community-based study aimed to investigate the prevalence of dementia among older adults from Florianópolis, in the Southern Region of Brazil, and to examine its distribution in relation to sociodemographics, clinical variables and habits.

2 | METHODS

2.1 | Population and sampling strategy

Data were drawn from the Epifloripa Aging Cohort Study, a longitudinal community-based epidemiological survey that has evaluated the health of older people (aged 60 years and older) from Florianópolis, Brazil, since 2009–2010, when the first wave was conducted. The sampling strategy was published previously.[12] Briefly, the cluster-sampling strategy consisted of two subsequent phases of systematic selection. Initially, of 420 census tracts, 80 were selected based on the average monthly income of the family's head. Secondly, 60 households from each census tract were selected, and all residents aged 60 years and older were invited to participate. According to the 2010 census,[13] Florianópolis had a population of approximately 400,000 and 10.8% of those people were aged 60 years and older. Of the 1705 older individuals evaluated in the first wave, 1488 were eligible for the second wave (there were 217 deaths). The second wave was carried out from 2013 to 2014, and its data were used in the present study.[12]

2.2 | Study design

A two-phase design was applied to estimate dementia prevalence: a community-screening phase and a hospital-diagnosis phase.

2.3 | Community-screening phase

The community-screening phase used data from the second wave of the Epifloripa Aging Cohort Study, especially those obtained by a clinical questionnaire and two instruments, the Mini-Mental State Examination (MMSE) and the multifunctional scale that assesses activities of daily living (ADL) (Multifunctional scale).

MMSE.[14,15] It is a well-known global cognitive test. The cutoff scores in the present study were adapted from previous studies.[9,10,15] They were based on years of schooling, as follows: <20 for illiterates; <25 for 1–4 years of schooling; <27 for 5–8 years of schooling; <28 for ≥9 years of schooling.

Multifunctional scale.[16] It is administered to a close informant and assesses functional performance in seven basic and eight instrumental ADL, resulting in a classification of absent/mild dependence in ADL (partial or total disability in 0–3 activities) and moderate/severe dependence in ADL (partial or total disability in 4–15 activities).

The combination of low MMSE scores and moderate/severe dependence in ADL was used to select the positive screened cases for dementia, according to previous studies.[17,18]

The clinical questionnaire mainly consisted of "yes or no" questions concerning the self-reported occurrence of clinical diseases. Alcohol use was assessed by using the two questions of the Alcohol Use Disorders Identification Test (AUDIT) related to frequency and usual dose, and three categories were created: no use, mild use (up to 9 units of alcohol weekly) and heavy use (over 9 units of alcohol weekly).[19] Community group (religious and other groups) activities and internet use were also assessed by using "yes or no" questions. Leisure physical activity was evaluated by the International Physical Activity Questionnaire considering the weekly time in minutes, and two categories were created: less than 150 min weekly and 150 min or over weekly.[20]

2.4 | Hospital-diagnosis phase

All the positive screened cases and a small part of the negative screened cases were referred to the hospital diagnosis phase, from

2017 to 2018. The Cambridge Examination (CAMDEX) questionnaire, a structured instrument developed for the diagnosis of mental illness in older people, was used to support the dementia diagnosis,[21] which was performed according to National Institute on Aging (NIA) criteria and based on the consensus by two physicians (one is a dementia expert).[22]

With the purpose of reducing losses, the positive screened cases of individuals who had died were referred to evaluation by interviewing an informant over the telephone, using the Clinical Dementia Rating scale (CDR)[23,24] and the Informant Questionnaire on Cognitive Decline in the Elderly (IQCODE).[25,26] This postmortem diagnosis of dementia was previously tested with good sensitivity (86.6%) and specificity (84.4%) levels for the dementia diagnosis.[27]

- CDR is a highly employed scale to stage dementia severity.[23] In the present study, a semi-structured questionnaire, the MMSE and the multifunctional scale were used to define the global CDR score.
- IQCODE is a cognitive and functional assessment scale with 26 items that compares current and previous performance (10 years). It is filled out by one of the subject's close acquaintances.[25,26]

2.5 | Data analysis

The data were analyzed using the SPSS software, version 14.0 for Windows.[28] Dementia prevalence was estimated by employing an adjustment for accuracy of the screening procedure,[29] controlling the number of cases to the positive and negative values of the screening instrument. That adjustment had been previously used in two dementia prevalence studies in the country,[9,10] and it complies with the recommendation of reducing selection bias in study designs using two or more phases.[1] The formula is shown below, and it considered the proportion of positive screened cases (Ps) and negative screened cases (Pn), the positive predictive value (VP+) and the negative predictive value (VP−). Finally, a 95% confidence interval was calculated.

$$Pe = Ps\,(VP+) + Pn\,(1 - VP-)$$

The comparisons between groups (evaluated subjects vs non-evaluated subjects; subjects with dementia vs subjects without dementia) were made by using the Student's t-test for continuous variables and the Pearson chi-square test for categorical variables. Multivariate analysis, by logistic regression, using backward stepwise and Wald's statistic, was conducted to assess the association between the dementia diagnosis and sociodemographic and clinical variables (Model 1) and sociodemographic variables and habits (Model 2); the odds ratio and its respective 95% confidence interval were also calculated. A p-value below 0.05 was considered for defining statistical significance.

