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Determinants of Cognitive Performance in Older Adults: Interplay Between Perceived Stress and Psychological Flexibility

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ABSTRACT

This study investigates the complex interrelations between perceived stress, psychological flexibility, and cognitive performance among older adults and considers the effects of sociodemographic variables on these factors. This study is important because it can provide fundamental scientific data for interventions related to the preservation or improvement of cognitive performance, stress coping, and psychological flexibility in elderly individuals. The research employed a cross-sectional design with a sample of 207 participants aged 65 and older, recruited from community health centers in Türkiye. The maximum age of the participants' was set at 92. The study utilized the following instruments: the Acceptance and Action Questionnaire-II (AAQ-II), the Perceived Stress Scale (PSS), and the Standardized Mini-Mental State Examination (SMMSE). Significant associations were found between perceived stress level, psychological flexibility, and cognitive performance. Higher education levels and better economic status were associated with improved cognitive performance, whereas advanced age was associated with lower cognitive functioning. Cognitive function was positively associated with perceived stress, whereas psychological flexibility demonstrated a negative relationship with perceived stress. Similarly, cognitive function was also inversely related to psychological flexibility. Age, education, and economic status were significant predictors of cognitive function according to the multivariate analysis. This study showed that the likelihood of mild cognitive impairment and normal cognitive function decreases with increasing age compared with severe cognitive impairment. Additionally, the findings indicate significant differences in cognitive function across different education levels. The results highlight the role of psychological flexibility in cognitive health protection among older adults. These interventions, which are aimed at enhancing psychological flexibility, may have a strong potential for reducing the perception of stress and improving cognitive performance in this population. These findings suggest the need for developing interventions aimed at increasing psychological flexibility to reduce perceived stress and improve cognitive performance among older adults. In particular, the positive relationship between stress and cognitive performance highlighted in this study could influence the direction of stress-related intervention programs.

Keywords: Perceived stress, psychological flexibility, cognitive performance, older adults, aging.

ÖZ

Yaşlı Yetişkinlerde Bilişsel Performansın Belirleyicileri: Algılanan Stres ve Psikolojik Esneklik Arasındaki Etkileşim

Bu çalışmanın amacı, yaşlı yetişkinlerde algılanan stres, psikolojik esneklik ve bilişsel performans arasındaki karmaşık ilişkileri araştırmak ve sosyodemografik değişkenlerin algılanan stres, psikolojik esneklik ve bilişsel performans üzerindeki etkisini ele almaktır. Bu çalışma, yaşlı bireylerde bilişsel performansın ko-

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runması veya iyileştirilmesi, stresle başa çıkma ve psikolojik esnekliğin geliştirilmesiyle ilgili müdahaleler için temel bilimsel veriler sağlayabileceği için önemlidir. Araştırma, Türkiye'deki toplum sağlığı merkezlerinden alınan ve 65 yaş ve üstü 207 katılımcıdan oluşan bir örneklem kullanılarak kesitsel olarak tasarlandı. Çalışmaya katılanların maksimum yaşı 92 yıl olarak belirlendi. Çalışmada kullanılan araçlar Kabul ve Eylem Anketi-II, Algılanan Stres Ölçeği ve Standardize Mini Mental Durum Muayenesi idi. Algılanan stres, psikolojik esneklik ve bilişsel performans arasında anlamlı ilişki bulundu. Daha yüksek eğitim düzeyi ve daha iyi ekonomik durum daha iyi bilişsel performansla ilişkiliyken, ileri yaş daha düşük bilişsel işlevselliği öngördü. Bilişsel işlev algılanan stres ile pozitif bir ilişki gösterirken, psikolojik esneklik algılanan stres ile negatif bir ilişki gösterdi. Benzer şekilde, bilişsel işlev de psikolojik esneklik ile ters bir ilişki gösterdi. Çok değişkenli analize göre yaş, eğitim ve ekonomik durum bilişsel işlevin belirleyicileri olarak önemli bir rol oynadı. Çalışma, yaş arttıkça hafif bilişsel bozukluk ve normal bilişsel işlevsellik olasılığının ciddi bilişsel bozukluğa kıyasla azaldığını gösterdi. Ayrıca, farklı eğitim seviyeleri arasında bilişsel işlevlerde önemli farklılıklar olduğuna işaret etmektedir. Sonuçlar, psikolojik esnekliğin yaşlı yetişkinler arasında bilişsel sağlığın korunmasında nasıl bir role sahip olabileceğinin altını çizmektedir. Psikolojik esnekliği artırmaya dayalı bu gibi müdahaleler, bu popülasyonda stres algısını azaltmak ve bilişsel performansı iyileştirmek için güçlü bir potansiyele sahip olabilir. Bu bulgular, yaşlı yetişkinlerde algılanan stresi azaltmak ve bilişsel performansı iyileştirmek için psikolojik esnekliği artırmayı amaçlayan müdahalelerin geliştirilmesine ihtiyaç olduğunu göstermektedir. Özellikle, çalışmada vurgulanan stres ve bilişsel performans arasındaki pozitif ilişki, stresle ilgili müdahale programlarının yönünü de değiştirebilir.

Anahtar Kelimeler: Algılanan stres, psikolojik esneklik, bilişsel performans, yaşlı yetişkinler, yaşlanma.

