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The role of mental toughness, sport imagery and anxiety in athletic performance: structural equation modelling analysis

Gönül Tekkurşun Demir¹, Sevinç Namlı², Ergün Çakır³, Batuhan Batu⁴, Fatih Ateş², Eda Yılmaz², Burcu Güvendi⁵, Selda Kocamaz Adaş⁶ and Musab Çağın^{7*}

Abstract

Mental toughness (MT), anxiety, and sport imagery (SI) are characteristics that are effective in the ups and downs of athletes' lives. The fact that these three characteristics, which have a direct effect on the performance of athletes (especially elite athletes), have not been examined by structural equation modeling in the literature to the best of our knowledge has led to the need for this study. The present study investigates the relationship between MT, anxiety levels, and SI skills among elite athletes in the 19–26 age group. A total of 407 elite athletes (143 females and 264 males) actively competing participated in the study, which was conducted within the framework of a correlational research model. Data were collected using the Mental Toughness Scale (MTS), the Sports Imagery Inventory (SII) and Anxiety subscale of the Emotion in Sport Scale (ESS). The theoretical model proposed to examine the effects of MT on SI and anxiety was tested using Structural Equation Modelling (SEM). It was found that the fit indices of the model established in the study gave a good fit, and the coefficients obtained were statistically significant ($p < .05$). The study revealed that athletes with higher MT had lower levels of anxiety and anxiety had a negative effect on SI skills ($p < .05$). Moreover, athletes with higher MT show high levels of SI abilities ($p < .05$). The present study suggests that training programs aimed at improving SI skills may also contribute to the development of MT.

Keywords Elite athlete, SEM, Sport imagery, Anxiety, Mental toughness

Introduction

Mental toughness (MT) is an important indicator of athletic performance. Mental toughness (MT) is conceptualized as a purposeful and adaptable psychological resource that enables individuals to maintain psychological stability and sustain optimal performance under conditions of stress, pressure, and adversity [1]. It encompasses core psychological attributes such as attentional control, self-confidence, and persistence, which collectively facilitate athletes' capacity to cope effectively with the demands of training, competition, and broader performance-related challenges [2]. It is suggested that MT, which shows the individual's capacity to maintain performance under

*Correspondence:

Musab Çağın
musabcagin@gazi.edu.tr

¹Independent researcher, Abu Dhabi, UAE

²Faculty of Sports, Department of Physical Training and Sports, Erzurum Technical University, Erzurum, Turkey

³Faculty of Sport Science, Department of Coaching Education, Van Yüzüncü Yıl University, Van, Turkey

⁴Faculty of Sports Science Department of Sports Management, Kafkas University, Kars, Turkey

⁵Department of Coaching Education, Yalova University, Yalova, Turkey

⁶Faculty of Sports Science Department of Sports Management: Istanbul, Istanbul Aydın University, Istanbul, Turkey

⁷Department of Coaching Education, Gazi University, Ankara, Turkey



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stress and pressure, consists of four basic components: control, commitment, struggle, and self-confidence [3]. The development of these core components contributes to enhancing athletes' performance levels [4, 5].

Mental toughness not only contributes directly to enhanced athletic performance but also plays a significant role in regulating emotional responses—particularly anxiety—in highly competitive environments [6, 7]. Research has shown that athletes with high levels of mental toughness tend to exhibit lower levels of anxiety compared to their peers [8]. To understand the underlying mechanisms of this relationship, Clough and Strycharczyk (2012) examined the association between the four components of mental toughness—control, commitment, challenge, and confidence—and levels of anxiety [9]. Their findings indicated that each of these components plays a critical role in reducing anxiety among athletes. Kalinin et al. (2019) also emphasized in their study that MT athletes tend to be less anxious and that any intervention to increase MT will indirectly contribute to the reduction of sports anxiety levels [10]. As Răzvan et al. (2021) stated, MT provides important support to sports performance, and therefore, determining the relationship between MT and anxiety is necessary to understand how MT can help athletes overcome challenging moments and perform at the highest levels [11]. Consequently, it is essential to develop a comprehensive understanding of the nature and underlying mechanisms of anxiety, a prevalent psychological barrier to athletic performance.

Anxiety is defined as a negative emotional response to stress, pressure, and uncertainty. In the field of sport psychology, competitive anxiety refers to the feelings of apprehension, tension, and uneasiness that athletes experience prior to or during competition. This psychological state comprises both cognitive and somatic components, each of which may adversely affect athletic performance [12]. It is stated that anxiety is a significant predictor of sports performance among athletes, and there is a significant negative relationship between sports anxiety and sports performance among players [13]. Athletes often face pressure to achieve the best results in sports. This increases their level of anxiety [14].

For instance, athletes who enhanced their self-efficacy with dynamic imagery techniques reported significant reductions in pre-competition anxiety levels [15, 16]. Moreover, structured imagery programs based on the PETTLEP model are more effective than traditional imagery approaches in reducing both cognitive and somatic components of anxiety [17]. The elevated prevalence of anxiety among elite athletes, compared to the general population, underscores the need for targeted psychological support within high-performance sport environments. In the general population, especially among adolescents aged 13–24, the prevalence of anxiety

disorders ranges between 6 and 20% [18]. Among elite individual and team athletes, the prevalence of anxiety/depression is 47.8% [19]; among French elite athletes, the reported prevalence of anxiety diagnosis is 8.6% over the past six months and 12.1% over a lifetime. These data show that anxiety is a more common and critical issue among elite athletes than previously expected. Most of the time, athletes' anxiety can take many forms, from pre-competition tension to the actual moment of competition [20]. In fact, the athlete's feeling of high anxiety may even lead to a decrease in sport imagery (SI) skills.