2.6 | Ethical considerations

The study was approved by the local Ethics Committee, and all the subjects and their relatives agreed to participate in the study by signing an informed-consent form.

3 | RESULTS

Of 1488 eligible subjects, 1184 were evaluated in the community-screening phase. There were 129 refusals to participate, 111 subjects with unavailable addresses and 64 losses due to other causes. The final sample had a men age of 76.6 years (SD: 7.163; 66–109), and 65.1% were females.

The screening procedure selected 243 positive screened cases for dementia, of which 102 (41.9%) were completely evaluated in the hospital-diagnosis phase: 69 in the hospital, 13 in the community and 20 by a postmortem diagnosis. Sixteen negative screened cases were evaluated (hospital and community). Forty-seven individuals were identified with dementia, corresponding to a crude prevalence of 4.5% (95% CI: 3.241–5.758). The estimated prevalence was 9.2% (95% CI: 7.446–10.954) (flowchart research in Figure 1).

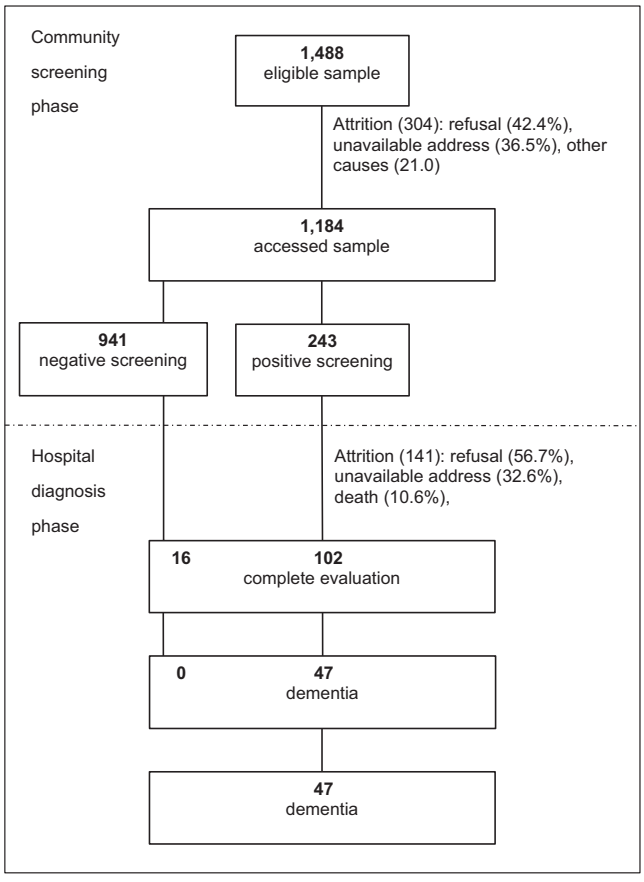

FIGURE 1 Flowchart research, in two phases. Screening procedure. Positive predictive value: 46%; negative predictive value 100%.

In the comparison between evaluated (complete evaluation) and non-evaluated subjects (attrition) in the hospital-diagnosis phase, as regards age, the Multifunctional Scale Score, the MMSE score by years of schooling, sex and years of schooling, there was a significant difference only for the MMSE score in individuals with 9 years of schooling and over (24.1 for the complete evaluation and 18.1 for attrition).

Bivariate analysis showed that the diagnosis of dementia was associated with older ages, lower education levels, the presence of stroke, hypertension and heart disease, no community-group practice and internet use, lower level of physical activity and no alcohol use (Tables 1 and 2).

In multivariate analysis (Table 3), a greater odds ratio for dementia was observed for older ages, lower levels of education and the presence of stroke (Model 1). In Model 2, mild alcohol use (in comparison with no alcohol use), community-group practice, internet use and a higher level of physical activity decreased the odds ratio for dementia; education was not associated. According to additional analysis, higher education levels showed greater frequency of three of these four lifestyle habits (Figure 2).

