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Original Research

Executive Dysfunctions and Mental Health Problems in University Students: A Canonical Correlation Analysis

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Abstract

In the context of adulthood, attending to students by focusing on all components of executive functions and preventing consequences related to their physical and psychological health appears essential. The present study investigated the canonical correlation between executive dysfunctions and mental health problems in students. This descriptive-correlational research design was conducted in 2023 with a statistical population comprising students from universities and higher education institutions in Mashhad. A sample of 245 individuals was selected through convenience sampling. Data

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were collected using the Barkley Deficits in Executive Functioning Scale (BDEFS) and the Symptom Checklist-90-Revised (SCL-90-R). The collected data were analyzed using descriptive statistics, the Pearson correlation coefficient, and canonical correlation analysis to examine the relationships between two sets of variables: predictors (executive dysfunctions) and criteria (symptoms of mental disorders). The results indicated a significant relationship between executive dysfunctions and various forms of psychopathology ($P \leq 0.01$). Therefore, executive functions may represent an important target for psychopathology prevention programs and interventions.

Introduction

The beginning of university life often coincides with the onset of emerging adulthood, a period accompanied by changes in health-related behaviors and the maturation of executive functions (EFs) (McGrath et al., 2023). Executive functions refer to a set of goal-directed cognitive and emotional processes that, by supervising basic skills, influence attentional control, planning, and goal-directed behavior (Mashhadi et al., 2021; Maleki et al., 2024). Executive dysfunction particularly affects self-regulation, which is associated with health in adulthood (Silverstein et al., 2020; Garcia Pimenta et al., 2024). Therefore, executive dysfunction and its components are considered a transdiagnostic internal construct and possibly a risk factor for psychological problems and disorders (Yang et al., 2022). In a meta-analytic review by East-Richard et al. (2020), executive dysfunction across different age groups and in disorders such as schizophrenia, attention-deficit/hyperactivity disorder (ADHD), autism spectrum disorder (ASD), anxiety, and mood disorders emerged as a transdiagnostic marker of psychopathology. Indeed, disorders and health problems hinder reflection in the face of new, ambiguous, or conflicting information that requires using EFs such as inhibition, task-shifting, and working memory (Saarinen et al., 2021). Consequently, repeated failure to evaluate new information to optimize decisions leads to a lower capacity to adapt to unexpected or novel events, resolve conflicts, and engage in adaptive actions (Zainal & Newman, 2022).

Mental health is defined as a state of well-being and absence of diagnosable mental illness, associated with realizing potential abilities, managing psychological stress, productive functioning, and contributing to society, and enhances the capacities for feeling, thinking, and acting toward the ability to enjoy life and cope with challenges (Wren-Lewis & Alexandrova, 2021). According to Wijbenga and colleagues (2024), executive dysfunctions are associated with many important aspects of health and human functioning, including academic and occupational performance, interpersonal problems, and physical and psychological health, reflecting the importance of executive dysfunction in most forms of psychopathology due to poor use of adaptive emotion regulation strategies like reappraisal (Moradi & Ghanaei Chamanabad, 2024). Thus, on the one hand, executive dysfunction can lead to hostility and impulsive behaviors due to self-regulation problems (Cruz et al., 2020); furthermore, impaired working memory, which moderates other cognitive abilities such as behavioral inhibition and decision-making, may result in impulsivity (Maleki et al., 2014). Indeed, deficits in inhibitory control and difficulties in decision-making and problem-solving—particularly in the context of deficits in emotion regulation skills—are associated with problems such as bulimia nervosa (Cury et al., 2020). On the other hand, cognitive inflexibility makes forming new behavioral patterns difficult, which impacts therapeutic interventions targeting maladaptive, entrenched patterns (Aydin & Yerin Güneri, 2022), representing a long-term psychopathological outcome in general (Poletti et al., 2021). In line with these findings, in a meta-analysis of 167 studies, these dysfunctions were significantly

associated with behavioral problems, substance use, ADHD, oppositional defiant disorder (ODD), and depression (Yang et al., 2022). Furthermore, data from 82 meta-analyses indicated significant links between anxiety constructs and cognitive functioning (Zainal & Newman, 2022). This notable dysfunction in anxiety disorders manifested during EF tasks; additionally, mediation by disorder type and EF domain was identified (Majeed et al., 2023). Thus, research shows that executive dysfunction correlates with poor functioning, symptoms, somatization, and interpersonal sensitivity (Gomez, 2022; Martinez-Esparza et al., 2021; McGrath et al., 2023). Overall, executive dysfunction prospectively predicts various externalized and internalized problems (Yang et al., 2022); therefore, it is often a core feature of disorders that, by reducing the capacity for a satisfying life, may also undermine the benefit from interventions (Van Aken et al., 2022).

