ASSOCIATIONS BETWEEN PHYSICAL FITNESS AND MENTAL TOUGHNESS IN COMPETITIVE ADOLESCENT DANCE SPORT ATHLETES

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Abstract:

Mental toughness (MT) is considered a major contributing factor for performing at high level in competitive sporting events. Despite its importance, few studies have examined probable correlations between MT and physical fitness (PF). Since both constructs are equally important in sport, it is necessary to establish whether MT may be correlated with PF. Two-hundred and nineteen competitive adolescent dancers took part in the study (mean age: 16.8±1.4 years; height: 169.5±8.7 cm; body mass: 61.4±9.2 kg; 58% girls). PF was assessed by the body mass index (body composition), standing broad jump (muscular fitness), sit-ups in 30 seconds (repetitive strength), 10x5 shuttle run (agility), sit-and-reach test (flexibility), and the 20-m shuttle run test (cardiorespiratory fitness). The Sports Mental Toughness Questionnaire (SMTQ) was used to evaluate MT. In boys, MT was positively correlated with standing broad jump (r = 0.54), sit-ups in 30 seconds (r = 0.56), the 20-m shuttle run test (r = 0.61) and the sit-and-reach test (r = 0.34) and negatively correlated with the 10x5 shuttle run test (r = -0.43). In girls, MT was also positively correlated with standing broad jump (r = 0.48), sit-ups in 30 seconds (r = 0.46), the 20-m shuttle run test (r = 0.53) and the sit-and-reach test (r = 0.30) and negatively correlated with the 10x5 shuttle run test (r = -0.32). Regardless of sex, no significant correlations between MT and body composition were observed (r = 0.12 in boys and r = 0.10 in girls). This study shows that PF parameters are correlated well with MT. This would suggest that both physical and psychological components need to be investigated to examine potential co-existence between them. Also, interventions aiming to enhance MT throughout PF are warranted.

Keywords: *readiness, performance, dance sport athletes, cardiorespiratory fitness, muscular fitness, correlations*

Introduction

Success in sports requires a combination of physical and mental attributes at elevated levels (Lu, et al., 2018; Thomas, Zebas, Bahrke, Araujo, & Etheridge, 1983). Both concepts explain a substantial share of the variance related to athletes' achievements (Farley, Stein, Keogh, Woods, & Milne, 2020; Raglin, 2001). Nonetheless, elite athletes are only marginally distinguished by their physical and technical-tactical abilities (Cowden, 2016), whereas differences between successful and unsuccessful competitors also pertain to their mental ability to stay calm and focused during contests (Hsieh, et al., 2024; Nicholls, Polman, Levy, & Backhouse, 2009). Among the different psychological internal factors linked to success (Nicholls, et al., 2009; Singh, Kaur Arora, & Boruah, 2024), mental toughness (MT) has emerged as a key component of accomplishment in competitive sports and the development of athletic skills (Crust, 2007; Liew, Kuan, Chin, & Hashim, 2019).

In general, researchers agree that MT refers to the ability or psychological characteristic that enables individuals to manage physical, mental, and emotional challenges successfully, while remaining concentrated, confident, determined, and in control of their situations (Clough, Earle, & Sewel, 2002; Crust, 2007; Liew, et al., 2019; Mack & Ragan, 2008). Although MT is often associated with success in sports (Mahoney, Gucciardi, Ntoumanis, & Mallett, 2014), other studies suggest that MT is also characterized by flourishing in environments with positive impacts and challenges (Sheard, 2009). As a result, MT influences both stressful and and pleasurable experiences, highlighting individuals who are undisturbed by competition and obstacles, while exhibiting resilience in situations that usually induce strong emotional responses

(Clough, Earle, & Sewel, 2002). Previous evidence has suggested that MT includes various elements, such as emotional control, life administration, dedication, enjoying challenges, and assurance (Clough, et al., 2002). These factors are vital for attaining success in athletic performance (Gerber, et al., 2012). Also, MT may be viewed as a personality characteristic that remains consistent in individuals participating in both individual and team sports (Abasgholipour, 2023). However, it can be cultivated through coping strategies and mechanisms linked to athletic performance, sport-specific accomplishments, successful actions, and overall resilience during competition (Demir, er al., 2025). Notably, it has been emphasized that competitors in individual sports frequently rely significantly on self-discipline, internal motivation, and the capability to maintain concentration amid solitary performance stress, while participants in team sports need to concurrently navigate social interactions, communication requirements, and group resilience (Demir, et al., 2025).