INTRODUCTION

The rapid growth of the global aged population highlights the need for further exploration of the aging process and its associated complications. The United Nations and its affiliated agencies project significant growth in the global population aged 65 years and older, estimating an increase from 761 million in 2021 to 1.6 billion by 2050. The population aged 80 years and older is expected to grow even more rapidly (United Nations, 2023). This demographic shift necessitates a comprehensive study of the determinants of the health and well-being of older adults. Among them, perceived stress, psychological flexibility, and cognitive performance are important variables that significantly influence general health and quality of life in later life, and they receive more attention in related research (Justice, 2018; Mousa Mohamed et al, 2023; Oumohand et al, 2020; Zukerman et al, 2023).

Perceived stress reflects the extent to which individuals appraise life events as overwhelming, uncontrollable, and exceeding their coping resources (Cohen et al, 1983). There is strong evidence to suggest that high levels of perceived stress in older adults are associated with an increased vulnerability to various negative health outcomes, such as depression, anxiety, and cognitive decline (Joshi et al, 2023; Korten et al, 2017). In comparison, psychological flexibility refers to a process of adapting to the changing circumstances of life and learning to live with them effectively in different situations (Kashdan & Rottenberg, 2010). Recent research suggests that psychological flexibility could serve as a protective factor against stress, supporting mental well-being and cognitive performance among older adults (Dajani & Uddin, 2015; Zukerman et al, 2023). However, the exact nature of this relationship with regard to psychological flexibility, perceived stress, and cognitive performance in the aging population, is still not clear.

Cognitive performance encompasses the abilities necessary to perform daily activities and therefore remain independent during the aging process. This includes memory, attention, and executive function, which naturally decline with age at varying degrees and rates, influnced by factors, such as stress and psychological flexibility (Harada et al, 2013). Empirical studies have shown that perceived stress negetaively impacts the cognitive performance in the elderly, according to most research findings published over the past decade (Aggarwal et al, 2014; Korten et al, 2017; Turner et al, 2017). In contrast, psychological flexibility interventions have been shown to improve cognitive performance with a focus on the domains of attention, subjective cognitive function, executive function, and memory (Liu et al, 2023). Understanding how cognitive performance interacts with perceived stress and psychological flexibility is vital for developing effective strategies to maintian and enhance cognitive health in aging populations.

Even with an increasing body of research, challenges related to perceived stress, psychological flexibility, and cognitive performance continue to be complicated and cannot be rationalized. The studies frequently isolate individual aspects of the variables within this relationship without due regard to how these elements interconnect with each other in depth.

A large gap exists in the literature regarding how these factors correlate with cognitive health in older adults. There is further need for research on these complex phenomena and an understanding of the mechanism through which perceived stress and psychological flexibility interact in influencing cognitive performance. In general, this research will contribute to the development of effective interventions for improving the cognitive health in older adults. This understanding will enable us to design specific strategies aimed at increasing psychological flexibility and reducing perceived stress, which will eventually lead to positive cognitive outcomes. These findings are crucial for public health policies and programs that will improve healthy aging and quality of life during old age.

In this regard, this study aimed to investigate the complicated interplay between the perceived stress level, psychological flexibility, and cognitive performance of older individuals. Based on the research questions, the following hypotheses were formulated:

H1: Higher perceived stress levels are negatively associated with cognitive performance in older adults.

H2: Psychological flexibility is associated with cognitive performance in older adults.

H3: Higher education levels and economic status are positively associated with cognitive performance in older adults.

METHODS

Design

This was a cross-sectional research to identify the relationship between perceived stress, psychological flexibility, and cognitive performance in old age. A cross-sectional design was selected to investigate multiple variables and test the relationships that exist among them at one point in time (Setia, 2016). This study followed the STROBE statement and checklist for cross-sectional reporting (Appendix 1).

Sample and Participants

This study included 207 older individuals registered at a community health center in northern Türkiye. The average age of the participants was 74.52 (SD=8.76) years, with 58% being male. The inclusion criteria were as follows: 65 years of age or older (to define the older population), voluntary participation (to fulfill ethical requirements), and being a regular visitor for health check-ups (for monitoring health conditions). The exclusion criteria included: severe sensory impairments (as it could hinder the administration of the scales), acute psychiatric disorders (to avoid temporary conditions that may affect the results), dementia, stroke or traumatic brain injury within the past six months (to prevent acute neurological changes), and substance dependence (as it can affect cognitive performance and psychological state). While cognitive impairment was assessed during the study, individuals who had severe sensory or physical impairments that prevented them from completing the assessment scales were excluded. Individuals diagnosed with moderate or severe cognitive impairment according to the Standardized Mini-Mental State Examination (SMMSE) were included in the study to ensure representation of the full spectrum of cognitive abilities among older adults. Although the inclusion of individuals with severely impaired cognitive status might seem contradictory to the general aim of assessing cognitive performance, it allows for a more comprehensive understanding of the factors associated with cognitive decline in this population. These criteria were established to enhance the validity and reliability of the research. In this context, individuals aged 65 and older were asked whether they had any restrictive problems (physical, cognitive, acute psychotic, or emotional) by the responsible physician at the community health center, where they were registered (regarding their lack of diagnoses and general monitoring), as well as by the nurses who attended them. Additionally, the researchers made observations during the face-to-face application of the scale forms.

