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Components of an indirect cognitive reserve: a longitudinal assessment of community-dwelling older adults

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ABSTRACT

Cognitive reserve enables individuals to preserve their cognition, despite a possible underlying brain pathology. The objective was to verify which components contribute to an indirect measurement of cognitive reserve in older adults, assessed longitudinally within a four-year interval. The sample was comprised of 64 older adults from the community. The following instruments were used: socio-demographic form; Mini-Mental State Examination; subtests from the Wechsler Adult Intelligence Scale – Third Edition; Trail Making Test; Verbal Fluency Test (animal category); Rey Auditory-Verbal Learning Test; Beck Anxiety Inventory; and the Geriatric Depression Scale 15-item version. Multiple linear regression analyses were performed for the data analysis. The sample was predominantly composed of women (81.3%) and the mean age of the sample was 73.19 years (*SD* = 6.12). With respect to the variables related to cognitive reserve, it was found that anxiety was the predictor variable of more cognitive components: It was found that poorer cognitive performance is associated with anxiety, and this variable is negatively related to cognitive reserve, as well as to the age variable. Engaging in cognitively stimulating activities, education level and living with someone were deemed to be factors that help build cognitive reserve in older adults. Keywords: cognitive reserve; older adults; longitudinal.

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Introduction

The concept of reserve was introduced by Katzman et al. (1989), while describing the discrepancy between the severity of an underlying pathology (e.g., Alzheimer's) and clinical manifestations in cognitively preserved older adults. The reserve has two models: the passive model, also called brain or neural reserve – which deals with structural characteristics of the brain (Stern, 2017) – and the active model, defined as a construct that helps the brain adapt to processes of degeneration, through cognitive processing resources used to compensate deficits that have occurred. This model considers that individual differences in cognitive or neural functions enable people to more effectively cope with brain damage resulting from the neurodegenerative process of normal aging

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(Stern, 2009; Stern et al., 2018). The term used to explain this process is called cognitive reserve. Both models are complementary and dependent, since cognitive reserve, which is acquired throughout life, contributes to brain reserve, causing increased volume or improvement of the neural connections of brain structures (e.g., prefrontal cortex, white matter and gray matter), after performing cognitively stimulating activities (Gleich et al., 2017; Gong et al., 2017). The cognitive reserve is related to the individual's capacity and the deployment of resources to perform the task (Cabeza et al., 2018). Brain compensation is a process associated with cognitive aging in individuals with no brain pathology (Gonzalez-Burgos et al., 2019). Depending on the cognitive reserve and brain reserve, the individual's cognitive functioning may be different, with greater ability to compensate for damage (Stern, Barnes et al., 2019).

Brain compensation comprises the individual's cognitive strategy of recruiting brain structures that are generally not used, resulting in better cognitive performance. Brain maintenance, in turn, refers to the brain's ability to adapt to changes resulting from aging, mitigating brain changes due to age (Cabeza et al., 2018; Stern, Barnes, et al., 2019). The distinction between the terms "cognitive reserve" and "brain reserve" are considered (Stern, Chételat, et al., 2019), however, only the first will be investigated, indirectly, in this article.

In the aging process, engaging in stimulating experiences throughout life can help people cope with age-related neuronal changes, minimizing cognitive decline through cognitive reserve (Steffener & Stern, 2012; Tucker & Stern, 2011). Neural activity is shaped by cognitive activities performed throughout life, and cognitive reserve can often be stimulated through life cycle activities. The working group of Stern et al. (2018) pointed out that there is still no consensus in the literature on the concept of cognitive reserve, despite the fact that there are major differences in cognitive performance among healthy older adults. This has sparked a growing interest in the factors that may contribute to individual differences in cognitive and brain aging. Some of the factors include: education level, years of profession, intelligence, lifestyle or engaging in social, cognitive, and leisure activities (O'shea et al., 2015; Stern, 2017).

Successful cognitive aging encompasses cognitive reserve and brain capacity (Cabeza et al., 2018; Zahodne et al., 2015). Existing cognitive or functional brain processes can be influenced by innate conditions (genetic) and experiences lived over the course of life, which are therefore mutable (Stern et al., 2018). Getting older (normal aging) can be mitigated by variables related to people's lifestyle, reinforcing the importance of longitudinal monitoring for an assessment of cognitive reserve in action, which may even establish causal relationships (Stern, 2017). Bennett et al. (2006) argued that the building of processing resources (perception speed and working memory) may be considered a component of cognitive reserve. Siedlecki et al. (2009) suggested that some components of executive functions, such as cognitive flexibility, may also be part of cognitive reserve, since it is influenced by life experiences. A study by Lojo-Seoane et al. (2014) included indicators associated with participation in social and cultural activities, which already have a positive effect on delaying symptoms of cognitive decline (Verghese et al., 2006; Wilson et al., 2007).

