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RESEARCH ARTICLE

Work-related stress and cognitive performance among middle-aged adults: The Brazilian Longitudinal Study of Adult Health (ELSA-Brasil)

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Abstract

Assessing risk factors exposure, such as stress in the workplace during adulthood, may contribute to detecting early signs of cognitive impairment in order to implement effective actions to improve brain health and consequently to decrease cognitive disorders later in life. In this cross-sectional study, we aimed to investigate whether work-related stress is associated with low cognitive performance in middle-aged adults from the Brazilian Longitudinal Study of Adult Health (*ELSA-Brasil*) and whether social support mediates this relationship. Work-related stress was evaluated in 9,969 workers using the Demand-Control-Support Questionnaire. Cognitive function was assessed using the verbal fluency, trail-making version B, and delayed recall word tests. Work-related stress was associated with lower performance on the delayed recall, verbal fluency, and executive function tests in middle-aged adults. Social support may mediate the association between work demands and cognitive performance. These findings support that work-related stress is associated with cognitive performance during adulthood.

KEYWORDS
cognition, occupational health, social support, work stress

1 | INTRODUCTION

Prevalence of dementia such as Alzheimer's disease is projected to dramatically increase worldwide, especially in low- and middle-income countries where non-communicable diseases, and low education levels represent the main risk for cognitive disorders (Ferri & Jacob, 2017). By 2030, around 74.7 million people are expected to be affected, and the total cost of dementia is estimated to rise to US$ 2 trillion (Alzheimer's disease International, 2015). Identification of modifiable risk factors has been one of the research priorities to reduce the global burden of dementia by 2025 (Shah et al., 2016). Exposure to psychological stress over one's life is a potential risk factor for cognitive decline in ageing (Wilson et al., 2005).

There are windows of vulnerability to the negative effects of stress throughout one's life, and adulthood constitutes one of the most critical periods because it is the longest phase of the human life cycle (Lupien, McEwen, Gunnar, & Heim, 2009). Sustained exposure to stress during adulthood contributes to cumulative neurotoxic

effects in the brain that may be manifested in older ages as cognitive disorders (Juster et al., 2011; Lupien et al., 2009). On the other hand, adulthood may also represent a promising window of opportunity for early detection of subclinical signs of brain diseases related to chronic stress and for interventions that could potentially counteract the effects of stress and decrease the risk of cognitive disorders later in life (Lupien, Juster, Raymond, & Marin, 2018).

Work-related stress constitutes one of the major sources of stress during adulthood, and it represents an indirect measure of chronic exposure to stress during midlife (Bergdahl & Bergdahl, 2002). According to the job demand–control–support theory, work-related stress occurs when employees are exposed to work demands, pressures, and challenges that overcome their abilities, knowledge, and coping resources (Karasek, 1979; Karasek & Theorell, 1990). The unbalance generated by high psychological work demands, low autonomy for decision making (known as job control or decision latitude) and low support from supervisors and colleagues characterizes a high job strain that contributes to work-related stress development (Karasek, 1979; Karasek & Theorell, 1990; Rhoades & Eisenberger, 2002). A passive job, defined as low demands with low control, is also associated with job strain due the combination of boredom, inability to control the work process, and the under exploration of one's potential. Conversely, low strain (low demands and high job control) and active job (high demands and job control) represent a positive and balanced relationship in the work place (Karasek, 1979).

In the relationship between demand and control, social support has been considered an essential resource to buffer the impact of job strain on health and well-being. High-strain jobs could be aggravating when workplace supports to acquire task information or assistance, or social companionship are perceived to be low (Häusser, Mojzisch, Niesel, & Schulz-Hardt, 2010; Aquino et al., 2013; Johnson & Hall, 1988; Karasek & Theorell, 1990). As a buffer factor, social support resources are able to counteract the effects of demand stressors on strain and therefore diminish the job strain effects in health outcomes (Karasek & Theorell, 1990).

The contemporary work environment, characterized by its fast-paced nature, elevated production and performance, high-skilled and competitive jobs, and time pressure derived from the use of information and communication technology, has generated intense psychological demands in different workplace scenarios. Allied to this, social isolation (isostrain) or a lack of support at work has been associated with low levels of employees' health, motivation, and work performance (Häusser et al., 2010; Karasek & Theorell, 1990; Nieuwenhuijsen, Bruinvels, & Frings-Dresen, 2010; Stavroula, Griffiths, & Cox, 2004).

High psychological demands, low control, conflict, and job insecurity in the work environment represent the main psychological risk factors for stress-related disorders, such as cardiovascular diseases, depression, anxiety, and burnout in workers aged 40 years and older (Adriaenssens, De Gucht, & Maes, 2015; Fishta & Backé, 2015; Nieuwenhuijsen et al., 2010; Wahrendorf et al., 2012; Wilson, Conroy, & Dorevitch, 2014). Recently, work-related stress during midlife was associated with cognitive impairment later in ageing (Agbenyikey et al., 2015; Andel et al., 2015; Andel, Crowe, Kåreholt, Wastesson, & Parker, 2011; Elovainio et al., 2009; Sindi et al., 2016; Wang, Wahlberg, Karp, Winblad, & Fratiglioni, 2012). Middle-aged workers with low job control showed poor episodic memory performance at retirement and poor global cognitive performance later in ageing, when participants were on average 83 years old (Andel et al., 2011; Andel et al., 2015). Similarly, adults with high work-related stress evaluated at midlife showed high risk to develop mild cognitive impairment, dementia, and Alzheimer's disease 20 years later (Sindi et al., 2016). Interestingly, none of these studies demonstrated the association between work-related stress and cognitive performance earlier during the middle life, when individuals are still in the workforce. The cognitive interference, whereby intrusive thoughts and the intention to suppress them from the mind compete with cognitive resources, explains why the negative effects of stress on cognition would be more evident in advanced age when the brain reserve is likely to decline (Stawski, Sliwinski, & Smyth, 2006).

