Causal Model of Psychological Awareness Based on Visual Spatial Transformation, Sports Mindfulness and Perceived Physical Fitness in Patients with Amyotrophic Lateral Sclerosis (ALS); The Mediating Role of Mental Balance

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Abstract: The aim of the present study was to present a model of psychological awareness in patients with amyotrophic lateral sclerosis (ALS) based on visual-spatial development, sports mindfulness, and perceived physical fitness with the mediating role of mental balance. The research design was a quantitative correlational type. The statistical population was all patients with ALS in the city of Al-Shatar (Lorestan province) in 2024-2025, and 300 people were selected for the sample using the Krejci-Morgan table using the available sampling method. The scales of visual-spatial development, sports mindfulness, perceived physical fitness, and mental balance were used. The obtained data were analyzed using SPSS24 and AMOS software. The findings showed that the standard coefficients of the path of visual-spatial development (β = 0.77), perceived physical fitness (β = 0.55), sports mindfulness (β = 0.50), and mental balance (β = 0.60) were significantly related to psychological awareness (P < 0.001). The findings also showed that 28% of the variance in mental balance and 37% of the variance in psychological awareness were explained by the present model. In addition, the use of the bootstrap method showed that mental balance has a mediating role in the relationship between exogenous variables and psychological awareness. Therefore, based on the results obtained, it is suggested that relevant authorities should pay more attention to the predictive role of visual-spatial development variables, sports mindfulness, and perceived physical fitness and the mediating role of mental balance in promoting psychological awareness in patients with ALS.

Keywords: Perceived physical fitness, Visual-spatial development, Mental balance, Psychological awareness, Sports mindfulness, Amyotrophic lateral sclerosis.

INTRODUCTION

Amyotrophic lateral sclerosis (ALS) is a progressive neurodegenerative disease that affects motor neurons in the brain and spinal cord, resulting in progressive muscle atrophy and paralysis (Mertens, 2023). The disease has been reported to occur two to three times more frequently in women than in men and is more prevalent among individuals aged 20–40 years (Tervonen *et al*., 2023). ALS is considered an autoimmune disorder in which the immune system mistakenly attacks components of the neuromuscular system (Ghasemi, Razavi, & Nikzad, 2017). Clinically, the disease typically begins with gradual muscle weakness and progressively leads to loss of voluntary motor control, impaired speech, dysphagia, and ultimately respiratory failure (Davies *et al*., 2021). The motor manifestations of ALS include severe progressive muscle weakness, which usually begins in the upper or lower limbs, complete loss of motor function in certain muscles, muscle cramps, fasciculations, and muscle wasting (Lakin *et al*., 2021). In addition, patients frequently experience muscle weakness, impaired balance, sensory disturbances such as numbness and tingling in the arms and legs, tremor, and gait incoordination (Silveria *et al*., 2019).

Since 2008, approximately 2.5 million individuals worldwide have been diagnosed with ALS. However, the incidence of the disease varies considerably across different geographical regions and populations (Kang, 2022). According to the Iranian ALS Association, approximately 70000 individuals are living with ALS in Iran. Owing to the limited understanding of many aspects of the disease, substantial concerns remain among patients, caregivers, and healthcare professionals (Ghasemi, Razavi, & Nikzad, 2017).

ALS can substantially impair patients' quality of life through the development of neurological dysfunctions, negatively affecting cognitive functioning (Govindarajan, 2020), visual processing, and psychological awareness (Suralinathi, Kumari, & Valk, 2021). Previous studies have also demonstrated that individuals with ALS experience markedly elevated levels of anxiety and depression (Jang, Jiang, & Qiu, 2023). One of the psychological constructs that appears to be adversely affected in patients with ALS is psychological