The sample size was calculated using G*Power 3.1 software. For a medium effect size (r=0.3), alpha level of 0.05, and power of 0.95, the minimum sample size was determined to be 134. This calculation was based on the moderate correlations reported in the literature between psychological flexibility and related variables (Plys et al, 2023; Zukerman et al, 2023). The 207-member study indicates that a sample size exceeding the minimum was achieved, ensuring sufficient statistical power.

Measurement Instruments

Demographic Information Form

A form developed by the researchers was used to assess the sociodemographic characteristics of the participants, including age, gender, marital status, education level, employment status, perceived economic situation, place of residence, and life satisfaction.

Acceptance and Action Questionnaire-II

The Acceptance and Action Questionnaire-II (AAQ-II) was developed by Bond et al. (2011) to measure individual psychological flexibility. The validity and reliability of the scale was examined by Yavuz et al. (2016) This 7-item self-report scale is rated on a 7-point scale, ranging from 1 (never true) to 7 (always true). Scores on the scale can range from 7–49. Higher scores indicate increased experiential avoidance and a lack of psychological flexibility. In other words, as the scores from AAQ-II decrease, psychological flexibility increases. The internal consistency coefficient of the scale in the Turkish study was found to be 0.84 (Yavuz et al, 2016). In this study, the internal consistency value of the scale was determined to be 0.99.

Table 1. Correlation matrix and descriptive statistics (n=207)

	α	Mean	SD	Skewness	Kurtosis	1	2	3
1. AAQ-II	0.99	28.83	16.04	-0.220	-1.850	–		
2. PSS	0.68	37.21	10.67	-0.408	-0.643	-0.837	–	
3. SMMSE	0.92	16.45	8.33	0.162	-1.833	-0.970*	0.841*	–

*: P<0.01 (two-tailed). AAQ-II: Turkish Version of Acceptance and Action Questionnaire-II; PSS: Perceived Stress Scale; SMMSE: Standardized Mini-Mental State Examination; α: Cronbach alfa; SD: Standard deviation.

Perceived Stress Scale

The Perceived Stress Scale (PSS) was developed by Cohen et al. (1983), and translated and adapted into Turkish by Eskin et al. in 2013. This 14-item scale assesses how stressful individuals' perceive their situations. Scale items are scored from "Never (0)" to "Very often (4)". Scores on the scale can range from 0–56, with higher scores indicating greater perceived stress intensity. The Cronbach alpha coefficient of the Turkish version of the scale was found to be 0.84. In this study, the internal consistency value of the scale was determined to be 0.68.

Standardized Mini-Mental State Examination

The SMMSE was developed by Folstein et al. in 1975, and its validity and reliability in the Turkish population was examined by Güngen et al. (2002) The SMMSE comprises 11 items across five main headings: orientation, registration memory, attention and calculation, recall, and language. It is scored out of a total of 30 points. Scores of 24–30 indicate normal cognitive function, 18–23 indicate mild cognitive impairment, and scores of 18 or below indicate severely impaired cognitive status. The threshold value of the scale was determined to be 23/24 with 0.95 specificity and 0.91 sensitivity (inter-rater reliability analysis: r=0.99, kappa value=0.92). In this study, the internal consistency value of the scale was determined to be 0.92.

Data Collection Process

Data were collected in a room at the community health center. Participants were invited to participate in the study during their outpatient clinic visits. After being informed about the purpose and content of the study, individuals who signed the informed consent form were included in the study. The scales were administered using a face-to-face interview. The data collection process lasted approximately 30–45 min.

Data Analysis

SPSS 25.0 (IBM Corp., Armonk, NY, USA) was used to analyze the data. Shapiro–Wilk and Kolmogorov–Smirnov tests were used to check the normality of the distribution. Therefore, independent sample t-tests and ANOVA were used for group comparisons, with Bonferroni correction applied for multiple comparisons. Percentages, means, and standard deviations were used for descriptive statistics. The reliability analysis of the scales was performed using Cronbach's α coefficient. The relationships between variables were examined using the Pearson correlation test. Prior to conducting the multinomial logistic regression, bivariate analyses (independent samples t-test and ANOVA) were conducted to examine the relationship between cognitive performance and other demographic variables. The variables found to have a statistically significant association with cognitive performance in the bivariate analyses were then included as control variables in the regression model. Multinomial logistic regression analysis, including age, economic status, gender, and marital status, was conducted to predict the level of cognitive impairment (normal, mild, or severe). The significance level was set at p<0.05 for all analyses.

Ethical Considerations

This research was approved by the Ethics Committee of Çankırı Karatekin University on April 21, 2022, with session number 25. Written informed consent was obtained from all participants. Participant privacy and anonymity were maintained, and the collected data were stored securely. Participants were informed that they had the right to withdraw from the study at any time. The study was conducted in accordance with the ethical standards of the Declaration of Helsinki (Holm, 2013).

