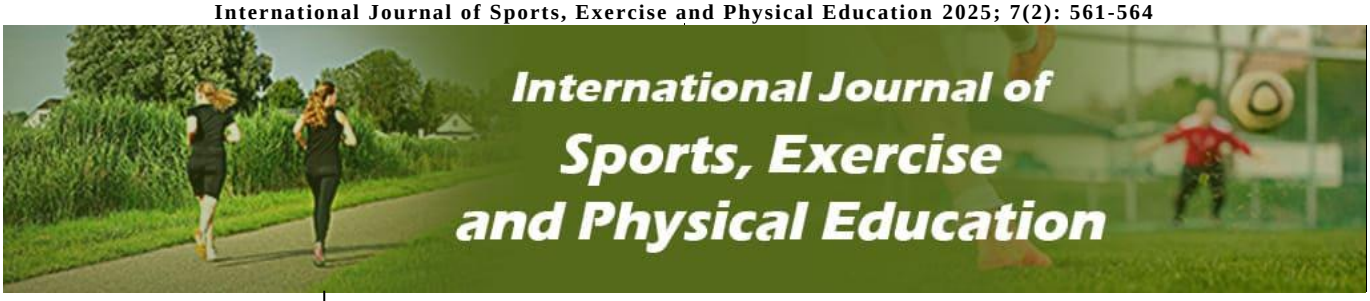

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Analysis of sensomotor co-ordination and reactive stress tolerance among female athletes of various sports groups

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Abstract
The present study examined differences in sensomotor coordination and reactive stress tolerance among female athletes from three team sports i.e. basketball, handball, and volleyball. For the purpose of this study sixty (60) female athletes, aged between 18 and 23 years randomly selected. The Vienna Test System was used to assess sensomotor coordination (SMK test) and reactive stress tolerance (Determination Test). Data were analyzed using one-way ANOVA to determine inter-group variations. The findings shown significant differences in both sensomotor coordination ($F(2,57) = 5.38$, $P=0.007$) and reactive stress tolerance ($F(2,57) = 6.06$, $P=0.004$) across sports groups. Post-hoc comparisons showed that volleyball players scored significantly lower than basketball and handball athletes on both measures. These results suggest that sport-specific skill demands and training intensity may influence athletes' perceptual-motor efficiency and cognitive adaptability under stress. The study highlights the importance of integrating psychomotor assessments into athletic training to optimize performance and decision-making efficiency.

Keywords: Vienna Test System, sensomotor coordination, reactive stress tolerance, female athletes, psychomotor performance, cognitive adaptability

Introduction
Athletic performance is a multidimensional construct shaped by physiological, psychological, and perceptual-motor factors. While physical training forms the foundation of sport excellence, emerging data highlights that success in competitive settings also depends on the unification of cognitive and sensomotor processes (Raab, 2021) [12]. Sensomotor coordination is the ability to skillfully link sensory perception with motor execution, which enables athletes to adjust immediately to changing environments and execute complex movements with accuracy (Bashir *et al*., 2022) [2]. In dynamic sports such as basketball, volleyball, and handball, where external stimuli grow continuously, the efficiency of these perceptual-motor links often differentiates elite athletes from their peers (Roca & Williams, 2017) [12]. Reactive stress tolerance is another critical determinant of performance which refers to the athlete's capacity to maintain decision accuracy and motor control under conditions of cognitive load or emotional strain (Fink *et al*., 2018) [6]. Sports are demanding open-skill execution, such as team ball games, place high cognitive demands on athletes to process multiple stimuli simultaneously and respond within milliseconds (Yarrow *et al*., 2009) [16]. Those athletes who exposed to complex, fast-paced stimuli show increased neural adaptability and attentional flexibility. These attributes are important for managing stress during high-pressure situations (Patócs *et al*., 2016; Di Domenico *et al*., 2020) [11, 4].
Regardless of extensive work on psychomotor performance, the actual empirical comparisons of sensomotor coordination and reactive stress tolerance across different women's team sports remain limited. Prior researches have mostly focused on male athletes or single-sport cohorts (Mishra & Acharya, 2016; Basumatary & Lohani, 2013) [10, 3]. Researcher's understanding of these mechanisms in female population is particularly relevant and it gives growing acknowledgment of gender-specific variances in cognitive and motor performance under stress (Ludyga *et al*., 2019) [9]. The aim of present study is to examine and compare sensomotor coordination and reactive stress tolerance among female athletes representing volleyball, basketball, and handball.