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awareness (Harsono Kulkarni, 2022). Several studies have demonstrated that exercise interventions exert beneficial effects on psychological awareness (Guner & Inanici, 2015), mindfulness (Ansari, Sandroff, & Motl, 2016), and psychological well-being (Hasanpour-Dehkordi, Jivad, & Soltani, 2016) among individuals with ALS. Consequently, exercise has been recognized as a promising non-pharmacological approach for improving psychological functioning and overall well-being in this population (Rogers & McDonald, 2015). Furthermore, researchers in the field of central nervous system disorders have reported that visuospatial functioning is one of the cognitive domains most profoundly affected in individuals with ALS (de Oliveira *et al*., 2016). Patients frequently develop psychosomatic manifestations secondary to the physical burden of the disease, which are often accompanied by significant psychological distress (Thakur *et al*., 2020). As a result, they commonly experience substantial impairments in visuospatial perception and processing (Naisby *et al*., 2023). Visuospatial development constitutes one of the fundamental foundations of human development, serving as the basis for learning and communication processes while enabling the formation of internal mental representations of the external environment (Gilad, Sadeh, Boaz, & Lempl, 2006). Unfortunately, this essential developmental domain is severely compromised in individuals with ALS, leading to significant impairments in visuospatial functioning and related cognitive abilities (Gontkovsky, 2002). Studies have shown that individuals with deficits in visuospatial processing often experience difficulty perceiving the broader context or overall configuration of visual information, frequently becoming overwhelmed by individual details rather than integrating them into a coherent whole (Nguyen *et al*., 2018). Moreover, these individuals encounter challenges in interpreting complex visual patterns and performing tasks that require the organization and assembly of component parts (Jakimowski *et al*., 2021). Based on theoretical foundations, there are common elements and subvariables in the predictor variables and criterion variable with the mediator variable of psychological balance, which causes them to have similar content. Therefore, this has caused psychological balance to significantly mediate the relationship between the predictor and criterion variables. Research has further demonstrated that impairments in visual ability and visual perception are directly associated with reduced visual-motor performance in individuals with ALS. Specifically, lower levels of visual ability and perceptual functioning are accompanied by poorer visual-motor perception and performance (Fraser & Stark, 2003). Several studies have reported that individuals with ALS exhibit low levels of perceived physical fitness, tending to evaluate their physical, emotional, and social capabilities less favorably than healthy individuals (Kalron, Menascu, Frid, Aloni, & Achiron, 2020; Mayo, Miksche, Atwell-Pope, & Gawryluk, 2019). Nevertheless, other investigations have yielded complementary findings. Specifically, evidence suggests that self-regulatory constructs (Sadri Demirchi & Aghazadeh Asl, 2018; Dietmaire *et al*., 2022) and mental balance (Kratz *et al*., 2016; Soyuer, Mirza, & Erkorkmaz, 2006) mediate the relationships between key predictive variables—including visuospatial development, perceived physical fitness, and sport mindfulness—and psychological awareness among individuals with ALS. More recently, researchers have emphasized the pivotal role of mental balance in enhancing the effectiveness of mindfulness-based techniques and promoting psychological well-being in patients with ALS (Ogunwale, 2023). Therefore, considering the existing gaps in the literature and the importance of addressing the psychological health of individuals with ALS, the present study aimed to investigate psychological awareness in patients with ALS based on visuospatial development, sport mindfulness, and perceived physical fitness, while examining the mediating role of mental balance.

METHODS AND MATERIALS

The present study was an applied quantitative investigation employing a correlational research design with path analysis. The target population comprised all women diagnosed with amyotrophic lateral sclerosis (ALS) in Alashtar, Lorestan Province, Iran, during the 2025–2026 study period (Iranian calendar years 1404–1405), totaling 1,561 individuals. According to the rule of thumb proposed by Klein (2011) for model-based analyses, a minimum sample size of 15 participants per observed variable is recommended to ensure adequate statistical power and stable parameter estimation. As the proposed model consisted of 20 observed variables, a participant-to-variable ratio of 15:1, as recommended by Klein (2011), was applied. Accordingly, 300 participants were recruited through convenience sampling. Because in the present study, there was no possibility of accessing a large and extensive sample, and the sample under study was limited, and on the other hand, our society was not an unlimited society, therefore, based on the type of disorder and disease, one of the comprehensive health centers in the city of Al-Shatar was referred and the sample was selected as available. Because the available sampling method is one of the non-random sampling methods, it is possible that the people selected as the sample have the same characteristics or that the differences between them are too high or too low due to the non-randomness of

the sampling method. Therefore, because the sampling method was non-random and available, great caution must be exercised in generalizing the results, and also in generalizing the results of this study and this sample to other populations, the characteristics between the present study population and other samples must be compared one by one and finally generalized. Also, because the sampling method is a potential source of bias, it is possible that the statistical findings may also be affected by this sampling method, and caution should be exercised in this regard and in interpreting the findings.

Visual-Spatial Transformation Questionnaire

The Visual-Spatial Transformation Questionnaire was developed by Wachs and Wyder (2014). The questionnaire consists of 51 items and comprises six subscales: Body Awareness and Sensation (Items 1–8), Locating the Body in Space (Items 9–16), Body's Relationship with the environment and the environments relationship with Others (Items 17–24), Space Maintenance (Items 25–32), Visual Logical Reasoning (Items 33–40), and Representational Thinking (Items 41–51).

Items are rated on a three-point Likert scale, ranging from 1 (Always) to 3 (Never). Total scores range from 51 to 153, with higher scores indicating higher levels of visual-spatial transformation. For the subscales Body Awareness and Sensation, Locating the Body in Space, Body–Environment and Environment–Others Relationships, Space Maintenance, and Visual Logical Reasoning, scores range from 8 to 24, whereas scores on the Representational Thinking subscale range from 11 to 33. In a previous study conducted by Yaqubi (2015), the questionnaire demonstrated acceptable internal consistency, with a Cronbach's alpha coefficient of 0.70 for the total scale. In the present study, the internal consistency coefficients (Cronbach's alpha) for both the total scale and its subscales are presented in Table **1**.