Although these studies demonstrated that cognitive decline during older age is associated with previous exposure to work-related stress, it remains inconclusive whether high job strains would be associated with low cognitive performance during adulthood, when individuals are already exposed to the cumulative effects of stress in the brain. Moreover, the majority of participants had high education levels and came from high-income countries, which compromises generalization regarding populations with lower education and different sociocultural backgrounds. These issues are relevant because pathophysiological mechanisms related to cognitive impairment in advanced age are supposed to be triggered decades before clinical diagnosis, and low education levels constitute one of the factors related to the earlier emergence of dementia in low- and middle-income countries (Dubois et al., 2016; Nitrini, 2012). In addition, the role of social support at the workplace in the relationship between work-related stress and low cognitive performance has yet to be investigated. This is critical because workplace interventions to control psychological demands should focus on organizational support to the worker, especially when lowering demands is improbable (Fisher, Chaffee, Tetrick, Davalos, & Potter, 2017; Griffin & Clarke, 2011).

Significant changes in retirement trends have showed that workers are retiring later and more gradually, implying that in a near future the workforce will be characterized by a large number of older workers (Cahill, Giandrea, & Quinn, 2015; Calvo, Madero-Cabib, & Staudinger, 2018; Fisher, Chaffee, & Sonnega, 2016). For successful ageing at work, it is essential to detect early signs of cognitive decline and risk factors that could impact on cognitive functioning (Fisher et al., 2017).

Therefore, we aimed to investigate whether work-related stress was associated with low cognitive performance in middle-aged adults from the Brazilian Longitudinal Study of Adult Health ("ELSA-Brasil") and whether social support mediates this relationship. We hypothesized that high demands and low control jobs are associated with poor performance on memory, verbal fluency, and executive function tests and that social support mediates this relationship.

2 | METHODS

2.1 | Participants, design, and ethical approval

The target population for the ELSA-Brasil study was active or retired civil servants of six educational or health institutions from the metropolitan areas of Brazil (São Paulo, Rio de Janeiro, Porto Alegre, Vitória, Belo Horizonte, and Salvador). Volunteers were recruited through on-site and radio announcements, mailings, outdoor billboards, and telephone calls. At this stage, 16,435 individuals were recruited. After that, there was a "pre-enrollment" stage conducted in the workplace or in the investigation center to analyse eligibility and to receive participants' consent, and a brief interview regarding sample characterization. Exclusion criteria included (a) employees with severe cognitive or communication impairments; (b) being pregnant or having been pregnant in the last 4 months; (c) intending to quit work at the institution in the near future for reasons not related to retirement; and (d) residing outside the corresponding metropolitan area if retired. Sequentially, the "enrollment" stage was conducted in the investigation center for clinical assessment and physical measurements. Both "pre-enrollment" and "enrollment" stages were structured in a face-to-face interview. Approximately 3.7% (n = 614) individuals were excluded between recruitment and the "pre-enrollment" stage and 4.5% (n = 716) between "pre-enrollment" and "enrollment". The ELSA-Brasil included 15,105 participants, 6,887 men and 8,218 women, 35 to 74 years old at study entry between 2008 and 2010. Efforts were made to recruit similar proportions of men and women, as well as predefined proportions of age groups and occupational categories (routine manual and non-manual jobs and routine or non-routine manual jobs). The ELSA-Brasil protocol was composed of previous documents used in Brazilian studies with representative national samples such as the *Vigilância de Fatores de Risco para doenças crônicas não transmissíveis*, *Programa Nacional de Saúde*, and Brazilian Census and several validated documents and charts based on previous international published data after translation and cultural adaptation of the charts to Brazilian Portuguese used in cohort studies. The present study focused on current workers, with cognitive performance and job stress assessment and without use of medications or clinical conditions that could impact on cognitive functioning (n = 10,292). Missing covariate data accounted for 323 deletions (Figure 1). The final analytic sample comprised 9,969 participants (~82.42% of the current workers from the ELSA-Brasil baseline sample n = 12,096).

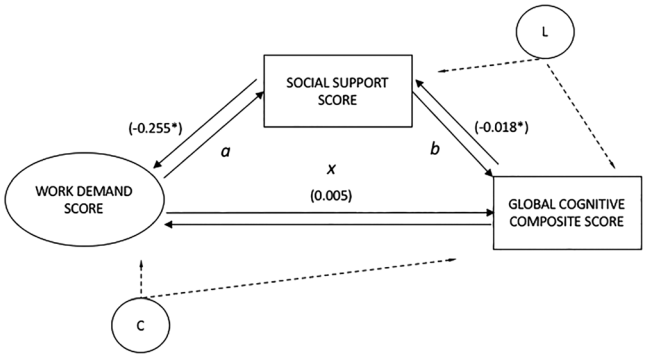

FIGURE 1 Flowchart representing the study population

The study was approved by the Ethics Committee of the "Hospital Universitário da Universidade de São Paulo" (CEP-HU 669/06), São Paulo, Brazil. All participants provided informed consent and identifying information of participants has been anonymized.