Imagery is defined as a mental process that simulates real experience through the integration of various sensory modalities in the absence of actual perceptual input [21]. This process allows individuals to mentally recreate an experience through visual, auditory, kinesthetic, olfactory, or gustatory senses [22]. MacIntyre and Moran (2010) describe imagery, particularly in the context of sport, as the mental rehearsal of movement [23]. Imagery is not merely a cognitive technique; it is widely utilized across diverse domains such as sport, exercise, dance, and rehabilitation. Within these contexts, it serves multiple purposes including enhancing motivation and self-efficacy, developing skills and strategies, regulating arousal and anxiety levels, and facilitating recovery [24]. Since imagery can be experienced through various sensory modalities, different types of imagery have been defined within the sport psychology literature. Among the most utilized forms are visual, motor, and sensory imagery. Visual imagery refers to the process of mentally simulating a situation or movement through the “mind's eye” [25]. This form of imagery represents a mode of learning that relies on visual representations of experience. Motor imagery involves mentally rehearsing a physical movement without actual execution. It plays a critical role in the acquisition and reorganization of complex motor skills [23, 26]. Sensory imagery, on the other hand, enables athletes to mentally simulate potential training or competitive scenarios using all of their senses. This type of imagery can serve multiple functions, including enhancing motivation, regulating anxiety levels, and supporting the development of motor skills [27].

In a study conducted by Ramsey et al. 2009, it was found that visual, kinesthetic, and sensory SI methods enable athletes to better understand movements and lead them to perform them more effectively [28]. In another study, it was emphasized that in cases where physical training should be reduced by athletes, SI is beneficial for the athlete to develop complex motor skills specific to the sport [29]. It is stated that there is a positive correlation between SI skill, which can be used in times when physical training cannot be done and during periods of injury, and MT, which allows athletes to maintain good performance under stress and pressure. Weinberg et al.

(2011) examined the effect of MT on athletes' SI skills and suggested that athletes with high MT have better SI skills [30]. Jones et al. (2007) also reported that athletes with high MT can use their SI skills more effectively [31]. Taken together, these findings suggest a reciprocal interaction between mental toughness and imagery capacity, indicating that strengthening one of these factors may contribute to the enhancement of the other. The effect of MT on sports performance has attracted the attention of many researchers and it has been suggested that strong mental capacity has effects that reduce anxiety and increase SI skills.

Although the concepts of SI skill, MT, and anxiety are frequently researched topics in the field of sports sciences, there is a limited number of studies in the literature that address these three concepts. Previous studies show that MT is a critical factor that improves performance [5]. Except for the study conducted by Budnik-Przybylska et al. (2018) with 109 participants examining the relationship between MT, anxiety, and SI in individual and team sports, there is no research addressing these three concepts together [32]. In this context, this study aims to analyze how MT affects anxiety in elite athletes and how anxiety is related to SI skills with structural equation modeling (SEM). The objectives related to the relevant parameters were formulated with the following hypotheses.

H1: Elite athletes with high MT have low anxiety levels.

H2: A high level of anxiety decreases SI skills in elite athletes.

H3: The SI ability of elite athletes with high MT increases.

Methods

Ethical approval

Ethics committee approval was obtained from Erzurum Technical University Scientific Research and Publication Ethics Committee (date: 23 January 2025; 2025-04) for the current study. The study was prepared in accordance with the principles of the Declaration of Helsinki [33]. In addition, ethical standards specific to sports and exercise sciences were taken into consideration. All elite athletes who voluntarily agreed to participate in the current study completed the informed consent form verbally and in writing, and then the athletes were included in the study.

Research model

This study, which is designed according to the relational survey model, one of the quantitative research methods, is a method that requires revealing the existing situations and aims to collect data from the participant group with the help of scales [34]. The research model is given in Fig. 1 in line with the hypotheses constructed in the study.