Although earlier research has identified MT as an essential factor in achieving sports success (Loehr, 1986; Nicholls, et al., 2009), there is limited evidence linking MT with physical fitness (PF) (Hsieh, et al., 2024; Liew, et al., 2019). PF has been often defined as a 'set of attributes, and consists of cardiorespiratory fitness (CRF), muscular fitness (MF), flexibility and body composition (Farley, et al., 2020). In recent decades, researchers have used MT metrics to explore its relationship with PF, yet the results have varied. While several earlier studies have recognized a significant link between MT and higher level of PF (Jones, Hanton & Connaughton, 2002; Morais & Rui Gomes, 2019), other research has not supported these associations (Brace, George, & Lovell, 2020; Cowden, Fuller, & Anshel, 2014). The majority of studies examining the link between MT and PF have focused on more strenuous activities, including combat or endurance sports, while information on aesthetic sports, like modern style dance sports is lacking. A recent systematic review and meta-analysis found only a weak positive relationship between PF and MT in adolescents (Hsieh, et al., 2024).

As one of the uprising sports in the world, the characteristics of dance sports include various technical and tactical parameters related to physical and psychological preparedness (Zhou & Štefan, 2025). As highlighted previously, although earlier research has examined MT in combat sports and endurance athletes, there is limited knowledge regarding its connection with PF in aesthetic activities such as modern dance sport. This type of activity is often accompanied by patterns of movement that are distinctive and gracious, with the choreography focusing on visual beauty and mental focus. To perform at their highest level, dance sport athletes are required to attain a very slender body with a low percentage of fat mass, but their mental capacity to sustain high levels of readiness is just as crucial. Conversely, modern dance sport athletes must maintain both MT and PF at an ideal level to achieve consistent success over time, thus the connection between them should offer both theoretical and practical insights for training and performance results (Despot & Plavec, 2025). To date, only one study has tried to examine the relationship between MT and PF in dance-related athletes from ballet (Zhou & Štefan, 2025). A study by Zhou and Štefan (2025) found that MT was positively and moderately-to-strongly correlated with CRF, MF and flexibility, yet inverse and moderate correlations with fat mass percentage were observed. However, ballet dancers differ from modern style dance sport athletes in terms of training routines and movement patterns (Ngo, et al., 2024). Moreover, ballet dancers seem to have lower fat mass percentage and higher physiological capacities, opposed to modern dance sport athletes (Ngo, et al., 2025). Studies have concluded that modern style dance sport athletes typically develop MT and PF at different rates, while a linear trend in other dance-related activities is observed (Liiv, et al., 2014). Given the important influence of both physical and psychological components on athletes' performance, mutual associations between MT and PF would be a cornerstone for coaches to plan and program training regimes under different psychological loadings to successfully prepare their trainees for coping with competition demands.

Therefore, the main purpose of the study was to investigate the correlations between MT and its components, on the one hand, and PF in male and female adolescent modern style dance sport athletes on the other. Based on previous literature in ballet dancers (Zhou & Štefan, 2025), we hypothesized that athletic performance would be positively and moderately correlated with MT.

Materials and methods

Study participants

The study involved 294 male and female adolescent dance sport athletes recruited from 10 professional dance sport clubs from the city of Jeonju (mean age: 16.8±1.4 years; height: 169.5±8.7 cm; body mass: 61.4±9.2 kg; 59.2% girls).The sensitivity analysis calculated from the G*power sample size calculator indicated that with a two-tailed significance of $\alpha<.01$, a minimal required statistical power of $1-\beta = 0.95$, and a total sample size of $n = 294$, the resulting effect size (ES) was 0.24, indicating medium strength of the correlation between MT and PF. The selection criteria were: (i) participation in competitive dance for a minimum of seven years at the national level, (ii) absence of physical or mental issues/disorders, (iii) consistent attend-

ance in dance sport classes, and (iv) completion of PF tests and MT questionnaire. Participants were made aware of the primary aim and hypothesis of the research, along with the assurance of their responses' confidentiality. All processes were conducted anonymously and in alignment with the Declaration of Helsinki (2013). Prior to the start of the study, participants along with their parents or guardians provided informed written consent. Approval for this project was granted by the Research on the Development Path of Ice and Snow Sports in Jilin Provincial Universities under the Perspective of Physical Education Integration (JJKH20240065SK).