2.2 | Work-related stress evaluation

Job stress was evaluated using the Brazilian version of the Swedish "Demand Control Support Questionnaire" composed of 17 questions related to three dimensions: psychological demands, decision latitude (or job control), and social support at work (Karasek, Baker, Marxer, Ahlbom, & Theorell, 1981). The psychological demands dimension is composed of five items that evaluate work characteristics, such as time requirement, speed to perform tasks, and conflict, among other demands. The decision latitude or control dimension is composed of six questions that evaluate skill discretion (learning new things, skill level, being creative, and variety of work) and decision authority (autonomy to make decisions in the workplace). The social support dimension is composed of six items that evaluate the atmosphere, spirit of unity, support from colleagues, helpfulness of the colleagues, relationship with superiors, and relationship with colleagues. All items were scored on a 4-point Likert-scale ranging from 1 (*often*) to 4 (*never/almost never*). The responses to each item were tallied, with higher scores in the psychological demands (range from 5 to 20 points), control subscales (range from 6 to 24 points), and social support at work (range from 6 to 24 points) indicating higher levels of demand, control and social support, respectively. To analyse the combination of job demand and job control, we used the job strain classification that was composed of four groups: (a) low strain work (low demand/high control); (b) passive work (low demand/low control); (c) active work (high demand/high control); and (d) high-strain work (high demand/low control; Karasek & Theorell, 1990). These groups were created using the median values of the demand and control subscales as cutoffs to dichotomize these variables (Camelo et al., 2015). The reliability of Demand Control Support Questionnaire has already been tested for the ELSA-Brasil study (Hökerberg et al., 2010), showing adequate internal consistency based on composite reliability (CR) values (Demands: CR = 0.79; 95% CI [0.76, 0.82]; Decision latitude: CR = 0.70; 95% CI [0.66, 0.74]; Skill discretion: CR = 0.70; 95% CI [0.64, 0.75]; Decision authority: CR = 0.80; 95% CI [0.76, 0.84]; Social support: CR = 0.87; 95% CI [0.85, 0.89]).

2.3 | Cognitive performance assessment

Cognitive performance was measured using the following tests: Delayed recall word test (DRWT) from the Consortium to Establish a Registry for Alzheimer's disease, the phonemic verbal fluency test (VFT), and the trail-making test (TMT) version B. Interviewers were trained by a supervisor to conduct these tests. After training completion, interviewers were evaluated through a written exam about the contents of the application manual and a practical test

composed by an interview to a volunteer. Pretesting and pilot analysis were conducted to test feasibility and to determine the "theme block sequencing" of the measures. Details regarding the development of the ELSA-protocol and questionnaires were described elsewhere (Chor et al., 2013; Passos, Caramelli, Benseñor, Giatti, & Barreto, 2014).

The DRWT from the Consortium to Establish a Registry for Alzheimer's disease includes a list of 10 unrelated words recalled after a 5-min delay. Participants were asked to read and learn 10 words after three learning trails. The words were showed to participants printed in large letters on cards, at a rate of one word every 2 s, and they were presented in a different order in each of the three learning trials. After a 5-min filled delay, participants had 60 s to record the words. The score was equal to the number of recalled words. This test was used to assess declarative memory related to the ability to retain new information (Bertolucci, Okamoto, Toniolo Neto, Ramos, & Brucki, 1998; Passos et al., 2014). The VFT consisted of asking participants to say as many words as possible starting with the letter F in 1 min, and it was used to evaluate semantic memory, language, attention to a task over time, and concentration (Passos et al., 2014). In the TMT version B, the participant was instructed to draw lines connecting letters and numbers in an order that alternated between increasing numeric value and alphabetic order (1, A, 2, B, 3, C, etc.). The participant was told to draw as quickly as possible, without lifting the pencil point from the page. The test score was the total time taken to complete the task in seconds. This test was used to assess executive function, including visual–spatial organization, speed, and cognitive flexibility (Passos et al., 2014). The reliability of all cognitive tests has already been evaluated for the ELSA-Brasil study (Batista, Giatti, Barreto, Galery, & Passos, 2013), showing moderate to excellent reliability based on intraclass correlation coefficient values (DRWT: intraclass correlation coefficient = 0.51; 95% CI [0.17, 0.83]; VFT (letter F): CR = 0.61; 95% CI [0.41, 0.81]; TMT: CR = 0.91; 95% CI [0.87, 0.95]).

Because cognition compromises different domains, a global score that aggregates the DRWT, TMT, and verbal fluency test scores in a single composite score was generated as measure of global cognition. This procedure has proved to be better than separated test scores in predicting cognitive decline (Crane et al., 2012). Other authors also showed that the composite score was useful to investigate associations between independent clinical variables and cognitive performance in middle-aged and older adults (Rawlings et al., 2014; Suemoto et al., 2018; Szlejf et al., 2018).

2.4 | Potential confounding variables

Possible confounding variables of the association between job stress and cognitive performance included age, sex, race (White, Brown, Black, and other races), education level (high school or less vs. college or more), monthly income categorized in tertiles, occupation category (routine manual and non-manual jobs and routine or non-routine manual jobs), hours of work per week, time in the workforce, hypertension, diabetes, coronary artery disease, heart failure (all these disorders with previous medical diagnosis), alcohol use (never, former, or current user), smoking (never, former, or current smoker), body mass index, and thyroid function (normal: thyrotrophic hormone [TSH] from 0.4 to 4 mIU/l and free T4 [FT4] levels between 0.8 and 1.9 ng/dl); hypothyroidism: TSH >4.0 mIU/l and FT4 < 0.8 ng/dl; and hyperthyroidism: TSH <0.4 mIU/dl and FT4 > 1.9 ng/dl). Common mental disorders, which include anxiety and depression symptoms without fulfilling a full diagnosis of anxiety or depression, were evaluated using the Clinical Interview Schedule-Revised. The Clinical Interview Schedule-Revised score ranges from 0 to 72. The presence of 12 or more symptoms but not fulfilling the criteria for depression or anxiety is classified as common mental disorders (Lewis, Pelosi, Araya, & Dunn, 1992).

