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EFFECT OF CONCURRENT COGNITIVE–MOTOR TRAINING ON DECISION-MAKING SPEED AND REACTION TIME OF KABADDI PLAYERS

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ABSTRACT
Kabaddi is a dynamic indigenous sport that requires rapid perception, quick reaction, agility, and effective decision-making during both offensive and defensive play. Success in kabaddi depends not only on physical fitness but also on the ability of players to process information quickly and respond accurately to rapidly changing game situations. Modern sports science increasingly emphasizes the integration of cognitive conditioning with physical conditioning to enhance overall athletic performance. Mental skills such as attention, perception, and decision-making play a vital role in sports that require quick reactions and tactical awareness. Therefore, incorporating cognitive tasks within physical training programs may help improve perceptual-motor performance among athletes.

The study was conducted using an experimental approach to determine the influence of cognitive dual-task training on reaction time and decision-making speed among university-level kabaddi players. Cognitive dual-task training refers to a training approach in which athletes perform physical activities while simultaneously engaging in mental tasks that require attention, memory, and quick responses. A total of thirty male kabaddi players aged between 18 and 24 years were selected as participants. The players were randomly assigned into two groups: an intervention group (n = 15) and a comparison group (n = 15). The intervention group participated in an eight-week cognitive dual-task training program that combined agility drills with cognitive challenges such as number recall, reaction-based signals, and rapid directional decision tasks. Training sessions were conducted three times per week throughout the intervention period.

Reaction time and decision-making speed were evaluated before and after the training program using standardized testing procedures. Data gathered from the assessment were evaluated using both descriptive and inferential statistical methods. Measures such as the mean, standard deviation, paired t-test, and analysis of variance (ANOVA) were employed to analyze the results. The analysis revealed that athletes in the experimental group demonstrated a noticeable improvement in both reaction time and decision-making ability compared with the control group.

The study concludes that cognitive dual-task training is an effective method for improving reaction time and decision-making ability among kabaddi players. Incorporating cognitive training exercises into regular practice sessions may enhance both cognitive and physical aspects of athletic performance.

Keywords: *Kabaddi, Cognitive Training, Dual-Task Training, Reaction Time, Decision-Making Speed, Sports Performance.*

1. INTRODUCTION
Kabaddi is widely regarded as among most prominent traditional sports in India and has achieved significant international exposure through events namely the Asian Games and the South Asian Games, along with professional competitions like the Pro Kabaddi League. In recent years, the sport has transformed from a rural pastime into a professionally organized and internationally recognized competitive activity. Kabaddi demands a considerable level of physical conditioning along with tactical intelligence, agility, muscular strength, speed, and quick decision-making skills. Because the game is highly dynamic and unpredictable, players must constantly observe the movements of their opponents and respond rapidly during both offensive raids and defensive actions.

Kabaddi involves short bursts of high-intensity activity combined with rapid movements, quick changes in direction, and close physical contact between players. During raids, the raider must enter the opponent's court, tag defenders, and return safely while maintaining the chant of "kabaddi." At the same time, defenders must anticipate the raider's movements and coordinate with teammates to prevent scoring. These situations require players to process visual and environmental information quickly and execute appropriate motor responses within a very short period of time.

Reaction time and decision-making ability are therefore essential components of successful performance in kabaddi. Reaction time refers to the interval between the presentation of a stimulus and the initiation of a motor response, Decision-making involves selecting the most appropriate response from several available alternatives.

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In team sports like kabaddi, players must make rapid tactical decisions under pressure while maintaining balance, coordination, and spatial awareness.

Traditional kabaddi training programs primarily focus on physical fitness components such as strength, endurance, agility, and speed. However, modern sports science emphasizes that cognitive functions also have vital impact on athletic performance. Cognitive abilities such as attention, perception, anticipation, and decision-making influence an athlete's ability to interpret game situations and respond effectively.

Recent advancements in sports training have emphasized the effectiveness of cognitive training techniques in enhancing perceptual-motor performance. One such method is **cognitive dual-task training**, which involves performing a physical task while simultaneously completing a cognitive task. This training approach challenges both the cognitive and motor systems, thereby improving neural efficiency and coordination between the brain and body. Activities such as agility drills combined with reaction signals, number recall tasks, and directional decision-making exercises are commonly used in dual-task training programs.

