Self and Relative Effects of Competitive State Anxiety on Perceived Performance in Middle and High School Taekwondo Athletes: An Actor and Partner Interdependence Model Analysis

*Hyunwoo Kang [1], *Seyong Jang [2]*

1. *College of Sport Science, Sungkyunkwan University, Seobu-ro 2066, Suwon, Korea*
2. *Department of Taekwondo, College of Arts and Physical Education, Gachon University, Seongnam 13120, Korea*

*Corresponding Author: Email: naganolala@gachon.ac.kr

Abstract

Background: The present study aimed to provide an empirical theoretical basis for the psychological phenomena that occur among competing athletes. To this end, we utilized the actor and partner interdependence model (APIM) to analyze the self- and relative effects of competitive state anxiety on perceived performance in middle and high school Taekwondo athletes.

Methods: Data were analyzed for 372 middle and high school athletes (red group=186, blue group=186) who participated in the first round of the 2020 Korea Taekwondo Association National Taekwondo Competition. Analysis based on the APIM was applied to the collected data, and a path analysis was conducted to verify the self- and relative effects of competitive state anxiety on perceived performance.

Results: Cognitive (red: $P<0.01$, blue: $P<0.001$) and physical state anxiety (red: $P<0.01$, blue: $P<0.01$) exerted a significant negative self-effect on perceived performance in both groups. In contrast, state confidence (red: $P<0.001$, blue: $P<0.001$) exerted a significant positive self-effect on perceived performance. Furthermore, cognitive (red: $P<0.001$, blue: $P<0.01$) and physical state anxiety (red: $P<0.001$, blue: $P<0.001$) exerted a significant positive relative effect on the opponent's perceived performance in both groups, while state confidence (red: $P<0.01$, blue: $P<0.001$) exerted a significant negative relative effect on the opponent's perceived performance.

Conclusion: Sports psychologists should focus on developing a psychological training program that provides practical psychological support as well as self-regulatory and relative strategies for improving athletic performance in competitive scenarios.

Keywords: Anxiety; Work performance; Relative biological effectiveness; Athletes

Introduction

In most sporting events, victory or loss is determined based on competition, making it important to exhibit superior performance compared to one's opponent. Athletic performance is influenced by complex interactions among physical

strength, skill, and psychological factors (1). Recently, scientists have elucidated key physical and technical factors associated with athletic performance, leading to rapid advancements in skill among competitive athletes. However, because there is a limit to enhancing athletic performance based on improvements in physical strength and technique alone, attention has shifted to the importance of psychological factors (2-3).

Anxiety is an essential psychological factor that exerts an important influence on player performance (4). During sporting events, athletes may experience competitive state anxiety, in which the competitive situation is perceived as threatening, leading to conscious reactions such as tension and concern. Competitive state anxiety is divided into three dimensions: cognitive state anxiety, physical state anxiety, and state confidence (5-6).

Previous studies have indicated that competitive state anxiety arising from sporting events is a major factor impeding performance (7-9). Specifically, cognitive and physical state anxiety is known to exert a negative effect on performance in the context of competitive sports, while state confidence is known to exert a positive effect (4,10-12). In addition, excessive anxiety interferes with the athlete's attention and concentration, causes physical tension, and induces fatigue and lethargy (13). Given that their skills require further development, anxiety can exert a profound effect on performance among elementary, intermediate, middle, and high school players. These athletes may be unable to demonstrate their usual level of performance and make uncharacteristic mistakes when they are too tense or hurried in an actual game situation (14).

Contrarily, it is necessary to pay attention to the psychological states of the opponent when playing sports in which victory or loss is determined based on direct interactions with a competitor. During an athletic event or game, players witness actions such as delays in game time, trash talk, time-outs at critical points, and player substitutions (15-17). These actions are part of a strategy to increase the chances of victory by decreasing the opponent's confidence, impairing concentration, and amplifying anxiety, highlighting the role of the opponent's

psychology in their performance. However, sports psychology focuses only on the self-effects of players' individual inner psychology (motivation, anxiety, confidence, concentration, psychological coping, psychological skills, etc.) on performance (18). Although some studies have analyzed relative effects in doubles' sports (19) such as badminton, tennis, and table tennis (20-22), these are limited in that they have only investigated psychological effects in interdependent relationships, rather than those in opponent/rival relationships.