Specifically, in the student population, Kianimoghadam and colleagues (2020) examined the relationship between mental health and religious orientation with cognitive-emotional strategies among medical interns at Shahid Beheshti University of Medical Sciences and found a significant relationship between mental health and cognitive-emotional regulation. These findings align with evidence supporting the role of student executive dysfunction in the occurrence and severity of emotional-behavioral problems like ADHD and suggest its mediating role (Garcia Pimenta et al., 2024). Accordingly, it was not surprising that Zhang and colleagues (2021) found a significant correlation between EFs and quality of life. Nevertheless, the implications of executive dysfunction for the mental health of specific populations, such as students, are still unknown (Silverstein et al., 2020; Garcia Pimenta et al., 2024; Robb, 2020; De vroege et al., 2022). In fact, most explanations have focused on a specific disorder and have been directed toward neurobiological correlations or mechanisms of psychological pathology (Abramovitch et al., 2021). Therefore, despite the considerable economic costs of executive dysfunction regarding academic underperformance, social relationships, occupational environment, physical health, and other quality-of-life indices (Zainal & Newman, 2022), its significance in students' daily functioning via canonical analysis has been understudied (Kamradt et al., 2019). Thus, the innovation of the present study lies in its focus on university students in emerging adulthood, with an emphasis on all components of executive functions in daily life; therefore, this study aimed to address this research gap by examining the canonical correlation between executive dysfunction and mental health problems among students.

Method

This study was conducted as a cross-sectional and descriptive research. According to Garson (2015), a minimum sample size of 200 participants is recommended for canonical correlation analysis. Therefore, considering possible participant dropout, 245 students from universities and higher education institutions in Mashhad were selected. Given the aim of the present study, which involved self-report measures and the advantages of convenience sampling—such as applicability in survey research, easier

access to participants, and lower time and cost (Golzar, Noor, & Tajik, 2022)—this method was employed for selecting participants. Participants were selected based on the criteria of not having psychiatric or psychological disorders, not taking psychiatric medications, and not having received psychotherapy in the past year. Data with more than 10% missing questionnaire responses were also excluded from the analysis. The study objectives and procedures were explained to the participants before data collection. All questionnaires were anonymous. Participants were assured of confidentiality and non-disclosure of their information. Participation in the study was completely voluntary. Data were collected using the following questionnaires:

Barkley Deficits in Executive Functioning Scale (BDEFS): This self-report tool was developed by Barkley (2011) to assess executive dysfunction in both clinical and non-clinical populations. The 89-item scale is rated on a four-point Likert scale ranging from 1 (never) to 4 (always). It consists of five subscales: self-management to time, self-organization/problem-solving, self-restraint, self-motivation, and self-regulation of emotion (Barkley, 2013). Scores for each subscale are calculated by summing the items belonging to that subscale; higher scores indicate greater executive dysfunction in that domain. The internal consistency of this scale was reported as 0.88 (Barkley, 2011). Cronbach's alpha for the total scale was 0.92, and for the emotion regulation subscale was 0.95 (Mashhadi et al., 2014). Confirmatory factor analysis supported the five-factor structure in the Iranian population (Parhizkar et al., 2013). In the present study, subscale reliability ranged from 0.84 to 0.92.

Symptom Checklist-90-Revised (SCL-90-R): The original form of this questionnaire was introduced in 1973 by Derogatis and colleagues to identify the psychological aspects of somatic and psychological problems, and it was revised in 1984 based on clinical experience and psychometric analyses (Derogatis, 2000). This 90-item questionnaire assesses psychological symptoms across nine subscales: somatization, obsessive-compulsive, interpersonal sensitivity, depression, anxiety, aggression, phobic anxiety, paranoid ideation, and psychoticism (Lignier et al., 2024). Responses are rated on a five-point scale from (not at all) to (extremely) (Anisi et al., 2015). Chegini and colleagues (2002) reported its reliability as 0.91 over a one-week interval. Bagheri Yazdi and colleagues (1994) reported its reliability, sensitivity, specificity, and efficiency as 0.94, 0.98, and 0.96, respectively. In Anisi and colleagues' study (2015), Cronbach's alpha for subscales ranged from 0.75 to 0.92. In this study, reliability ranged from 0.74 to 0.82 based on Cronbach's alpha.

For data analysis, Pearson correlation and canonical correlation analyses were employed. Canonical correlation produces two canonical functions and examines the canonical weights to assess the contribution of each main variable to the canonical correlation coefficients, as well as the canonical loadings to assess the simple

correlation between the main variables and their corresponding canonical function. Data analysis was conducted using SPSS version 27.

Results

The demographic description showed that 65.8% of the participants (n = 245) were female; the mean and standard deviation of age were 22.35 and 4.91, respectively, with a range of 18 to 52 years. Additionally, 85.7% of participants were undergraduate students; 61.3% were studying in humanities, 4.2% in basic sciences, 27.7% in engineering and technical fields, and 6.8% in other disciplines.