4 | DISCUSSION

This study has found a low rate for dementia prevalence as compared to those observed in Latin America, the Caribbean, Brazil itself and worldwide.[1,7–11] Dementia prevalence was associated with older ages, lower education levels, stroke occurrence, no alcohol use (in comparison with mild alcohol use), no community-group practice, no internet use, and a low level of physical activity.

The relative low rate observed out of São Paulo state, in Brazil, needs to be cautiously interpreted considering methodological, demographic, and clinical perspectives. As regards the method, there is an important issue in comparison with other local studies, which is related to the number of phases and, consequently, the adjustment procedure for screening accuracy in two-phase studies. The two-phase studies with adjustment for screening accuracy[9,10] and the representative one-phase study[11] found higher rates, namely 12.5%, 12.9% and 17.5% (samples with individuals aged 60 years and over), respectively, than the adjusted rate in the present study, 9.2%. The other two-phase study,[30] without adjustment, with a sample aged 65 years and over, also relatively observed a higher rate, 7.1%, than the non-adjusted rate in the present study, 4.5%. In addition, the case definition differed in relation to three of these four studies, which used the DSM IV criteria to diagnose dementia[9,10,30] and was the same as that in the study with the highest rate, the NIA criteria.[11] Considering the two principal demographic factors, education and age had a divergent sample distribution in comparison with the other studies. The proportion of subjects with up to 3–4 years of schooling, which is the lowest education level, was 8.5%–24.8% higher in the four studies cited above than in the present study. Paradoxically, the mean age was lower, between 70.9% and 71.5%, than the 76.6% figure observed in the present study. In the same direction, considering the clinical perspective, the hypertension, diabetes, and stroke rates found in two studies[9,10] were approximately 30% lower than those observed in the present study. In summary, in view of

TABLE 1 Total sample, comparison between subjects with dementia and without dementia, according to age and education.

			Male					Female					Total				
	Total Sample		Without dementia		With dementia			Without dementia		With dementia			Without dementia		With dementia		
	n	%	*n*	%	*n*	%	*p*-value	*n*	%	*n*	%	*p*-value	*n*	%	*n*	%	*p*-value
Age 1																	
65–69	226	19.1	82	100.0	0	0	<0.001	132	100.0	0	0	<0.001	214	100.0	0	0	<0.001
70–74	312	26.4	115	98.3	2	1.7		174	98.3	3	1.7		289	98.3	5	1.7	
75–79	245	20.7	69	94.5	4	5.5		141	94.6	8	5.4		210	94.6	12	5.4	
80–84	226	19.1	65	97.0	2	3.0		122	95.3	6	4.7		187	95.9	8	4.1	
≥85	175	14.8	35	81.4	8	18.6		61	81.3	14	18.7		96	81.4	22	18.6	
Age 2																	
65–74	538	45.4	197	99.0	2	1.0	<0.001	306	99.0	3	1.0	<0.001	503	99.0	5	1.0	<0.001
75–84	471	39.8	134	95.7	6	4.3		263	94.9	14	5.1		397	95.2	20	4.8	
≥85	175	14.8	35	81.4	8	18.6		61	81.3	14	18.7		96	81.4	22	18.6	
Education[a]																	
Illiteracy	90	7.6	23	85.2	4	14.8	0.001	41	89.1	5	10.9	0.011	64	87.7	9	12.3	<0.001
1–4	435	36.7	107	93.0	8	7.0		238	93.3	17	6.7		345	93.2	25	6.8	
5–8	198	16.7	53	94.6	3	5.4		113	95.8	5	4.2		166	95.4	8	4.6	
≥9	461	38.9	183	99.5	1	0.5		238	98.3	4	1.7		421	98.8	5	1.2	

[a]Years of schooling.

TABLE 2 Comparison between subjects with dementia and without dementia, according to clinical variables and habits.

	Without dementia		With dementia				
	n	%	*n*	%	OR	95% CI	*p*-value
Stroke					9.640	5.184–17.925	<0.001
No	919	97.2	26	2.8			
Yes	77	78.6	21	21.4			
Hypertension					2.832	1.309–6.126	0.006
No	366	97.9	8	2.1			
Yes	630	94.2	39	5.8			
Heart disease					1.821	1.009–3.287	0.044
No	690	96.4	26	3.6			
Yes	306	93.6	21	6.4			
Alcohol use[a]					–	–	0.001
No use	579	93.5	40	6.5			
Mild use	371	98.4	6	1.6			
Heavy use	45	97.8	1	2.2			
Community group[b]					0.401	0.202–0.796	0.007
No	565	94.0	36	6.0			
Yes	431	97.5	11	2.5			
Internet use					0.049	0.007–0.355	<0.001
No	689	93.7	46	6.3			
Yes	307	99.7	1	0.3			
Physical activity					0.104	0.025–0.431	<0.001
<150 min weekly	696	93.9	45	6.1			
≥150 min weekly	298	99.3	2	0.7			
	Mean	SD	Mean	SD			*p*
Physical activity	14.26	40.940	122.54	195.225	–	–	<0.001

Note: Bronchitis or asthma, cirrhosis, renal failure, spine disease, osteoporosis, arthritis, cancer, diabetes, depression, and body mass index were not associated with presence of dementia.