Mental Balance Scale

The Mental Balance Scale was developed by Rogers *et al*. (2020). The instrument consists of 16 items distributed across two subscales: Experiential Acceptance (Items 1–8) and No reaction (Items 9–16). Responses are rated on a 5-point Likert scale, ranging from 1 (Strongly disagree) to 5 (Strongly agree). Total scores range from 16 to 80, with higher scores indicating greater mental balance. Items 9–16 are reverse scored. Rogers *et al*. (2020) reported good internal consistency for the total scale, with a Cronbach's alpha coefficient of 0.88.

Psychological Awareness Questionnaire

The psychological awareness Questionnaire was developed by Cooper (1997). The questionnaire consists of 25 items and comprises three subscales: Private psychological awareness (Items 1–10), Public psychological awareness (Items 11–18), and Social psychological awareness (Items 19–25). Responses are rated on a 5-point Likert scale, ranging from 1 (Never) to 5 (Always). Total scores range from 25 to 125, with higher scores indicating greater psychological awareness. Cooper (2020) reported satisfactory internal consistency for the overall questionnaire, with a Cronbach's alpha coefficient of 0.79.

Perceived Physical Fitness questionnaire

The Perceived Physical Fitness questionnaire was developed by Yavari (2015). The scale consists of 12 items and includes four subscales: Physical Condition (Items 1–3), Flexibility (Items 4–6), Muscle Condition (Items 7–9), and Body Composition (Items 10–12). Responses are rated on a 5-point Likert scale, ranging from 1 (Strongly disagree) to 5 (Strongly agree). Total scores range from 12 to 60, with higher scores indicating higher levels of perceived physical fitness. In Yavari's (2015) study, the overall scale demonstrated acceptable internal consistency, with a Cronbach's alpha coefficient of 0.71.

Sport Mindfulness Scale

The Sport Mindfulness Scale was developed by Thienot *et al*. (2014). The scale consists of 15 items and comprises three subscales: Awareness (Items 1–5), Non-Judgment (Items 6–10), and Refocusing (Items 11–15). Responses are rated on a 5-point Likert scale, ranging from 1 (Strongly disagree) to 5 (Strongly agree). Total scores range from 15 to 75, with higher scores indicating greater levels of sport mindfulness. Thienot *et al*. (2014) reported good internal consistency for the overall scale, with a Cronbach's alpha coefficient of 0.84. In the present study, the content validity of the reported to be satisfactory by qualitative method by asking 13 experts in the field of health psychology from Lorestan University (7 people) and general psychology (6 people) from Farhangian University of Tehran. The reliability was measured by the internal consistency method by calculating the Cronbach's alpha coefficient for 300 patients with Amyotrophic Lateral Sclerosis who were selected as the sample of the present study and was obtained as 0.88 for the Sports Mindfulness Scale.In the study by Hemayat Talab *et al*. (2017). Titled Psychometric Properties of the Sports Mindfulness Inventory, which was conducted on 235 women majoring in physical

Table 1: Cronbach's Alpha Reliability Coefficients for the Measures Used in the Present Study

Variable	Subscale	Cronbach's α
Perceived Physical Fitness	Cardiorespiratory Endurance	0.88
Sport Mindfulness	Strength	0.93
	Muscular Endurance	0.79
	Flexibility and Body Composition	0.77
	Total Score	0.80
	Awareness	0.94
	Non-Judgment	0.86
	Refocusing	0.59
	Total Score	0.75
psychological awareness	Private psychological awareness	0.59
	Public psychological awareness	0.71
	Social Anxiety	0.68
	Total Score	0.66
Mental Balance	Experiential Acceptance	0.85
	Non-Reactivity	0.91
	Total Score	0.82
Self-Control	Inhibitory Self-Control	0.85
	Primary Self-Control	0.91
	Total Score	0.82
Visual-Spatial Transformation	Representational Thinking	0.86
	Visual Logical Reasoning	0.83
	Space Maintenance	0.87
	Body Awareness and Sensation	0.85
	Locating the Body in Space	0.88
	Environmental Relationship with Others	0.83
	Body–Environment Relationship	0.73
	Total Score	0.88

education at the University of Tehran, the face and content validity and reliability Sports Mindfulness Scale was by Cronbach's alpha method were reported as 0.81 and satisfactory.