Therefore, additional scientific evidence is required to verify the psychological counterpart effect that occurs between players competing in a one-to-one pair (dyad), as in a Taekwondo game. In this paired data format, the actor and partner interdependence model (APIM) can be applied to analyze simultaneously self- and relative effects. To provide an empirical theoretical basis that can explain the psychological phenomena that occur among competing athletes, we aimed to verify the self- and relative effects of competitive state anxiety on perceived performance in middle and high school Taekwondo athletes by applying APIM analysis.

Methods

Participants

We collected data from 396 middle and high school athletes (red group=198, blue group n=198) who participated in the national Taekwondo competition held by the Korea Taekwondo Association in 2020. Prior to the event date, after explaining the purpose of the study to the association and leaders in detail and seeking cooperation, 10 researchers and research assistants visited the site and collected data using a questionnaire. The players encountered in the first game of the tournament were classified into pairs, and data were collected by classifying them according to the color (blue, red) of the *hogu* (body protection in Taekwondo game) worn in the first game. Data from 372 participants (red group=186, blue group n=186) were used for the analysis, after excluding the data of 24 participants (12 pairs)

who were judged to have omitted or duplicated entries or answered unscrupulously. Table 1 presents the general characteristics of the participants.

All study participants provided informed consent, and the study design was approved by Gachon University in Korea.

Table 1: General characteristics of participants

Characteristics		N	%
Gender	Male	244	65.6
	Female	128	34.4
School level	Middle school	174	46.8
	High school	198	53.2
Grade	1st	134	36.0
	2nd	138	37.1
	3rd	100	26.9
Years of career	Less than 2 years	46	12.4
	3–4 years	172	46.2
	5 years or more	154	41.4
Total		372	100%

Instruments

A modified version of the Competitive State Anxiety Inventory-2 (CSAI-2), developed by Martens et al (6), was used to assess competitive anxiety. The competitive anxiety questionnaire was composed of 27 questions, including nine questions related to cognitive state anxiety, physical state anxiety, and state confidence each. Participants responded to each question using a 5-point Likert scale (absolutely agree=5 points, absolutely disagree=1).

A questionnaire developed by Mamassis and Doganis (23) was used to measure perceived athletic performance. The perceived performance scale was composed of a single factor, which consisted of eight questions designed to obtain information regarding a player's thoughts on their performance during the game. Responses to each question were scored on a Likert scale ranging from not good (1 point) to very good (5 points).

Evaluation of the measurement model

Prior to analyzing our results, we conducted a confirmatory factor analysis using the maximum likelihood method to verify the validity and reliability of the overall measurement model consisting of four sub-factors and 35 items. The goodness-of-fit index of the whole measurement model was found to be relatively suitable, given the following data: X^2=1,447.774, df=554, $P<0.001$; Turker–Lewis index (TLI)=0.915; comparative fit index (CFI)=0.921; root mean square error of approximation (RMSEA)=0.066. The factor load of the item explaining each latent variable was 0.577–0.876. In addition, as shown in Table 2, the concept reliability of each sub-factor was 0.700 or higher, the average variance extracted (AVE) was 0.500 or higher, and Cronbach's α was 0.700 or higher. Therefore, the validity and reliability of the measurement tools used in this study were verified.

Table 2: Evaluation of the measurement model

Variables	Classifica-tion	Items	Standard regression weight	Critical ratio (t)	Construct reliability	Average variance extracted	Cronbach α
Competitive state anxiety	Cognitive anxiety	1	0.577	11.677***	0.913	0.539	0.912
		4	0.758	16.240***			
		7	0.735	15.623***			
		10	0.697	14.617***			
		13	0.816	17.915***			
		16	0.764	16.817***			
		19	0.689	14.404***			
		22	0.749	16.013***			
		25	0.791	-			
	State anxiety	2	0.768	17.778***	0.922	0.569	0.932
		5	0.738	16.783***			
		8	0.763	17.614***			
		11	0.817	19.595***			
		14	0.581	12.188***			
		17	0.845	20.733***			
		20	0.867	21.678***			
		23	0.767	17.757***			
		26	0.841	-			
	Confidence	3	0.853	21.836***	0.935	0.616	0.949
		6	0.820	20.340***			
		9	0.859	22.128***			
		12	0.856	21.983***			
		15	0.589	13.042***			
		18	0.846	21.531***			
		21	0.876	22.955***			
		24	0.834	20.996***			
		27	0.855	-			
Perceived performance		1	0.827	14.218***	0.946	0.689	0.933
		2	0.823	14.158***			
		3	0.803	13.882***			
		4	0.872	14.869***			
		5	0.831	14.290***			
		6	0.863	14.738***			
		7	0.661	14.778***			
		8	0.671	-			