2.5 | Statistical analysis

We used mean and standard deviation (*SD*) to describe quantitative variables and relative frequencies to describe categorical ones. We tested the associations of job strain variables with sociodemographic and clinical variables, using one-way ANOVA for continuous variables and χ^2 test for categorical variables. To investigate the association between work-related stress variables (e.g., demands, control, and social support) and performance on cognitive tests, we first examined the Pearson correlation coefficients between these variables followed by linear regression models adjusted for the potential confounding variables described above. Multiple comparisons were corrected using the Bonferroni correction. The dependent variables were the Z-scores for the cognitive tests. The Z-scores were calculated for each test by subtracting each participant's test score from the mean score of the sample and dividing the difference by the *SD* of the sample scores. A Z-score of −1 refers a cognitive performance that was 1 *SD* below the mean score of the sample score. The Z-scores for the TMT were inverted beause higher scores indicate poorer performance, whereas higher scores on the other tests are related to better performance. A composite global cognitive Z-score was calculated by averaging the Z-scores of the three cognitive tests (DWRT, TMT, and verbal fluency) and then standardized the averaged Z-score (Rawlings et al., 2014; Shah et al., 2013; Suemoto et al., 2018; Szlejf et al., 2018). We investigated the mediation effect of social support on the association between work-related stress variables and the global composite Z-score using linear structural equation modelling (SEM) and decomposition of effects into total, direct, and indirect (estat teffects) in Stata 15 (Stata, 2017, College Station, TX). Conceptually, SEM is a multivariate technique to test a path diagram where the primary hypothesis is that the effect of the independent variable on the outcome (direct effect) can be mediated by a change in the mediating variable (indirect effect). Using regression-style equations, the SEM fits a single model for estimation of the direct, indirect, and total effects (MacKinnon & Fairchild, 2009; Sobel, 1987). In the current study, the direct effect was tested measuring standardized estimates between work demands and cognitive performance, whereas the indirect effect was analysed estimating the effect of work demands on cognitive performance through social support (Paths a and b; Figure 2). If a mediation effect exists, both estimated paths (a and b) for the indirect effect will be

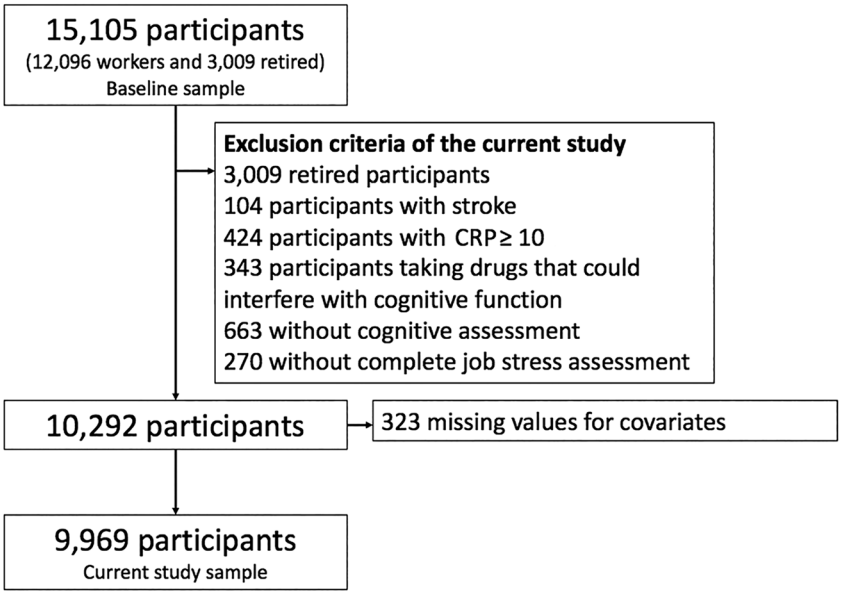

FIGURE 2 Schematic representation and regression coefficients for the relationship between global cognitive performance and work demands mediated by social support. The standardized regression coefficients are shown in parentheses. The C represents the confounders for exposure–outcome (age, sex, race, education, income, hypertension, diabetes, body mass index, smoking, excessive alcohol use, common mental disorders, occupation type, hours of work per week, and time in the workforce). The L represents the mediator–outcome confounders that are affected by the exposure (age, sex, education, income, common mental disorders, occupation type, hours of work per week, and time in the workforce). Letters *a* and *b* represent the paths for *indirect effect* of mediation, whereas letter *x* represents the *direct effect*. The arrows represent the possible directions of the relationship between the work demands, social support, and cognitive performance. The dashed lines represent the covariate effects. **p* < .05. C-reactive protein (CRP)

statistically significant, whereas the estimate of the direct effect will be close to zero and not significant. The mediation analysis was adjusted for the set of possible confounders described above. The level of statistical significance was set at 0.05, and all tests were two tailed.

3 | RESULTS

3.1 | Sample characteristics

The age of participants ranged from 34 to 72 years, approximately 55.7% had 11 years of education or more (Table 1). They were in the workforce for more than 30 years on average; they were in their current work activities for an average of 13.0 ± 9.3 years (range 0–47 years), and 24.7% of them held a supervisory position (Table 1).

When compared with the low-strain group, the high-strain and passive groups were composed of more female participants, younger individuals, with lower education level, and lower monthly income. Regarding clinical variables, participants of the high-strain and passive groups showed higher smoking (current and previous), chronic disease (hypertension and diabetes only for passive group), and common mental disorder rates. Additionally, they showed lower performance in the verbal fluency and trial-making tests (Table 1). No differences were found in low-strain with passive or high-strain groups regarding alcohol consumption (Table 1).

