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KEYWORDS	ABSTRACT
Psychological factors, performance analysis, racket sport, high and low performance	Background: Badminton, a popular racket sport, requires a unique combination of physical, technical, and psychological attributes for success. Method: A total of 50 young male and female athletes were recruited from established badminton academies. Psychological constructs questionnaire proposed by TOPS containing 52 items on psychological factors which include emotional control, imagery, activation, Self-talk, relaxation, negative thinking, was used. Statmine application was installed on a tablet phone and used as a device for the collection of the players' performance based on the main performance indicators such as clear shot, drop shot, drive shot, net shot, service, smash, and backhand drive. Players were classified into high- and low-performance groups using Hierarchical Agglomerative Cluster Analysis (HACA), followed by binomial logistic regression and group comparison analyses. Results: Regression analysis revealed that psychological variables did not significantly predict performance outcomes. However, group comparison results indicated that high-performing athletes demonstrated better emotional control, imagery, activation, and self-talk, along with superior technical performance. Additionally, negative thinking was more prevalent among lower-performing athletes, suggesting a potential negative influence on cognitive and attentional processes during performance. Conclusion: Psychological skills enhance technical performance, whereas negative thinking may hinder performance. Integrating psychological and technical training is recommended, with further longitudinal research warranted.
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Introduction

Badminton is a sport that uses a shuttlecock, racket, net and competes in men's and women's singles, men's women's doubles and mixed doubles c Badminton is one of the most popular sports in the world, and is a racket sport that does not have body contact with the opponent (Tong et al., 2023). In the world of sports, especially badminton, athlete performance is not only determined by physical and technical abilities but also by their psychological condition. Sport psychology, as a branch of science that studies the influence of psychological factors on sports performance and its opposite, plays an important role in improving athlete performance (Guszkowska & Wójcik, 2021). Assert that athletes' mental abilities contribute significantly to success in competition, implying that the management of psychological as goal setting, relaxation, and imagery, are effective in improving sports performance. In the context of badminton, sports psychology plays a role in helping athletes develop strategies to deal with match pressure, build confidence through goal achievement, and maintain long-term motivation through the development of process- and outcome-orientated goals (Ong & Harwood, 2018). The study of sports psychology not only provides insight into how to improve performance but also into how sports can be used as a tool to develop life skills, such as teamwork, discipline, and time management (Williams et al., 2022). Badminton athletes, just like athletes in other sports, face pressures and challenges that are not only physical but also mental. Competitive anxiety, motivation, confidence, concentration, and mental resilience are some of the psychological aspects that play an important role in their performance (Gould et al., 2022). Competitive anxiety disrupts focus and physiological control, but relaxation techniques like breathing exercises and visualization can mitigate its effects (Moore et al., 2021; Arthur et al., 2017). Research shows that athletes with high self-efficacy tend to be more committed to their training goals, more resilient in the face of adversity, and have lower anxiety levels during competition (Lu & Xu, 2023). In badminton, self-efficacy may influence athletes' ability to execute complex strokes, persist in long stroke exchanges, and make strategic decisions under pressure. Focus and concentration are key elements in sports psychology, especially in sports with speed and the need for quick reactions, such as badminton. The theory of divided attention, proposed by (Pool et al., 2016), explains how a person's attention can be distributed between different stimuli, affecting their ability to focus on the most important task. From a practical perspective, (Zakrajsek & Blanton, 2017). Identified that mental training, including goal setting and stress management, positively impacted athlete performance, providing empirical evidence of the importance of sports psychology. Furthermore, explored the concept of "mental resilience" in sports, concluding that athletes with high mental resilience are better able to deal with competitive pressure and maintain high performance.

Badminton performance is also highly sensitive to mental fatigue, as long rallies and extended matches require sustained focus and emotional control. Athletes who effectively regulate their emotions, maintain composure under pressure, and use psychological strategies such as goal setting, visualization, and mindfulness demonstrate superior competitive performance (Birrer et al., 2012; Han et al., 2020). Performance in elite badminton is determined by a combination of technical, tactical, physical, and psychological components. Unlike purely endurance-based sports, badminton requires rapid bursts of speed, agility, precise coordination, and quick reflexes, all of which must be

executed under competitive pressure (Phomsoupha, M. & Laffaye, 2015). At the elite level, physical conditioning and technical mastery often reach similar standards among athletes, meaning that psychological factors frequently become the differentiating element in performance outcomes (Weinberg & Gould, 2019).