***$P<0.001$; tested via confirmatory factor analysis

Statistical analysis

The collected data were analyzed using SPSS 25.0 and AMOS 25.0 (IBM Corp., Armonk, NY, USA). Frequency analysis was performed to determine the general characteristics of the participants, and confirmatory factor analysis was performed to verify the validity and reliability of the collected data.

Conceptual reliability, AVE, and Cronbach's α values were also calculated. Descriptive statistics were used to verify normality through a review of the mean and standard deviation of sub-factors, skewness, and kurtosis. In addition, Pearson correlation analysis was performed to determine the relationships between sub-dimensions. Finally, the

APIM was applied for path analysis using synthetic scores to verify the self- and partner effects of competitive state anxiety on perceived performance. The significance level of the analysis was set to α=0.05.

Results

Descriptive statistics and correlation analysis

Descriptive statistics and correlation analyses were conducted for the seven sub-dimensions of the data. As shown in Table 3, the average score of each sub-factor ranged from 2.62 to 3.99, and the score distribution had no outliers in the standard deviation, skewness (≤2.00), and kurtosis (≤4.00). Therefore, the score distribution of the measured variables was considered normal. Correlation analysis revealed that, in both red and blue groups, cognitive anxiety and physical anxiety were negatively (-) correlated with confidence and performance, and that confidence was positively (+) correlated with performance. In addition, cognitive and physical anxiety in the red group was positively (+) correlated with performance in the blue group, while confidence in the red group was negatively (-) correlated with performance in the blue group. Likewise, cognitive anxiety and physical anxiety in the blue group were positively (+) correlated with performance in the red group, while confidence in the blue group was negatively (-) correlated with performance in the red group. As no factors exhibited a correlation of 0.80 or more in these analyses, there was no issue with multicollinearity.

Table 3: Descriptive statistics and correlation analysis

Variable	1	2	3	4	5	6	7	8
Mean	3.16	2.90	3.22	3.99	3.08	2.62	3.24	3.91
Standard deviation	0.79	0.81	0.93	0.75	0.89	0.94	1.00	0.71
Skewness	0.45	0.96	-0.37	-0.05	0.30	1.23	-0.45	0.11
Kurtosis	0.83	1.67	1.26	-1.13	0.28	1.33	0.66	-0.85
Cognitive anxiety (red)	1.00							
Physical anxiety (red)	0.78**	1.00						
Confidence (red)	-0.73**	-0.70**	1.00					
Performance (red)	-0.24**	-0.21**	0.33**	1.00				
Cognitive anxiety (blue)	0.55**	0.38**	-0.34**	0.26**	1.00			
Physical anxiety (blue)	0.53**	0.42**	-0.35**	0.29**	0.66**	1.00		
Confidence (blue)	-0.38**	-0.26**	0.25**	-0.25**	-0.73**	-0.69**	1.00	
Performance (blue)	0.29**	0.28**	-0.21**	0.26**	-0.26**	-0.23**	0.38**	1.00

**P<0.01; tested via Pearson correlation analysis

Self-effects and relative effects of competitive state anxiety on performance

We applied the APIM to verify the self- and relative effects of competitive state anxiety on perceived performance among middle and high school Taekwondo athletes. Path analysis was performed according to each factor using synthetic scores.