Physical fitness

To assess PF components, we used the following tests: body mass index calculation for body composition, standing broad jump for muscular fitness, sit-ups in 30 seconds for repetitive strength, 10x5 shuttle run for agility, sit-and-reach test for flexibility, and 20-m shuttle run test for cardiorespiratory fitness (CRF). *Body mass index* (weight [kg]/ height [m^2]) was calculated by objectively measured body height and mass using stadiometer and digital scale with a precision of 0.1 cm and 0.1 kg, respectively. *Sit-and-reach test* was completed by reaching forward as far as possible, while keeping knees straight in a sitting position. The final score was recorded in centimeters. *Standing broad jump* was performed from the initial position by bending the knees at approximately 90° with arms in front raise parallel with the ground. From that position and by swinging both arms, each participant needed to push off vigorously, jump forward as far as possible, and land with both feet together staying upright. The final score was recorded in centimeters (Ortega, Ruiz, Castillo, & Sjöström, 2008). *Sit-up test* evaluated repetitive strength of the trunk as the number of sit-ups completed from the lying position (the knees bent at a 90°) in 30 s. The initial position was supine lying on the floor with the back straight and the hands being clasped behind the neck, while the knees were bent at 90° with the heels and feet flat on the mat. After the signal, the participants moved their upper body to the sitting position, keeping their hands clasped behind their neck the whole time. The number of correctly performed sit-ups in 30 s was the final score (Ortega, et al., 2008). *The 10x5 shuttle run* was used as a proxy measure of agility. Each participant needed to run back and forth over the 5-m distance from a standing start five times to complete five 10 m laps (Ortega, et al., 2008). *Sit-and-reach test* was performed by sitting on a mat with the back straight up (under the right angle of 90º), the legs straight and reaching forward as far as possible with the overlapped arms without raising the knees. The final score was recorded as the distance of reach in centimeters (Ortega, Ruiz, Castillo, & Sjöström, 2008). CRF was assessed by the *20-m shuttle run test* (Ortega, et al., 2008). The test was performed by running between the two lines 20-m apart with a pivot at the lines. The starting speed was set at 8.5 km/h and was increased by 0.5 km/h at each level (Léger, Mercier, Gadoury, & Lambert, 1988). The number of properly completed stages was recorded as the final score. The termination criteria included failing to make it to the line on a beep signal twice in a row. All the tests included in this study are reliable and valid tools for assessing health-related PF components in youth (Ortega, et al., 2008).

Sport Mental Toughness Questionnaire (SMTQ)

To assess the level of MT, the participants were requested to fill out the SMTQ (Sheard, Golby, & Van Wersch, 2009). The questionnaire was translated into Chinese and then translated back into English to verify its validity features and guarantee uniform comprehension of each question. Responses to items were structured on a four-point Likert scale ranging from 'not at all true' to 'very true'. A factor analysis resulted in a three-factor model that explained 40.7% of the variance. Three factors were designated as 'confidence' (items 1, 5, 6, 11, 13, and 14), 'constancy' (items 3, 8, 10, and 12), and 'control' (items 2, 4, 7, and 9) (Sheard, et al., 2009). A solution using a higher-order model indicates that items associated with a specific factor have a strong relationship ($r > 0.71$), and the calculation of Cronbach's αs revealed satisfactory internal consistency for each factor ('confidence' = 0.87, 'constancy' = 0.89, and 'control' = 0.85). A preliminary analysis conducted in this study showed robust item relationships with 'confidence' ($r = 0.78 – 0.89$, $p<.001$), 'constancy' ($r = 0.81 – 0.91$, $p<.001$), and 'control' ($r = 0.79 – 0.89$, $p<.001$). The internal reliability was adequate for 'confidence' (0.89), 'constancy' (0.88), and 'control' (0.86). The SMTQ was administered 48 hours following physical testing in a thoroughly monitored environment to mitigate bias and fatigue.