Abbreviations: CI, confidence interval; *n*, number; OR, odds ratio; SD, standard deviation.

[a]Mild use: ≤ 9 units weekly; Heavy use: >9 units weekly.

[b]Religious and other groups.

the factors mentioned above, education is the only evident factor that could explain, at least partially, the lower rate, according to a review of Korean studies which found that 16% of dementia cases were attributed to illiteracy.[31] In addition, it is important to note the proportion with recommended physical activity in the present sample, 32.1% for the 65–74 age range and 21.7% for subjects aged 75 years and over, which is much higher than the rates of 15.7% and 8.8%, respectively, observed in the Southeastern Region,[32] where São Paulo state is located, as it may have contributed to this relative low dementia rate.

In relation to the review of Latin-American studies,[7] particularly those out of Brazil, three studies found similar rates, from 3.1% to 6.7%, considering the present non-adjusted rate, but they have limitations for comparison (two with data presented in abstracts in congresses, and one with a case definition based on an expert opinion). Two other two studies found higher rates: the one-phase study from Venezuela showed a rate of 13.0%, and the two-phase study from Cuba, without adjustment for screening accuracy, found a rate of 8.1% (both using DSM-IV criteria). Considering the other review with 31 Latin-American and Caribbean studies,[8] the dementia prevalence of 8.9% for the population aged 65 years or over was much higher than the non-adjusted rate found in the present study. In spite of the great variation in studies from the developing world,[3] even the present low dementia prevalence is in accordance with the higher rates observed in certain Latin-American and Asian countries than those in Indian and sub-Saharan Africa.

The age-related findings confirmed what is strongly expected in the world distribution of dementia cases, that is, higher rates of dementia at older ages, but they showed a difference in relation to the prevalence studies in Latin-America[7] and Brazil,[9,10,30] as the rates at younger ages were proportionally much lower, and possibly affected by a better educational level and its influence on the cognitive reserve of the population sample. With this regard, the education-related findings corroborated those observed in local studies[9–11,30]

TABLE 3 Multivariate analysis with sociodemographic and clinical variables and habits (Model 1 and Model 2), in relation to presence of dementia.

	Model 1			Model 2		
	OR	95% CI	*p*-value	OR	95% CI	*p*-value
Age						
75–84	3.647	1.327–10.026	0.012	4.133	1.518–11.249	0.005
≥85	14.471	5.158–40.602	<0.001	14.145	5.143–38.904	<0.001
Education[a]						
Illiteracy	6.053	1.811–20.230	0.003	–	–	–
1–4	3.751	1.370–10.272	0.010	–	–	–
5–8	3.018	0.930–9.791	0.066	–	–	–
Stroke	6.485	3.305–12.724	<0.001	–	–	–
Alcohol use[b]						
Mild use	–	–	–	0.398	0.161–0.984	0.046
Heavy use	–	–	–	0.499	0.062–4.033	0.515
Community group[c]	–	–	–	0.452	0.220–0.927	0.030
Internet use	–	–	–	0.128	0.017–0.957	0.045
Physical activity						
≥150 min weekly	–	–	–	0.191	0.045–0.810	0.025

Note: Model 1: age, education, stroke, hypertension and heart disease / Model 2: age, education, alcohol use, community group, internet use and physical activity.

Abbreviations: CI, confidence interval; OR, odds ratio.

[a]Education: years of schooling.

[b]Mild use: ≤9 units weekly; Heavy use: >9 units weekly.

[c]Religious and other groups / Reference for age: 65–74; education: ≥ 9; stroke, community group and internet use: No; alcohol use: no use; physical activity: <150 min weekly.