Self- and relative effects of cognitive state anxiety on performance

Table 4 and Fig. 1 show the self- and relative effects of cognitive state anxiety on perceived performance among middle and high school Taekwondo players. First, we observed significant negative (-) self-effects of cognitive state anxiety on performance in both red (-0.242, P<0.01) and blue groups (-0.439, P<0.001). Contrarily, we observed significant positive (+) relative effects of
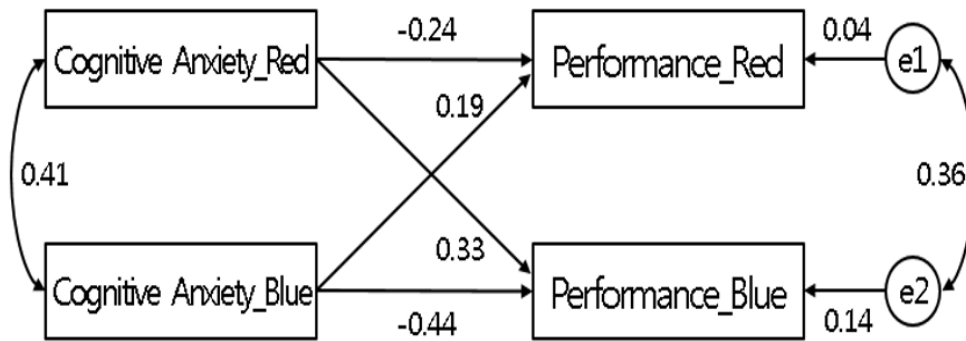
the red group's cognitive state anxiety on the blue group's performance (0.332, *P*<0.001), and of the blue group's cognitive state anxiety on the red group's performance (0.160, *P*<0.01).

Table 4: Self-effects and relative effects of cognitive state anxiety on performance

Path	RW	SRW	SE	CR
Cognitive state anxiety → performance				
Red group's self-effect	-0.230	-0.242	0.082	-2.816**
Blue group's self-effect	-0.348	-0.439	0.064	-5.394***
Red group's relative effect	0.299	0.332	0.073	4.076***
Blue group's relative effect	0.160	0.191	0.072	2.227**

**P*<0.01, ****P*<0.001; tested via actor and partner interdependence model, and was applied for path analysis
RW: regression weight, SRW: standard regression weight, SE: standard error, CR: critical ratio

Fig. 1: Effect of cognitive state anxiety on performance. e1, e2: measurement error variance

Self- and relative effects of physical state anxiety on performance

Table 5 and Fig. 2 show the self- and relative effects of physical state anxiety on perceived performance among middle and high school Taekwondo players. First, we observed significant negative (-) self-effects of physical state anxiety on performance in both red (-0.221, *P*<0.01) and blue groups (-0.247, *P*<0.01). Contrarily, we observed significant positive (+) relative effects of the red group's physical state anxiety on the blue group's performance (0.283, *P*<0.001), and of the blue group's physical state anxiety on the red group's performance (0.278, *P*<0.001).

Table 5: Self-effects and relative-effects of physical state anxiety on performance

Path	RW	SRW	SE	CR
Physical state anxiety → Performance				
Red group's self-effect	-0.205	-0.221	0.072	-2.856**
Blue group's self-effect	-0.187	-0.247	0.058	-3.191**
Red group's relative effect	0.243	0.283	0.068	3.588***
Blue group's relative effect	0.226	0.278	0.062	3.651***