As presented in Table **1**, all study measures and their respective subscales demonstrated satisfactory levels of internal consistency, as evidenced by their Cronbach's alpha coefficients. These findings indicate that the instruments possessed acceptable reliability and were therefore considered appropriate for use in the present study. Data Collection Procedure: After obtaining the necessary institutional approvals, the researchers visited a Comprehensive Health Center in Alashtar, Lorestan Province, Iran, which provides healthcare services to patients diagnosed with amyotrophic lateral sclerosis (ALS). Initially, a list of all eligible patients with ALS was obtained from the center. Subsequently, 300 participants were selected from this list using a convenience sampling method. The researchers then contacted the selected individuals using the demographic and contact information (including address and telephone number) available in their medical records. During the initial contact, participants were provided with a detailed explanation of the study objectives and procedures. After obtaining written informed consent, the administration of the study instruments was initiated. Data Analysis. Statistical analyses were performed using data obtained from 293 participants. The collected data were analyzed using IBM SPSS Statistics version 24 and IBM AMOS version 24. Descriptive statistics, including means, standard deviations, and Pearson's correlation coefficients, were computed to summarize the data. Inferential analyses were conducted using

Table 1: Descriptive Statistics for Visual-Spatial Transformation, Mental Balance, Psychological Awareness, and Their Subscales

Variable	Subscale	Minimum	Maximum	Mean	SD
Visual-Spatial Transformation	Representational Thinking	11	33	21/45	2/44
	Visual Logical Reasoning	8	24	19/80	2/40
	Space Maintenance	8	24	20/49	2/89
	Body Awareness and Sensation	8	23	21/82	2/71
	Locating the Body in Space	8	24	20/21	2/90
	Body–Environment Relationship and Environmental Relationship with Others	8	24	22/73	2/14
	Total Score	51	153	121/67	11/83
Mental Balance	Experiential Acceptance	8	40	29/30	4/21
	Non-Reactivity	8	40	36/48	5/14
	Total Score	16	80	69.56	12/09
psychological awareness	Private psychological awareness	10	50	33/55	3/25
	Public psychological awareness	8	40	36/32	4/10
	Social psychological awareness	7	35	22/87	3/85
	Total Score	25	125	96.15	10.28

confirmatory factor analysis (CFA) and path analysis to examine the hypothesized relationships among the study variables.

RESULTS

The demographic characteristics of the participants indicated that 53% of the women with amyotrophic lateral sclerosis (ALS) were between 20 and 30 years of age, whereas 47% were between 31 and 50 years of age. Regarding employment status, family economic status, and educational attainment, the findings revealed that 71.66% of the participants were employed, while 28.33% were unemployed. In addition, 38.33% of the participants reported a low family socioeconomic status, 40.00% reported a moderate socioeconomic status, and 21.66% reported a high socioeconomic status. With respect to educational level, 26.00% had a high school diploma or lower educational attainment, 50.66% had an associate's or bachelor's degree, and 23.33% had a master's degree or higher.

Table 2: Skewness and Kurtosis Indices for Assessing the Normality of the Study Variables

Variable	Skewness		Kurtosis	
	Value	SE	Value	SE
Representational Thinking	−1.74	0.14	2.43	0.25
Visual Logical Reasoning	−1.08	0.14	2.22	0.25
Space Maintenance	−2.72	0.14	0.74	0.25
Body Awareness and Sensation	−0.99	0.14	0.53	0.25
Locating the Body in Space	−0.99	0.14	0.53	0.25
Body–Environment Relationship and Environmental Relationship with Others	−0.52	0.14	0.20	0.25
Experiential Acceptance	−3.09	0.11	0.56	0.23
Non-Reactivity	−1.03	0.11	11.09	0.23
Private psychological awareness	−1.41	0.11	1.40	0.23
Public psychological awareness	−1.23	0.11	0.73	0.23
Social psychological awareness	−1.14	0.11	0.70	0.23

Table 3: Tolerance and Variance Inflation Factor for the Exogenous Predictor and Mediating Variables

Variables	Multicollinearity Statistics	
	Tolerance	Variance Inflation Factor (VIF)
1. Representational Thinking	0.47	2.22
2. Visual Logical Reasoning	0.70	1.75
3. Space Maintenance	0.66	1.10
4. Body Awareness and Sensation	0.49	2.20
5. Locating the Body in Space	0.72	1.11
6. Body–Environment Relationship and Environmental Relationship with Others	0.70	1.36
7. Experiential Acceptance	0.42	2.29
8. Non-Reactivity	0.73	1.71
9. Private psychological awareness	0.70	1.11
10. Public psychological awareness	0.63	1.29
11. Social psychological awareness	0.50	2.32

Table **1** presents the descriptive statistics, including the means and standard deviations, for the study variables and their respective subscales. Pearson's correlation analysis revealed that psychological awareness was positively and significantly correlated with visual-spatial transformation ($r = 0.57$, $p < .05$) and mental balance ($r = 0.44$, $p < .05$). In addition, visual-spatial transformation showed a significant positive correlation with mental balance ($r = 0.42$, $p < .05$).