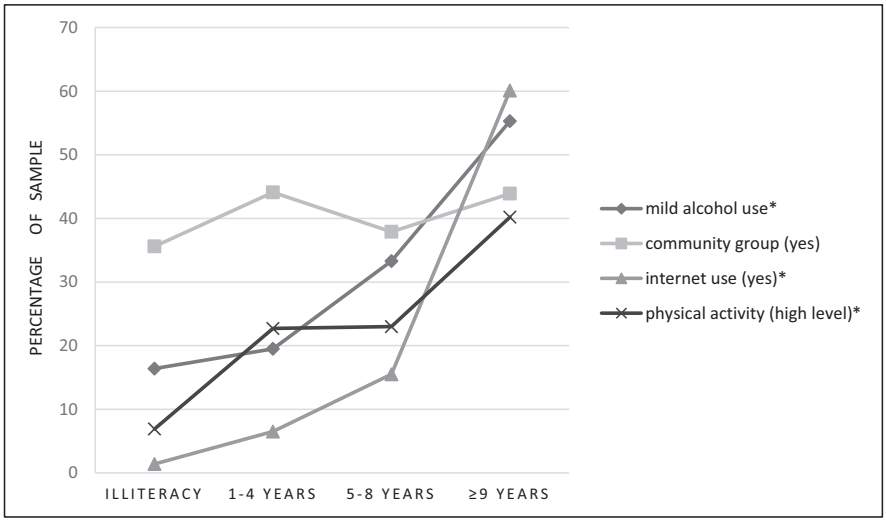

FIGURE 2 Distribution of sample in relation to lifestyle habits by educational levels (years of schooling). **p-value* <0.001(Pearson chi-square test).

and the two Latin-American reviews,[7,8] and they are in accordance with a systematic review that provided support for the cognitive reserve hypothesis and a meta-analysis of world prospective studies which suggested that each year of schooling reduced risk by 7% and that low education increased the risk for any dementia by 45%.[33] On the other hand, Model 2, in multivariate analysis, confirms the association between lower dementia rates and four habits rather than education, and similarly to a previous study in Brazil,[9] it highlights the complex relationship between education and dementia as well as corroborates the sociological perspective according to which education is a proxy for behaviors and life events and indirectly reduces the risk for dementia.[34]

As mentioned above with regard to the four habits, the higher rates in non-alcohol users, in comparison with mild alcohol users, corroborated the findings in the previous study in Brazil, which showed similar results in women.[9] It also corroborated some former international studies that observed the known J-shaped relationship,[35–38] and a recent review with 15 international prospective studies,[39] thus

raising the hypothesis of a protective effect of alcohol against the development of cognitive decline and dementia. In spite of limitations related to design (cross-sectional study) and the weakness of measure (personal declaration of alcohol consumption), the statistical control for some lifestyle-associated habits in the present study, which are possible confounders, reinforced the independent effect of mild alcohol use. On the other hand, mild alcohol use has not been usually included in the prevention field, in accordance with a systematic review that does not recommend beginning alcohol use to reduce dementia risk because of heterogeneous results, methodological issues (confounders), individual variability and susceptibility and risk for addiction.[40] Although the inherent difficulty in establishing the real cause-effect relationship in a cross-sectional study, the findings related to lifestyle habits actually bring to the prevention field three modifiable factors with the potential to reduce dementia cases. While physical activity already has a considerable amount of good evidence in observational and experimental studies, both reducing the incidence of dementia[41,42] and improving cognition in dementia cases,[43] internet use and community-group practice need to be further investigated and understood. On the other hand, the association between internet use and lower dementia rates corroborated the findings from the original Epifloripa Aging Cohort Study, which observed a decline in the incidence of cognitive impairment among internet users,[44] as well as those from two large international longitudinal studies that found lower risk for dementia.[45,46] Indeed, social and cognitive stimulation and access to health information have been considered to explain that protective effect. In relation to social stimulation, the results concerning community-group practice are in accordance with those in the studies associating social isolation with increased risk for dementia[47–49] and reveal an additional way of protective intervention.

The strong association with stroke occurrence corroborated the close interaction between these two neurological disorders, which are sources of great disability, as they share the same risk factors, affect each other pathophysiologically and should be the object of a policy for joint prevention,[50] particularly in low-to-middle-income countries, where vascular risk factors have a significant role in developing dementia.[3,50]

The main limitation in the present study was high attrition, particularly in the second-hospital phase, which could result in a source of rate underestimation. Efforts were made to reduce attrition by providing the option of home interviews and by conducting post-mortem evaluation. However, there was only one difference between evaluated and non-evaluated subjects, which reduced the potential for bias selection, specifically for the selective loss of subjects. Finally, clinical conditions and habits were assessed by subjects' or informants' direct reporting, thus resulting in an imprecise form of assessment.

On the other hand, the study's strengths are noteworthy, such as the robust cohort survey from which the original data were drawn (rigorous sampling strategy, wide and judicious assessment of parameters), the clinical approach to identify dementia cases with recognized and validated instruments, and the adjustment for screening accuracy in a two-phase study.

5 | CONCLUSION

This study presents the geographic expansion of clinical research investigating dementia in a developing country with one of the highest dementia prevalence rates in the world. Mild alcohol use, community-group practice, internet use, and a higher level of physical activity, rather than education, were associated with lower dementia rates. Prevalence was lower than in previous studies in the country. These findings reinforce the importance of lifestyle in preventing cognitive disorders in older adults.