**P*<0.01, ****P*<0.001; tested via actor and partner interdependence model, and was applied for path analysis
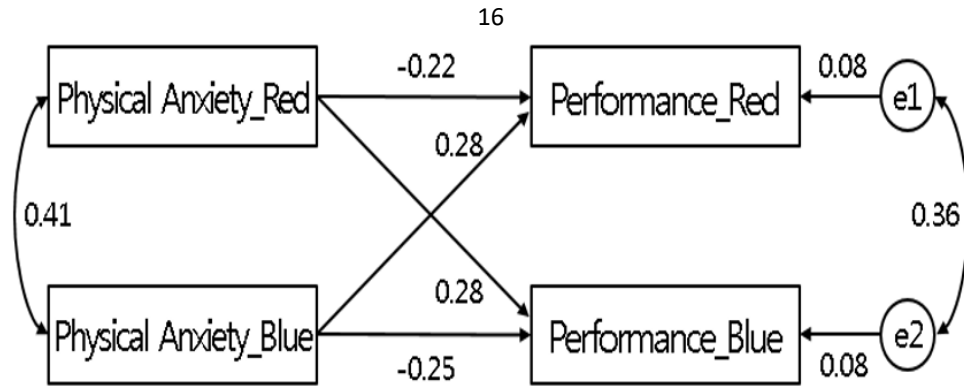RW: regression weight, SRW: standard regression weight, SE: standard error, CR: critical ratio
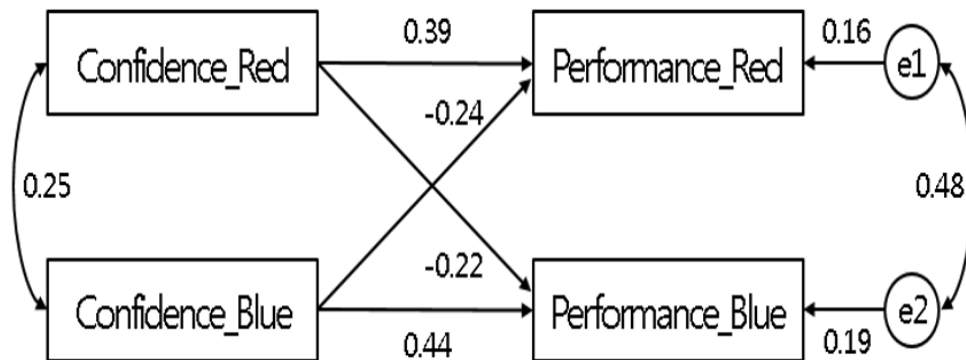
16

Fig. 2: Effect of physical state anxiety on performance. e1, e2: measurement error variance

Self- and relative effects of confidence on performance

Table 6 and Fig. 3 show the self- and relative effects of confidence on perceived performance among middle and high school Taekwondo players. On the one hand, we observed a significant positive (+) self-effect of confidence on performance in both red (0.311, *P*<0.001) and blue groups (0.312, *P*<0.001). On the other hand, we observed significant negative (-) relative effects of the red group's confidence on the blue group's performance (-0.169, *P*<0.01), and of the blue group's confidence on the red group's performance (-0.182, *P*<0.001).

Table 6: Self-effects and relative effects of confidence on performance

Path	*RW*	*SRW*	*SE*	*CR*
Confidence → Performance				
Red group's self-effect	0.311	-0.221	0.056	5.559***
Blue group's self-effect	0.312	-0.247	0.048	6.440***
Red group's relative effect	-0.169	0.283	0.052	-3.243**
Blue group's relative effect	-0.182	0.278	0.052	-3.495***
**P<0.01, ***P<0.001; tested via actor and partner interdependence model, and was applied for path analysis				
RW: regression weight, SRW: standard regression weight, SE: standard error, CR: critical ratio				

Fig. 3: Effect of confidence on performance.e1, e2: measurement error variance

Discussion

In this study, we utilized APIM analysis to verify the self- and relative effects of competitive state anxiety on perceived performance in middle and high school Taekwondo players. Our findings indicated that, in both red and blue groups, cognitive and physical state anxiety exerted significant negative self-effects on perceived athletic performance, and state confidence exerted a significant static self-effect on perceived performance. These findings indicate that perceived performance decreases as cognitive state anxiety (e.g., excessive nerves or worry about the game) and physical state anxiety (e.g., physical tension and stiffness, excessive increase in heart rate) increase. In contrast, perceived performance increases as confidence in one's state of mind and relaxation increase.

These results are consistent with those of previous sports psychology studies regarding Taekwondo (7-8, 24), judo (25), golf (10), Kumdo (26), and volleyball (27), which have also reported negative effects of cognitive and physical state anxiety and positive effects of confidence on performance. Therefore, these findings highlight the need to engage actively in self-regulating psychological skills training to attenuate the negative effects of anxiety and enhance the positive effects of confidence in competitive Taekwondo, especially given recent increases in the intensity of competition.