RESULTS

Perceived Stress, Psychological Flexibility, Cognitive Performance Levels, and Correlations

Table 1 presents the descriptive statistics and correlation coefficients of the study variables. The correlation analysis revealed a statistically significant strong positive correlation (r=0.841, p<0.01) between PSS and SMMSE. This suggests that cognitive performance tends to increase as perceived stress increases. Pearson's analysis revealed a statistically significant negative correlation (r=-0.837, p<0.01) between PSS and AAQ-II. This indicates that as psychological flexibility increases, perceived stress tends to decrease. Similarly, a statistically significant negative correlation (r=-0.970, p<0.01) was found between AAQ-II and SMMSE. This suggests that individuals with lower psychological flexibility tend to have lower cognitive performance.

Table 2. Univariate analysis of variables related to AAQ-II, PSS, and SMMSE scores (n=207)

	AAQ-II			PSS			SMMSE		
Variable	**M (SD)**	**t/F**	**p**	**M (SD)**	**t/F**	**p**	**M (SD)**	**t/F**	**p**
Age		80.163	0.001 *		30.252	0.001 *		61.731	0.001 *
65–68 (a)	18.27 (12.20)			42.23 (9.66)		a>c	21.67 (7.19)		a>b>c
69–79 (b)	26.20 (16.54)		c>b>a	38.57 (11.15)	0.	b>c	17.47 (8.66)		
80 (c)	43.44 (4.60)			30.17 (7.06)			9.50 (2.21)		
Gender		0.046	0.964**		225	0.822 **		-0.167	0.867 **
Female	28.89 (16.72)			37.41 (10.29)			16.34 (8.56)		
Male	28.79 (15.60)			37.07 (10.98)			16.54 (8.20)		
Marital status		-3.478	0.001**		1.712	0.089**		2.608	0.010 **
Married	26.22 (16.21)			38.06 (11.28)			17.48 (8.51)		
Single	33.94 (14.49)			35.55 (9.23)			14.44 (7.64)		
Education level		22.326	0.001 *		11.475	0.001 *		19.929	0.001 *
Illiterate (a)	43.86 (1.53)		a>b	29.98 (7.33)		b>a	9.14 (1.37)		b>a
Primary school (b)	24.89 (16.17)		a>c	39.43 (10.51)		c>a	18.35 (8.34)		c>a
Secondary school (c)	16.71 (11.24)		a>d	44.19 (8.16)		c>d	23.19 (6.47)		d>a
High school (d)	26.92 (15.84)			34.14 (11.40)			16.42 (8.60)		
University (e)	27.00 (11.06)			37.00 (12.74)			17.20 (8.46)		
Employment status		-9.943	0.001**		7.349	0.001**		9.556	0.001**
Employed	14.86 (10.45)			44.76 (7.89)			23.75 (5.89)		
Unemployed	33.52 (14.83)			34.68 (10.30)			14.01 (7.58)		
Perceived economic situation		51.157	0.001 *		20.421	0.001 *		32.577	0.001 *
Low (a)	40.35 (9.41)		a>b>c	31.92 (7.36)		b>a	11.36 (4.83)		c>b>a
Moderate (b)	25.53 (16.13)			38.40 (10.32)		c>a	17.90 (8.77)		
High (c)	18.15 (13.29)			42.51 (11.67)			21.20 (7.93)		
Place of residence: a		6.261	0.002 *		2.223	0.111 *		4.460	0.013 *
Village (a)	30.60 (16.60)		a>c	37.28 (11.55)			15.76 (8.49)		c>a
District (b)	30.87 (15.29)		b>c	35.54 (10.28)			15.44 (7.99)		c>b
City (c)	20.97 (13.73)			39.97 (8.57)			19.92 (7.80)		
Life satisfaction		517.474	0.001 *		159.473	0.001 *		391.631	0.001 *
Very satisfied (a)	8.73 (1.48)		d>c>b>a	51.15 (3.83)		a>b>c>d	26.00 (1.37)		a>c
Satisfied (b)	12.97 (6.13)			45.91 (2.82)			24.75 (3.34)		a>d
Dissatisfied (c)	40.41 (8.58)			31.20 (7.51)			10.65 (5.12)		b>c
Very dissatisfied (d)	43.30 (2.01)			28.30 (7.30)			9.00 (1.51)		b>d

*: One-Way ANOVA; **: Independent sample t-test; p<0.05 are in bold. AAQ-II: Turkish Version of Acceptance and Action Questionnaire-II; PSS: Perceived Stress Scale; SMMSE: The Standardized Mini-Mental State Examination; M: Mean; SD: Standard deviation.