AUTHOR CONTRIBUTIONS

MAL: conceptualization, funding acquisition, formal analysis, methodology and writing (editing). ASJ and YCN: investigation, methodology and writing (review). ED: conceptualization and writing (review).

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CONFLICT OF INTEREST STATEMENT

The authors report there are no competing interests to declare.

DATA AVAILABILITY STATEMENT

There are restrictions in relation to data availability, considering the terms with local Ethics Committee. The corresponding author has full access to all the data in the study, and takes responsibility for the integrity of the data and the accuracy of the data analysis.

ETHICS STATEMENT

The study was approved by the local Ethics Committee (Human Research Ethics Committee, Federal University of Santa Catarina, CAAE: 26431514.4.0000.0121), according to Declaration of Helsinki, and all participants and their relatives agreed to participate in the study by signing an informed-consent form.

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REFERENCES

1. Prince M, Bryce R, Albanese E, Wimo A, Ribeiro W, Ferri CP. The global prevalence of dementia: a systematic review and metaanalysis. *Alzheimers Dement*. 2013;9:63-75. doi:10.1016/j.jalz.2012.11.007
2. Ferri CP, Prince M, Brayne C, et al. Alzheimer's disease international. Global prevalence of dementia: a Delphi consensus study. *Lancet*. 2005;366:2112-2117. doi:10.1016/S0140-6736(05)67889-0
3. Kalaria RN, Maestre GE, Arizaga R, et al. World Federation of Neurology Dementia Research Group. Alzheimer's disease and vascular dementia in developing countries: prevalence, management,