Our APIM analysis also revealed significant positive relative effects of cognitive and physical state anxiety on the opponent's perceived athletic performance in both red and blue groups. In contrast, state confidence had a significant relative negative effect on perceived performance. This finding indicates that, as cognitive and physical anxiety increased during the competition, the perceived performance of the opponent increased. However, increases in self-confidence were associated with decreases in the perceived performance of the opponent.

The findings of the present study support the notion that psychological factors related to the other player can lead to changes in one's own psychological state and performance during competition

(16, 28). In addition, Taylor and Demick (29) argued that, for changes in a player's own psychological state and performance to result in victory or loss, the opposite changes must be observed in the opponent. This viewpoint is in accordance with the results of the present study.

In fact, players grasp information regarding habits or phenomena that occur when the opponent is anxious or when their confidence is high. Knowledge and manipulation of this information can decrease morale while increasing vigilance, excitement, anger, and distractibility in the opponent. Players often employ psychological strategies to impede the opponent's performance by stimulating the opponent, distorting information, and making sudden actions (18, 30). Therefore, winning a Taekwondo match requires not only training to control one's own psychological state, but also developing a psychological strategy that can affect the opponent's performance without compromising sportsmanship. Applying such strategies to competitive situations will ultimately aid athletes in improving their performance.

This study has some limitations. It did not take cultural differences or different sports into account in that it was conducted exclusively on Korean Taekwondo athletes. There is also a limitation in that the study was conducted using only two variables, anxiety and perceived performance, and causation could not be determined. Therefore, caution is required in interpreting and utilizing research results. Moreover, since the participants were recruited in the 2020 Korea Taekwondo Association National Taekwondo Competition, they may not accurately represent the global population of Taekwondo athletes.

Conclusion

We used APIM analysis to verify the self- and relative effects of competitive state anxiety on perceived performance among middle and high school Taekwondo players. First, cognitive and physical state anxiety exerted significant negative self-effects on perceived performance in both red and blue groups, while state confidence exerted a

significant positive self-effect on perceived performance. Second, cognitive and physical state anxiety exerted significant positive relative effects on the perceived performance of the opponent in both red and blue groups, while state confidence exerted a significant negative relative effect on the opponent's perceived performance. These findings indicate that psychological training in self-regulatory and relative strategies may help to enhance performance among athletes during real-world competitive situations.

We believe that additional studies are required to investigate the relative effects of competition on performance in various sports other than Taekwondo. Furthermore, such studies should aim to analyze psychological variables other than anxiety, and to develop a psychological training program that can provide practical psychological support, as well as self-regulatory and relative strategies for improving athletic performance in competitive scenarios.

Ethical considerations

Ethical issues (Including plagiarism, informed consent, misconduct, data fabrication and/or falsification, double publication and/or submission, redundancy, etc.) have been completely observed by the authors.

Acknowledgements

Conflict of interest

The authors have no conflicts of interest to declare.

References

1. Yang DS (2015). The mediating effects of sport confidence on the relationship between coach-athlete interaction and performance in Taekwondo Kyorugi. *Korean Journal of Sports Science*, 24(1):401-13.

2. Lee KH, Kang HY (2019). The effects of autonomy-supportive coaching behaviors on performance of university Taekwondo players: mediating effects of Grit. *Korean Journal of Physical Education*, 58(6):89-99.

3. Jang SY, So WY (2017). The effect of Taekwondo coach-athlete interaction on perceived performance: the moderating effect by two Taekwondo styles, Gyeorugi and Poomsae. *J Mens Health*, 13(2):34-39.

4. Weinberg R, Gloud D (2010). *Foundations of sport and exercise psychology (5th ed.)*. Champaign, IL, USA. Human Kinetics.

5. Cratty BJ (1983). *Psychology in contemporary sport (2nd ed.)*. Engle-wood Cliffs, NJ: Prenric Hall.

6. Martens R, Burton D, Vealey RS, et al (1990). *Development and validation of the competitive state anxiety inventory-2*. Champaign, IL, USA. Human Kinetics.

7. Lee YJ (2017). A structure model on exercise stress, competitive state anxiety and exercise performance of high-school Taekwondo athletes. *The Korean Journal of Sport*, 15(2):51-61.

8. Shin SJ (2020). The influence of university Taekwondo athletes' grit on competitive state anxiety and performance. *Korean Journal of Physical Education*, 59(6):115-29.