Univariate Analysis of Factors Associated With Perceived Stress, Psychological Flexibility, and Cognitive Performance

The univariate analysis presented in Table 2 highlights the relationships between the sociodemographic variables and scores for psychological flexibility (AAQ-II), perceived stress (PSS), and cognitive performance (SMMSE). Age was a significant factor, with older participants (aged 80 and above) showing higher psychological inflexibility and lower cognitive performance than younger age groups. Sex did not reveal statistically significant differences in any scale. Marital

Table 3. Analysis of AAQ-II and PSS scores according to SMMSE level

SMMSE	n (%)	AAQ-II			PSS		
		M (SD)	F	p	M (SD)	F	p
Severe impaired cognitive status (a)	112 (54.1)	43.31 (1.95)			29.00 (7.20)		
Mild cognitive impairment (b)	12 (5.8)	16.83 (3.43)	3449.825	<0.001*	44.50 (5.86)	243.835	<0.001*
Normal cognitive function (c)	83 (40.1)	11.03 (3.43)		a>b>c	47.25 (3.10)		b>a c>a

*: One-Way ANOVA; p<0.05 are in bold. AAQ-II: Turkish Version of Acceptance and Action Questionnaire-II; PSS: Perceived Stress Scale; SMMSE: The Standardized Mini-Mental State Examination; M: Mean; SD: Standard deviation.

status showed that single participants exhibited higher psychological inflexibility and lower cognitive performance than married individuals. Education level demonstrated a gradient effect, where higher education levels were associated with greater psychological flexibility, lower perceived stress, and better cognitive performance. Similarly, employed participants showed better cognitive performance and higher perceived stress than unemployed participants. Economic status displayed a clear pattern, as those with higher perceived economic well-being scored better across all measures. Finally, life satisfaction and place of residence were significant predictors, with individuals reporting higher satisfaction and residing in urban areas scoring more favorably on cognitive performance and psychological flexibility.

Table 3 presents the ANOVA results for the AAQ-II and PSS scores according to the SMMSE level. The results indicate that as the level of cognitive impairment increased, the psychological flexibility scores also increased (F=3449.825, p<0.001). The psychological flexibility scores were as follows: severely impaired cognitive status>mild cognitive impairment > normal cognitive function. Individuals with severely impaired cognitive status had lower perceived stress scores than those with mild or normal cognitive function (F=243.835, p<0.001). The order of perceived stress scores was as follows: normal cognitive function>mild cognitive impairment>severely impaired cognitive status.

Predictors of Cognitive Performance

Before conducting the multinomial logistic regression, univariate analyses of sociodemographic variables were performed to identify significant predictors of cognitive performance (Table 2). Only statistically significant variables were included in the regression model, ensuring the relevance of the predictors presented in Table 4. Table 4 presents the results of the multinomial logistic regression analysis for the factors influencing cognitive status. The analysis results indicate that, compared to the reference category of "Severely Impaired Cognitive Status," increasing age significantly reduced the probability of mild cognitive impairment (Exp(B)=0.647, p=0.008). When examined in terms of education level, illiterate individuals had significantly lower odds of having normal cognitive function compared to the reference category (Exp(B)=5.285E-8, p<0.000). Individuals with primary, secondary, and high school education had significantly higher odds of having normal cognitive function compared to the reference category (Exp(B)=7.363, p=0.066; Exp(B)=11.947, p=0.045; and Exp(B)=2.277, p=0.498, respectively). Individuals with low economic status had significantly different odds of both mild cognitive impairment (Exp(B)=10.301, p=0.051) and normal cognitive function (Exp(B)=0.208, p=0.029) compared to the reference category.

The overall model fit was evaluated, and the decrease in -2 Log likelihood (162.751, df=16, p<0.001) was found to be statistically significant, indicating that the model is significant. Additionally, the Cox and Snell R-squared was 0.544, the Nagelkerke R-squared and McFadden R-squared values were 0.662 and 0.455, respectively. These findings indicate that the model explains the data well. Marital status was not significantly associated with cognitive performance. Although married participants showed slightly higher cognitive performance scores, the difference was not statistically significant (p>0.05).

DISCUSSION

This study investigated the intricate relationships among perceived stress, psychological flexibility, and cognitive performance in older adults. Our findings reveal significant relationships between these variables and the interplay of these dynamics with various sociodemographic factors.

One of the key findings of our research was the positive association between perceived stress and cognitive performance. This indicates that cognitive performance also increases as perceived stress increases. This result may seem

Table 4. Multinomial logistic regression

								%95 CI for Exp(B)	
Dependent variable	**Independent variable**	**B**	**SE**	**Wald**	**df**	**p**	**Exp(B)**	**Lower bound**	**Upper bound**
Mild cognitive impairment	Intercept	28.206	10.971	6.610	1	0.010	–	–	–
	Age	-0.435	0.165	6.926	1	0.008	0.647	0.468	0.895
	[Education level=illiterate]	-17.974	–	–	1	–	–	–	–
	[Education level=primary school]	-0.048	1.479	0.001	1	0.974	0.953	0.053	17.290
	[Education level=secondary school]	0.440	1.685	0.068	1	0.794	1.552	0.057	42.154
	[Education level=high school]	-2.589	1.931	1.798	1	0.180	0.075	0.002	3.305
	[Education level=university]	0[b]	–	–	–	–	–	–	–
	[Marital status=married]	-0.568	0.822	0.478	1	0.489	0.567	0.113	2.835
	[Marital status=single]	0[b]	–	–	–	–	–	–	–
	[Economic situation=low]	2.332	1.193	3.824	1	0.051	10.301	0.995	106.688
	[Economic situation=moderate]	0.808	1.002	0.649	1	0.420	2.243	0.315	15.987
	[Economic status=high]	0[b]	–	–	–	–	–	–	–
	Intercept	14.046	3.742	14.089	1	0.000	–	–	–
Normal cognitive function	Age	-0.212	0.053	15.681	1	0.000	0.809	0.729	0.899
	[Education level=illiterate]	-16.756	5730.324	0.000	1	0.998	5.285E-8	0.000	.[c]
	[Education level=primary school]	1.996	1.086	3.382	1	0.066	7.363	0.877	61.815
	[Education level=secondary school]	2.480	1.237	4.019	1	0.045	11.947	1.057	135.038
	[Education level=high school]	0.823	1.215	0.458	1	0.498	2.277	0.210	24.649
	[Education level=university]	0[b]	–	–	–	–	–	–	–
	[Marital status=married]	-0.002	0.531	0.000	1	0.996	0.998	0.352	2.824
	[Marital status=single]	0[b]	–	–	–	–	–	–	–
	[Economic situation=low]	-1.569	0.717	4.787	1	0.029	0.208	0.051	0.849
	[Economic situation=moderate]	-0.682	0.498	1.879	1	0.170	0.505	0.190	1.341
	[Economic status=high]	0[b]	–	–	–	–	–	–	–