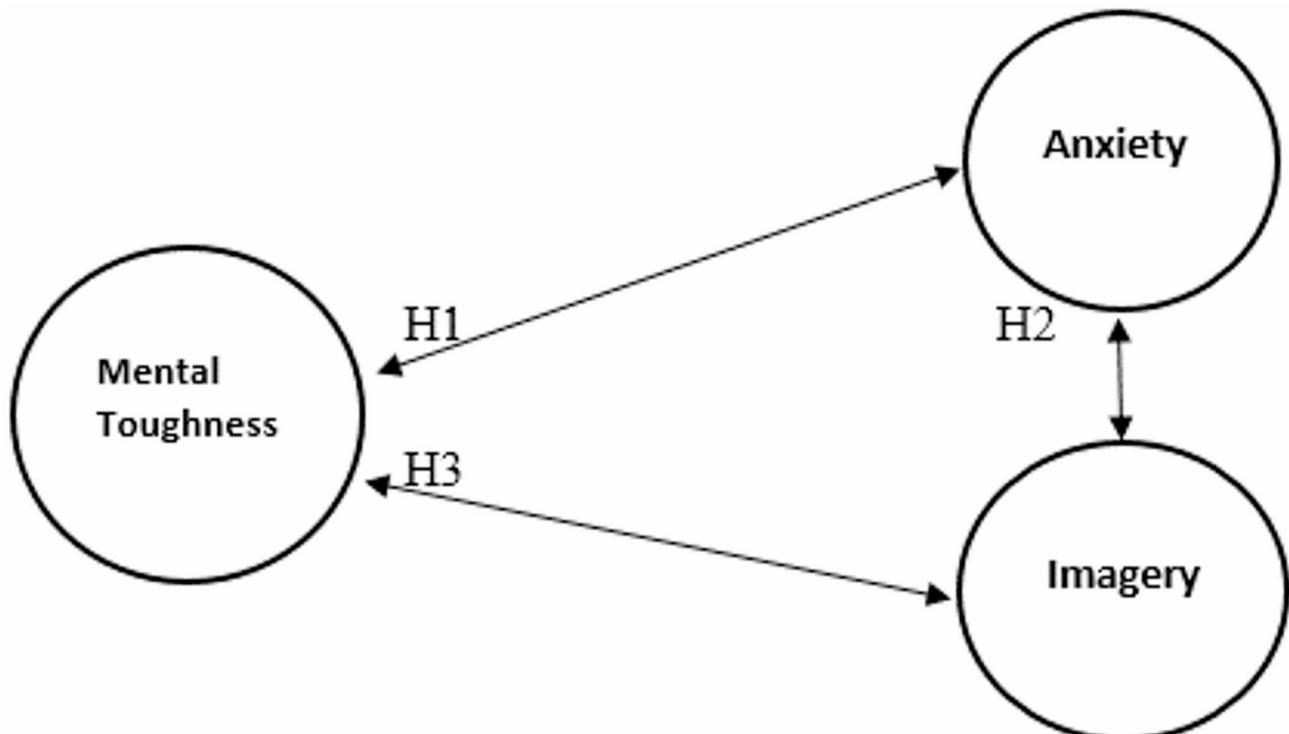


Fig. 1 Research proposal framework

Sample size estimation

While determining the research design, it was planned to include elite athletes actively involved in individual and team sports in the study. There are various recommendations for determining the sample size in scale studies in which exploratory and confirmatory factor analyses are performed. While Comrey and Lee (2013) refer to 50 as very poor, 100 as poor, 200 as moderate, 300 as good, and 500 as very good for sample size, Kline (1994) stated that the sample size should be 10 times the number of items, and Bryman and Cramer (2002) stated that it is appropriate to be 5 or 10 times [35–37]. The sample group required for this study was determined according to the number of participants 10 times the number of items [36, 38]. The number of items of the scales used in the study was 38 and the number of participants in the study was 407. In this context, more than 10 times the number of participants was reached.

Research group

With the announcements made through coaches, 455 elite athletes participated in the study within the framework of the principle of volunteerism. After removing the missing, erroneous, and extreme values in reliability analyses, the following sports were included in the study: Shooting, Athletics, Badminton, Basketball, Arm Wrestling, Cycling, Bocce, Bodybuilding, Boxing, Fencing, Football, Fitness, The data of 407 athletes interested in Wrestling, Weightlifting, Judo, Karate, Kickboxing, Masatenisi, Muay Thai, Beach Volleyball, Taekwondo, Tennis, Climbing, Volleyball, Wushu and Swimming branches were subjected to statistical analyses. The study included 143 women (\bar{X} age = 21,41 ± 3,26; \bar{X} years of sport = 10,25 ± 2,98; 101 (70,6%) individual and 42 (20,4%) team sports). 264 men (\bar{X} age = 21,30 ± 2,94; \bar{X} sports experience = 9,16 ± 4,27; 160 (60,6%) individual and 104 (39,4%) team sports). The general \bar{X} age of the research was 21,34 ± 3,05, and the \bar{X} years of sports experience was determined as 9,54 ± 3,90. In order to be included in the present study, participants were required to meet specific eligibility criteria. These included having participated in at least one international competition, currently being active in their athletic careers, and holding official recognition as national athletes. These criteria were established to ensure that the sample accurately represented elite-level athletes with significant competitive experience at both national and international levels. All the data were collected in 2025.

Data collection method

The research covers active elite athletes in national teams. Since the athletes were mostly in camps, the camps were

visited by the researchers. In this context, the coaches were informed about the study in advance and reached the athletes accompanied by the coaches. After making explanations about the purpose of the research, the consent form was filled out and the data were collected face-to-face from the participants based on the principle of volunteering.

Personal information form

This form was prepared to obtain the demographic information of the elite athletes included in the study. In this form, information about the age, gender, sports experience, and branch of the athletes were collected.

Mental toughness scale (MTS) The original form of the MTS developed by Madrigal et al. (2013) was adapted into Turkish by Erdoğan (2016) [39, 40]. Consisting of 11 items and one sub-dimension, the scale is likert-scored as [1] strongly disagree [2] disagree [3] undecided [4] agree [5] strongly agree. Item factor loadings vary between 0.314 and 0.524. The Cronbach's alpha internal consistency coefficient of the scale was calculated as 0.87 and the test-retest reliability coefficient was calculated as 0.79. In the reliability analyses conducted for this study, Cronbach's alpha internal consistency coefficient was 0.91.

Sport imagery inventory (SII) This scale, developed by Hall et al. in 1998, consists of 30 items and five sub-dimensions [41]. In the original study, Cronbach Alpha reliability coefficients of the inventory ranged between 0.68 and 0.87. This inventory was adapted and reorganized by Kızıldağ and Tiryaki (2012) for Turkish athletes [42]. As a result of adaptation, the inventory was revised to consist of 21 items and four sub-dimensions (Cognitive Imagery, Motivational Specific Imagery, Motivational General Awareness, Motivational General Mastery). The Likert scale of the scale is 1 = completely disagree, 2 = partially disagree, 3 = disagree, 4 = undecided, 5 = agree, 6 = partially agree and 7 = completely agree.

In this study conducted on Turkish athletes, the reliability and validity of the scale were extensively analyzed. Cronbach Alpha values of the sub-dimensions were reported as follows: 0.81 for Cognitive Imagery, 0.80 for Motivational Specific Imagery, 0.71 for Motivational general awareness, and 0.59 for Motivational General Mastery. In the reliability sub-dimensions for this study, it was determined as 0.81, 0.80, 0.82, and 0.81, respectively.

Emotion scale in sport (ESS) The scale was developed by Jones et al. (2005) and Turkish validity and reliability analyses were conducted by Urfa and Aşçı (2019) [43, 44]. Only the "Anxiety" (A) sub-dimension of the scale, which consists of 5 sub-dimensions separately, was used for this study. Consisting of 5 items, the corrected item-total cor-

relation of the sub-dimension varies between 0.41 and 0.61. The scale is in the form of a 5-point Likert scale and the Cronbach alpha value of the sub-dimension, which is evaluated between Never (0), A little [1], Moderately [2], Frequently [3] and Very much [4], is 0.71. As a result of the analyses conducted for this study, Cronbach alpha value was found as 0.92.

Analysing the data

Structural Equation Modelling (SEM) was used to test the research hypotheses. Structural equation modeling is a theory-driven data analytical approach for testing predetermined hypotheses about causal relationships between measured and/or latent variables [45]. SEM not only estimates the correlation between variables but also accounts for measurement error in observed variables. Since the method provides a more precise measurement of theoretical concepts [46], it is ideal for the correlation analysis targeted by the research. The data obtained from the scales were analyzed with the SPSS 21.0 package program to determine whether they meet the normality assumptions required to construct the structural equation model. Skewness and kurtosis coefficients and unidirectional and multidirectional outliers were analyzed. The Kolmogorov-Smirnov normality test showed that the data were normally distributed. Then, the variance inflation factor and autocorrelation were examined

before the analysis. It was determined that there was no autocorrelation and the variance inflation factors were within the limit values required for the research and it was decided that the data were suitable for parametric statistical analysis. Descriptive statistics, exploratory factor analysis, and confirmatory factor analyses were performed with SPSS 21.0 software and testing of the model was performed with AMOS 21.0 software. “Maximum Likelihood (ML)” and “Covariance Matrix” were used as parameter estimation methods. Statistical significance was set at $p < .05$. The process diagram of the research is given in Fig. 2.