Statistical analysis

We followed the statistical methodology of the most recent study conducted in ballet dancers (Zhou & Štefan, 2025). To identify data normality, we used the Kolmogorov-Smirnov test. Data statistics were presented as mean and standard deviation (SD). Pearson's product-moment correlations were calculated to analyze the relationships between MT ('SMTQ-total' and 'confidence', 'constancy' and 'control') and PF, indicating weak ($r = 0.10 – 0.39$), moderate ($r = 0.40 – 0.69$), strong ($r = 0.70 – 0.89$), very strong ($r = 0.90 – 0.99$), and perfect ($r = 1.00$) correlations (Akoglu, 2018). We conducted

Table 1. Characteristics of the study sample according to sex

Study variables	Mean/N	SD/%	Boys	Girls	t - test	p
Sex, N (%)			Mean (SD)	Mean (SD)		
Boys	120	40.8				
Girls	174	59.2				
Age (years)	16.8	1.4	16.7 (1.7)	16.9 (1.5)	0.899	.428
Stature (cm)	169.5	8.7	175.4 (6.4)	164.9 (7.3)	8.332	<.001
Weight (kg)	61.4	9.2	67.5 (9.3)	55.2 (10.2)	4.346	<.001
Health-related PF						
Body mass index (kg/m^2)	21.4	3.2	21.6 (2.6)	20.9 (3.1)	2.001	.063
Standing broad jump (cm)	160.8	32.5	174.1 (33.9)	156.9 (32.1)	10.781	<.001
Sit-ups in 30 s (#)	15.9	5.9	17.1 (6.4)	14.2 (5.3)	6.345	<.001
10x5 shuttle run test (s)	23.1	4.1	21.8 (4.9)	24.5 (5.0)	-8.333	<.001
Sit-and-reach test (cm)	20.3	6.4	17.3 (6.8)	24.6 (6.5)	-14.802	<.001
20-m shuttle run test (stage)	5.0	1.5	5.9 (1.6)	4.2 (1.8)	13.299	<.001
SMTQ						
Confidence	16.7	3.9	17.4 (4.2)	16.0 (3.8)	2.112	<.001
Constancy	11.6	2.9	12.0 (3.2)	11.1 (2.8)	2.336	<.001
Control	10.4	2.8	11.2 (3.3)	9.0 (2.6)	4.111	<.001
SMTQ-total score	38.7	7.4	40.6 (8.3)	36.1 (7.0)	3.326	<.001

Note. p<.05

a sex-specific analysis, because there were significant differences in PF and MT between boys and girls, respectively. Two-sided p-values were used, and significance was set at $\alpha<.05$. All the analyses were calculated in Statistical Packages for Social Sciences v.26 (SPSS, Chicago, IL, United States).

Results

Basic descriptive statistics are presented in Table 1. Boys were taller and heavier, yet body mass index yielded no significant difference between the sexes. Also, boys performed better in all PF and MT components and overall SMTQ score, yet girls had better values in flexibility ($p<.05$).

Table 2 displays correlation coefficients (r) between PF and MT components and 'SMTQ-total'. In boys, MT was positively correlated with the standing broad jump ($r = 0.54$), sit-ups in 30 s ($r = 0.56$), the 20-m shuttle run test ($r = 0.61$), and the sit-and-reach test ($r = 0.34$), whereas it was negatively correlated with the 10x5 shuttle run test ($r = -0.43$). In girls, MT was also positively correlated with the standing broad jump ($r = 0.48$), sit-ups in 30 s ($r = 0.46$), the 20-m shuttle run test ($r = 0.53$), and the sit-and-reach test ($r = 0.30$), and also negatively correlated with the 10x5 shuttle run test ($r = -0.32$). Regardless of sex, no significant correlations between MT and body composition were observed ($r = 0.12$ in boys and $r = 0.10$ in girls).

Discussion and conclusion

The main purpose of the study was to investigate the associations between MT and its components and PF in a relatively large sample of adolescent modern dance sport athletes. Findings suggest mostly moderate positive associations between subscales of SMTQ as well as overall MT score with PF, especially with MF and CRF.