The reference category is "Severely Impaired Cognitive Status." b: This parameter is set to zero because it is unnecessary; c A floating point overrun occurred while calculating this statistic. Therefore, its value was set to missing the system; Pseudo R-Square: Cox and Snell: 0.544, Nagelkerke: 0.662, McFadden: 0.455; Intercept Only Model: AIC: 319.624, BIC: 326.289, –2 Log Likelihood: 315.624; Final Model: AIC: 188.873, BIC: 248.862, –2 Log Likelihood: 152.873, Chi-Square: 162.751, df=16, p<0.001. Reference categories for education level, marital status, and economic status variables are "university," "single" and "high," respectively.

counterintuitive at first glance (Justice, 2018; Oumohand et al, 2020), suggesting that moderate levels of stress may act as cognitive stimulants in older adults. This finding is consistent with previous research indicating that acute stress can enhance cognitive function through increased arousal and attention (Lupien et al, 2009; Saez-Sanz et al, 2023; Shields et al, 2016). This finding is also parallel to a study, which highlighted that cumulative exposure to stress can lead to improved cognitive function, provided a healthy lifestyle is maintained to buffer the effects of stress (D'Amico et al, 2023). However, this finding contradicts the consensus that chronic stress negatively impacts cognitive health (Kulshreshtha et al, 2023; Qin et al, 2009; Shields et al, 2016). This discrepancy could be attributed to differences in the stress measurements, population characteristics, or cognitive tasks used in the studies. The literature indicates that the effects of stress on cognitive function are complex and multifaceted (Lupien et al, 2009; Qin et al, 2009; Shields et al, 2016). It has been reported that high and low levels of stress have different effects on cognitive performance, especially in older individuals. The presence of low-level stress is associated with higher memory and cognitive performance outcomes in older adults compared to situations with no stress (Guerdoux-Ninot & Trouillet, 2019).

The negative relationship between psychological flexibility and perceived stress, where individuals with lower psychological flexibility experience higher levels of perceived stress, is consistent with the general notion that psychological flexibility is a positive factor in coping with stress, as outlined in some studies (Arslan & Allen, 2022; Kashdan & Rottenberg, 2010; Wersebe et al, 2018). This association underscores the importance of psychological flexibility as a buffer against the adverse effects of stress on mental health (Kashdan & Rottenberg, 2010). Although this study supports the potential buffering role of psychological flexibility, further research is needed to confirm this relationship. In the face of increasing physical and social changes associated with aging, psychological flexibility can enhance an individuals' ability to adapt to such changes and cope with stress.

The strong inverse correlation between a lack of psychological flexibility and cognitive performance indicates the protective effect of psychological flexibility on cognitive health with increasing age. These results further suggest that better cognitive performance is associated with greater psychological flexibility. Psychological flexibility was demonstrated in a previous study by Dajani and Uddin (2015) to be related to resilience and may play an important role in determining cognitive performance (Dajani & Uddin, 2015). Psychological flexibility may be related to better cognitive performance, specifically a higher level of executive functioning, and better overall cognitive health in older populations (Plys et al, 2023). Psychological flexibility is a key component of overall psychological functioning. Its enhancement has been associated with improvements in executive functions, which are critical cognitive processes, such as planning, decision-making, and problem-solving (Zukerman et al, 2023). Higher psychological flexibility may also be associated with a reduced cognitive load due to stress and, therefore, may preserve cognitive resources for other tasks (Mousa Mohamed et al, 2023). The observed association between psychological flexibility and cognitive performance suggests that psychological factors may contribute to cognitive functioning in older adults, although further research is needed to establish causal relationships. Psychological flexibility in this context is considered to contribute to the maintenance of cognitive function in older individuals.

Theoretically, our study contributes to understanding the dynamic interplay among stress, psychological flexibility, and cognitive performance in older adults. Practically, these findings suggest that interventions targeting the enhancement of psychological flexibility may be effective in reducing stress and improving cognitive health in older adults. The results suggest that psychological flexibility may not be a direct cause of cognitive impairment, but it can potentially explain these issues indirectly. These findings provide essential insights into understanding complex cognitive challenges and changes in stress coping mechanisms during the aging process. This knowledge may be valuable in developing effective cognitive and psychological programs for older adults. Programs focusing on stress management and cognitive-behavioral techniques to enhance psychological flexibility could prove beneficial (Hayes et al, 2012).