Using the Vienna test system, the study seeks to measure inter-sport variations and to explain in detailed manner that how training specificity impacts perceptual-motor adaptability. For enhancement of female athletes' psychomotor performance and resilience under stress the findings of this study are expected to provide understandings for coaches and sport psychologists to provide supporting evidence-based training plans and strategies.

Methods

Participants

The study included a total of 60 female athletes (N=60) representing three different team sports i.e. volleyball (N=20), basketball (N=20), and handball (N=20). Participants were between 18 and 23 years old (M = 19.57, SD=1.42). All athletes were selected randomly from the Lakshmibai National Institute of Physical Education, Gwalior, and Madhya Pradesh, India. Each participant had a minimum of three years of competitive experience and was actively training during the study period. Written informed consent was obtained from all participants, and ethical approval was secured in accordance with institutional research standards for human subjects.

Instruments

Two standardized tools from the Vienna Test System (VTS) were employed to assess sensomotor coordination and reactive stress tolerance.

Sensomotor Coordination Test (SMK)

The test form SMK-S1 was used to evaluate eye-hand coordination and motor control efficiency. Participants were required to maintain a moving pointer along a prescribed path (a yellow circular segment displayed in a 3D space), where deviations indicated reduced coordination accuracy. In which circle segment moves unpredictably and requiring the user to react and adjust its position in real time using the joystick. (Keller *et al*., 2019) [7].

Determination Test (DT): The test form DT-S1 assessed reactive stress tolerance and the ability to respond accurately to rapidly changing visual and auditory stimuli. In this test participants were responded to multiple-coloured lights and audio signals, measuring their response speed and accuracy under time pressure. In previous studies literature supports the DT as a strong measure of attention and stress tolerance in sport circumstances (Schuhfried *et al*., 2017) [15].

Procedure: Testing was conducted in a controlled laboratory environment with standardized lighting and minimal external distractions. Prior to testing, participants were given practice trials to ensure familiarity with the apparatus and instructions. Each athlete completed the SMK and DT assessments individually, with adequate rest intervals to avoid fatigue effects. The order of testing was counterbalanced across participants to minimize order bias. All tests were administered by a trained examiner following the VTS guidelines.

Statistical Analysis

Descriptive statistics, including means and standard deviations, were computed for all variables. To evaluate inter-group differences, a One-Way Analysis of Variance (ANOVA) was performed with sports type as the independent variable and test scores (SMK and DT) as dependent measures. When significant F-ratios were observed, post-hoc analyses using Turkey's HSD test were conducted to determine pairwise differences between sports groups. All statistical analyses were carried out using IBM SPSS Statistics version 20, with the level of significance set at $p<.05$.

Results

Descriptive statistics for Sensomotor Coordination (SMK) and reactive stress tolerance (DT) across the three sports groups are presented in Table 1. Volleyball players demonstrated lower mean scores for both SMK and DT compared to basketball and handball athletes.

Table 1: Descriptive statistics for sensomotor coordination (SMK) and Determination Test (DT) among female athletes

Variable	Sport Group	N	M	SD
SMK	Volleyball	20	2.65	1.73
	Basketball	20	4.80	2.46
	Handball	20	5.25	3.54
DT	Volleyball	20	246.20	41.32
	Basketball	20	292.75	55.99
	Handball	20	290.65	44.78

Note: SMK = Sensomotor Coordination; DT = Determination Test.

A one-way analysis of variance (ANOVA) was performed to examine differences among the three sports groups. The results indicated a significant main effect of sport type for both SMK, F (2, 57) = 5.38, P=.007, and DT, F (2, 57) = 6.06, P=.004 (see Table 2).

Table 2: Analysis of Variance for SMK and DT Among Female Athletes of Different Sports Groups

Variable	Source	SS	DF	MS	F	P
SMK	Between Groups	77.23	2	38.62	5.38	.007
	Within Groups	409.50	57	7.18		
	Total	486.73	59			
DT	Between Groups	27,647.43	2	13,823.72	6.06	.004
	Within Groups	130,109.50	57	2,282.62		
	Total	157,756.93	59			

Note. SS = Sum of Squares; MS = Mean Square.