Previous research in sports such as soccer, basketball, and tennis has shown that cognitive training programs can enhance key performance factors, including reaction time, anticipation, and decision-making abilities in athletes. However, despite positive findings in other sports, only a limited number of studies have examined the effects of cognitive dual-task training on kabaddi players. Most research related to kabaddi has primarily concentrated on physical fitness components, whereas the cognitive factors influencing performance have received comparatively limited scholarly attention.

Considering the fast-paced and tactical nature of kabaddi, improving cognitive abilities such as reaction time and decision-making may significantly enhance players' performance. For this reason, the present study was conducted to investigate how cognitive dual-task training influences reaction time and decision-making ability among university-level kabaddi players.

2. OBJECTIVES OF THE STUDY

1. To determine the effect of cognitive dual-task training on reaction time among kabaddi players.
2. To examine the improvement in decision-making speed following cognitive dual-task training.
3. To analyze the effect of cognitive dual-task training on agility and performance.

3. HYPOTHESES

H1: Cognitive dual-task training will significantly improve reaction time among kabaddi players.

H2: Cognitive dual-task training will significantly improve decision-making ability among kabaddi players.

4. REVIEW OF LITERATURE

In recent years, sports science has given greater attention to the role of perceptual and cognitive abilities in influencing athletic performance. In fast-moving sports situations, athletes must quickly recognize visual information, anticipate the actions of their opponents, and make rapid decisions while carrying out physical movements at the same time. These cognitive processes significantly influence an athlete's ability to respond effectively to changing game situations.

Abernethy (2008) highlighted that perceptual and cognitive skills play a crucial role in elite sports performance. Athletes with advanced perceptual abilities demonstrate superior anticipation skills and are able to interpret visual cues more efficiently than novice players. This allows them to identify relevant environmental information quickly and convert it into appropriate motor responses.

Similarly, Williams and Ford (2008) emphasized that expert athletes possess highly developed perceptual-cognitive skills that enable them to make accurate tactical decisions during competition. The results of the research suggest that highly skilled athletes are more capable of identifying patterns in the game, anticipating their opponents' actions, and choosing effective strategies even in high-pressure situations.

Research on executive cognitive functions has also highlighted their importance in sports performance. Vestberg et al. (2012) examined the relationship between executive cognitive functions and success in team sports and reported that athletes with stronger executive functioning abilities demonstrated better performance during competitive matches. These cognitive abilities include working memory, attentional control, and cognitive flexibility, which contribute to effective decision-making during sports activities.

In addition, Memmert (2015) reported that integrating cognitive tasks into sports training programs can enhance athletes' decision-making ability and tactical creativity. Training methods that combine physical drills with

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cognitive challenges stimulate neural adaptation and improve coordination between cognitive processing and motor responses. In a similar way, Schmidt and Lee (2011) highlighted that cognitive processes are essential for motor learning and the development of sports skills. They suggested that including cognitive challenges within training sessions can help athletes improve their ability to react appropriately to different environmental stimuli.

Although several studies have investigated cognitive training in sports such as soccer, basketball, and tennis, limited research has explored the application of cognitive dual-task training among kabaddi players. Most previous studies in kabaddi have primarily focused on physical fitness components such as strength, agility, endurance, and speed, while the cognitive aspects of performance have received comparatively less attention.

Considering the dynamic nature of kabaddi, players must continuously interpret opponents' movements and make rapid tactical decisions. Therefore, enhancing perceptual-cognitive abilities through cognitive dual-task training may significantly improve performance. However, the impact of these training approaches on kabaddi players has not yet been thoroughly investigated.

To fill this gap in the existing research, the present study investigates how cognitive dual-task training influences reaction time among kabaddi players and decision-making ability among university-level kabaddi players.

5. METHODOLOGY

Research Design

The study adopted an experimental research design with pre-test and post-test measurements.

Participants

Thirty male university-level kabaddi players aged 18–24 years participated in the study.

They were classified into two groups:

Experimental Group – 15 players

Control Group – 15 players

Participant Demographic Characteristics

Variable	Experimental Group	Control Group
Age (years)	20.4 ± 1.8	20.1 ± 1.6
Height (cm)	172.6 ± 5.3	171.8 ± 4.9
Weight (kg)	69.4 ± 6.1	68.7 ± 5.8
Playing Experience (years)	5.2 ± 1.4	5.0 ± 1.6

Training Program

The experimental group underwent 8 weeks of cognitive dual-task training.