A prospective longitudinal study, conducted in Brazil's South Region, investigated the cognitive abilities of older adults at two specific times, within an interval of 3 years. Despite considerable sample loss due to the participants' ages (over 80 years old), it was possible to identify that physical and leisure activities, as well as social interaction, served as protective factors against cognitive decline in the participants (Argimon & Stein, 2005). In other words, having an active lifestyle, with intellectual, physical, and leisure activities, contributed to better cognition and quality of life, and had an influence on decreasing the risk of neurological disorders, deceleration, and neurodegeneration throughout the aging process (Shah & Martins, 2017; Silveira & Portuguez, 2017).

The objective of the present study was to determine which factors contribute to an indirect measurement of cognitive reserve in older adults, within a four-year interval. In this study, cognitive reserve was measured indirectly through the performance of the older adults in tests that assessed cognitive functions. The variables examined in this study that could boost cognitive reserve were based on previous studies (Farina et al., 2017; Stern, et al., 2018): years of profession, retirement years, education level of the parents and the participant, reading, crossword puzzles, use of electronic devices, learning another language, physical activity, history of dementia in the family, and living with someone. The age, symptoms of anxiety, and depression operate separately from the cognitive reserve, however they were included in the analysis to verify whether they interfere with an indirect measure of cognitive reserve.

Method

Design

This is a study with a longitudinal and prospective design, which estimated the temporal effects of various variables and fine-tuned the level of inference in relation to the association and influence of these variables. The assessments were carried out on two occasions, 4 years apart from each other, in 2013 and in 2017.

Participants

In 2013, stage I, 108 older adults residing in the state of Rio Grande do Sul, Brazil, were assessed and recruited by convenience, in a newspaper advertisement inviting them to participated in a survey. In stage II, in 2017, the participants from the first stage were contacted by phone and invited for a reassessment. The final sample of stage II was comprised of 64 older adults, with 44 former participants excluded. The exclusion criteria were: the phone number was out-of-date or disconnected (n = 20), the individual did not want to participate in stage II (n = 13), the individual was manifesting symptoms of dementia, according to family members (n = 4), the individual had moved to another city (n = 4) or was traveling during the collection period (n = 3).

In relation to the socio-demographic information, there were 64 community-dwelling older adults (mean age: 73.2 years; 81.3% female) in stage II, ranging from 64 to 87. Among the characteristics that did not vary over the four-year period were: education level, with a mean of 12.67 years (SD = 5.2); years of profession, with a mean of 30.78 years (SD = 12.59); number of years retired, with a mean of 15.86 years (SD = 9.64); and parents years education level, with a mean of 4.95 years (SD = 3.78). Concerning the health conditions, in the first data collection stage, 67.2% (n = 42) of the participants had health problems. In the second stage, 87.5% (n = 55) reported health problems (any disease, e.g., diabetes or high pressure), representing an increase of 20.3% (n = 13) of individuals with new clinical conditions. The mean of anxiety symptoms was 11.28 (SD = 11.19) and 9.07 (SD = 8.20) in the first and second stage, respectively. The mean of depression was 5.49 (SD = 2.56) in stage I and 2.04 (SD = 1.59) in the stage II.

Instruments

Sociodemographic and clinical data form: structured interview that inquired about gender, age, marital status, education level, with whom the person lives, years of profession, number of years retired, intellectual activities (reading, crossword puzzles, use of electronic devices, and learning another language), physical activity, and health conditions. The variable "learning another language" was evaluated asking if the participant understood another language besides Portuguese.

Mini-Mental State Examination (MMSE): a screening tool that provides an overall view of a patient's cognitive functions. Scores can range from zero to a total of 30 points (Bertolucci et al., 1994; Folstein et al., 1975; Kochhann et al., 2010).

Digit Span and coding subtests from the Wechsler Adult Intelligence Scale (WAIS-III): the coding subtest primarily assesses processing speed, whereas the digit subtest assesses auditory attention, immediate memory, and working memory (Nascimento, 2004; Wechsler, 2004).