Post-hoc analyses using Turkey's HSD test revealed significant mean differences between the volleyball group and both the basketball and handball groups for SMK and DT scores. Specifically, volleyball players showed lower performance in sensomotor coordination compared to basketball (P=.037) and handball athletes (P=.009). Similarly, volleyball athletes scored significantly lower in reactive stress tolerance than basketball (P=.009) and handball players (P=.013). No significant differences were observed between basketball and handball players for either variable ($p>0.05$).

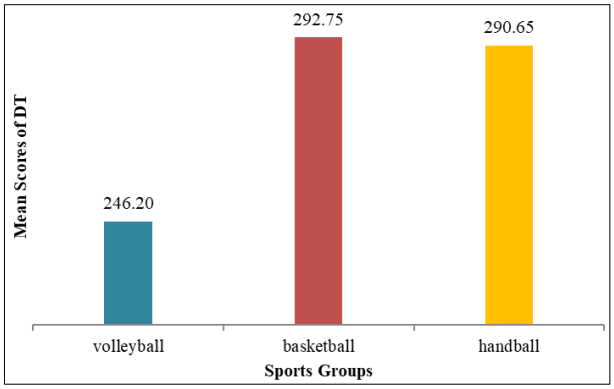

Fig 1: A graphical representation of mean differences across the three sports groups

Note, figure plotted using the means presented in Table 1. Volleyball athletes exhibited lower mean performance across both variables compared to basketball and handball groups.

Summary of Findings

- Significant differences were observed across sports groups for both sensomotor coordination and reactive stress tolerance.
- Volleyball players consistently showed lower performance levels than basketball and handball athletes.
- The absence of significant differences between basketball and handball players suggests similar cognitive-motor profiles in these two sports.

Discussion and Conclusion

The findings of this study revealed significant differences in sensomotor coordination and reactive stress tolerance among female athletes from volleyball, basketball, and handball. Volleyball players demonstrated comparatively lower levels of performance in both measures, whereas basketball and handball athletes performed similarly. These outcomes underscore the influence of sport-specific demands and training patterns on psychomotor and cognitive performance.

The superior sensomotor coordination observed among basketball and handball athletes may be attributed to the dynamic and multidirectional nature of these sports, which require rapid visual-motor adjustments and decision-making under continuous environmental changes (Raab, 2021) [12] Frequent engagement in such open-skill contexts may strengthen perceptual-motor coupling and enhance neural efficiency for information processing (Fink *et al*., 2018) [6]. In contrast, volleyball, while highly technical, may involve shorter reaction sequences and more predictable ball trajectories, leading to less consistent exposure to reactive stress stimuli (Yarrow *et al*., 2009) [16].

The observed differences in reactive stress tolerance align with previous findings suggesting that athletes trained in environments demanding rapid responses to multiple stimuli develop superior attentional flexibility and stress regulation (Patócs *et al*., 2016; Ludyga *et al*., 2019) [11, 9]. The capacity to sustain performance accuracy under stress conditions is mediated by both cognitive control and autonomic regulation, emphasizing the importance of integrating mental resilience and perceptual training into sport-specific conditioning programs (Di Domenico *et al*., 2020) [4].

The results also contribute to growing evidence on gender-specific cognitive-motor profiles in sport. Research indicates that female athletes may exhibit distinct stress-response mechanisms and cognitive regulation patterns compared to male counterparts (Bashir *et al*., 2022) [2]. Hence, tailored psychomotor interventions targeting decision making speed, coordination, and emotional control may help optimize female athletes' performance across diverse sporting contexts. From an applied perspective, the study emphasizes the need for coaches and sport psychologists to consider psychomotor assessment as a critical part of athlete development. Incorporating sensomotor and reactive stress tolerance training can enhance both technical execution and psychological adaptability under competitive pressure. Such integrative training models combining physical, cognitive, and emotional components are likely to foster superior performance outcomes in high-intensity sports (Raab, 2021; Roca & Williams, 2017) [12].

Conclusion

In conclusion, the present study demonstrates that sport-specific demands significantly affect sensomotor coordination and reactive stress tolerance among female athletes. Basketball and handball players exhibited higher levels of coordination and stress tolerance compared to volleyball athletes, likely due to the varied cognitive-motor demands inherent in their respective sports. These findings highlight the importance of psychomotor evaluation in sports science and suggest that training programs should systematically incorporate exercises that develop perceptual, cognitive, and motor integration. Future research should explore longitudinal interventions to examine how targeted sensomotor training influences both neural and behavioral performance outcomes in female athletes.

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