9. Kais K, Raudsepp L (2004). Cognitive and somatic anxiety and self-confidence in athletic performance of beach volleyball. *Percept Mot Skills*, 98:439-49.

10. Kim KJ, Park SH, Kim SH (2018). The relationship between of anxiety and performance to predict junior golf player's game performance. *Journal of The Korean Society of Living Environmental System*, 25(6):702-11.

11. Park JJ, Baek J K (2017). Causal relationship among coping strategy, competition anxiety, state confidence, perceived performance of bowling athletes. *The Korean Journal of Sport*, 15(4):825-34.

12. Martin JJ (2002). Training and performance self-efficacy, affect, and performance in wheelchair rod racers. *Sport Psychol*, 16:384-95.

13. Lee JK (2005). *Influences of golfers' stress and mental power on their attention and performance*. Ph.D. Thesis, Chosun University, Republic of Korea.

14. Ji YJ (2012). The relationship of a pre-shot routine, psychological skills and golf performance. *Journal of Sport and Leisure Studies*, 48(1):407-18.

15. Goldschmied N, Nnakin M, Cafri G (2010). Pressure kicks in the NFL an archival exploration into the deployment of timeouts and other environmental correlates. *Sport Psychol*, 18:300-12.

16. Jeon JY, Yun YK (2014). Maintenance process of psychological homeostasis in Badminton competition. *Korean Journal of Sport Science*, 25(3):575-589.

17. Jones MI, Harwood H (2008). Psychological momentum within competitive soccer: Players' perspectives. *J Appl Sport Psychol*, 20:57-72.

18. Jeon JY (2017). Athletes' psychological competition viewed from a strategic perspective. *Korean Journal of Sport Science*, 28(1):214-29.

19. Jang CW, Suh JM, Kim DJ (2020). Relationship between personality dimensions and leisure satisfaction according to couples' participation in leisure sports: self and relative effects. *The Korean Journal of Sport*, 18(3):185-94.

20. Kim BS, Shin SM, Lee HG (2016). The casual relationship between psychological characteristics and game satisfaction of badminton club members's doubles match: actor effect and partner effect by APIM Technique. *Journal of Coaching Development*, 18(4):41-50.

21. Jang CW, Kim BJ (2021). The relationship between partner trust and perceived performance of double athletes in life sports using APIM. *Journal of Sport and Leisure Studies*, 83:299-310.

22. Jackson B, Beauchamp MR, Knapp P (2007). Relational efficacy beliefs in athlete dyads: An investigation using actor–partner interdependence models. *J Sport Exerc Psychol*, 29(2):170-89.

23. Mamassis G, Doganis G (2004). The effects of a mental train in program on juniors pre-competitive anxiety, self-confidence, and tennis performance. *J Appl Sport Psychol*, 16(2):118-37.

24. Lim SJ, Jung MK, Jeon MW (2015). The influences of exercise stress on competitive state anxiety and athletic performance to Taekeondo Poomsae players. *Journal of Korean Physical Education Association for Girls and Women*, 29(1):45-58.

25. Cho HC, Kim JS (2011). A study of competitive uneasiness on athletic performance depending on University Judo athletes' gender, sporting history. *The Journal of Korean Alliance of Martial Arts*, 13(3):151-59.

26. Lee YJ (2018). The relationship among judgment stress, self-efficacy, competitive anxiety and perceived athletic perceived athletic performance of youth Kumdo player. *The Journal of Korean Alliance of Martial Arts*, 20(3):55-69.

27. Yoon WJ, Song JS (2018). A study on the effects of psychological well-being on competitive state anxiety and performance in high school and university volleyball players. *Korean Journal of Sports Science*, 27(4):251-67.

28. Won HJ, Yoo J (2012). Structuring self-regulatory processes in elite athletes. *Korean Journal of Sport Psychology*, 23(2):57-73.

29. Taylor J, Demick A (1994). A multidimensional model of momentum in sports. *J Appl Sport Psychol*, 6(1):51-70.

30. Jang, SY (2019). The Relationship between Sports-confidence and Grit in Taekwondo players. *The Korean Journal of Sport*. 17(22), 1125-1136.