Trail Making Test: is a task that assesses sustained attention, divided attention, sequencing, and graphomotor skills. It contains two parts: TMT-A and TMT-B. The score is calculated through the time spent by the individual to complete each part (Chan et al., 2003; Lezak, 2004; Strauss et al., 2006). Verbal Fluency (animal category): assesses executive function components, such as verbal fluency, inhibition, and word generation (Strauss et al., 2006). Rey Auditory-Verbal Learning Test (RAVLT): is composed of two lists, containing 15 words each. The first list is repeated five times (A1, A2, A3, A4, and A5) to help participants remember the largest number of words heard. Afterward, a distracter list is read (B). After 20 to 30 minutes, participants are asked to recall the first list (A7) (Boake, 2000; Rey, 1958). A1 assesses immediate memory and A7 refers to delayed recall (Malloy-Diniz, et al., 2007). Beck Anxiety Inventory (BAI): measures the intensity of anxiety symptoms through a symptom scale comprised of 21 items, where individuals need to mark how they felt in the last 2 weeks, using a four-point scale. In this study, the cutoff points suggested by the manual were used, subdivided as follows: 0 to 10: minimal symptoms; 11 to 19: mild; 20 to 30: moderate; and 31 to 63: serious (Cunha, 2001). Geriatric Depression Scale (GDS-15): measures the level of symptoms of depression in older adults. It consists of a questionnaire with 15 questions, with two response options: yes and no. Scores lower than five are considered as absence of symptoms and above five indicates the presence of symptoms of depression (Almeida & Almeida, 1999; Yesavage et al., 1983).

Ethical procedures

The study design was sent to the Scientific Commission of the School of Health Sciences and submitted for approval by the Research Ethics Committee of the University under No. 12,324,413.4.0000.5336 in stage I and No. 63,196,816.8.0000.5336 in stage II. After agreeing to participate in the study, the participants signed a Free and Informed Consent Form.

The ethical procedures were based on the Guidelines and Regulatory Standards for Research Involving Human Beings (Resolution No. 510/16 and Resolution No. 466/12 of the National Health Council). This study takes part from an integrative project on non-clinical aging, being hypotheses completely separate from a previous publication (Farina et al., 2019).

Data collection procedures

In both stages (I and II), the assessment was performed by a psychologist and Psychology students, who had been trained in advance. The data collection instruments were applied in a psychological treatment clinic and in rooms provided by the Graduate Studies Program in Psychology of the University. The older adults were assessed individually in a session that lasted approximately 2 h. Participants indicating any loss or the need for treatment were referred to the Psychology Treatment and Research Center at University. The results were delivered in April 2018, in a group setting, with an average number of 10 older adults per meeting. Most of the participants received their results in person ($n = 42$) and the others ($n = 22$) by phone.

Data analysis procedures

The cognitive function predictor variables were selected theoretically, based on previous cognitive reserve studies (Farina et al., 2017; Stern, 2017). For indirect measurement estimate of cognitive reserve, the cognitive performance of the individuals in stage II was considered by raw scores. In relation to the sociodemographic characteristics, due to collinearity, only one of the stages for collecting the variables was used: age (stage II), years of profession (stage I), number of years retired (stage I), education level of the parents and participant (stage I). For the other variables, the results from both stages I and II were considered: cognitively stimulating activities such as reading, crossword puzzles, use of electronic devices or learning another language, physical activity, history of dementia in the family, living with someone, and symptoms of anxiety and depression. It should be pointed out that temporal effects are considered when independent variables from stage I influence or explain the outcome (stage II). When independent variables that explain the outcome (stage II) are variables from stage II, they are considered contemporary effects.

Afterward, multiple linear regression analyses were carried out, with cognitive functions serving as dependent variables (DV), and sociodemographic and anxiety/depression information as independent variables (IV). The estimation method used was stepwise least squares, which progressively selects the main predictors, taking into account the criterion of statistical difference in relation to the previous model. The standardized and non-standardized regression weights were analyzed, as well as confidence intervals, statistical significance, and variance explained by the model.

Results

The average score of the instruments that assessed the participants' cognitive performance in stage II was: 27.82 ($SD = 2.38$) in overall cognitive function, 4.82 ($SD = 1.54$) in immediate verbal episodic memory, 7.46 (*SD* = 3.16) in delayed verbal episodic memory, 46.43 (*SD* = 13.68) in processing speed, 13.07 (*SD* = 2.91) in auditory attention, immediate and working memory, 23.57 (*SD* = 1.10) in sustained attention, sequencing, and graphomotor skills, 18.82 (*SD* = 7.56) in divided attention, sequencing, flexibility and graphomotor skills, and 17.14 (*SD* = 4.07) in verbal fluency, inhibition, and word generation.