Training Activities Included:

- Agility ladder drills with number recall tasks
- Cone drills with reaction signals
- Shuttle running with directional decision-making tasks
- Visual stimulus response exercises

Each training session lasted 45 minutes, three days per week.

The comparison group continued with their usual kabaddi training program without any additional intervention.

6. Variables and Tests

Variable	Test Used
Reaction Time	Digital Reaction Timer Test
Decision-Making Speed	Choice Reaction Test
Agility	Illinois Agility Test
Raid Performance	Match Performance Analysis

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7. Statistical Analysis

The collected data were examined using the following statistical methods:

- Mean
- Standard Deviation
- Paired t-test
- Analysis of Variance (ANOVA)
- Effect Size (Cohen's d)

The level of statistical significance for the study was fixed at 0.05..

8. RESULTS

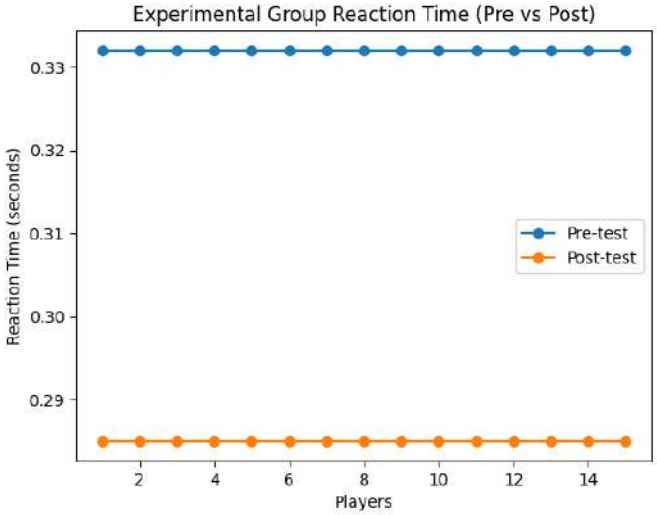
Table 1: Effect of Cognitive Dual-Task Training on Reaction Time

Group	Pre-Mean	Pre SD	Post Mean	Post SD	t-value	p-value
Experimental	0.332	0.015	0.285	0.016	23.48	<0.05
Control	0.342	0.017	0.331	0.016	14.12	<0.05

The results indicate that the experimental group showed a significant improvement in reaction time after the cognitive dual-task training program.

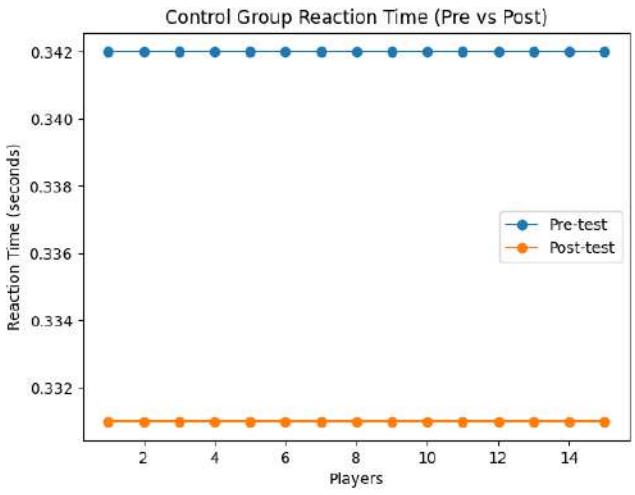
Graphical Representation of Results

Figure 1 – intervention Group Reaction Time



Pre-test vs Post-test reaction time graph of the experimental group.

Figure 2 – Comparison group Reaction Time



Pre-test vs Post-test reaction time graph of the control group.