Data screening identified and corrected outliers. The box plot indicated no univariate outliers. The Mahalanobis statistic showed no multivariate outliers. Descriptive statistics of the study variables are presented in Table 1.

Table 1 shows significant positive relationships between the dimensions of executive dysfunction and mental health problems ($p \leq 0.01$). Subsequently, the assumptions were tested. Considering skewness (± 2) and kurtosis (± 7) (Table 1), univariate normality was confirmed. The one-sample Kolmogorov–Smirnov test indicated that the distribution of standardized residuals was normal ($P \geq 0.05$). The variance inflation factor (VIF) ranged from 2.42 to 2.95, confirming no multicollinearity. Furthermore, the Durbin–Watson statistic was 2.03, indicating the independence of errors. The results of the canonical correlation are presented in Table 2, and the canonical coefficients are shown in Table 3.

Table 2 indicates a significant positive relationship between executive dysfunction and mental health problems, with the canonical functions explaining 62% of the variance.

Table 3 shows that emotional self-regulation had the highest weight (–0.361) in the canonical correlation for the executive-dysfunction. In the mental-health-problems function, obsessive-compulsive had the highest weight (–0.507). In the first function, holding other variables constant, a one-unit decrease in emotional self-regulation reduces the canonical correlation by 0.36. In the second function, a one-unit decrease in obsessive-compulsive reduces the canonical correlation by 0.51. The canonical loadings indicate that the highest contribution to the executive dysfunction canonical variable was self-restraint (–0.875), and the highest contribution to the mental health problems canonical variable was obsessive-compulsive (–0.945).

Table 1. Descriptive statistics and correlation coefficients

Variables	1	2	3	4	5	6	7	8	9	10	11	12	13	14
1. ED-TM	--													
2. ED-OPS	0.70**	--												
3. ED-SR	0.64**	0.65**	--											
4. ED-SM	0.69**	0.65**	0.69**	--										
5. ED-SRE	0.53**	0.63**	0.74**	0.61**	--									
6. SCL-S	0.40**	0.48**	0.50**	0.32**	0.49**	--								
7. SCL-OC	0.64**	0.65**	0.64**	0.55**	0.62**	0.63**	--							
8. SCL-IS	0.54**	0.57**	0.58**	0.51**	0.61**	0.54**	0.76**	--						
9. SCL-D	0.58**	0.55**	0.61**	0.50**	0.63**	0.60**	0.80**	0.79**	--					
10. SCL-A	0.47**	0.52**	0.58**	0.40**	0.63**	0.64**	0.71**	0.73**	0.76**	--				
11. SCL-AH	0.36**	0.44**	0.49**	0.30**	0.53**	0.56**	0.61**	0.59**	0.62**	0.67**	--			
12. SCL-PH	0.38**	0.43**	0.48**	0.33**	0.50**	0.49**	0.61**	0.64**	0.61**	0.64**	0.50**	--		
13. SCL-PA	0.48**	0.48**	0.56**	0.41**	0.55**	0.52**	0.67**	0.72**	0.72**	0.67**	0.59**	0.56**	--	
14. SCL-P	0.59**	0.58**	0.62**	0.53**	0.58**	0.54**	0.72**	0.79**	0.78**	0.70**	0.57**	0.70**	0.69**	--
Mean	39.59	42.06	31.81	21.15	24.78	22.00	21.01	18.24	27.50	18.67	10.22	10.17	14.30	17.52
SD	11.84	12.16	8.30	5.59	8.42	7.30	7.98	6.36	10.79	6.91	3.17	2.80	5.44	6.29
Skewness	0.48	0.64	0.48	0.43	0.61	0.68	0.68	0.64	0.78	0.86	0.70	0.74	0.54	0.70
Kurtosis	-0.57	-0.17	-0.42	-0.46	-0.40	-0.37	-0.39	-0.33	-0.17	0.06	-0.51	-0.30	-0.12	-0.47

Note: SD= standard deviation; ED = executive dysfunctions; TM= time management; OPS= organization and problem solving; SR= self-restraint; SM= self-motivation; SRE= self-regulation of emotions; SCL= symptom checklist; S= somatization; OC= obsessive-compulsive; IS= Interpersonal sensibility; D= depression; A= anxiety; AH= anger-hostility; PH= phobic-anxiety; PA= paranoid ideation; P= psychoticism; **$p<0.01$; *$p<0.05$