3.2 | Job stress and cognitive performance

High demand was significantly correlated with high skill discretion, high decision authority and low social support. Skill discretion and decision authority were positively correlated. Social support was positively related to both skill discretion and decision authority. Significant correlations were observed between job stress indicators and cognitive performance. Work demands, skill discretion, and decision authority were positively associated with global cognitive composite, DRWT, verbal fluency, and TMT Z-scores. Work demands were not significantly associated with verbal fluency. Social support was inversely correlated with all cognitive tests. These correlations demonstrated that lower job demands, poorer skill discretion and decision authority, and higher social support were associated with lower cognitive performance (Table 2).

Controlling for potential confounders, high work demands were associated with lower verbal fluency. The lower the skill discretion (decision latitude or control), the lower the scores on TMT and on the global cognitive composite Z-scores. Similarly, low decision authority in the workplace was associated with lower scores on verbal fluency, TMT, and global cognitive composite Z-scores (Table 3).

Regarding job strain classification, high job strain and passive work, controlling for confounders, were associated with low global cognitive score. Specifically, high job strain and passive work were associated with lower scores on DWRT (only for high strain), verbal fluency, and TMT even controlling for potential confounders (Table 4).

TABLE 1 Characteristics of the sample according to job strain categories ("ELSA-Brasil," *n* = 9,969)

	Total sample	Low strain	Active	Passive	High strain	
	n = 9,969	*n* = 2,268	*n* = 1,706	*n* = 3,979	*n* = 2,016	*p*
DWRT (number of words), mean (*SD*)[a]	7.1 (1.9)	7.3 (1.9)	7.4 (1.9)	6.9 (1.9)	7.1 (1.9)	<.0001[c,d,f,g,h]
VFT (number of words), mean (*SD*)[a]	13.0 (4.3)	13.8 (4.2)	13.7 (4.2)	12.4 (4.3)	12.6 (4.3)	<.0001[d,e,f,g]
TMT (seconds), mean (*SD*)[a]	116.1 (78.6)	98.5 (57.3)	99.3 (62.6)	130.6 (90.1)	121.4 (80.4)	<.0001[d,e,f,g,h]
Occupation type (%)						<.0001[c,d,e,f,g,h]
Routine manual jobs	15.5	7.1	5.9	22.8	19.2	
Non-routine manual jobs	0.8	0.7	0.5	1.1	0.6	
Routine non-manual jobs	28.3	20.2	14.7	36.9	31.8	
Non-routine non-manual jobs	55.4	72.0	78.9	39.2	48.4	
Hours of work/week[b]	43.5 (10.8)	43.6 (10.2)	48.9 (12.9)	40.9 (9.0)	43.9 (11.1)	<.0001[c,d,f,g,h]
Time in the workforce, mean (*SD*)[a]	31.4 (8.4)	31.3 (8.9)	31.0 (8.3)	32.0 (8.3)	30.9 (7.9)	<.0001[d,f,h]
Age (years), mean (*SD*)[a]	48.9 (7.2)	49.7 (7.9)	49.3 (7.1)	48.8 (7.0)	47.8 (6.8)	<.0001[d,e,f,g,h]
Male (%)[b]	48.1	54.7	47.0	49.8	40.0	<.0001[c,d,e,g,h]
Race 9%)[b]						<.0001[d,e,f,g]
White	52.1	63.4	61.8	45.4	45.4	
Black	15.4	10.8	10.7	18.3	18.3	
Brown	29.1	22.4	24.0	32.9	33.2	
Other	3.4	3.4	3.5	3.4	3.1	
College education or more (%)[b]	55.7	75.0	79.9	39.1	46.7	<.0001[c,d,e,f,g,h]
Monthly income (USD) tertiles (%)[b]						<.0001[d,e,f,g]
<970	37.2	20.6	18.5	49.9	46.0	
970–2000	36.2	40.7	40.7	32.8	34.2	
>2000	26.6	38.7	40.8	17.3	19.8	
Hypertension (%)[b]	29.3	27.5	26.5	31.9	28.3	<0.0001[d,f,h]
Diabetes (%)[b]	15.6	13.6	14.1	17.4	15.5	<0.0001[d,f]
Body mass index (kg/m^2), mean (*SD*)[a]	26.7 (4.5)	26.6 (4.5)	26.5 (4.4)	26.8 (4.5)	26.9 (4.7)	.01
Smoking (%)[b]						<.0001[d,e,f,g]
Never	58.9	60.3	62.4	57.5	57.1	
Current	28.0	28.5	27.0	28.2	28.5	
Previous	13.1	11.2	10.6	14.3	14.4	
Binge drinking (%)[b]	7.9	8.4	7.2	8.2	7.0	.19
Common mental disorder (%)[b]	26.3	16.7	29.4	24.8	38.2	<.0001[c,d,e,f,g,h]
Thyroid function						0.27
Normal	85.6	87.6	86.1	87.6	88.7	
Hypothyroidism	10.7	10.7	12.1	10.7	9.4	
Hyperthyroidism	1.7	1.7	1.8	1.7	1.9	

Abbreviations: DWRT, Delayed Word Recall Test (number of words); ELSA-Brasil, Brazilian Longitudinal Study of Adult Health; *SD*, standard deviation; TMT, Trail Making Test version B (seconds); VFT, Verbal Fluency Test (number of words).

[a]One-way ANOVA.

[b]χ^2 test.

[c]Active different than low-strain in post hoc analysis using Bonferroni correction.

[d]Passive different than low-strain in post hoc analysis using Bonferroni correction.

[e]High strain different than low strain in post hoc analysis using Bonferroni correction.

[f]Passive different than active in post hoc analysis using Bonferroni correction.

[g]High strain different than active in post hoc analysis using Bonferroni correction.

[h]High strain different than passive in post hoc analysis using Bonferroni correction.