These data are in line with previous findings related to MT and PF (Hsieh, et al., 2024). A study by Hsieh et al. (2024) showed that the mean point estimate between MT and PF was $r = 0.36$, indicating moderately high positive correlation between MT and PF levels. However, this study was one of the first in examining the associations between MT and PF in modern dance sport. Previous research has primarily focused on establishing a 'MT—PF' relationship in individual combat or endurance sports (Abasgholipour, 2023; Brace, et al., 2020; Christensen, Brewer, & Hutchinson, 2018; Hagag & Ali, 2014; Jones & Parker, 2019; Méndez-Alonso, Prieto-Saborit, Bahamonde, & Jiménez-Arberás, 2021; Morais & Rui Gomes, 2019; Slimani, Miarka, Briki, & Cheour, 2016). Specifically, there has been a genuine amount of evidence that MT may impact PF, but findings have been limited to individual sports, such as kickboxing (Slimani, et al., 2016), triathlon (Jones & Parker, 2019), tennis (Morais & Rui Gomes, 2019), marathon/ultra-marathon

Table 2. Sex-related correlations between subscales and total SMTQ score with PF components

PF components	'Confidence'	'Constancy'	'Control'	'SMTQ-total'
Body mass index (kg/m^2)				
Total	0.13	0.09	0.05	0.08
Boys	0.14	0.10	0.08	0.11
Girls	0.11	0.11	0.02	0.07
Standing broad jump (cm)				
Total	0.48***	0.55***	0.60***	0.51***
Boys	0.61***	0.51***	0.56***	0.54***
Girls	0.48***	0.53***	0.50***	0.48***
Sit-ups in 30 s (#)				
Total	0.55**	0.57***	0.60***	0.51***
Boys	0.60***	0.55***	0.64***	0.56***
Girls	0.45***	0.51***	0.51***	0.46***
10x5 shuttle run (s)				
Total	-0.40***	-0.35***	-0.43***	-0.37***
Boys	-0.50***	-0.43***	-0.52***	-0.43***
Girls	-0.32***	-0.30***	-0.35***	-0.32***
Sit-and-reach test (cm)				
Total	0.33**	0.33**	0.32**	0.33**
Boys	0.37***	0.35***	0.36**	0.34**
Girls	0.30**	0.31**	0.29**	0.30**
20-m shuttle run test (stage)				
Total	0.61***	0.55***	0.58***	0.57***
Boys	0.67***	0.62***	0.60***	0.61***
Girls	0.54***	0.50***	0.49***	0.53***

Note. *p<.05; **p<.01; ***p<.001

(Brace, et al., 2020; Christensen, et al., 2018), ultra-trail mountain (Méndez-Alonso, et al., 2021), and fencing (Hagag & Ali, 2014). In these studies, MT was correlated with PF. Other studies have failed to confirm a positive correlation between MT and athletic performance in individual sports (Brace, et al., 2020). For team sports, little evidence has been provided whether MT is correlated with PF (Madrigal, Hamill, & Gill, 2013; Murray, Dugdale, Habeeb, & Arthur, 2021; Newland, Newton, Finch, Harbke & Podlog, 2013; Sheard, 2009; Wieser & Thiel, 2014). The findings of these studies have been conflicting, where some studies have shown positive associations between MT and PF (Sheard, 2009), while others have found null associations (Madrigal, et al., 2013; Newland, et al., 2013). Interestingly, a previous meta-regression analysis has shown that combined individual group sports have a high effect (r = 0.72), while team sports exhibit a low correlation between MT and athlete performance (r = 0.21) (Hsieh, et al., 2024). Most recently, a study by Zhou and Štefan (2025) found that MT was moderately-to-strongly correlated with PF in ballet dancers, indicating that the results in PF might be explained by psychological components of MT. Similar to this, we also found that CRF and MF were the strongest predictors of MT in adolescent modern style dance sport athletes.