and risk factors. *Lancet Neurol*. 2008;7:812-826. doi:10.1016/s1474-4422(08)70169-8
4. Llibre Rodriguez JJ, Ferri CP, Acosta D, et al. 10/66 dementia research group. Prevalence of dementia in Latin America, India, and China: a population-based cross-sectional survey. *Lancet*. 2008;372:464-474. doi:10.1016/s0140-6736(08)61002-8
5. Zhu Y, Liu H, Lu XL, et al. Prevalence of dementia in the People's Republic of China from 1985 to 2015: a systematic review and meta-regression analysis. *BMC Public Health*. 2019;19:578. doi:10.1186/s12889-019-6840-z
6. Nitrini R. Dementia incidence in middle-income countries. *Lancet*. 2012;380:1470. doi:10.1016/S0140-6736(12)61838-8
7. Nitrini R, Bottino CM, Albala C, et al. Prevalence of dementia in Latin America: a collaborative study of population-based cohorts. *Int Psychogeriatr*. 2009;21:622-630. doi:10.1017/s1041610209009430
8. Ribeiro F, Teixeira-Santos AC, Caramelli P, Leist AK. Prevalence of dementia in Latin America and Caribbean countries: systematic review and meta-analyses exploring age, sex, rurality, and education as possible determinants. *Ageing Res Rev*. 2022;81:101703. doi:10.1016/j.arr.2022.101703
9. Lopes MA, Ferrioli E, Nakano EY, Litvoc J, Bottino CM. High prevalence of dementia in a community-based survey of older people from Brazil: association with intellectual activity rather than education. *J Alzheimers Dis*. 2012;32:307-316. doi:10.1111/j.1530-0277.2009.01142.x
10. Bottino CM, Azevedo D Jr, Tatsch M, et al. Estimate of dementia prevalence in a community sample from São Paulo. *Brazil Dement Geriatr Cogn Disord*. 2008;26:291-299. doi:10.1159/000161053
11. César KG, Brucki SM, Takada LT, et al. Prevalence of cognitive impairment without dementia and dementia in Tremembé. *Brazil Alzheimer Dis Assoc Disord*. 2016;30:264-271. doi:10.1097/wad.0000000000000122
12. Schneider IJC, Confortin SC, Bernardo CO, et al. EpiFloripa aging cohort study: methods, operational aspects, and follow-up strategies. *Rev Saude Publica*. 2017;51:104. doi:10.11606/s1518-8787.2017051006776
13. Fundação Instituto Brasileiro de Geografia e Estatística. Pesquisa Nacional por Amostra de Domicílios: Síntese de Indicadores 2009: Domicílios Rio de Janeiro. 2009.
14. Folstein MF, Folstein SE, McHugh PR. "mini-mental state". A practical method for grading the cognitive state of patients for the clinician. *J Psychiatr Res*. 1975;12:189-198. doi:10.1016/0022-3956(75)90026-6
15. Brucki SM, Nitrini R, Caramelli P, Bertolucci PH, Okamoto IH. Sugestões para o uso do mini-exame do estado mental no Brasil [suggestions for utilization of the mini-mental state examination in Brazil]. *Arq Neuropsiquiatr*. 2003;61:777-781. doi:10.1590/S0004-282X2003000500014
16. Fillenbaum GG. Center for the Study of aging and human development, Duke University medical center, Durham, NC, USA. *The Wellbeing of the Elderly: Approaches to Multidimensional Assessment. Geneva: World Health Organization; 1984*.
17. Lopes MA, Xavier AJ, D'Orsi E. Cognitive and functional impairment in an older community population from Brazil: the intriguing association with frequent pain. *Arch Gerontol Geriatr*. 2016;66:134-139. doi:10.1016/j.archger.2016.05.010
18. Bottino CM, Zevallos-Bustamante SE, Lopes MA, et al. Combined instruments for the screening of dementia in older people with low education. *Arq Neuropsiquiatr*. 2009;67:185-190. doi:10.1590/S0004-282X2009000200003
19. Saunders JB, Aasland OG, Babor TF, et al. Development of the alcohol use disorders identification test (AUDIT): WHO collaborative project on early detection of persons with harmful alcohol consumption. *Part II Addiction*. 1993;88:791-804. doi:10.1111/j.1360-0443.1993.tb02093.x
20. World Health Organization. *Guidelines on Physical Activity and Sedentary Behaviour*. World Health Organization; 2020.
21. Roth M, Tym E, Mountjoy CQ, et al. A standardised instrument for the diagnosis of mental disorder in the elderly with special reference to the early detection of dementia. *Br J Psychiatry*. 1986;149:698-709. doi:10.1192/bjp.149.6.698
22. McKhann GM, Knopman DS, Chertkow H, et al. The diagnosis of dementia due to Alzheimer's disease: recommendations from the National Institute on Aging-Alzheimer's Association workgroups on diagnostic guidelines for Alzheimer's disease. *Alzheimers Dement*. 2011;7:263-269. doi:10.1016/j.jalz.2011.03.005
23. Hughes CP, Berg L, Danziger WL, Coben LA, Martin RL. A new clinical scale for the staging of dementia. *Br J Psychiatry*. 1982;140:566-572. doi:10.1192/bjp.140.6.566
24. Montaño MB, Ramos LR. Validade da versão em português da clinical dementia rating [validity of the Portuguese version of clinical dementia rating]. *Rev Saude Publica*. 2005;39:912-917. doi:10.1590/s0034-89102005000600007
25. Jorm AF, Jacomb PA. The informant questionnaire on cognitive decline in the elderly (IQCODE): socio-demographic correlates, reliability, validity and some norms. *Psychol Med*. 1989;19:1015-1022. doi:10.1017/s0033291700005742
26. Perroco TR, Bustamante SE, Moreno Mdel P, et al. Performance of Brazilian long and short IQCODE on the screening of dementia in elderly people with low education. *Int Psychogeriatr*. 2009;21:531-538. doi:10.1017/s1041610209008849
27. Ferretti REL, Damin AE, Brucki SMD, et al. Post-mortem diagnosis of dementia by informant interview. *Dement Neuropsychol*. 2010;4:138-144. doi:10.1590/S1980-57642010DN40200011
28. SPSS, *Statistical Package for the Social Sciences, Version 14.0 for Windows*; Chicago, IL: SPSS, Inc, 1999.
29. Fleiss JL. The control of misclassification error. In: Fleiss JL, Levin B, Cho Paik M, eds. *In Statistical Methods for Rates and Proportions*; New York: Wiley, 1981.
30. Herrera E Jr, Caramelli P, Silveira AS, Nitrini R. Epidemiologic survey of dementia in a community-dwelling Brazilian population. *Alzheimer Dis Assoc Disord*. 2002;16:103-108. doi:10.1097/00002093-200204000-00007
31. Suh SW, Han JW, Park JY, et al. Impacts of illiteracy on the risk of dementia: a Global Health perspective. *J Alzheimers Dis*. 2016;53:731-741. doi:10.3233/jad-160108
32. Mielke GI, Malta DC, de Sá GB, Reis RS, Hallal PC. Regional differences and correlates of leisure time physical activity in Brazil: results from the Brazilian National Health Survey-2013. *Rev Bras Epidemiol*. 2015;18:158-169. doi:10.1590/1980-5497201500060014
33. Maccora J, Peters R, Anstey KJ. What does (low) education mean in terms of dementia risk? A systematic review and meta-analysis highlighting inconsistency in measuring and operationalising education. *SSM Popul Health*. 2020;12:100654. doi:10.1016/j.ssmph.2020.100654
34. Sharp ES, Gatz M. Relationship between education and dementia: an updated systematic review. *Alzheimer Dis Assoc Disord*. 2011;25:289-304. doi:10.1097/wad.0b013e318211c83c
35. Deng J, Zhou DHD, Li J, Wang YJ, Gao C, Chen M. A 2-year followup study of alcohol consumption and risk of dementia. *Clin Neurol Neurosurg*. 2006;108:378-383. doi:10.1016/j.clineuro.2005.06.005
36. Huang W, Qiu C, Winblad B, Fratiglioni L. Alcohol consumption and incidence of dementia in a community sample aged 75 years and older. *J Clin Epidemiol*. 2002;55:959-964. doi:10.1016/s0895-4356(02)00462-6
37. Mukamal KJ, Kuller LH, Fitzpatrick AL, Longstreth WT Jr, Mittleman MA, Siscovick DS. Prospective study of alcohol consumption and risk of dementia in older adults. *JAMA*. 2003;289:1405-1413. doi:10.1001/jama.289.11.1405
38. Ruitenberg A, van Swieten JC, Wittemann JCM, et al. Alcohol consumption and risk of dementia: the Rotterdam study. *Lancet*. 2002;359:281-286. doi:10.1016/S0140-6736(02)07493-7
39. Mewton L, Visontay R, Hoy N, et al. Collaborators from the cohort studies of memory in an international consortium (COSMIC).