By examining the influence of sociodemographic factors, we observed that variables, such as age, education level, marital status, employment status, and economic status significantly impact psychological flexibility, perceived stress, and cognitive performance. Notably, with increasing age, a decrease in psychological flexibility, perceived stress, and cognitive performance was observed. These findings appear to be consistent with those of previous studies (Banjongrewadee et al, 2020; Ihle et al, 2020; Saez-Sanz et al, 2023). Our finding that gender did not have a significant effect on psychological flexibility, perceived stress, and cognitive performance is consistent with the existing literature. Research indicates that psychological and cognitive variables are typically more strongly associated with individual and environmental factors than with gender differences (Rimmele et al, 2022). The impact of education level on psychological flexibility, perceived stress, and cognitive performance is noteworthy. The lowest psychological flexibility exhibited by illiterates suggests that a lack of education can negatively impact adaptive and coping strategies (Askary et al, 2019). The highest perceived stress level among middle school graduates may be associated with their life expectations and coping strategies. The increase in cognitive performance with increasing education levels underscores the importance of the cognitive reserve gained through education (Ihle et al, 2019). The higher psychological flexibility and cognitive performance observedin employed individuals can be explained by the mental stimulation and social interaction provided by their work (Bjelajac et al, 2019). However, the higher perceived stress among those employed could be linked to the responsibilities and pressures associated with their work (Borzyszkowska & Basinska, 2020). The increase in psychological flexibility and cognitive performance with an improved perception of economic status reflects the positive impact of financial security on psychological and cognitive health (Bell et al, 2021). However, the increase in perceived stress associated with economic status may suggest that individuals with higher incomes face greater responsibilities and expectations (Joshi et al, 2023). The higher psychological flexibility and cognitive performance of individuals residing in a city could be attributed to the amenities and opportunities for social interaction offered by urban life (Mousa Mohamed et al, 2023). The improvement in psychological flexibility and cognitive performance with

increasing life satisfaction supports the positive impact of overall life satisfaction on psychological and cognitive health (Maye et al, 2023). The increase in perceived stress may stem from individuals who are satisfied with life potentially taking on more responsibilities and tasks.

The multinomial logistic regression analysis revealed that age, education level, and economic status had independent effects on cognitive status. Specifically, our findings indicated that as age increases, the likelihood of mild cognitive impairment and normal cognitive function decreases compared with severe cognitive impairment. This is consistent with the literature, as there is, on average, a general decline in cognitive function with age (Saez-Sanz et al, 2023). This indicates that neurodegenerative diseases and brain plasticity decline with age. This, among other factors, can explain the decrease in cognitive performance among older adults (Bell et al, 2019). This finding emphasizes early intervention and continued cognitive stimulation as a way of maintaining good cognitive health in later life. This clearly indicates apparent differences in cognitive function among different educational levels. The extremely low likelihood of normal cognitive function among illiterates emphasizes the concern regarding cognitive reserve from education (Ihle et al, 2019). The greater likelihood of normal cognitive function among primary, middle, and high school graduates provides further evidence of higher education as a determinant of better cognitive performance. This effect is statistically significant only among middle school graduates, which may be a critical turning point in education (Askary et al, 2019). Economic status affects cognitive function, as indicated by higher odds of mild cognitive impairment and lower odds of normal cognitive function among those with low economic status. This finding suggests that economic stress could be bad for our brains and that economic status per se may contribute to some increased reserve capacity (Guerdoux-Ninot & Trouillet, 2019). Such needs and their linkage to other determinants warrant further research to explore other factors influencing cognitive health and the interactions among these factors. Further, it will be essential to conduct experimental research to establish the efficacy of intervention programs in the recognition of strategies meant to maintain and enhance cognitive health (Zaheed et al, 2021).

The practical application of our findings provides critical insights for intervention development that can enhance the mental health of older adults. For example, interventions aimed at enhancing psychological flexibility may improve cognitive performance and the management of perceived stress. Consequently, various cognitive-behavioral therapies, including Acceptance and Commitment Therapy, should be able to offer effective means to enhance psychological flexibility among older adults, thereby alleviating the perception of stress and ameliorating cognitive performances (Petkus & Wetherell, 2013; Plys et al, 2023). Accordingly, given the value of education and active lifestyles, lifelong education programs and social participation opportunities should also help maintain cognitive health among seniors. Due to the impact of economic status, it can be reasoned that social policies that promote economic security for older adults have positive implications for good health and quality of life in general (Marmot, 2020).

Some limitations are associated with our study. Given the study's cross-sectional design and the potential for multicollinearity among variables, direct moderation analyses could not be performed. Future research should explore the potential moderating role of psychological flexibility using longitudinal designs or alternative analytical approaches that can address multicollinearity. Longitudinal designs could be implemented to examine how the relationships between these variables have changed over time. Hence, the generalization of our results may be limited, considering that our sample was regional. The generalization to larger and more diverse samples should be tested in future research. In addition, some unexpected findings, such as a positive association between perceived stress and cognitive performance, have occurred. In contrast, generalization to chronic stress will be tested in terms of its detrimental effects on cognitive functioning. After all, studies on the underlying neurobiological mechanisms linking psychological flexibility, stress, and cognitive performance will reveal further details. Research conducted using neural-based neuroimaging techniques can provide a more complete depiction of the aging process.