As shown in Table **3**, all study variables satisfied the assumption of univariate normality, with the exception of Experiential Acceptance (skewness = −3.09, kurtosis = 11.09). Furthermore, the Mardia coefficient for the study data was 4.789, indicating that the assumption of multivariate normality was met. To assess the presence of multicollinearity, the correlation matrix, tolerance values, and variance inflation factor (VIF) were examined. The correlation matrix revealed no correlation coefficients exceeding 0.80, suggesting that the assumption of no multicollinearity was met. To further evaluate multicollinearity, tolerance and variance inflation factor (VIF) values were examined, as presented in Table **3**.

To examine univariate outliers, boxplots were used, and 50 extreme cases were identified. The minimum and maximum Mahalanobis distances in the present study were 1.75 and 65.22, respectively. Given that the critical χ^2 value with 16 degrees of freedom (the number of predictor variables) at $\alpha = .001$ was 32.59, the presence of multivariate outliers was confirmed. Therefore, at this stage, seven participants were also excluded from the data analysis process, reducing the sample size to 293 participants. The results of the bootstrap method indicated that the path from visual-spatial transformation to psychological awareness, mediated by mental balance, was significant at the 0.005 level, The 95% lower and upper limits of the bootstrap method were 1.29 and 2.08, respectively. In the present study, the assumption of linearity was confirmed using scatterplots.

As shown in Figure **1**, 33% of the variance in self-control, 30% of the variance in mental balance, and 42% of the variance in psychological awareness were explained by the proposed model. Table **4** also presents the estimated parameters of the direct relationships among the study variables.

As shown in Table **4**, the standardized path coefficients for the relationships between visual-spatial transformation and self-control ($\beta = 0.54$, $p < .001$), visual-spatial transformation and mental balance ($\beta = 0.60$, $p < .001$), visual-spatial transformation and psychological awareness ($\beta = 0.67$, $p < .001$), perceived physical fitness and self-control ($\beta = 0.59$, $p < .001$), perceived physical fitness and mental balance ($\beta = 0.46$, $p < .001$), perceived physical fitness and psychological awareness ($\beta = 0.52$, $p < .001$), sport mindfulness and self-control ($\beta = 0.50$, $p < .001$), sport mindfulness and mental balance ($\beta = 0.59$, $p < .001$), sport mindfulness and psychological awareness ($\beta = 0.51$, $p < .001$), self-control and psychological awareness ($\beta = 0.47$, $p < .001$), mental balance and self-awareness ($\beta = 0.57$, $p < .001$), and mental balance and self-control ($\beta = 0.63$, $p < .001$) were all statistically significant.