TABLE 2 Correlation coefficients between cognitive and job stress variables (n = 9,969)

Variable	Correlation coefficients																		
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19
1. GCC score																			
2. DRWT	0.688*																		
3. VFT	0.712*	0.202*																	
4. TMT	0.745*	0.272*	0.325*																
5. Demand	0.083*	0.071*	0.030	0.074*															
6. Skill discretion	0.214*	0.114*	0.134*	0.021*	0.260*														
7. Decision authority	0.172*	0.066*	0.134*	0.170*	0.033*	0.338*													
8. Social Support	−0.127*	−0.078*	−0.082*	−0.113*	−0.267*	0.046*	0.080*												
9. Age	−0.235*	−0.167*	−0.093*	−0.243*	−0.057*	0.022*	0.007*	0.010*											
10. Male sex	−0.137*	−0.192*	−0.055*	−0.046*	−0.082*	0.047*	0.049*	0.061*	0.043*										
11. College education	0.447*	0.276*	0.288*	0.394*	0.134*	0.347*	0.299*	−0.118*	−0.012	−0.061*									
12. Income	0.304*	0.189*	0.193*	0.270*	0.086*	0.282*	0.264*	−0.060*	0.094*	−0.036	0.536*								
13. Race	−0.161*	−0.078*	−0.087*	−0.181*	−0.031*	−0.112*	−0.120*	0.029	−0.028	0.006	−0.193*	−0.214*							
14. Hypertension	−0.145*	−0.085*	−0.090*	−0.137*	−0.037*	−0.037*	−0.035	0.072*	0.260*	0.110*	−0.108*	−0.058*	0.061*						
15. Diabetes	−0.165*	−0.119*	−0.098*	−0.138*	−0.024	−0.048*	−0.036	0.040*	0.206*	0.097*	−0.120*	−0.071*	0.063*	0.251*					
16. BMI	−0.090*	−0.084*	−0.054*	−0.054*	0.001	−0.017	−0.041*	0.003	0.076*	0.038*	−0.100*	−0.085*	0.014	0.269*	0.219*				
17. Smoking	−0.120*	−0.136*	−0.047*	−0.074*	−0.018	−0.077*	−0.028	−0.024	0.151*	0.091*	−0.172*	−0.160*	−0.064*	0.052*	0.080*	0.026			
18. Alcohol use	−0.034	−0.041*	−0.022	−0.011	−0.032	−0.000	0.015	−0.003	0.045*	0.161*	−0.061*	−0.061*	−0.050*	−0.007	−0.015	0.090	0.048*		
19. Thyroid function	0.013	0.030	0.005	−0.008	0.004	0.006	0.023	−0.003	0.083*	−0.121	0.036*	0.044*	−0.022	0.027	0.010	0.032	0.005	−0.036*	
20. CMD	−0.032	−0.011	−0.013	−0.044*	0.142*	−0.066*	−0.078*	−0.187*	−0.078*	−0.177*	−0.078*	−0.115*	0.046	0.002	0.022	0.063*	0.046*	−0.007	0.0012

Abbreviations: CMD, common mental disorder; DRWT, delayed recall word test; GCC, global cognitive composite score; TMT, trail-making test; VFT, verbal fluency test.

*$p < .05$ after Bonferroni correction.

TABLE 3 Association between job stress domains and cognitive test z-scores (n = 9,969)

	Global composite			DWRT			VFT			TMT		
	β (95% CI)	p	R^2	β (95% CI)	p	R^2	β (95% CI)	p	R^2	β (95% CI)	p	R^2
Demand												
Crude	0.029 [0.022, 0.036]	<.001	.007	0.025 [0.018, 0.032]	<.0001	0.005	0.011 [0.003, 0.018]	.002	.001	0.027 [0.020, 0.033]	<.0001	.006
Model 1[a]	0.0004 [−0.006, 0.006]	.99	.281	0.004 [−0.002, 0.011]	.20	0.138	−0.006 [−0.013, 0.0004]	.07	.096	0.002 [−0.004, 0.008]	.53	.240
Model 2[b]	−0.005 [−0.011, 0.001]	.11	.326	0.005 [−0.002, 0.012]	.15	0.158	−0.011 [−0.018, −0.004]	.002	.111	−0.005 [−0.011, 0.001]	.14	.290
Skill discretion												
Crude	0.133 [0.121, 0.145]	<.0001	.046	0.071 [0.059, 0.083]	<.0001	.013	0.083 [0.071, 0.095]	<.0001	.018	0.130 [0.118, 0.142]	<.0001	.04
Model 1[a]	0.041 [0.030, 0.052]]	<.0001	.285	0.019 [0.007, 0.031]	.002	.139	0.023 [0.011, 0.036]	<.0001	.097	0.047 [0.035, 0.058]	<.0001	.244
Model 2[b]	0.019 [0.008, 0.030]	.001	.326	0.007 [−0.005, 0.020]	.25	.158	0.012 [−0.001, 0.024]	.07	.110	0.023 [0.011, 0.034]	<.0001	.291
Decision authority												
Crude	0.106 [0.094, 0.117]	<.0001	.030	0.040 [0.028, 0.052]	<.0001	.004	0.082 [0.070, 0.094]	<.0001	.018	0.104 [0.092, 0.116]	<.0001	.029
Model 1[a]	0.030 [0.020, 0.041]	<.0001	.284	−0.002 [−0.014, 0.009]	.67	.138	0.033 [0.021, 0.045]	<.0001	.099	0.035 [0.024, 0.046]	<.0001	.242
Model 2[b]	0.015 [0.004, 0.026]	.005	.326	−0.012 [−0.024, −0.0001]	.05	.128	0.026 [0.013, 0.038]	<.0001	.111	0.019 [0.008, 0.029]	.001	.291

Abbreviations: DWRT, delayed word recall test; TMT, trail-making test; VFT, verbal fluency test.
[a]Model 1: Linear regression model adjusted for age, sex, race, education, and income
[b]Model 2: Linear regression model adjusted for age, sex, race, education, income, hypertension, diabetes, body mass index, smoking, excessive alcohol use, common mental disorders, thyroid function, occupation type, hours of work per week, and time in the workforce.