CONCLUSIONS

To sum up, the present investigation highlights the relationship between psychological flexibility and perceived stress in older adults, offering insights for designing interventions aimed at promoting the maintenance of mental and cognitive health up to old age. Our results highlight the importance of conducting research with the aim of improving the health and quality of life of older adults. Future research should focus on the mechanisms underlying these relationships and the development of effective intervention strategies. Specifically, exploring the directionality of the observed relationships between perceived stress and cognitive performance is crucial for future interventions. Moreover, our research indicated that the cognitive functions of older adults largely depend on their age, education level, and economic status. These results emphasize the need for planning and conducting interventions aimed at improving cognitive health in older adults, particularly targeting those with lower education and economic status.

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Author Contributions: Concept – PH, EY; Design – PH, EY; Supervision – EY; Resource – PH; Materials – PH, EY; Data Collection and/or Processing – PH, EY; Analysis and/or Interpretation – EY, PH; Literature Review – PH, EY; Writing – PH, EY; Critical Review – PH, EY.

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Appendix 1. STROBE statement—A checklist of items to be included in cross-sectional studies

	Item no	Recommendation	Reported on page #
Title and abstract	1	(a) Indicate the study's design with a commonly used term in the title or abstract.	Abstract
		(b) Provide an informative and balanced summary of what was done and what was found in the abstract	Abstract
Introduction			
Background/rationale	2	Explain the scientific background and rationale for the investigation	Introduction
Objectives	3	State-specific objectives, including prespecified hypotheses	Abstract and introduction
Methods			
Study design	4	Key elements of the study design are presented in the	Design
Setting	5	Describe the setting, locations, and relevant dates, including the periods of recruitment, exposure, follow-up, and data collection	Design
Participants	6	(a) Eligibility criteria and sources and methods of participant selection	Sample and participants
Variables	7	Clearly define all outcomes, exposures, predictors, potential confounders, and effect modifiers. Provide diagnostic criteria, if applicable	Sample and participants
Data sources/measurement	8*	For each variable of interest, provide sources of data and details of assessment methods (measurement). Describe the comparability of assessment methods among groups	Data collection tools
Bias	9	Describe any efforts to address potential sources of bias	N/A
Study size	10	Explain how study size was estimated	Sample and participants
Quantitative variables	11	Explain how quantitative variables were handled in the analyses. If applicable, describe which groupings were selected and why	Data analysis
Statistical methods	12	(a) Describe all statistical methods, including those used to control for confounding	Data analysis
		(b) Any methods used to examine subgroups and interactions	N/A
		(c) Explain how the missing data were addressed	Data analysis
		(d) If applicable, describe the analytical methods that take into account the sampling strategy	Sample and participants
		(e) Any sensitivity analyses	N/A
Results			
Participants	13*	(a) Report numbers of individuals at each stage of study—eg numbers potentially eligible, examined for eligibility, confirmed eligible, included in the study, completing follow-up, and analyzed)	Methods
		(b) Reasons for non-participation at each stage	Methods
		(c) Using a flow diagram	N/A
Descriptive data	14*	(a) Characteristics of the study participants (eg demographic, clinical, social), information on exposures, and potential confounders	Sample and participants
		(b) Number of participants with missing data for each variable	N/A
Outcome data	15*	The number of outcome events or summary measures	N/A

Appendix 1 (cont). STROBE statement—A checklist of items to be included in cross-sectional studies

	Item no	Recommendation	Reported on page #
Main results	16	(a) Unadjusted estimates and, if applicable, confounder-adjusted estimates and their precision (eg, 95% confidence interval). Explain which confounders were adjusted and why they were included	Predictors of cognitive performance
		(b) Report category boundaries when categorizing continuous variables	N/A
		(c) If relevant, consider translating relative risk estimates into absolute risk over a meaningful time period	N/A
Other analyses	17	Report other analyses done—eg analyses of subgroups and interactions and sensitivity analyses	Results
Discussion			
Key results	18	Key results with reference to study objectives	Discussion
Limitations	19	Discuss the limitations of the study, taking into account the sources of potential bias or imprecision. Discuss both the direction and magnitude of potential bias	Discussion
Interpretation	20	Provide a cautious overall interpretation of the results considering the objectives, limitations, multiplicity of analyses, results from similar studies, and other relevant evidence	Discussion
Generalisability	21	The generalisability (external validity) of the study results	Discussion
Other information			
Funding	22	Provide the source of funding and the role of the funders for the present study and, if applicable, for the original study on which the present article is based	Title page

*: Give information separately for exposed and unexposed groups. An Explanation and Elaboration article discusses each checklist item and gives methodological background and published examples of transparent reporting. The STROBE checklist is best used in conjunction with this article (freely available on the Web sites of PLoS Medicine at http://www.plosmedicine.org/, Annals of Internal Medicine at http://www.annals.org/, and Epidemiology at http://www.epidem.com/). Information on the STROBE Initiative is available at www.strobe-statement.org.