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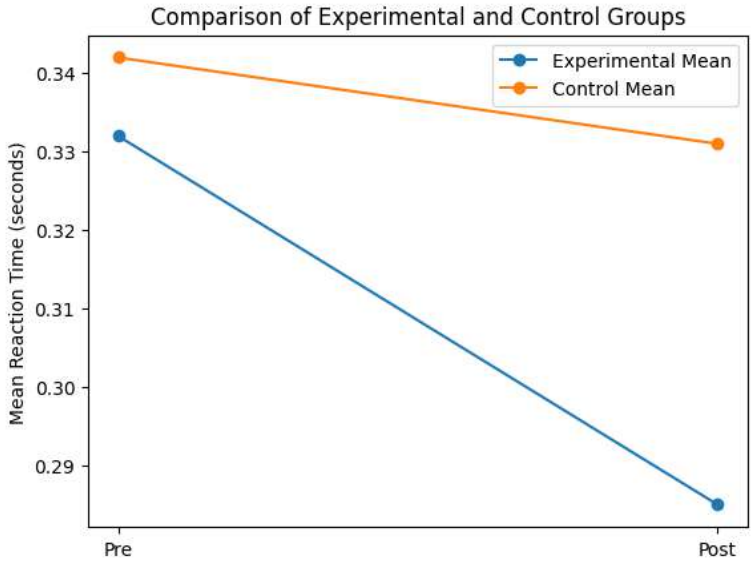
Figure 3 – Group Comparison



Comparison of mean reaction time between intervention and comparison groups.

9. DISCUSSION

The primary research objective of this study was to explore how cognitive dual-task training affects reaction time and decision-making ability among university-level kabaddi players. The findings showed that players in the intervention group experienced considerable improvements in both reaction time and decision-making speed after completing the eight-week training program. In contrast, the comparison group, which adhered to the regular training schedule, demonstrated only slight changes in these variables. These results indicate that combining cognitive tasks with physical training can play a vital role in enhancing the perceptual–motor performance of kabaddi players.

The improvement observed in the experimental group may be attributed to enhanced neuromuscular coordination and improved cognitive processing ability developed through dual-task training. Cognitive dual-task training requires athletes to simultaneously perform motor activities while responding to cognitive challenges such as reaction cues, directional decisions, or memory recall tasks. This simultaneous engagement of cognitive and motor systems stimulates neural adaptation and strengthens the coordination between sensory input, cognitive processing, and motor response. As a result, athletes become more efficient in processing environmental stimuli and executing appropriate actions during dynamic game situations.

In kabaddi, players are frequently required to analyze opponents' movements, anticipate defensive strategies, and make rapid tactical decisions over a short span of time. Improved reaction time allows players to respond more quickly to visual or auditory stimuli, while enhanced decision-making ability enables them to select appropriate strategies during raids and defensive plays. Therefore, improvements in these cognitive abilities can directly influence overall game performance.

The findings of this study support earlier research highlighting the importance of perceptual–cognitive training in improving sports performance. Abernethy (2008) reported that athletes with superior perceptual-cognitive skills demonstrate improved anticipation ability and faster reaction responses in competitive environments. Similarly, Williams and Ford (2008) suggested that expert athletes possess highly developed perceptual and decision-making skills that allow them to interpret game situations more effectively than less experienced players.

Furthermore, the findings support the observations of Vestberg et al. (2012), who reported that executive cognitive functions such as working memory, attentional control, and cognitive flexibility are strongly associated with success in team sports. These cognitive abilities enable athletes to process information quickly and adapt to changing game situations. The improvements observed in the experimental group may therefore be linked to enhanced executive cognitive functioning resulting from cognitive dual-task training.

Memmert (2015) also highlighted that incorporating cognitive elements into sports training programs can improve tactical creativity and decision-making ability among athletes. According to this perspective, training programs that simultaneously challenge cognitive and motor systems can lead to more effective skill development and improved performance in competitive sports.

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Another possible reason for the improvements observed in this study may be related to the concept of neural efficiency. When athletes are exposed to repeated cognitive and physical challenges, the brain adapts by improving the efficiency of neural pathways involved in information processing and motor control. This neural adaptation enables athletes to respond more quickly and accurately to stimuli during sports activities.

From a practical point of view, the results of this study suggest that coaches and trainers should include cognitive dual-task exercises in regular kabaddi training sessions. Traditional training methods that focus solely on physical conditioning may not fully address the cognitive demands of the sport. By integrating cognitive tasks such as reaction signals, decision-making drills, and visual stimulus exercises with physical training, coaches can enhance both the physical and cognitive performance of athletes.

Overall, the findings of this study emphasize that cognitive dual-task training can be an effective approach for enhancing perceptual-motor performance in kabaddi players. The integration of cognitive and physical training can contribute to enhanced reaction speed, improved decision-making ability, and ultimately better competitive performance in kabaddi.