Material & methods

The questionnaire used for data collection was the Test of Performance Strategies (TOPS) developed by (Thomas et al., 1999). This instrument is designed to measure psychological performance strategies during training and after competition. It assesses key psychological skills such as emotional control, imagery, activation, self-talk, relaxation, and negative thinking. In addition, the Statmine application was installed on a tablet device and used to collect data on players' performance based on the main performance indicators relevant to the demands of the game.

Participants

A total of 50 young male and female badminton players were recruited with the (mean $\pm$ SD age: 13.08 ± 1.29 years, experience: 5.04 ± 1.65 years). All participants were fully aware of the risks and benefits of participating. All participants aged 18 and above signed a consent form, while those under 18 had their parents or guardians sign on their behalf. The study protocol was approved by the (UHREC) Approval No: UniSZA.800-1/1/4 Jld.4 (10).

Instruments

Procedure

The questionnaire was distributed to the players before the beginning of the competition, and the scores of each player were recorded. Four analysts were recruited to help in the collection of the players' performance in such a way that each performance analyst covers a particular player during the analysis. Operational definition was given to each performance indicators in such that the coach, the controller of the analysis and the performance analysts were using the term unanimously. The players' performances were assessed based on clear shot, drop shot, drive shot, net shot, service, smash, backhand drive, through pass coded either winner (w) or loser (l). The information collected was analyzed by the controller of the analysis before being transferred to the coach at half time interval of the match. Performances of the club for 2 days were evaluated. The performance indicators were approved by the chief coach of the badminton club. Statistical analysis a standard multiple regression was performed at $p \leq 0.05$ alpha level with the motivation, confidence, anxiety control, mental preparation, team emphasis, concentration and cognition as (IVs) to predict performance (DV).

Results

Table 1 showed the descriptive analysis of psychological variables indicates that athletes generally demonstrate a balanced level of mental skills across different dimensions. Emotional control appears to be relatively well-developed, suggesting that players are capable of managing their emotions effectively during performance situations. Similarly, imagery and activation levels reflect that player possess a moderate ability to mentally prepare and regulate their arousal states before and during play. Self-talk, while present, seems to be slightly less prominent compared to other psychological skills, indicating that athletes may not consistently use internal dialogue as a strategy to enhance performance. Relaxation levels suggest that players have a reasonable capacity to remain calm, although there may still be room for improvement in stress management techniques. In contrast, negative thinking shows a noticeable presence, implying that some athletes experience intrusive or counterproductive thoughts that could potentially hinder optimal performance.

Regarding performance variables, the results indicate considerable variability among different technical skills. Smash performance shows a high level of inconsistency across players, suggesting differences in skill execution or physical ability. In comparison, other skills such as backhand drive, drive shot, net shot, and service appear to be more stable, reflecting a relatively consistent level of technical proficiency among participants. Overall, the findings suggest that while athletes demonstrate moderate psychological readiness and fairly stable technical skills, certain areas particularly the management of negative thoughts and consistency in high-intensity skills like smashing may require further development. These patterns highlight the importance of integrating psychological training with technical practice to achieve more consistent and optimal performance outcomes.

Table 1. Descriptive Statistics of the Variables.

Variable	Mean	SD
Emotional Control	3.38	0.71
Imagery	3.30	0.72
Activation	3.34	0.69
Self-talk	3.20	0.75
Relaxation	3.29	0.68
Negative Thinking	3.01	0.69
Smash	8.08	11.36
Backhand Drive	5.64	1.38
Drive Shot	6.12	1.52
Net Shot	5.88	1.41
Service	6.30	1.44

Table 2. Correlation among the variables.