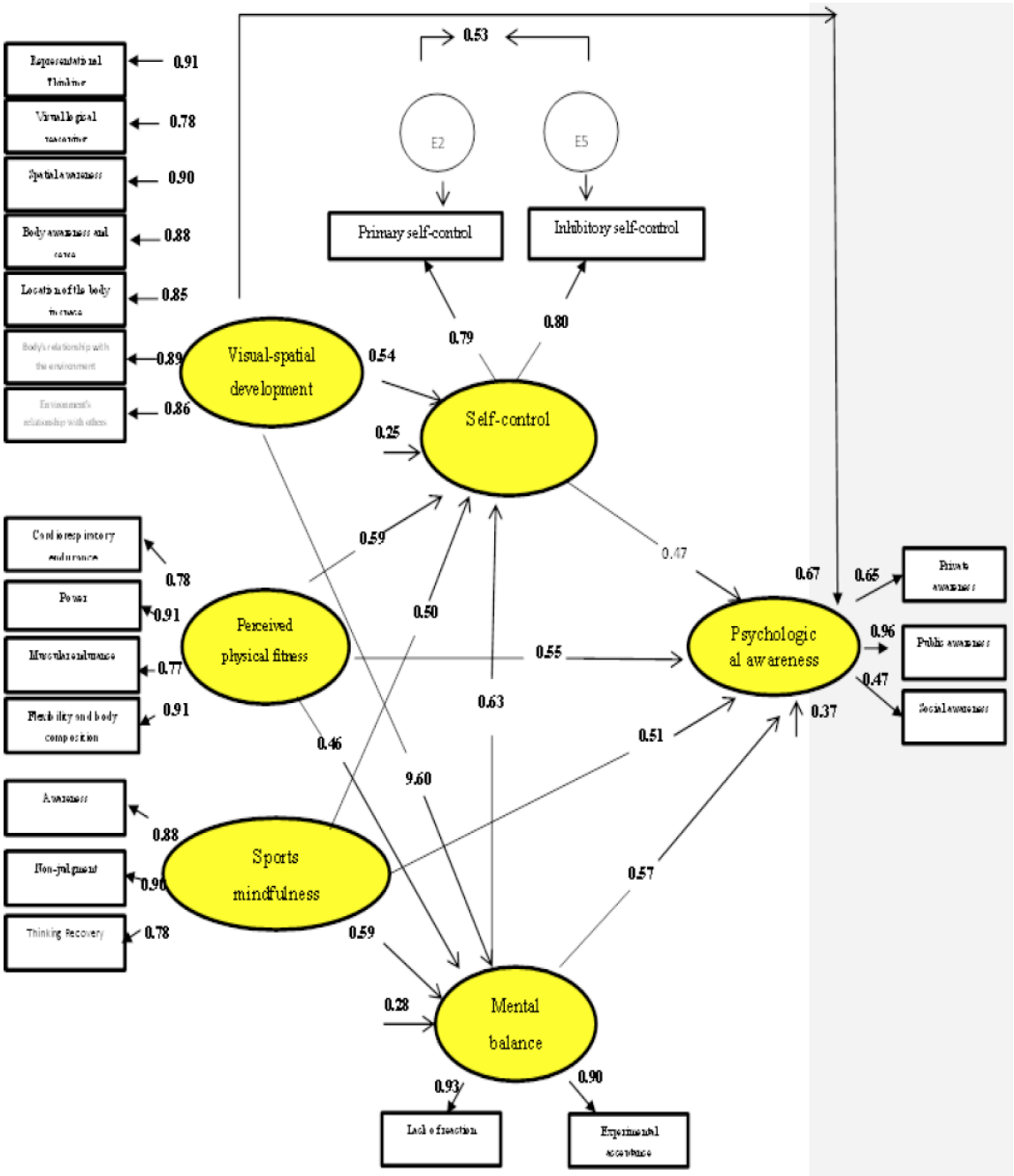

Figure 1: The Model with Standardized Coefficients.

Table 4: Estimated Parameters of the Direct Relationships Among the Variables in the Proposed Model

Paths	Standard Error (SE)	Unstandardized Coefficient (B)	Standardized Coefficient (β)	Critical Ratio (CR)	p-value
Visual-Spatial Transformation → Self-Control	0.69	0.58	0.54	2.02	< .001
Visual-Spatial Transformation → Mental Balance	0.60	0.65	0.60	3.47	< .001
Visual-Spatial Transformation → psychological awareness	0.67	0.70	0.67	1.75	< .001
Perceived Physical Fitness → Self-Control	0.68	0.67	0.59	2.57	< .001
Perceived Physical Fitness → Self-Awareness	0.57	0.57	0.52	2.36	< .001
Sport Mindfulness → Self-Control	0.60	0.55	0.50	4.42	< .001
Sport Mindfulness → psychological awareness	0.73	0.51	0.51	1.63	< .001
Self-Control → psychological awareness	0.64	0.50	0.47	2.82	< .001

Table 5: Model Fit Indices

Model Fit Indices			
Fit Indices	**Values**	**Acceptable Range**	**Result**
Chi-square (χ^2)	426.42	$p > .05$	
Significance level (*p*-value)	.001		Not Acceptable
Chi-square/degrees of freedom (χ^2/df)	2.76	< 5	Acceptable
Goodness-of-Fit Index (GFI)	0.85	> 0.90	Acceptable
Root Mean Square Error of Approximation (RMSEA)	0.042	< 0.10	Acceptable
Comparative Fit Index (CFI)	0.91	> 0.90	Acceptable
Tucker–Lewis Index (TLI)	0.90	> 0.90	Acceptable
Bentler–Bonett Normed Fit Index (NFI)	0.87	> 0.90	Acceptable
Parsimonious Normed Fit Index (PNFI)	0.74	> 0.50	Acceptable

Given that the GFI and NFI values are below the acceptable threshold, it should be said that the model has a relatively good fit.

DISCUSSION

The present study aimed to examine the fit of a causal model of psychological awareness in patients with amyotrophic lateral sclerosis (ALS) based on visual-spatial transformation, sport mindfulness, and perceived physical fitness, with mental balance as a mediating variable within the framework of a structural model. In the proposed model, visual-spatial transformation, sport mindfulness, and perceived physical fitness were considered exogenous variables, mental balance was specified as the mediating variable, and psychological awareness was treated as the endogenous variable.