Results

The results of the exploratory factor analysis of the scales used in the study are given below.

In the study, Exploratory Factor Analysis (EFA) was applied to determine the factor structure of the SI, Anxiety, and MT scales respectively, and to evaluate their construct validity. Factor analysis is frequently preferred to determine whether there is a certain order among the items in the developed or adapted measurement tool, to reveal the latent structures between variables and to reveal the factor structure of the measurement tool [47]. Kaiser-Meyer-Olkin (KMO) sampling adequacy test and Bartlett’s sphericity test were applied to test whether the data were suitable for factor analysis. According to Kaiser

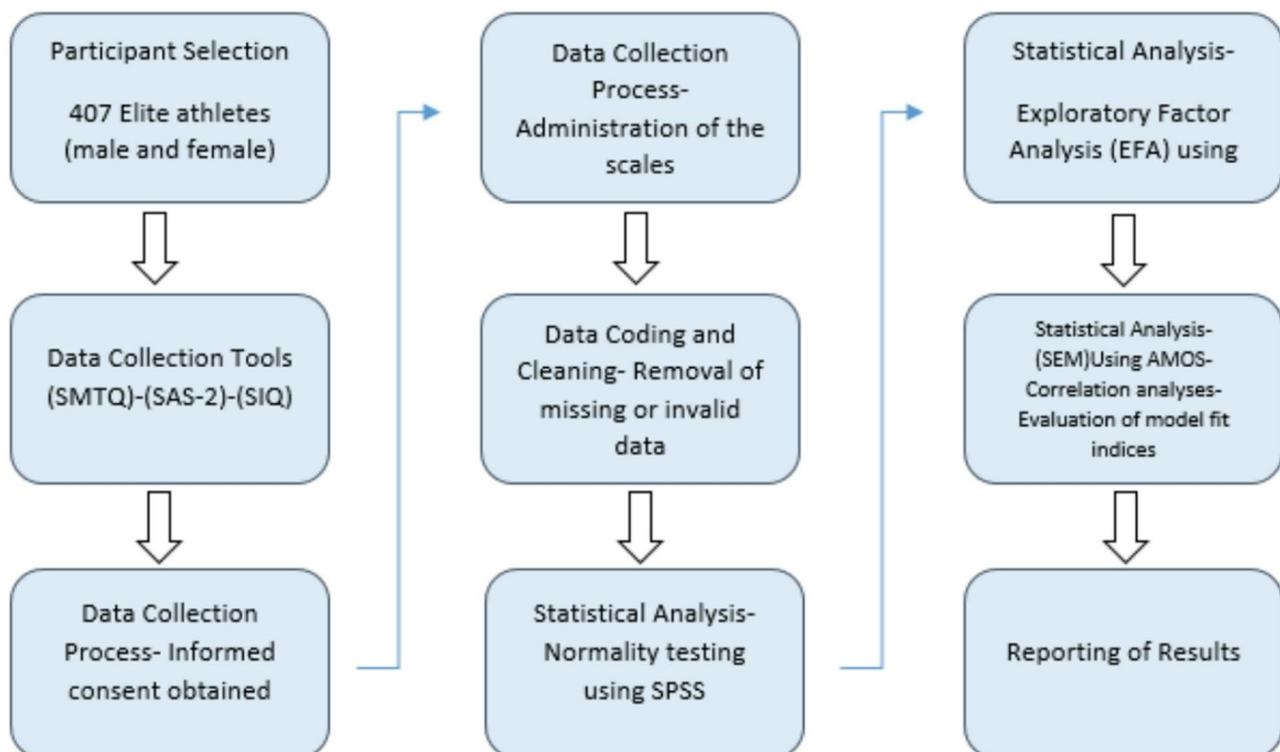


Fig. 2 Process diagram of the research

Table 1 Item analysis of SIS

	Corrected Item-Total Correlation	Cronbach's Alpha if Item Deleted
CI1	0.350	0.818
CI2	0.410	0.815
CI3	0.403	0.815
CI4	0.462	0.812
CI5	0.371	0.817
CI6	0.526	0.810
CI7	0.337	0.818
CI8	0.498	0.811
CI9	0.462	0.812
MSI1	0.419	0.814
MSI2	0.601	0.805
MSI3	0.574	0.806
MSI4	0.496	0.810
MSI5	0.574	0.805
MGA1	0.067	0.832
MGA2	0.289	0.821
MGA3	-0.073	0.840
MGA4	0.244	0.823
MGM1	0.440	0.813
MGM2	0.389	0.816
MGM3	0.427	0.815

*CI: Cognitive Imagery-MSI: Motivational Special Imagery-MGA: Motivational General-Awareness-MGM: Motivational General Mastery

(1974), a KMO value below 0.50 is not accepted and a KMO value between 0.90 and 1 indicates an excellent adequacy level of the sample size [48, 49]. In the factor analysis process, Principal Component Analysis (PCA) and varimax orthogonal rotation technique were used to ensure that the scale items were collected under the most appropriate factor structure (sub-dimension). In factor analysis, variables with factor loadings above 0.50 were included in the models. In addition, the analysis results of the Cronbach Alpha coefficient are given in each table. It paid attention to whether the Cronbach Alpha coefficient was above 0.70. Because a Cronbach Alpha coefficient above 0.70 indicates that the scale is reliable, and a Cronbach Alpha coefficient above 0.80 indicates high reliability [50].

