

**IMPACT OF BRAIN GYM EXERCISES ON  
SKILL-RELATED COMPONENTS AMONG  
DEVELOPMENTAL FOOTBALL PLAYERS – A  
RANDOMIZED CONTROLLED TRIAL**

**by**

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**In**

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**Under the Guidance of**

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2023-2025**

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I hereby declare that this dissertation/thesis entitled “**Impact of Brain Gym Exercises on Skill-Related Components among Developmental Football Players: A Randomised Controlled Trial**” is a bonafide and genuine research work carried out by me under the guidance of Dr. Sunanda Bhowmik (PT), Associate Professor, Abhinav Bindra Sports Medicine and Research Institute, Bhubaneswar, Odisha and there is no conflict of interest associated with this dissertation work.

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## LIST OF ABBREVIATIONS

1. **ACL**- Anterior cruciate ligament
2. **BG**- Brain gym
3. **COD**- Change of direction
4. **DS**- Down syndrome
5. **DTA**- Dual task agility
6. **EF**- Executive function
7. **ICCDT**- Illinois Change of direction test
8. **ICC**- Intraclass correlation coefficient
9. **IEC**- Information, Education and communication
10. **IT**- Illinois test
11. **JT**- Juggling test
12. **RT**- Reaction test
13. **SE**- Standard exercise
14. **SEM**- Structural equation modeling

## ABSTRACT

**Background:** Impact of Brain Gym Exercises on Skill related components among Developmental Football Players- A Randomised Controlled Trial. The aim of the study is to investigate the Impact of Brain Gym Exercises On skill related components among developmental Football Players

**Methods:** Ninety-six male participants both male and female were selected based on specific inclusion and exclusion criteria. Demographic data were collected, and written informed consent was obtained. Participants were categorized into experimental and controlled groups. Both groups followed a standardized 4-week training program, consisting of 12 sessions of brain gym exercises. Coordination, agility and reaction time were measured using the juggling test, Illinois change of direction test (ICODT) and batak lite reaction test, with assessments performed on both dominant and non-dominant lower extremities before and after the intervention.

**Results:** The findings of the study have important implications for youth sports training. The improvements shown across multiple skill-related components suggest that Brain Gym exercises could be valuable additions to developmental football programs. The exercises appear particularly effective for enhancing reaction time and coordination, which are crucial for football performance.

**Conclusion:** According to this study the developmental football players may greatly increase their agility, reaction time, and coordination by using Brain Gym exercises.

**Keywords:** “Football”, “Youth sports”, “Reaction time”, “Exercise”, “Brain”, “Lower extremity”

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# **INTRODUCTION**

## INTRODUCTION

Football (known as soccer in some countries) most popular sport in the world, Football is a team sport involve two teams of eleven players each, competing to goal by moving a ball into the opposing teams net without using their arms or hands (except for the goalkeeper within their penalty area). Matches last for 90minutes, dividing into two halves, ensure fair competition, skilful play and sportsmanship. <sup>1</sup>

According to reports, over 270 million people play football worldwide, both males and females in an organized settings and informal pick-up games. The growth of women's football has been significant in recent years with increase in sponsorship, recognition and fan following. <sup>2</sup>

Football is characterized by its dynamic blend of sudden accelerations, rapid changes in direction, tactical complexity, skill-based passing, dribbling and close contact physical play, the game demands wide range of motor skills i.e. sustained running, explosive sprints, rapid decelerations, sudden changes in trajectory, tackling, leaping and the use of feet, head and trunk to control the ball. Biomechanically, repetitive lower limb actions are involved in football i.e. kicking, pivoting, lateral cuts, planting and jumps- which place considerable amount of load on musculoskeletal system, especially on the knees, ankle and hip joints. Due to anatomical, hormonal and neuromuscular differences female players demonstrate distinct movement patterns such as increased knee valgus while landing compared to males, it alters their biomechanical load response and injury risk profiles. <sup>1</sup>