The relationship between alcohol use and dementia in adults aged more than 60 years: a combined analysis of prospective, individual-participant data from 15 international studies. *Addiction*. 2023;118:412-424. doi:10.1111/add.16035
40. Wiegmann C, Mick I, Brandl EJ, Heinz A, Gutwinski S. Alcohol and dementia - what is the link? *A Systematic Review Neuropsychiatr Dis Treat*. 2020;16:87-99. doi:10.2147/ndt.s198772
41. Xu W, Wang HF, Wan Y, Tan CC, Yu JT, Tan L. Leisure time physical activity and dementia risk: a dose-response meta-analysis of prospective studies. *BMJ Open*. 2017;7:e014706. doi:10.1136/bmjopen-2016-014706
42. Iso-Markku P, Kujala UM, Knittle K, Polet J, Vuoksimaa E, Waller K. Physical activity as a protective factor for dementia and Alzheimer's disease: systematic review, meta-analysis and quality assessment of cohort and case-control studies. *Br J Sports Med*. 2022;56:701-709. doi:10.1136/bjsports-2021-104981
43. Demurtas J, Schoene D, Torbahn G, et al. European Society of Geriatric Medicine Special Interest Group in systematic reviews and meta-analyses, frailty, sarcopenia, and dementia. Physical activity and exercise in mild cognitive impairment and dementia: an umbrella review of intervention and observational studies. *J Am Med Dir Assoc*. 2020;21:1415-1422. doi:10.1016/j.jamda.2020.08.031
44. Quialheiro A, Figueiró TH, Rech CR, et al. Can internet use reduce the incidence of cognitive impairment? Analysis of the EpiFloripa aging cohort study (2009-2019). *Prev Med*. 2022;154:106904. doi:10.1016/j.ypmed.2021.106904
45. Almeida OP, Yeap BB, Alfonso H, Hankey GJ, Flicker L, Norman PE. Older men who use computers have lower risk of dementia. *PLoS One*. 2012;7:e44239 10. doi:10.1371/journal.pone.0044239
46. d'Orsi E, Xavier AJ, Rafnsson SB, Steptoe A, Hogervorst E, Orrell M. Is use of the internet in midlife associated with lower dementia incidence? Results from the English longitudinal study of ageing. *Aging Ment Health*. 2018;22:1525-1533. doi:10.1080/13607863.2017.1360840
47. Goldberg TE, Choi J, Lee S, Gurland B, Devanand DP. Effects of restriction of activities and social isolation on risk of dementia in the community. *Int Psychogeriatr*. 2021;33:1207-1215. doi:10.1017/S1041610221000776
48. Huang AR, Roth DL, Cidav T, et al. Social isolation and 9-year dementia risk in community-dwelling Medicare beneficiaries in the United States. *J Am Geriatr Soc*. 2023;71:765-773. doi:10.1016/s0895-4356(02)00462-6
49. Shen C, Rolls E, Cheng W, et al. Associations of social isolation and loneliness with later dementia. *Neurology*. 2022;8:10-e175. doi:10.1212/wnl.0000000000200583
50. Hachinski V, Einhäupl K, Ganten D, et al. Preventing dementia by preventing stroke: the Berlin manifesto. *Alzheimers Dement*. 2019;15:961-984. doi:10.1016/j.jalz.2019.06.001

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