Findings related to item analysis and exploratory factor analysis of the scales

As seen in Table 1, the item analyses in the sub-factors of the SI scale were performed and it was seen that 4 items in the “motivational general arousal” sub-factor were below 0.32 (MGA4-0.244, MGA3- -0.073, MGA2- 0.289, MGA1- 0.067). Yong and Pearce (2013) argue that in general, the minimum acceptable factor loading value should be 0.32 [51]. Therefore, these items were not included in the exploratory and confirmatory factor analyses. The

Table 2 Exploratory factor analysis of SIS

Articles	F1	F2	F3
CI2	0.834		
CI6	0.754		
CI8	0.725		
CI1	0.710		
CI5	0.682		
CI7	0.670		
CI3	0.664		
CI9	0.429		
CI4	0.499	0.535	
MSI5		0.831	
MSI3		0.823	
MSI4		0.818	
MSI2		0.757	
MSI1		0.581	
MGM3			0.781
MGM1			0.780
MGM2			0.746
Cumulative %			61.846
Bartlett's Test: 3445.88 df:210 sig:0.000			
Kaiser-Meyer-Olkin Measure of Sampling Adequacy.		0.0816	
Cronbach Alpha	0.81	0.80	0.81

findings of the exploratory factor analysis conducted after the MGA sub-factor was removed are given in Table 2.

The KMO value of the SIS was calculated as 0.816 and it was found to be suitable for factor analysis. Bartlett's sphericity test was performed, and the result was found significant as $\chi^2 = 3445.88$, $df=210$, $p<.001$ and it was proved that factor analysis could be applied to the scale items [52]. In the factor analysis, item 4 of the Motivational general arousal sub-dimension of the SIS was found to load on the first and second factors at the same time and was not included in the confirmatory factor analysis ($0.535 - 0.499 = 0.036 < 0.10$). Costello and Osborne (2005) state that if an item loads on both factors, the item should be excluded from the analyses if the difference is less than 0.10 [53]. It was observed that the factor loadings of the remaining 16 items were above 0.40. As a result of the EFA analysis, three factors with eigenvalues above 1 were obtained in the SIS. In order to evaluate the validity of the factor structure, the total variance explained was analyzed and the scale items explained 61.846% of the total variance.

When the distribution of the items in the SIS to the factors was examined, it was observed that Cognitive Imagery (CI) items were significantly distributed to the first factor, Motivational Special Imagery (MSI) items to the second factor, and Motivational General Mastery (MGM) items to the third factor. In order to evaluate the internal consistency of the scale, the Cronbach Alpha reliability coefficient was calculated and it is as follows:

- Cognitive Imagery (CI): 0.81.
- Motivational Special Imagery (MSI): 0.80.
- Motivational General Mastery (MGM): 0.81.

The overall Cronbach Alpha coefficient of the scale was calculated as 0.823.

According to Table 3, the item analyses of the anxiety scale showed that the loading values of all items were above 0.30. All items were included in exploratory and confirmatory factor analyses. The results of the exploratory factor analysis of the anxiety scale are given in Table 4.

The KMO value of the anxiety scale was 0.881 and the obtained structure was found to be suitable for factor analysis. In addition, Bartlett's test of sphericity = 1659.810 df = 10, $p < .001$ was found to be significant. In the factor analysis, it was determined that the loadings of all items of the anxiety scale were above 0.50. As a result of the EFA analysis, a single factor with an eigenvalue above 1 and five variables were obtained in the Anxiety scale. In order to evaluate the validity of the factor structure, the total variance explained was analysed and the scale items explained 78.128% of the total variance. Cronbach Alpha reliability coefficient of the internal consistency of the scale was calculated as 0.92. The results of the mental toughness item analysis are given in Table 5.

According to the results of the item analysis of the MT scale, it was determined that all items had an item load value greater than 0.30 and could be included in the factor analyses. The findings related to the exploratory factor analysis of the MTS are given in Table 6.

As a result of the EFA, the KMO value of the MTS was calculated as 0.923. In addition, Bartlett's test of sphericity showed that $\chi^2 = 2216.138$ df = 55, $p < .001$ and provided evidence that factor analysis could be applied [54]. As a result of the Varimax vertical rotation technique, variables with factor loadings above 0.50 were included in the model. In this context, it was seen that not all the items were below this value. As a result of the EFA analysis, a single factor with an eigenvalue above 1 and eleven variables were obtained in the MT scale. In order to evaluate the validity of the factor structure, the total variance explained was analysed and the scale items explained 53.052% of the total variance. Cronbach Alpha reliability coefficient of the scale is 0.91.

Measurement model

In order to test the validity of the measurement model of the research, Confirmatory Factor Analysis (CFA) was applied using AMOS software. CFA is a frequently used analysis method to verify the theoretical structure of the measurement tool and to test the relationships between variables [55].

Table 3 Anxiety scale item analysis

	Corrected Item-Total Correlation	Cronbach's Alpha if Item Deleted
Anxiety1	0.778	0.920
Anxiety2	0.852	0.905
Anxiety3	0.811	0.913
Anxiety4	0.877	0.900
Anxiety5	0.757	0.924

Table 4 Exploratory factor analysis of anxiety scale

	Component 1
Anxiety1	0.858
Anxiety2	0.911
Anxiety3	0.881
Anxiety4	0.926
Anxiety5	0.840
Cumulative %	78.128
Kaiser-Meyer-Olkin Measure of Sampling Adequacy.	0.881
Bartlett's Test: 1659.810 df:10 sig:0.000	
Cronbach Alpha	0.929

Table 5 Mental toughness item analysis

	Corrected Item-Total Correlation	Cronbach's Alpha if Item Deleted
MT1	0.659	0.903
MT2	0.681	0.902
MT3	0.587	0.907
MT4	0.696	0.901
MT5	0.700	0.901
MT6	0.676	0.902
MT7	0.645	0.904
MT8	0.658	0.903
MT9	0.667	0.903
MT10	0.624	0.905
MT11	0.671	0.902

*MT: Mental Toughness

Figure 3 shows the hypothesis test results of the model. Item 8 of the "Cognitive Imagery" factor, one of the sub-factors of imagery skill, was not included in the model since its load value was below 0.50. On the other hand, modifications were made between items e1-e2, e7-e8, e9-e11 of MT and items e23-e24 of SIS. According to the results of the structural model, it was confirmed that there was a significant relationship between MT and anxiety in a negative direction ($\beta = -0.31$, $p < .01$), between anxiety and SI in a negative direction ($\beta = -0.34$, $p < .01$) and between MT and SI in a positive direction ($\beta = 0.77$, $p < .01$). These results showed that hypotheses H_1 , H_2 and H_3 were confirmed.