Variable	1	2	3	4	5	6	7	8
Performance	1							
Goal Setting	~ 0.246	1						
Emotional control	~ 0.269	0.637***	1					
Imagery	~-0.16	0.586***	0.539**	1				
Activation	~-0.27	0.545***	0.373**	0.410**	1			
Self-talk	~ 0.347*	0.462**	0.556**	0.528**	0.650***	1		
Relaxation	~ 0.313*	0.608***	0.567**	0.593***	0.714***	0.643***	1	
Negative thinking	~ 0.265	0.656***	0.377**	0.430**	0.460***	0.440**	0.497***	1

Note. * $p < .05$, ** $p < .01$, *** $p < .001$

Table 2 shows the relationship between performance and psychological indicators. The correlation analysis showed key links among psychological variables and performance. Performance was negatively related to self-talk and relaxation, meaning more use of these strategies corresponded to lower performance. While Goal setting had strong positive correlations with emotional control, imagery, activation, self-talk, relaxation, and negative thinking, indicating athletes who used goal setting also used other psychological strategies. Emotional control was positively linked to imagery, activation, self-talk, relaxation, and negative thinking, showing its central role. Imagery, activation, self-talk, relaxation, and negative thinking also clustered with each other through multiple positive associations.

Table 3 indicates the regression analysis was conducted to explore how psychological and performance-related factors contribute to overall performance. The results revealed that none of the psychological variables acted as significant predictors. Emotional control showed a minor inverse relationship with performance, indicating that differences in emotional regulation had little practical impact on performance outcomes within this group. In a similar way, imagery displayed a positive but weak association, suggesting that although mental visualization may play a role, its influence was not strong enough to reliably predict performance. Activation demonstrated an almost negligible connection with performance, implying that levels of readiness or arousal were not decisive in shaping outcomes. Self-talk was negatively related to performance, indicating that internal dialogue did not consistently support better results and may sometimes have unfavourable effects. Relaxation also showed a slight negative association, suggesting that the ability to stay calm was not a key factor in determining performance levels. Negative thinking followed the same general trend, with a weak negative relationship, indicating that although such thoughts exist, they

did not significantly affect measurable performance. Among the skill-based variables, smash performance showed a comparatively stronger positive tendency than the other predictors, suggesting it may have a more noticeable role in influencing overall performance, although its effect was still not statistically meaningful. Backhand drive also presented a positive association, but its contribution remained limited and non-significant.

Table 3. Multiple Regression of Performance predicting Psychological Variables

Predictor	B	β	t	p
Emotional Control	-1.93	-0.08	-0.50	0.62
Imagery	3.45	0.12	0.79	0.43
Activation	0.39	0.02	0.09	0.92
Self-talk	-5.80	-0.18	-1.11	0.27
Relaxation	-3.25	-0.09	-0.62	0.53
Negative Thinking	-2.65	-0.10	-0.74	0.46
Smash	0.21	0.15	1.88	0.06
Backhand Drive	0.18	0.13	1.32	0.19

Table 4 shoed the effect size analysis provides insight into the magnitude of differences between groups across psychological and performance variables. Emotional control demonstrates a small to moderate effect, indicating a noticeable but not strong difference between groups in the ability to regulate emotions. Imagery shows a moderate effect, suggesting that mental visualization differs meaningfully between groups and may play a role in distinguishing performance levels. Among the performance variables, smash exhibits a large effect size, highlighting a substantial difference between groups and indicating that this skill is a key factor separating higher and lower performers. In contrast, drive shot and backhand performance both display moderate effects, suggesting that these technical skills also contribute to group differences, although to a lesser extent than smash.

Table 4. Effect Size

Variable	Cohen's d	Interpretation
Emotional Control	0.45	Small-Moderate
Imagery	0.48	Moderate
Smash	0.74	Large
Drive Shot	0.52	Moderate
Backhand	0.53	Moderate

Table 5 showed the comparison between high- and low-performance groups reveals meaningful differences across both psychological and performance-related variables. Players in the high-performance group tend to be slightly older, suggesting that age and experience may contribute to

improved performance levels. In terms of psychological characteristics, high-performing players demonstrate better emotional control, indicating a stronger ability to manage emotions during competition. They also show higher levels of imagery, suggesting more effective use of mental visualization techniques. Activation and self-talk are also more developed in the high-performance group, reflecting better mental readiness and more constructive internal dialogue. Similarly, relaxation appears to be more effectively managed among higher-performing players, highlighting their ability to remain calm under pressure. In contrast, negative thinking is more prominent in the low-performance group, suggesting that less successful players may be more prone to experiencing disruptive thoughts during performance. Regarding technical skills, the high-performance group consistently outperforms the low-performance group across all measured areas. Smash performance shows a particularly strong difference, indicating that this skill plays a key role in distinguishing performance levels. Backhand drive, drive shot, net shot, and service also demonstrate clear advantages for the high-performance group, suggesting a more refined and consistent technical ability.