In the multiple linear regression analysis, the explanatory models for cognitive reserve were verified as shown in Table 1. It can be seen that symptoms of anxiety (stage II), use of electronic devices (stage I), learning another language (stage I), and living with someone (stage I) jointly accounted for 51.3% of the variance in overall cognitive function (MMSE) of the participants. The use of electronic devices (stage I) and symptoms of anxiety (measured by the BAI) (stage II) explained 18.8% of the variance in verbal episodic memory (immediate) (RAVLT A1). Symptoms of anxiety (stage II) and living with someone (stage I) explained 21.5% of the performance of verbal episodic memory (delayed) (RAVLT A7).

Education level, doing crossword puzzles (stage I), and age (stage II) accounted for 40.6% of processing speed performance (Coding). Age (stage II) and symptoms of anxiety (stage I) explained 19.6% of the scores for attention, immediate memory, and working memory (Digit Span). Symptoms of anxiety (stage II), doing crossword puzzles (stage I), and age (stage II) accounted for 24.6% of the variance in performance in sustained attention tasks, sequencing, and graphomotor skills (TMT-A). These same variables accounted for 31.5% of the performance in divided attention tasks, sequencing, flexibility, and graphomotor skills (TMT-B). Finally, the age variable (stage II), alone, accounted for 12.7% of the variance in verbal fluency (animals), which assessed executive functions such as verbal fluency, inhibition, and word generation.

The anxiety was the most frequent significant predictor variable, accounting for behavior in six out of the eight cognitive tasks performed. The age variable was next, corresponding to five out of the eight cognitive tasks. In relation to cognitively stimulating activities, doing crossword puzzles were the most frequent predictor variable, explaining the performance of three out of the eight cognitive tasks, followed by use of electronic devices and living with someone, corresponding to two tasks. The other variables – education level and learning another language – explained one cognitive task.

Discussion

The primary objective of this study was to identify the variables that contribute to cognitive reserve in older adults, over a four-year interval. The cognitive reserve was measured indirectly through the performance of the older adults in tests that assessed cognitive functions. So, the stage II cognitive performance was considered to be an indirect measure of cognitive reserve.

It was found that use of electronic devices, learning another language, crossword puzzles, education level, and living with someone were part of the cognitive reserve of older adults. Symptoms of anxiety and age do not operate as typical cognitive reserve proxies. In that study, these two variables have had a negative impact on cognitive reserve and all the rest had a positive effect.

According to these results, it concludes that anxiety was the variable that accounted the most for the cognitive performance of the older adults within the four-year period,

Table 1. Multiple linear regression for predicting cognitive reserve (n = 64).

Cognitive functions (DV)	R^2 (variance)	Predictors (IV)	*F (df)*	*p*	Non-standardized Beta coefficient (β)	Standard Error (SE)	Standardized Beta coefficient (β)	*t*	*p*	CI (95%) Lower Limit	CI (95%) Upper imit
Overall cognitive function (MMSE)	51.30%	BAI2	17.295 (4, 58)	<0.001	−0.181	0.034	−0.535	−5.373	<0.001	−0.248	−0.113
		Use of electronic devices1			1.855	0.512	0.337	3.623	0.001	0.830	2.880
		Learning another language1			1.766	0.544	0.296	3.249	0.002	0.678	2.854
		Living with someone1			0.27	0.115	0.23	2.346	0.022	0.04	0.501
Immediate verbal episodic memory (RAVLT A1)	18.80%	Use of electronic devices1	8.173 (2, 60)	<0.001	1.169	0.429	0.324	2.725	0.008	0.311	2.027
		BAI2			−0.056	0.026	−0.253	−2.127	0.038	−0.109	−0.003
Delayed verbal episodic memory (RAVLT A7)	21.50%	BAI2	6.902 (2, 41)	0.003	−0.208	0.063	−0.455	−3.312	0.002	−0.335	−0.081
		Living with someone1			0.419	0.184	0.312	2.272	0.028	−0.335	−0.081
Processing speed (Coding)	40.60%	Education level	15.132 (3, 59)	<0.001	1.556	0.316	0.500	4.919	<0.001	0.923	2.188
		Crossword puzzles1			7.377	3.217	0.226	2.293	0.025	0.940	13.815
		Age2			−0.594	0.267	−0.227	−2.222	0.03	−1.128	−0.059
Auditory attention and immediate and working memory (Digit Span)	19.60%	Age2	8.548 (2, 60)	0.002	−0.21	0.059	−0.405	−3.548	0.001	−0.328	0.920
		BAI1			−0.09	0.039	−0.268	−2.349	0.022	−0.167	−0.013
Sustained attention, sequencing and graphomotor skills (TMT-A)	24.60%	BAI2	7.742 (3, 59)	<0.001	1.247	0.466	0.299	2.679	0.01	0.316	2.179
		Crossword puzzles1			−19.713	7.422	−0.295	−2.656	0.01	−34.564	−4.863
		Age2			1.305	0.599	0.244	2.177	0.033	0.106	2.505
Divided attention, sequencing, flexibility and graphomotor skills (TMT-B)	31.50%	BAI2	10.491 (3, 59)	<0.001	4.755	1.326	0.382	3.586	0.001	2.102	7.407
		Age2			4.714	1.707	0.295	2.762	0.008	1.299	8.129
		Crossword puzzles1			−47.599	21.132	−0.238	−2.252	0.028	−89.884	−5.314
Verbal fluency, inhibition and word generation (Fluency – Animals)	12.70%	Age2	10.000 (1, 61)	0.002	−0.258	0.082	−0.375	−3.162	0.002	−0.422	−0.095