TABLE 4 Association between job strain level and cognitive test z-scores (n = 9,969)

	Global composite			DWRT			VFT			TMT		
	β (95% CI)	p	R^2	β (95% CI)	p	R^2	β (95% CI)	p	R^2	β (95% CI)	p	R^2
Crude												
Active	0.024 [−0.037, 0.086]	.44	.037	0.084 [0.022, 0.147]	.0008	.009	−0.022 [−0.084, 0.040]	.49	.020	−0.011 [−0.072, 0.051]	.73	.033
Passive	−0.410 [−0.461, −0.360]	<.0001		−0.169 [−0.220, −0.118]	<.0001		−0.303 [−0.354, −0.252]	<.0001		−0.408 [−0.459, −0.358]	<.0001	
High strain	−0.293 [−0.353, −0.235]	<.0001		−0.062 [−0.121, −0.0002]	.04		−0.276 [−0.336, −0.217]	<.0001		−0.292 [−0.351, −0.233]	<.0001	
Model 1[a]												
Active	−0.042 [−0.096, 0.011]	.12	.283	0.025 [−0.033, 0.083]	.40	.138	−0.059 [−0.118, 0.001]	.06	.098	−0.057 [−0.112, −0.002]	.04	.242
Passive	−0.108 [−0.154, −0.062]	<.0001		0.004 [−0.047, 0.054]	.88		−0.106 [−0.158, −0.054]	<.0001		−0.129 [−0.176, −0.082]	<.0001	
High strain	−0.102 [−0.155, −0.049]	<.0001		0.020 [−0.037, 0.078]	.49		−0.140 [−0.199, −0.081]	<.0001		−0.100 [−0.154, −0.046]	<.0001	
Model 2[b]												
Active	−0.049 [−0.102, 0.003]	.07	.326	0.036 [−0.023, 0.095]	.23	.158	−0.070 [−0.131, −0.010]	.02	.111	−0.071 [−0.125, −0.017]	.01	.290
Passive	−0.057 [−0.102, −0.012]	.01		0.032 [−0.018, 0.082]	.21		−0.081 [−0.132, −0.029]	.002		−0.074 [−0.120, −0.028]	.002	
High strain	−0.065 [−0.116, −0.013]	.01		0.058 [0.0003, 0.116]	.05		−0.131 [−0.190, −0.071]	<.0001		−0.066 [−0.119, −0.013]	.01	

Note. Reference: Low-strain category.
DWRT: Delayed Word Recall Test; VFT: Verbal Fluency Test; TMT: Trail Making Test
[a]Model 1: Linear regression model adjusted for age, sex, race, education, and income
[b]Model 2: Linear regression model adjusted for age, sex, race, education, income, hypertension, diabetes, body mass index, smoking, excessive alcohol use, common mental disorders, thyroid function, occupation type, hours of work per week, and time in the workforce.

3.3 | Mediation effect for the relationship between work demands and cognitive performance

The relationship between work demands and cognitive performance was mediated by social support. As Figure 2 illustrates, the regression coefficient between work demands and social support (path *a* in Figure 2) was statistically significant (coefficient = −0.255; 95% CI [−0.277, −0.232]; $p < .0001$), as was the regression coefficient between social support and the global cognitive composite score (path *b* in Figure 2; coefficient = −0.018; 95% CI [−0.023, −0.012]; $p < .0001$), whereas the correlation coefficient between work demand and global cognitive performance (path *x* in Figure 2) were close to zero (coefficient = 0.005; 95% CI [0.003, 0.007]; $p < .0001$), supporting an indirect effect from work demands on cognitive performance through social support. Specifically, higher work demand scores were significantly associated with lower social support scores, which in turn were negatively correlated with global cognitive composite Z-score.

4 | DISCUSSION

The current study shows that higher work-related stress was associated with lower cognitive performance in middle-aged workers and that social support mediates this relationship. Specifically, our findings demonstrated that middle-age individuals with high job strain and passive jobs showed lower performance in delayed memory, verbal fluency, and executive function compared with workers with active jobs and low job strain. In addition, work demands were negatively associated with verbal fluency, whereas job control (high skill discretion and decision authority) was associated to better performance in all the cognitive domains. These findings suggest that job characteristics such as high work demands, low skill level to manage different tasks, and low autonomy to make decisions in the workplace are associated with low cognitive performance during adulthood. Given the cross-sectional design, the low cognitive performance could be interpreted as the consequence of job strain or as the cause of individuals experiencing high work-related stress.