The fit of the measurement model (Table 7) was evaluated in line with the acceptable and perfect fit

Table 6 Exploratory factor analysis of mental toughness

	Component 1
MT1	0.725
MT2	0.746
MT3	0.658
MT4	0.758
MT5	0.764
MT6	0.743
MT7	0.715
MT8	0.728
MT9	0.735
MT10	0.695
MT11	0.739
Cumulative %	53.052
Kaiser-Meyer-Olkin Measure of Sampling Adequacy.	0.923
Bartlett's Test: 2216.138 df:55 sig:0.000	
Cronbach Alpha	0.91

*MT: Mental Toughness

Table 7 Measurement model fit values

Indexes of Fit	Perfect Fit Criteria	Acceptable Fit Criteria	Measured Value
χ^2/sd	$0 \leq \chi^2/sd \leq 2$	$2 \leq \chi^2/sd \leq 3$	2.532
CFI	$0.95 \leq CFI \leq 1.00$	$0.90 \leq CFI \leq 0.95$	0.900
IFI	$0.95 \leq IFI \leq 1.00$	$0.90 \leq IFI \leq 0.95$	0.901
RMSEA	$0.00 \leq RMSEA \leq 0.05$	$0.05 \leq RMSEA \leq 0.08$	0.061
PNFI	$0.95 \leq PNFI \leq 1.00$	$0.50 \leq PNFI \leq 0.95$	0.772
PGFI	$0.95 \leq PNFI \leq 1.00$	$0.50 \leq PNFI \leq 0.95$	0.729
NNFI (TLI)	$0.95 \leq NNFI (TLI) \leq 1.00$	$0.90 \leq NNFI (TLI) \leq 0.95$	0.900

[52, 54, 56–60]

literature. As a result of the analysis, χ^2/sd ratio was calculated as 2,532. Since this value is between 2 and 3, it is at the acceptable fit level. The CFI value evaluating the fit of the model was calculated as 0.900, IFI index as 0.901, and TLI as 0.900. CFI, IFI, and TLI indices are within the acceptable fit limits. However, it can be said that the overall fit level of the model is adequate. Another variable in the model, the RMSEA value was calculated as 0.061. The RMSEA index between 0.05 and 0.08 indicates that

value ranges specified for goodness of fit indices in the

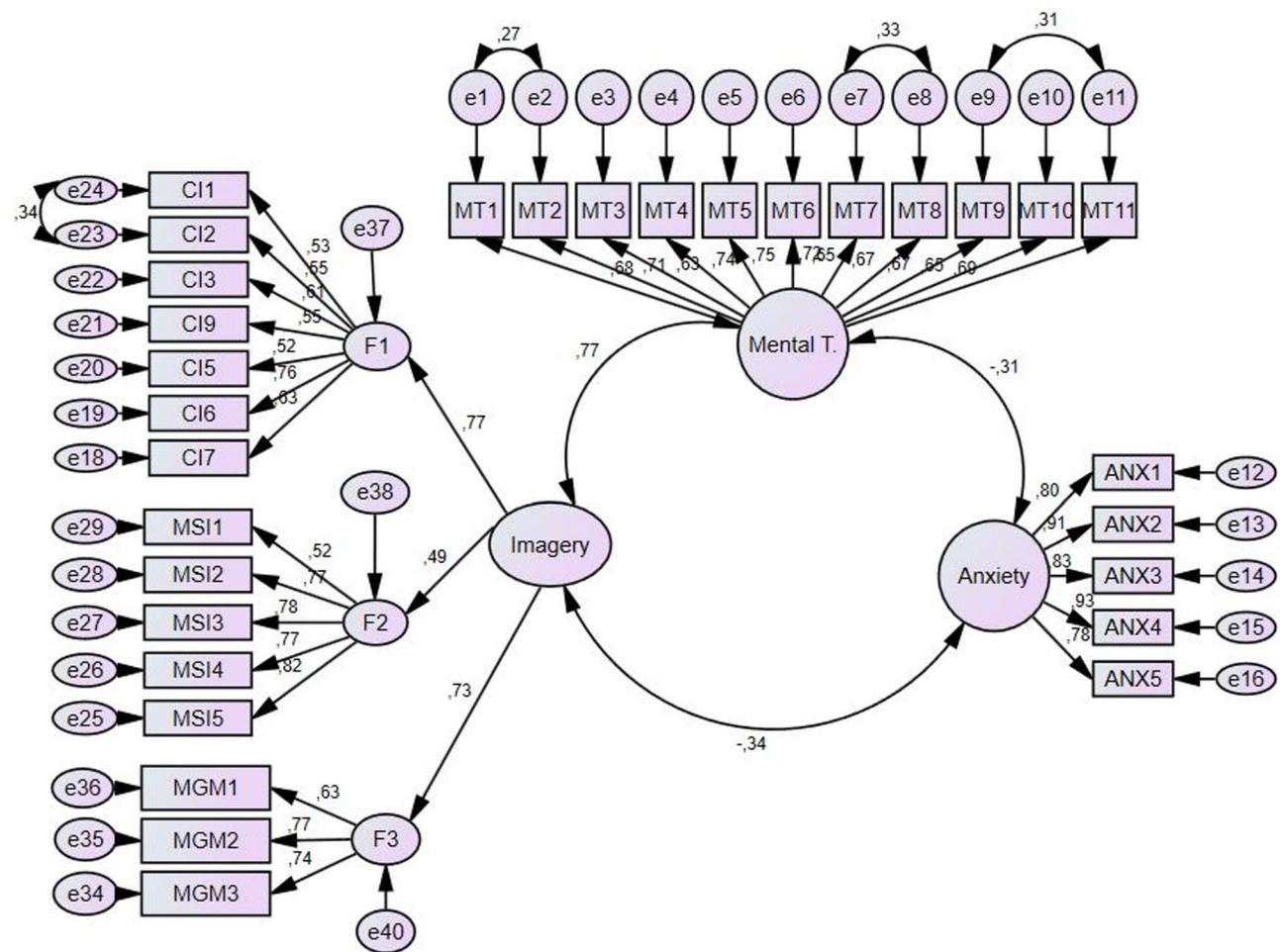


Fig. 3 Parameter values of the structural model

the model offers a good fit. Among the other fit indices, PNFI and PGFI values were calculated as 0.772 and 0.729, respectively. PNFI and PGFI indices between 0.50 and 0.95 are within the acceptable fit criteria. In general, χ^2 /sd, CFI, IFI, RMSEA, PNFI, and PGFI values of the model fit indices fully meet the expected good fit criteria. It is stated that it would be a healthier approach to interpret the model fit with more reliable and stable indices such as CFI, TLI, and RMSEA [52, 56].