Table 2. Canonical correlations

Canonical function	Correlation	R^2	Eigenvalue	Wilks statistic	F	p value
1	0.79	0.62	1.65	0.29	7.40	0.001
2	0.42	0.18	0.21	0.76	2.04	0.001
3	0.21	0.04	0.05	0.92	0.91	0.576
4	0.16	0.03	0.03	0.97	0.70	0.749
5	0.09	0.01	0.01	0.99	0.42	0.837

Table 3. Standardized canonical correlation coefficients and canonical loadings

Variables	Canonical correlation	Canonical loading
Executive dysfunctions		
Time management	-0.355	-0.835
Organization and problem solving	-0.257	-0.849
Self-restraint	-0.291	-0.875
Self-motivation	0.110	-0.722
Self-regulation of emotions	-0.361	-0.858
Symptom Checklist (SCL)		
Somatization	-0.078	-0.703
Obsessive-compulsive	-0.507	-0.945
Interpersonal sensibility	-0.056	-0.852
Depression	-0.035	-0.881
Anxiety	-0.138	-0.831
Anger-hostility	-0.007	-0.683
Phobic-anxiety	-0.081	-0.667
Paranoid ideation	-0.069	-0.776
Psychoticism	-0.307	-0.876

Discussion

The present study aimed to examine the canonical correlation between executive dysfunction (EFs) and mental health problems in university students. To date, similar studies on certain EF components and mental health problems have faced limitations in explaining the possible role of executive dysfunction in psychopathology, often focusing on early developmental stages and using regression-based methods (Abramovitch et al., 2021). To address this research gap, the novelty of this study lies in its focus on university students in emerging adulthood, emphasizing all EF components in daily life and using canonical analysis, which offers advantages for inferring information from covariance matrices of multidimensional variables.

The findings of this study showed that executive dysfunction is significantly associated with a range of psychological problems. There was a significant positive relationship between executive dysfunction and mental health problems, with the canonical functions explaining 62% of the variance. Among the executive dysfunction components, emotional self-regulation had the highest weight, while obsessive-compulsive symptoms had the highest weight among mental health problems. These findings are consistent with previous research by Robb (2020), Cruz et al. (2020),

Zhang et al. (2021), and Kianimoghadam and colleagues (2020), conducted with different groups and EF components. Impaired processing of new information for optimal decision-making, due to executive dysfunction, predicts a lower capacity for adapting to changing conditions in adulthood (Zainal & Newman, 2022). Therefore, executive dysfunction, as a risk factor for various mental health problems (Yang et al., 2022), is associated with reduced psychological well-being in adults (Silverstein et al., 2020; Garcia Pimenta et al., 2024).

The canonical loadings also indicated that the highest contribution to the executive dysfunction canonical variable was from self-restraint, while obsessive-compulsive symptoms had the highest contribution to the mental health canonical variable. Considering these findings, deficits in inhibitory control—as a core mechanism of executive functioning and top-down cognitive control—are identified as key contributors to the emergence and relapsing of mental health problems (Martinez-Esparza et al., 2021). For example, inefficiency in inhibitory control, combined with decision-making and problem-solving difficulties, especially in the presence of emotion regulation deficits, may be associated with bulimia nervosa or obsessive-compulsive problems. Additionally, in patients with obsessive-compulsive disorder, anxiety, and obsessive beliefs negatively affect performance on inhibition and working memory tasks (Martinez-Esparza et al., 2021).

Overall, these findings (similar to those of Wijbenga et al. (2024)) suggest that executive dysfunction during adulthood may represent transdiagnostic phenotypes or risk factors for cognitive, emotional, behavioral, and psychotic disorders in students. Therefore, the findings support the idea that executive dysfunction and its components may represent a transdiagnostic internal construct for disorders and mental health problems (Yang et al., 2022). Accordingly, executive functions may have protective effects against cognitive, emotional, and behavioral problems in both clinical and non-clinical populations (Saarinen et al., 2021). On the other hand, by reviewing the findings of studies that focus on improving executive dysfunctions, it becomes clear how executive functions and other cognitive features influence the risk of mental health problems (Poletti et al., 2021). Contributing to the development of theoretical models of psychopathology in adulthood and the design of therapeutic programs focusing on enhancing cognitive abilities related to mental health outcomes in student populations are among the theoretical and practical applications of the present study.

When generalizing these findings, it is important to consider geographic-cultural limitations, convenience sampling, and the restricted university context. Therefore, further research is needed to explore other neurocognitive functions, such as sensitivity to reinforcements, which may mediate the relationship between EFs and various mental health dimensions in both clinical and non-clinical populations. It is also recommended that future studies, alongside survey-based assessments of cognitive performance-related components through questionnaires, include neurocognitive performance evaluations with an emphasis on daily life, as well as evaluations of the effectiveness of various therapeutic programs aimed at enhancing these components, using objective

tests such as ecologically valid cognitive software that directly assess participants' actual performance rather than their subjective perceptions.

Ethical Considerations

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