Effects of chronic stress on cognition have been demonstrated through biological mechanisms that chronically dysregulate target physiological systems, including neuronal structures, involved in stress response and cognition. The perception of having demands and challenges that overcome the available abilities and autonomy for decision making might represent uncontrolled and unpredictable psychological determinants of stress capable of triggering the stress response (Lupien, Maheu, Tu, Fiocco, & Schramek, 2007). Additionally, low discretion and autonomy on decision making in the work process may inhibit the skills development that one possesses to carry out challenging work tasks, and thus the ability to recall and manage different information simultaneously could be compromised (Agbenyikey et al., 2015; Fisher et al., 2017). Conversely, according to the concept of "flow," active jobs whereby individuals with high control or wide latitude for decision making are cognitively stimulated to overcome the challenges and to rapidly move to the next activity, instead of overvaluing the demands arising from the challenge, were associated with cognitive improvement, such as in the abstract reasoning domain (Fisher et al., 2017). As a result, our findings could lead to the interpretation that exposure to high job demands allied to low control over the work process may contribute to low cognitive performance. Corroborating our findings, in a longitudinal study, high job strain and low control were associated with decline in verbal learning, word recognition skills, and word reading performance. These associations were more pronounced in highly educated middle-aged adults than in older participants (Agbenyikey et al., 2015). Similarly, high job strain at midlife was independently associated with poor global cognitive performance, memory, inductive reasoning, phonemic, and semantic verbal fluency when participants were older (Andel et al., 2011; Andel et al., 2015; Elovainio et al., 2009). Similarly, low job control combined with high job demands was associated with increased dementia risk (Sindi et al., 2016; Wang et al., 2012). Interestingly, only at midlife was time pressure, regardless of work demands, associated with higher Alzheimer's disease risk in later life (Sindi et al., 2016). Unlike those studies in which work-related stress was related to low cognitive performance later in life, our work adds to the previous literature by showing that cognitive performance, mainly semantic verbal fluency and executive functions, may be negatively associated with high psychological work demands combined with low amount of control over the work processes during adulthood, when middle-aged adults are actively inserted in the labour market. Furthermore, our findings were observed in adults with a heterogeneous education background (only half of the sample had high education level), inserted in a low-middle income country, whose work situation is characterized by long work hours (up to 44 hours), work overload, informal employment, as well as low salaries with low purchasing power (Instituto de Pesquisa Econômica Aplicada [IPEA], 2009), highlighting the vulnerability of these individuals to cognitive disorders.

Our findings also revealed that social support mediates the association between work demands and cognitive performance. Specifically, higher work demand scores were associated with lower social support scores, which in turn were correlated with higher global cognitive performance (global cognitive and executive function performance). According to Viswesvaran, Sanchez, and Fisher (1999), strain can motivate one to seek social support in a reversed relationship, whereby it is the level of the strain that drives social support instead of social support leading to strain reduction (Viswesvaran et al., 1999). In line with this, it can be assumed that under the strain to address certain challenging work activities, workers with low cognitive functioning may mobilize more support from their supervisors and co-workers, which in turn can suppress the stress derived from the challenging job. These findings are in line with the mediational model of suppressor effects that implies a positive stressor–strain correlation (i.e., work demands and cognitive performance), a negative support–strain correlation (i.e., social support and cognitive performance), and a negative stressor–support correlation (i.e., work demand and social support; Viswesvaran et al., 1999).

Occupational characteristics also represent an important factor to consider. Different occupations are related to different basic

stressors, levels of control over work decisions, and hours spent working. Johnson et al. (2005) reported that physical health, psychological well-being, and job satisfaction varies between occupation types and within each occupation level. Senior police officers presented lower stress and higher job satisfaction levels compared with junior police officers (Johnson et al., 2005). In the current study, individuals who occupied manual job positions characterized by support levels with low education background were predominantly distributed in the passive and high job strain group. Conversely, participants from high non-manual positions engaged in technical or research and academic activities were predominantly distributed in the active and low job strain. It is also possible that the occupation type can influence the relationship between cognitive performance and job strain whereby individuals who occupied manual jobs considered of less cognitive complexity could exert more job strain due to the unbalance between demands and low decision latitude. The combination of boredom, low control, and more support from co-workers is associated with low work demands. Nevertheless, the association between work-related stress and cognition observed in the current study was independent of job characteristics.

Despite the current findings providing evidence that work-related stress is associated with low cognitive function in middle-aged adults, the strength of the correlations was notably weak suggesting that significant associations may be influenced by the large sample size of the study, and, therefore, a Type I error has to be considered. We performed a complete case analysis, whereby participants with missing data were excluded. Excluded participants were older and had worse cognitive and clinical profiles, suggesting that we would find a stronger association between job stress and cognitive performance if their data were available. Furthermore, other sources of stress were not evaluated and should be considered in future studies because both life and work-related stress may exacerbate the negative healthy outcomes (Juster, McEwen, & Lupien, 2010; Karasek & Theorell, 1990). In addition, no information about personal protective factors, such as effective coping strategies and resilience, were available, which are relevant elements in modulating the negative effects of chronic stress (Juster et al., 2010; Lupien et al., 2009). Finally, our results were based on cross-sectional data and therefore no assumptions about causality can be made. Longitudinal data from ELSA-Brasil study may confirm whether low cognitive performance related to stress in the work environment at midlife constitutes an early sign of cognitive impairment and a predictor of dementia in later life.

On the other hand, the current findings extend previous research by showing associations among job strain levels, work demands, decision latitude, and multiple cognitive domains mediated by social support already during adulthood, in a large sample of middle-aged adults with heterogeneous education and income backgrounds, whereas controlling for several sociodemographic, clinical, and work-related confounders.

In conclusion, work-related stress measured as high job strain and passive job, low job control, and high work demands was associated with low performance in multiple cognitive domains in a large and heterogeneous sample of middle-aged adults from a low/middle income country. Social support may mediate this relationship suppressing the influence of work demands on cognitive performance. These findings suggest that work-related stress is associated with cognitive performance during adulthood. Given the ageing population and the global tendency to postpone the retirement age, cognitive health should be an occupational concern to promote long-lasting worker well-being.

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CONFLICT OF INTEREST

All authors state that there is no conflict of interest to declare.

DATA ACCESSIBILITY STATEMENT

The current findings were based on the Brazilian Longitudinal Study of Adult Health (ELSA-Brasil) large data. The data sets used to draw the conclusions can be accessed upon request to Dr Isabela JM. Bensenõr; Email: isabensenor@gmail.com

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