A comprehensive meta-analysis indicates that for youth players, overall injury incidence rates are 5.70 per 1000 hours in males and 6.77 per 1000 hours in females with match injury rates rising to about 14.4 per 1000 hours for males and 15.0 per 1000 hours for females. [1] Injury rates among adult amateurs and professionals may be higher during high intensity competitive periods, Chances of injuries mostly occur during matches rather than training, with the risk of injury per hour of exposure much greater in competitive play. <sup>3</sup>

Faude et al. (2021) stated that between 60 to 90% football injuries are traumatic and 10 to 40% are overuse injuries. Major Football injuries results due to contact (traumatic) i.e. tackles, collisions or non-contact i.e. sudden change in direction, overstretching, overuse injuries are also prevalent due to insufficient recovery and repetitive loading. In Male players most common injuries occur in lower extremity such as- muscle/tendon strains (especially hamstring and quadriceps), ankle sprains, contusion and ligament injuries, In Females most common injuries are joint/ligament injuries (notably ACL injuries), ankle sprains and muscle injuries. Occurrence of fractures more frequently seen children younger than 15 years than in older players. <sup>4</sup>

Increase in injury risks with age and competitive level, post pubertal adolescents (U17-U19) has highest injury rates compared to younger age group. Elite players experiences higher match injury rates than sub-elite or recreational players, likely due to greater intensity and physical demands.<sup>[1][5]</sup>

Risk of injury is also higher during periods of growth spurts, as there is rapid change in body size and coordination capabilities which can temporarily disrupt motor control and increases injury susceptibility. For Constant change in game dynamics,

unpredictable stimuli and need for rapid adaptations, development of skill-related components including agility, coordination and reaction time necessary. <sup>5</sup>

Agility is defined as ability to quickly respond to unexpected stimuli, like dodging an opponent or change in direction suddenly. More than physical, agility in football relies on brain skills (cognitive processes) such as integration of sensory information, rapid decision making and anticipation of opponent's actions. This is the recent conceptualization in sports science highlighting the "motor-cognitive duality" of sport performance, that is, interdependence between physical actions and higher order cognitive functions like working memory, executive control and perceptual speed. <sup>2</sup>

Coordination is the ability to control and smoothly combine body movements when actions are complex and require fine motor control such as dribbling, passing or performing a series of movement together during game. Coordination depends on good timing, rhythm, and capacity to adapt to rapidly changing and unpredictable environments, not just depends on muscular strength or flexibility. This is particularly important for children and teenagers, since their brains and nervous systems are developing rapidly. Training at this stage can create lasting improvements due to high levels of neuroplasticity in growing athletes. <sup>6</sup>

Reaction time refers to how quickly person responds after noticing a signal, it is the interval between the presentation of a stimulus and the initiation of the appropriate motor response. Quick reactions make the difference between losing the ball and creating a goal scoring opportunity. Faster responses during the game help players anticipate tactics, avoid tackles and use short openings. During developing age when brain connections are forming rapidly the skills like agility, coordination and reaction time develop together, according to research these skills improve not only with age but

also with the training that combines both thinking and movement challenges. In the past youth football training mainly focused on physical drills like running, endurance and strength without involving mental side of the game. Newer studies support the training methods which combines both mental challenges and physical tasks such as multitasking or making tactical choices while under time pressure for example, studies shows that when cognitive tasks are added to agility drills, performance of the player gets better. Friebe et al. (2024) found that adding cognitive elements such as multiple objects tracking or reactive decision making into agility training enhanced football - specific test performance- particularly in tests mimicking the decision taking, multitasking situation of actual matches. <sup>2</sup>

Similarly, another study was done in 2015 by Alesi et al. which stated that participation in well-structured football exercise program not only improved running and coordination skills but also yielded shorter visual discrimination and selective attention times in children, supporting interplay between physical and cognitive development. In the youth football, integration of cognitive challenges during physical activity are more closely reflect the unpredictable, information rich environment of a competitive match, forcing young athletes to constantly switch attention and make rapid tactical decisions. Such approaches are supported by neurological research indicating that complex motor activities, involving coordinative and cognitive elements are effective in promoting changes in brain structure and function, including enhanced connectivity and increased volumes in relevant cortical areas. <sup>7</sup>