and was present in six out of the eight explanatory models. In this study, symptoms of anxiety were predictors of poor performance in overall cognitive function, working memory, immediate memory, and verbal episodic memory (immediate and delayed), attention (auditory, sustained, and divided), sequencing, flexibility, and graphomotor skills. Similar findings were obtained in other studies, indicating that executive functions may decrease in older adults suffering from anxiety (Beaudreau & O'Hara, 2008; Mantella et al., 2007). Bierman et al. (2005) found that symptoms of anxiety may be predictors of poorer performance in verbal memory tasks, as well as loss of learning skills in older adults. Beaudreau and O'Hara (2009) observed that symptoms of anxiety were associated with impaired attention performance in this population.

Yochim et al. (2013) also found a relationship between anxiety and executive functions, especially in the TMT test (sequencing, flexibility, and graphomotor skills), which was also used in the present study. The findings suggest that older adults may have difficulties switching between two lines of thought or in performing multiple tasks simultaneously, which can affect work productivity as well the ability to engage in complex or multi-faceted tasks, such as driving or participating in social activities. In the view of these authors, decreased executive function due to anxiety can have a high cognitive impact, hindering individuals from wielding all the cognitive resources needed for executive tasks. On the other hand, it can also be assumed that individuals with fewer executive function skills are less able to suppress anxiety.

After anxiety, age was the variable with the highest predictive power for cognitive performance, found in five of the eight explanatory models. Since normal aging process is associated with a decrease in cognition – brain aging (Cabeza et al., 2018; Monica et al., 2018), the age variable would be expected to be a predictive factor. However, apart from age, other variables also influence certain cognitive components.

According to the results, age is a predictive factor of poorer cognitive performance in working memory, immediate memory, processing speed, auditory, sustained and divided attention, and executive functions: sequencing and graphomotor skills, verbal fluency, inhibition, and word generation. Neurological diseases sometimes accompany biological aging. The study of neurodegenerative diseases, as well as age-associated cognitive decline, has been extensively addressed in the literature, in view of the modifications in plasticity and neural connections that occur during aging (Mertens et al., 2018; Navakkode et al., 2018; Wolinsky et al., 2016). Different studies have indicated that increased age is associated with a decrease in certain cognitive domains, such as information processing speed (Eckert et al., 2010), episodic memory (Grady & Craik, 2000; Prull et al., 2000), and working memory (Park, 2002). A Spanish study investigated implicit and explicit memory in an associative verbal recognition task in older adults with mild cognitive decline, in relation to cognitive reserve. In the assessment of cognitive performance, it was noted that higher cognitive reserve levels were associated with better performance in both groups, where the age variable was a contributing factor to cognitive reserve (Algarabel et al., 2016). Engaging in activities such as crossword puzzles, learning another language, and use of electronic devices were also found to contribute to overall cognitive function, processing speed, verbal episodic memory (immediate), divided and sustained attention, sequencing, flexibility, and graphomotor skills in the present study. There were also indications in the literature that individuals who frequently participate in cognitively stimulating leisure activities, such as reading, playing cards, and doing crossword puzzles, started cognitive decline later (Hall et al., 2009; Zhu et al., 2017).