The results showed that there is a direct and significant relationship between visual-spatial development and mental balance. This finding is consistent with the results of previous studies (Heo & Han, 2021; Wieczek, Barkley, & Vandersall, 2011; Lai, 2011). These studies suggested that enhanced visual-spatial transformation contributes to greater mental balance among individuals with ALS by promoting a sense of inner peace and psychological satisfaction. Therefore, higher levels of visual-spatial transformation and perception may enhance mental balance in patients with ALS. Another possible explanation for this finding is that the construct of visual-spatial transformation includes a subcomponent referred to as body awareness and sensation, which enables individuals to develop a better understanding of their physical and psychological conditions. Similarly, the construct of mental balance comprises the subcomponent of experiential acceptance, which facilitates the acceptance of negative emotions and feelings and promotes their transformation into more positive emotional experiences. Accordingly, the positive and significant effect of visual-spatial transformation on mental balance may be explained by the shared conceptual component of body awareness and perception embedded within both constructs.

The results showed that there is a direct and significant relationship between visual-spatial development and self-control. This finding is consistent with the results reported by Setyaningrum & Siswantari (2020) and Soldatova, Vishneva & Koshevaya (2022). According to the theory proposed by Clinton *et al*. (2020), self-control refers to the ability to regulate levels of arousal in order to achieve optimal performance under challenging conditions and to inhibit maladaptive responses such as anger. More broadly, self-control is defined as the capacity to modify or adapt oneself to the surrounding environment in a manner that facilitates better adjustment between the individual and the external world. On the other hand, visual-spatial transformation encompasses an important subcomponent referred to as body–environment relationship, which emphasizes the individual's interaction with the surrounding environment. Therefore, one possible explanation for the significant direct effect of visual-spatial transformation on self-control is the presence of a common underlying element in both constructs, namely the individual's effort to establish an optimal relationship with the environment. This interpretation is also consistent with the theoretical foundations of the present study.

The results showed that there is a direct and significant relationship between visual-spatial development and psychological awareness. This finding is consistent with the results reported by Malekian, Narimani, and Sahebjamei (2010), Salarifar and Mazaheri (2010), Demir *et al*. (2013), and Huang and Yang (2020). In line with the findings of Malekian *et al*. (2010), one possible explanation is that improvements in visual-spatial transformation promote

the development of cognitive processing and adaptive thinking in individuals with ALS, which, in turn, directly enhance their level of psychological awareness. Another explanation for the positive association between visual-spatial transformation and psychological awareness is that visual-spatial transformation incorporates the components of self-focused attention and reflection on one's physical and psychological condition. Accordingly, the shared elements of cognitive awareness and mental acceptance may explain why visual-spatial transformation exerts a positive and statistically significant effect on psychological awareness.

The results showed that there is a direct and significant relationship between perceived physical fitness and psychological awareness. This finding is consistent with the results reported by Brytek-Matera and Kozieł (2015) and Liao *et al*. (2023). According to McGraw's (1986) theory of psychological awareness, awareness of oneself and one's various personal characteristics enables individuals to recognize their strengths, weaknesses, and other personal attributes. Such psychological awareness helps individuals identify their emotions, become aware of their existence, and regulate them appropriately when necessary. Furthermore, McGraw's (1986) theory proposes that psychological awareness facilitates the recognition of personal needs and the identification of appropriate ways to address them. It also enables individuals to define their life goals more clearly and realistically while fostering a more accurate understanding of their own values and those of the surrounding environment. Moreover, McGraw (1987) argued that psychological awareness facilitates the healthy process of identity formation, promotes inner peace, and enhances overall life satisfaction. Furthermore, previous studies have shown that individuals with higher levels of perceived physical fitness also exhibit greater psychological awareness. This relationship may be explained by the fact that individuals with higher perceived physical fitness place greater importance on maintaining both their physical and psychological well-being. Similarly, the construct of psychological awareness emphasizes attention to one's personal identity and psychological health. Therefore, the shared emphasis on physical and psychological well-being within both perceived physical fitness and psychological awareness may explain why perceived physical fitness exerts a direct and positive effect on psychological awareness.

The results showed that there is a direct and significant relationship between perceived physical fitness and mental balance. This finding is consistent with the results reported by Badmil and Lovok (2018), Amberti, Fogliata, and Di Palma (2024), and Jo, Kim, and Yang (2021). The concept of mental balance is emphasized in Dartmouth's (1975) theory, which proposes that the construct of balance comprises several subcomponents, including mental balance and physical balance. Similarly, the construct of perceived physical fitness places considerable emphasis on both mental and physical balance. Overall, based on both the theoretical framework and the existing empirical evidence, individuals with higher levels of perceived physical fitness tend to exhibit higher levels of mental balance.

The results showed that there is a direct and significant relationship between perceived physical fitness and self-control. This finding is consistent with the results reported by Hamaideh *et al*. (2018) and Amberti, Fogliata, and Di Palma (2024). One possible explanation for this finding is that the construct of perceived physical fitness encompasses concepts such as maintaining physical health, exercise management, and regular participation in physical activity. Similarly, the construct of self-control places considerable emphasis on maintaining both physical and psychological well-being. Therefore, the presence of these shared conceptual components may explain why perceived physical fitness significantly predicts self-control. Overall, the conceptual overlap between perceived physical fitness and self-control provides a plausible explanation for the significant direct effect of perceived physical fitness on self-control observed in the present study.