Dance sport athletes often tend to cope better with physical and psychological demands during training and competition (Zhou & Štefan, 2025). The attributes of MT for dance sport athletes highlight the importance of their resilient character and the presence that affects them through physical self-representation and behavioral traits, which affect the success during competition (Crust, 2007). Thus, it is not surprising that we obtained moderate correlations between MT and PF. Although previous evidence in individual combat and endurance sports has shown conflicting results, our findings may be explained by the level of motivation, self-belief, coping and psychological skills, and emotional intelligence (Crust, 2007). According to Jones et al. (2002), athletes tend to have a high level of MT, due to the accumulated energy directed towards competition goals and internalized motives to succeed. Also, higher levels of MT are strongly correlated with personal beliefs and efficacy to contribute and handle difficult situations with less stress and more control (Piepiora, Čaplová, Zimoń, & Gumienna,

2024; Ronca, Tari, Xu, & Burgess, 2025). In line with that, emotional intelligence plays an important role as a mediator between MT and athletic performance, since it relies on how an individual manages, expresses and copes with personal and other people's emotions (Piepiora, et al., 2024; Ronca, et al., 2025; Wright & Masten, 2015). For example, Doyle, Lutz, Pellegrino, Sanders, and Arent (2016) stated that high emotional intelligence may adequately facilitate strength and endurance in sports characterized by fast changes of direction, which is vastly associated with dance sport.

Prior research has emphasized that coaches play a critical role in cultivating MT by creating structured, psychologically challenging training scenarios that mirror competitive stressors, providing constructive feedback, modeling resilience, and encouraging strategies such as goal setting, reflection, and team cohesion (Bormann, Schulte-Coerne, Diebig, & Rowold, 2016; Clough & Strycharczyk, 2012). Similarly, integrating performance metrics into practice allows coaches to identify key moments where psychological strengths or vulnerabilities emerge, thereby informing targeted mental skills interventions. Evidence has suggested that team leadership, like setting positive behavior and inspiring motivation, may be crucial factors for enhancing MT and physical performance in athletes (Clough & Strycharczyk, 2012). The role of the coach should also serve as a potential avenue to raise awareness, higher level needs, putting the team at first place, and understanding the contribution of each individual on a team level (Bormann, et al., 2016).

Despite an effort to investigate the correlations between MT and PF, this study is not without limitations. By using a cross-sectional design, we were unable to establish causal associations between MT and PF levels. It is still unknown whether a high level of MT leads to better PF or *vice versa*. Second, we only established correlations in adolescent dance sport athletes, while previous studies have highlighted the importance of moderating factors of the 'MT—PF', such as age, sports category and sports type (Hsieh, et al., 2024). For example, Hsieh et al. (2024) performed a set of meta-regression analyses and found that older athletes of combat and endurance sports and individual sports had higher correlations with MT compared to younger athletes of ball- and team-related sports, respectively. Third, we were confident that by adjusting the associations between MT and physical performance with emotional intelligence, the findings might have been different. Thus, future research should be able to examine longitudinal correlations between MT and PF in various age- and sport-related events with complete technical and tactical outcomes.

This study found that MT was cross-sectionally correlated with PF in modern style dance sport athletes. Coefficients of correlation were mostly described as being moderate, indicating that the result obtained in physical performance could be potentially explained by a certain level of MT. Although we failed to examine these correlations at follow-up in longitudinal and intervention-based approaches, findings from this study might be a cornerstone for both physical and psychological improvements during training and competition periods. Based on our findings, it is speculated that higher levels of MT might lead to better physical performance outcomes, however, the causality has yet to be investigated. On the other hand, many strategies to enhance MT have been developed over the years, including psychological skills training, coping and optimism training, mindfulness, yoga, general relaxation, imagery, and a combination of both (Park & Jeon, 2023). However, physical training seemed to be less beneficial, limiting its effectiveness for MT development. This would suggest that research is needed to confirm longitudinal correlations between MT and PF in athletes in individual sports. Unfortunately, there has still been a lack of information regarding the combinatory effects of MT and PF in sport-related settings of dance. Since previous evidence has confirmed that MT and PF may be developed through training initiatives (Stamatis, et al., 2020), future findings on this topic are important pathways into structuring and implementing these components in everyday routines of athletes.

In summary, this study aimed to investigate the correlations between MT and PF in adolescent dance sport athletes who competed in modern style dance sport. The findings suggest positive and moderate correlations between MT and PF, extending the existing knowledge of the 'MT—PF relationship. Coaches and professional teams may be able to use both physical and psychological abilities to ensure proper training during preparative period and performance during the competitive period.

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List of abbreviations

CRF – cardiorespiratory fitness
MF – muscular fitness
MT – mental toughness
PF – physical fitness
SD – standard deviation
SMTQ – Sport mental toughness questionnaire
95% CI – 95 percent confidence intervals