Doing crossword puzzles was also identified in the present study as a predictor of processing speed, sequencing, and graphomotor skills, and sustained and divided attention. Crossword puzzles are a learned skill, related to education, even though not all people with formal education actively engage in this pastime. Therefore, doing crossword puzzles is a way of assessing proficiency in a specific-learned skill and, for this reason, can help maintain cognition (Pillai et al., 2011).

The role of crossword puzzles in maintaining cognitive function is relevant, considering their widespread availability (newspapers, books, and the Internet), ease of access and low cost (Pillai et al., 2011). According to some authors, they can reduce the risk of cognitive decline, due to the effect of memory on cognitive reserve, by directly intervening in the modification of a disease or they may be markers for other healthy behaviors (Verghese et al., 2006, 2003). Use of electronic devices was identified as a predictor of overall cognitive function and immediate verbal episodic memory. A hypothesis for explaining this result would be that the use of electronic devices contributes to activation in brain regions, and may promote greater neural and functional plasticity (Pessini et al., 2018) and, consequently, lead to better cognitive performance. The literature indicates that performing computerized cognitive activities is beneficial to overall cognitive performance, memory, processing speed, executive functions, attention, and visual-spatial capacity in cognitively preserved adults (Kueider et al., 2012).

Learning another language was identified as contributing to cognitive reserve, mainly in relation to overall cognitive function. It was observed that learning another language has an impact on brain structure, in that people need to select a language or communicate, which involves executive function capacity, cognitive control, and cognitive flexibility (Dasha et al., 2017; Reyes et al., 2018). In addition, it can be considered that this activity protects against symptoms of dementia in older adults (Bialystok et al., 2007).

The regression model also revealed that education level was a predictor of processing speed performance. Springer et al. (2005) found that older people with more education level had higher frontal involvement during successful memory recall, compared to participants with fewer education level. These findings indicate that healthy older adults with high cognitive reserve are more inclined to involve other brain regions – not normally activated – when they perform certain tasks, in order to assist cognitive function. The findings of a longitudinal study by Zahodne et al. (2011) demonstrated that education influences cognitive performance, especially in relation to processing speed, which coincided with the findings of the present study. The authors of that study reported that although better cognitive performance is associated with education level, the rate of poorer cognitive performance during aging is independent of education.

The living with someone variable was also a predictor of overall cognitive function and delayed verbal episodic memory in older adults. It can be argued that individuals who live with someone have greater social interaction and that this ultimately boosts their cognitive and memory function (Derksen et al., 2015). In a longitudinal assessment of individuals over 55 years of age, Rawtaer et al. (2017) identified that the association between having a spouse and satisfaction with life protected individuals from the development of dementia or poorer cognitive performance. Another study found that individuals with fewer interpersonal relationships had a greater tendency toward developing dementia (Kuiper et al., 2015). Therefore, it is possible to propose that interaction with other people encourages individuals to engage in intellectual and physical activities, which help keep older adults more active.

This study makes important contributions with respect to the components that can contribute to an indirect measurement of cognitive reserve in older adults. It was decided to consider different indicators as components of cognitive reserve, in view of the fact that most of the variables reported in the literature had some level of influence on this construct. Thus, the authors believe that it is possible to obtain a more comprehensive and complete understanding of the building of cognitive reserve, as well as minimize the risk of overlooking any activity to that contributes to this construct. Another contribution is related to the fact that this was an innovative study, in the sense of assessing the elderly population of Rio Grande do Sul longitudinally. The participation of elderly women was prevalent in this study. This data is also widely observed in other studies with elderly people in the Brazilian community and in international research. This information deserves to be highlighted so that the results can be analyzed with caution.

Despite the relevant outcomes, this study has some limitations. Due to the longitudinal design of the study, a sample loss was expected, but it was larger than expected, based on the parameters of a study by Argimon and Stein (2005). Also, some variables in the regression models, such as educational level, sex, and other demographic variables were not controlled; and the study used a not validated cognitive reserve questionnaire.

Future studies can fix these limitations and also assess all cognitive domains and use neuroimaging measures, which would be useful to clarify the brain processes underlying the results obtained in this study. Therefore, the authors suggest that future longitudinal studies with older adults use a larger sample size since loss can be greater than expected. The authors believe it is still important to carry out further studies that monitor older adults, in order to determine the impact of socioeconomic variables on the cognitive function of individuals over the course of years. This will make it possible to develop preventive and treatment measures for the elderly, leading to cognitive aging with better health and quality of life.

Disclosure statement

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