Discussion

Mental toughness is a psychological phenomenon that can enable athletes to sustain and maximize their performance in stressful moments. Anxiety is a negative emotion experienced in the face of a situation/event and is likely to reduce performance. SI involves the activation of cognitive skills to perform movements and can be expected to positively affect the athlete's performance. For this reason, in this study, it was aimed to determine how the ME of elite athletes affects their anxiety level and how anxiety is related to SI skill by structural equation modeling. In this context, three hypotheses were established in the study. It was determined that hypothesis $H_{(1)}$ of the research -The anxiety levels of athletes with high MT are low- was confirmed because of the findings obtained. As a result of the analyses, it was determined that the relationship between MT and anxiety was negative. This result can be interpreted as a tendency for MT to decrease as anxiety increases, or vice versa; however, due to the cross-sectional nature of the study, causal interpretations should be made with caution. When the researches on MT and anxiety levels in the literature were analyzed, it was seen that important findings were obtained.

For example, in the study on sport climbing conducted by Drăgoi (2019), there is a low negative correlation between MT and all state anxiety levels before easy route climbing [61]. In their evaluations, it was seen that the increase in state anxiety levels negatively affects MT; they commented that mental preparation before easy route climbing can reduce state anxiety levels. In another study, Barrington et al. (2019) stated that there is a negative relationship between MT and anxiety levels [62]. Mojta-hedi et al. (2023) compared mentally strong athletes with athletes with low MT in a study on combat athletes [8]. He reported that athletes with high MT levels exhibited lower levels of cognitive and physical anxiety and higher levels of self-confidence.

Kalinin et al. (2019) suggest that there is a negative relationship between anxiety and MT, suggesting that higher levels of MT are associated with lower levels of anxiety [10]. At the same time, they made a general inference that the relationship between anxiety and MT is generally negative, meaning that MT tends to decrease as anxiety

increases. Zubić, (2021), on the other hand, stated that MT is significantly effective in reducing cognitive and somatic anxiety and claimed that developing MT is the right approach for better performance in competitions [63]. MT appears to be an important factor that may help in reducing anxiety during competitions; however, its exact role and mechanisms require further investigation [64, 65]. Mental toughness refers to an athlete's ability to maintain performance under pressure and remain psychologically resilient in the face of adversity. Research has shown that the type of sport athletes engage in can influence their level of mental toughness. For instance, elite individual athletes have been reported to exhibit higher levels of mental toughness compared to those participating in team sports [5]. In addition, it has been indicated that mental toughness improves with increasing years of experience, which in turn enhances athletes' abilities to cope with stress [66]. On the other hand, researchers argue that MT is effective in reducing not only anxiety but also non-clinical mental problems such as stress and depression [67]. Gucciardi et al. (2014) stated that individuals with strong MT exhibit high levels of control and struggle even in the face of challenging situations and tend to evaluate the problems they face as challenges [68]. When the results are analyzed, it is seen that individuals with high MT cope with stressful and anxiety-provoking situations more easily, and thus their negative emotional reactions decrease. Therefore, it may be suggested that interventions aimed at increasing MT could be associated with reduced anxiety; however, further longitudinal or experimental studies are needed to confirm this causal relationship.

H_2 . It is seen that the hypothesis "High level of anxiety reduces SI skill in athletes" is confirmed as a result of the analyses. It was determined that there was a negative relationship between anxiety and SI skills. This result can be inferred that as the anxiety level increases, the SI skill will decrease or as the SI skill increases, the anxiety level will decrease. When the researches in the literature are analysed; [69] examined the relationship between SI ability, physical anxiety, and athletic performance in a study of 55 swimmers and stated that SI training improved the performance of athletes and significantly reduced their anxiety during the competition. Another study by Williams and Cumming (2016) examined how SI ability affects self-confidence and anxiety intensity in athletes [70]. The findings revealed that SI ability increased self-confidence and this reduced anxiety intensity. In the study conducted by Liu et al. (2024) during the COVID-19 pandemic period, it was concluded that low SI levels in individuals caused a high degree of anxiety [71]. In a systematic review study conducted by Chapman et al. (2020), a strong relationship was found between social anxiety and mental SI in children and young people, and

it was concluded that individuals with high social anxiety created worse SI [72]. In another study, the relationship between musical imagery and anxiety was investigated and it was shown that individuals with high anxiety levels experienced more frequent and negatively evaluated musical imagery [73]. Van Den Berg et al., (2024) conducted a study on the temporal relationships between imagery, anxiety, and mood instability and found that there are complex interactions between these three factors and that imagery experiences affect anxiety and mood fluctuations [74]. In another study, the effects of imagery use on the competitive anxiety of ballet dancers were examined. As a result of the study, it was concluded that imagery techniques were effective in reducing anxiety and increasing performance [75]. According to Omar-Fauzee et al. (2009), imagery is an important part of sports psychology and is a mental skill that affects an athlete's success in tournaments or matches [76]. Today, many athletes and coaches recognize the power of imagery in sports performance. By visualizing moments of successful performance, athletes can rehearse their skills, improve their focus, reduce anxiety, and increase self-confidence; all these factors contribute to achieving optimal performance in competitive environments.