Table 5. Group Variable: Hierarchical clustering (High vs Low Performance)

Variable	High Performance (n=30)	Low Performance (n=20)	t-value	p-value
Age	17.92 ± 0.67	16.85 ± 1.42	3.21	0.002*
Emotional Control	3.62 ± 0.41	3.28 ± 0.52	2.41	0.019*
Imagery	3.58 ± 0.44	3.21 ± 0.55	2.22	0.031*
Activation	3.61 ± 0.39	3.25 ± 0.54	2.18	0.034*
Self-talk	3.47 ± 0.46	3.10 ± 0.58	2.05	0.044*
Relaxation	3.55 ± 0.43	3.18 ± 0.50	2.30	0.026*
Negative Thinking	2.85 ± 0.51	3.12 ± 0.60	-1.98	0.053
Smash	10.25 ± 3.18	7.12 ± 2.94	3.12	0.003*
Backhand Drive	6.88 ± 1.12	5.42 ± 1.33	3.08	0.004*
Drive Shot	7.10 ± 1.22	5.80 ± 1.41	2.96	0.005*
Net Shot	6.95 ± 1.10	5.75 ± 1.35	2.88	0.006*
Service	7.25 ± 1.05	6.02 ± 1.30	3.01	0.004*

Figure 1 shows that the high-performance group achieved higher median service scores and displayed less variability compared to the low-performance group. The low-performance group had a lower median score and a wider range of values, indicating greater inconsistency in service performance. These findings suggest that better service performance is associated with higher player performance levels.

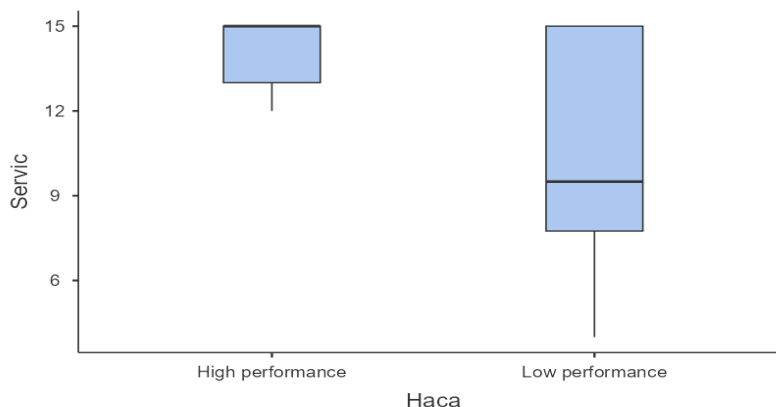


Figure 1. Boxplot Comparison of Service Performance Between High-Performance and Low-Performance Badminton Players

Discussion

The present study aimed to examine how psychological factors relate to badminton performance among young players. The findings indicate that, although several psychological variables demonstrated associations with performance, none emerged as statistically significant predictors in the regression model. This suggests that performance in badminton cannot be explained by isolated psychological constructs alone, but rather reflects a more complex interaction between mental, technical, and possibly contextual factors.

One notable observation is the weak and non-significant predictive role of psychological variables such as emotional control, imagery, activation, and self-talk. This outcome may be attributed to the developmental stage of the participants, as younger athletes often exhibit variability in their ability to consistently apply psychological skills during competition. Previous research has highlighted that the effectiveness of mental skills is influenced by experience level, with younger athletes showing less stable psychological regulation compared to elite performers (MacNamara et al., 2010). 2010). Therefore, the limited predictive power observed in this study may reflect an ongoing maturation process rather than the absence of psychological influence. Interestingly, negative relationships were observed between performance and certain variables such as self-talk and relaxation. While these findings may appear counterintuitive, they could indicate ineffective or maladaptive use of these strategies. For instance, self-talk that is overly critical or poorly timed can disrupt attentional focus rather than enhance it. Similarly, excessive relaxation may reduce optimal arousal levels required for high-intensity sports like badminton. This aligns with the multidimensional perspective of arousal-performance relationships, where both under- and over-regulation can impair performance outcomes (Craft et al., 2003).