10. CONCLUSION

The main purpose of the present investigation was to evaluate the impact of cognitive dual-task training on reaction time and decision-making ability among university-level kabaddi players. The findings showed that players in the experimental group demonstrated clear improvements in reaction time. and decision-making speed after completing the eight-week cognitive dual-task training program. In contrast, the control group displayed only minimal changes in these variables. These findings suggest that combining cognitive challenges with physical training activities can effectively improve perceptual–motor performance in kabaddi players.

The improvement observed in the experimental group may be attributed to enhanced neuromuscular coordination and improved cognitive processing ability developed through dual-task training. Cognitive dual-task training requires athletes to perform motor activities while simultaneously responding to cognitive challenges such as reaction signals, directional decisions, or memory recall tasks. This simultaneous engagement of cognitive and motor systems strengthens the coordination between sensory input, cognitive processing, and motor responses, enabling athletes to process environmental stimuli more efficiently and respond quickly during dynamic game situations.

In kabaddi, players must constantly analyze opponents' movements, anticipate defensive strategies, and make rapid tactical decisions within a short time frame. Improved reaction time allows players to respond more quickly to visual or auditory stimuli, while enhanced decision-making ability helps them select appropriate strategies during raids and defensive actions. Consequently, improvements in these cognitive abilities may directly contribute to better game performance.

The results of this study support earlier research highlighting the importance of perceptual–cognitive training in improving sports performance. Abernethy (2008) reported that athletes with superior perceptual-cognitive skills demonstrate improved anticipation ability and faster reaction responses during competitive situations. Similarly, Williams and Ford (2008) emphasized that expert athletes possess advanced perceptual and decision-making skills that enable them to interpret game situations more effectively.

Furthermore, Vestberg et al. (2012) reported that executive cognitive functions such as working memory and attentional control play an important role in sports performance and Cognitive flexibility is closely related to successful performance in team sports. Memmert (2015) also highlighted that integrating cognitive tasks into sports training programs can enhance tactical creativity and decision-making ability among athletes.

Another explanation for the improvements observed in the study may be the concept of neural efficiency. Repeated exposure to simultaneous cognitive and physical challenges improves the efficiency of neural pathways responsible for information processing and motor control. This neural adaptation enables athletes to respond more accurately and quickly during sports activities.

From a practical point of view, the results of this study suggest that coaches and trainers should include cognitive dual-task exercises in regular kabaddi training sessions. Training activities that combine physical drills with reaction signals, decision-making tasks, and visual stimulus exercises may enhance both cognitive and physical aspects of athletic performance.

Overall, the findings of this study emphasize that cognitive dual-task training can serve as an effective approach for enhancing reaction time and decision-making ability among kabaddi players.

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11. RECOMMENDATIONS

Based on the results of this study, several recommendations can be made for coaches, trainers, sports scientists, and future researchers involved in sports training and performance.

First, coaches and trainers are encouraged to incorporate cognitive dual-task training into regular kabaddi practice sessions. Traditional training programs mainly focus on physical fitness components such as strength, speed, agility, and endurance. However, the results of this study indicate that integrating cognitive tasks with physical drills can significantly improve reaction time and decision-making ability among players. Therefore, training activities such as agility drills combined with reaction signals, number recall exercises, and directional decision-making tasks should be included in kabaddi training programs.

Second, sports training institutions and coaching academies should develop structured cognitive training modules specifically designed for kabaddi players. These modules may include visual stimulus drills, reaction-based exercises, and game simulation activities that challenge both cognitive and motor abilities. Such training approaches may enhance perceptual-motor coordination and improve overall game performance.

Third, further research should be conducted to examine the long-term effects of cognitive dual-task training on various performance variables in kabaddi. Future studies may explore additional factors such as anticipation ability, tactical decision-making, spatial awareness, and Performance indicators during matches should also be examined to gain a clearer understanding of how cognitive training contributes to overall sports performance.

Fourth, future investigations should involve a larger number of participants and include athletes from various levels of competition, such as national or professional kabaddi players. Incorporating a more diverse sample would enhance the generalizability of the results and offer a deeper understanding of the effectiveness of cognitive training approaches in kabaddi.

Finally, sports governing bodies and coaching organizations should encourage the integration of modern sports science approaches into traditional training programs. Combining physical conditioning with cognitive training techniques may lead to more comprehensive athlete development and improved competitive performance.

Overall, the incorporation of cognitive dual-task training into kabaddi practice sessions may serve as an effective strategy for enhancing reaction time, decision-making ability, and overall athletic performance.