The third hypothesis of the study, H₃ "Athletes with high MT have increased SI skills" was confirmed as a result of the analyses. As a result of the analyses, a positive high level relationship was found between MT and SI skill. In short, it can be interpreted that athletes with high MT also have increased SI skills. Additionally, in the current study, the relationship between the Motivational General Awareness (MGA) subscale and overall mental toughness was not found to be statistically significant. Statistical analyses showed that some items in the MGA subscale had very low factor loadings, and therefore, had to be excluded from the model. This indicates that the MGA subscale has limited capacity to represent the mental toughness construct. Some studies in the literature [77–79] suggest that the components of motivational general awareness may show a weaker relationship with mental toughness or that this relationship might be strengthened through more indirect pathways. When the studies investigating the relationship between MT and SI skills in the literature are examined;

Mattie & Munroe-Chandler (2012) investigated the relationship between SI use and MT and suggested that SI use may be an effective strategy to develop or increase MT in athletes [80]. Yarayan et al. (2024) also investigated whether there is a difference between SI and MT levels in the context of sports performance [81]. As a result of the findings, it was determined that there was no significant difference between the SI and MT levels of athletes with high, medium, and low performance among male athletes. However, a significant difference was

found between the SI and MT levels of female athletes with medium and high performance, and it was shown that athletes in the high-performance range had higher SI and MT levels than athletes in the medium and low-performance range. Geikie (2016) especially highlighted that while male athletes tend to show higher performance in goal-oriented imagery and some dimensions of mental toughness, female athletes may be more successful in types of imagery that require emotional regulation [82]. Mattie and Munroe-Chandler (2012) found that male athletes perform better in motivational general-mastery (MG-M) imagery, challenge, and commitment, while female athletes are better in motivational general-arousal (MG-A) imagery [80]. MG-M imagery is considered the strongest predictor of mental toughness. Vashisht et al. (2024), in an eight-week experimental study involving 450 athletes, found that SI training provides evidence that SI training is indeed a helpful tool in improving MT and performance in sports training [83]. Akgül et al. (2024), in a study on national athletes in different sports branches, found that SI positively affected MT [84]. Lindsay et al. (2021) used a meta-analysis method and aimed to provide practical suggestions that physical education and coaches think will be effective in motor skills in athlete training, and stated that SI provides a general benefit in developing sport-specific motor skills [29]. In this context, considering that ME and SI skills can be effective tool for athletes to overcome personal difficulties and improve their focusing skills, it is important to conduct more research and to include these techniques more widely in athlete development programs. These psychological concepts are also considered important in other performance-focused areas, such as academic and professional settings [7, 67, 85]. However, the generalization of these findings should be made cautiously, as the present study did not include such populations. Future research should explore how these factors change across individuals' life cycles and career stages in more detail [5, 8]. Additionally, studies that examine the effects of cultural context on these relationships will make valuable contributions to the field.

Strengths and limitations

The main strength of this study is that it has a study group consisting of high-level elite athletes who are difficult to reach. In addition, another strength is that it consists of athletes competing in different sports disciplines. Moreover, the other strength of the study is that it deals with the relationship between the three characteristics that affect the performance of elite athletes with structural equation modeling for the first time as far as we know. There are some limitations in the study. The fact that many characteristics such as age, gender and sport age of the athletes were not included in the model is one

of the limitations of the research in reaching in-depth results. Although athletes from different branches participated in the research, the fact that an equal number of participants from each branch was not reached is a limitation of the research.

Another important limitation of this study is that it relies on self-reported data, which may limit the objectivity of the findings. It should be considered that participants' responses may have been influenced by personal biases. Future research should also consider using multi-method data collection approaches to enhance the validity and reliability of the findings.

Conclusion

In the present study, it was determined that the anxiety level of athletes with high MT was low and anxiety had a negative effect on SI skills. In addition, it was concluded that athletes with high MT also had high SI skills. The present study suggests that training programmes that increase SI skills have the potential to improve MT and may have possible effects on reducing anxiety levels. The findings obtained in the present study are important not only for improving athletes' performance but also for the fields of sport psychology and education. The results suggest that integrating visualization exercises and mindfulness-based interventions into training processes may be beneficial for developing mental toughness and reducing anxiety levels in athletes.

Suggestions

- As a result of the study, it was determined that high MT reduces anxiety in athletes. Therefore, it is recommended that sports experts and coaches should turn to methods to increase MT.
- It is suggested that SI practices should be integrated into training processes in order to make athletes more MT in the face of difficulties.
- It would be useful for coaches and sport psychologists to teach athletes how to use SI techniques to improve their mental toughness.
- Awareness training for trainers to help them understand the psychological needs of athletes is also an important step.
- In future study, the effects of mental toughness on anxiety and SI can be compared with its effects on different age groups and amateur athletes. Furthermore, a long-term study could be designed to examine how the development of mental toughness changes at different stages of an athlete's career. Alternatively, the effects of interventions to increase mental toughness on anxiety and SI can be investigated with an experimental design.

- The results of the present study should be interpreted with consideration of cultural context. Given that psychological constructs such as mental toughness, anxiety, and sport imagery may be influenced by cultural norms and values, the findings may not be fully generalizable to athletes from different cultural backgrounds. Therefore, future studies are encouraged to adopt a longitudinal design and to include samples from countries with diverse cultural characteristics. Such research would contribute to a more comprehensive understanding of the cross-cultural validity of the observed relationships and enhance the global applicability of the findings.

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Author contributions

"Conceptualization, G.T.D., S.N. and E.Ç.; methodology, G.T.D. and E.Ç.; analysis, S.N.; sources, E.Y., B.B., F.A. and B.G.; data curation, G.T.D., S.N. and S.K.A.; writing of original draft, M.Ç., and G.T.D.; manuscript review and editing, M.Ç., S.N. and F.A. All authors read and accepted the published version of the manuscript."

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Data availability

Data are available for research purposes upon reasonable request to the corresponding author.

Declarations

Ethics approval and consent to participate

Ethics committee approval was obtained from Erzurum Technical University Scientific Research and Publication Ethics Committee (date: 23 January 2025; 2025-04) for the current study. The study was prepared in accordance with the principles of the Declaration of Helsinki [33]. In addition, ethical standards specific to sports and exercise sciences were taken into consideration. All elite athletes who voluntarily agreed to participate in the current study completed the informed consent form verbally and in writing, and then the athletes were included in the study. Confidentiality was carefully ensured during data collection and analysis. All personal information and responses provided by the participants were anonymized during the data collection process. The responses obtained from the participants were used solely for the present study and were not shared with any third parties or institutions. All data were securely stored in digital format, protected with password access, and were only accessible to the research team.

Consent for publication

Not applicable.

Competing interests

The authors declare no competing interests.

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