The correlation analysis further revealed strong interrelationships among psychological variables, suggesting that these constructs tend to operate collectively rather than independently. This clustering effect supports the notion that psychological skills are interdependent and may exert influence through combined application. Athletes who engage in one psychological strategy are more likely to utilize others, forming an integrated mental skills profile. Such findings reinforce the importance of adopting a holistic approach to psychological training rather than focusing on single techniques in isolation. From a performance perspective, technical skills particularly smash performance demonstrated relatively stronger associations compared to psychological variables. The large effect size observed for smash performance indicates that high-intensity offensive skills play a critical role in differentiating performance levels. This is consistent with performance analysis literature, which emphasizes the importance of decisive and attacking strokes in racket sports as key determinants of success (Lees, 2003). Therefore, while psychological factors contribute to overall readiness, technical execution remains a central component of competitive performance. The group comparison analysis provides further insight into the role of psychological and technical factors. High-performing players exhibited better emotional control, imagery, activation, and self-talk, alongside superior technical performance. These findings suggest that psychological skills may not directly predict performance in statistical models but still contribute meaningfully to performance differences when considered in a broader context. It is possible that psychological factors act as facilitators, enhancing the effectiveness of technical skills rather than directly influencing performance outcomes (Gucciardi et al., 2015).

An additional observation is the tendency toward negative thinking among lower-performing players. Although not statistically significant in the regression model, its higher prevalence in the low-performance group indicates a potential disruptive influence. Cognitive interference caused by negative thoughts can impair decision-making, reduce confidence, and limit attentional control during play. This highlights the need for interventions aimed at cognitive restructuring and mental resilience development in young athletes (Beilock & Carr, 2001). The findings of this study also underscore the importance of integrating psychological and technical training. Rather than treating psychological skills as standalone predictors, coaches should embed mental training within sport-specific practice. For example, imagery can be incorporated into skill rehearsal, while self-talk strategies can be practiced during match simulations. Such integration may enhance the practical application of psychological skills and improve their effectiveness in real competitive situations (Thelwell et al., 2010). Despite its contributions, the study has several limitations. The relatively small sample size may have limited the statistical power to detect significant effects. Additionally, the cross-sectional design restricts the ability to establish causal relationships. Future research should consider longitudinal designs to examine how psychological skills develop over time and influence performance progression. Expanding the sample to include different competitive levels may also provide a more comprehensive understanding of these relationships (Hardy et al., 2020).

In conclusion, the results suggest that psychological factors play a supportive rather than dominant role in badminton performance among young athletes. While they are not strong independent predictors, their combined and indirect influence appears meaningful, particularly when aligned

with technical proficiency. These findings emphasize the need for a multidimensional approach to athlete development, where psychological training is integrated with technical and tactical preparation to optimize performance outcomes.

Conclusions

In conclusion, this study highlights those psychological skills, although not direct predictors in statistical models, play a meaningful role in differentiating performance levels among athletes. High-performing individuals exhibit stronger psychological competencies that likely enhance the execution and consistency of technical skills. Conversely, the presence of negative thinking patterns among lower-performing athletes suggests a potential barrier to optimal performance. The findings reinforce the importance of adopting a holistic training approach that integrates psychological skill development with technical practice. Such an approach can improve the practical application of mental strategies in real competitive environments and support overall performance enhancement. However, the study's limitations, including a relatively small sample size and cross-sectional design, should be acknowledged. Future research is recommended to explore these relationships over time and across different competitive levels to provide a more comprehensive understanding. Overall, incorporating structured psychological training alongside technical development may offer significant benefits for athlete performance and long-term development.

Conflict interest

The authors have no conflict of interest to declare.

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