The results showed that there is a direct and significant relationship between self-control and psychological awareness. This finding is consistent with the results reported by Pakmanesh and Javidan (2020) and Rhea and Rhea (2024). According to McGraw's (1987) theory psychological awareness, most individuals tend to describe themselves in terms of general characteristics, such as age, gender, and educational background, while possessing limited knowledge of their own personality traits and behavioral characteristics. The theory further conceptualizes psychological awareness as the process of recognizing one's emotions, thoughts, beliefs, and values, as well as the ability to regulate and manage emotions, behaviors, and life-related stress. Likewise, self-control theory posits that individuals who are capable of effectively managing their daily activities and who possess adequate awareness of their emotions and feelings exhibit higher levels of self-control.

The results showed that there is a direct and significant relationship between mental balance and psychological awareness. This finding is consistent

with the results reported by Rajabi and Vperkos (2017) and Aguenas and Matos (2019). One possible explanation for this finding is that patients with ALS often experience impairments in mental–motor balance as a result of damage to the nervous system, which may consequently reduce their level of psychological awareness. Therefore, interventions aimed at improving mental balance in these patients may also facilitate the enhancement of psychological awareness.

Another explanation, consistent with previous research and empirical findings, is that the construct of mental balance places particular emphasis on the regulation of motivation, emotions, and cognitive processes. In other words, individuals can determine whether they possess an adequate level of mental balance only if they are able to effectively regulate and monitor their emotions and cognitive functioning. Likewise, the theoretical framework of psychological awareness highlights both private psychological awareness and public psychological awareness as essential dimensions of the construct. Therefore, based on both the theoretical framework and empirical evidence, it can be concluded that mental balance and psychological awareness share a common emphasis on the regulation and acceptance of emotions and feelings. This conceptual overlap may explain the significant effect of mental balance on psychological awareness.

The results showed that there is an indirect and significant relationship between visual-spatial development and psychological awareness, with the mediation and mediating role of mental balance. This finding is consistent with the results reported by Cahal (2021), Shi and Qiu (2022), Li *et al*. (2024), and Chen and Wei (2023). The results also demonstrated that the indirect effect of perceived physical fitness on psychological awareness, mediated by mental balance, was statistically significant. This finding is in agreement with the studies conducted by Liang *et al*. (2024), Potozny, Herzong-Krzywzanska, and Krzywzanski (2022), Ziang *et al*. (2024), and Chen and Wei (2021). One possible explanation for these findings is that visual-spatial transformation enhances individuals' sense of competence, which in turn facilitates the development of greater psychological awareness. In addition, mental balance not only contributes to the enhancement of visual-spatial transformation but also promotes higher levels of psychological awareness among patients with ALS. Therefore, it can be concluded that mental balance serves as a mediator in the relationship between visual-spatial transformation and psychological awareness.

According to McGraw's (1987) theory of psychological awareness, individuals living with ALS should develop a higher level of psychological awareness regarding their condition in order to cope more effectively with disease management and treatment. Furthermore, individuals with higher levels of perceived physical fitness and more advanced visual-spatial transformation tend to demonstrate greater psychological awareness because better perceived physical fitness and visual-spatial transformation enable them to regulate their emotions more effectively and maintain more optimal levels of psychological arousal. Therefore, based on both the theoretical framework and empirical evidence, it can be concluded that the shared conceptual components of perceived physical fitness, visual-spatial transformation, and mental balance explain the positive mediating role of mental balance in the relationships between perceived physical fitness and psychological awareness, as well as between visual-spatial transformation and psychological awareness.

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AUTHOR'S CONTRIBUTION STATEMENT

Mehdi Yousefvand formulated the problem statement and methodology, analyzed the data, and supervised the writing of the discussion and conclusion. He also acted as the final reviewer of the entire text of the article; ***Maryam Shamsifar*** played an active role in writing the problem statement and collecting data; ***Homeira Shojaei*** wrote the importance and necessity of the work, and was also responsible for organizing and matching the sources throughout the text of the article.

CONFLICT OF INTEREST AND FUNDING

The authors declare no conflict of interest. This study was conducted entirely at the authors' personal expense, and no financial support was received from any institution or funding agency.

ETHICAL CONSIDERATIONS

This article was derived from a research project approved under Approval Code No. 162741842. All ethical principles were strictly observed throughout the study. Prior to data collection, written informed consent was obtained from all participants, who voluntarily agreed to participate by completing and signing the consent form. Participants were also assured that all information collected would remain confidential and would be used solely for research purposes. Furthermore, they were informed that the study

findings would be made available to them upon completion of the research.

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