Brain gym has been popular for movement-based intervention designed to enhance cognitive performance through structured physical activities. Brain gym consists of a series of simple movements that develop neural integration, promotes hemispheric

balance and enhance variety of cognitive functions such as memory, attention and processing speed. Brain gym exercises, including cross lateral movements (such as cross crawls and lazy eights), energy exercises (such as brain buttons) and postural adjustments, these exercises stimulate both sensory and motor cortices, inducing neuroplastic changes that positively impact cognitive, academic and athletic outcomes. These exercises are easily accessible, minimal equipment required and can be practiced in both individual and group settings, and making it attractive for incorporation into school-based settings and sports training environments. <sup>8</sup>

Pasko et al. (2021) conducted one of the largest assessments of cognitive abilities in youth practicing football, revealing statistically significant relationship between age and psychomotor performance (hand-eye coordination, reaction time, spatial orientation) and also shows positive correlations between physical fitness and psychomotor test scores. Activities like ball juggling which is practiced as a fun drill, have shown improvement in working memory and executive function through sustained engagement of perceptual and cognitive circuits which are responsible for simultaneous management of multiple motor and sensory demands. Brain gym exercises when combined with football drills, boost brain function, sharpen attention and help young athletes showcase what they have learn in practice into real-game scenarios.<sup>[9][10]</sup>

Need for the study:

In sport like football quick decision making, agility, coordination and fast reaction time is required. These skills are especially important in young players, as it influence both performance and injury prevention. Brain Gym Exercises mainly focuses on improving learning, attention and motor skills and their influence on football specific skills like agility, coordination and reaction time has not been well explored yet. Most existing

studies have been done in older population, preschool children and adults mainly on balance and cognitive function. There is lack of evidence which suggests the effectiveness of brain gym exercises on skill related components among developmental football players (6-12years). The research aims to scientifically examine whether brain gym exercises can bring improvement in skill related components (i.e. agility, coordination, and reaction time).

## **AIM AND OBJECTIVES**

### **AIM OF THE STUDY**

1. To find the effect of brain gym exercises on agility among football players
2. To find the effect of brain gym exercises on coordination among football players
3. To find the effect of brain gym exercises on reaction time among football players

### **OBJECTIVES OF THE STUDY**

1. To evaluate the effectiveness of Brain gym exercises in enhancing the Agility among football players using illinois change of direction test
2. To evaluate the effectiveness of Brain gym exercises in enhancing the Coordination among football players using juggling test
3. To evaluate the effectiveness of Brain gym exercises in enhancing the Reaction time among football players using batak lite reaction test

## **HYPOTHESIS OF THE STUDY**

## **HYPOTHESIS OF THE STUDY**

**Null Hypothesis:** There will be no significant impact of Brain Gym Exercises on football skills (Agility, Coordination and Reaction time) in Football players

**Alternate Hypothesis:** There will be significant impact of Brain Gym Exercises on football skills (Agility, Coordination and Reaction time) in Football players

## **REVIEW OF LITERATURE**

## **REVIEW OF LITERATURE**

### **SECTION 1: LITERATURE REGARDING EPIDEMIOLOGY OF INJURIES AND BIOMECHANICS OF FOOTBALL**

1. A review published in 2004 by Mark S. Adickes and Michael J. Stuart et al. on Youth Football Injuries, aim of the study was to review the existing literature on injuries in youth football (soccer), focusing on the types and frequency of injuries in children who play organized football before high school, and to discuss common injuries, their diagnosis, and treatment. The result of the study found that injury rates in young football players are generally low compared to older athletes, but as kids grow bigger, faster, and stronger, their risk of injury increases. The most common injuries occur in the knee, ankle, wrist, and hand, with serious injuries like brain or spine trauma being very rare. Certain positions, such as quarterbacks and running backs, are injured more often than others. Most injuries are minor and can be managed with proper care and recovery. The study emphasizes that teaching correct techniques, enforcing rules, and ensuring good-fitting protective equipment are key to preventing injuries in young football players.
2. A study done in 2009 by Anne Froholdt, MD, Odd Egil Olsen, PT, PhD et al. on Low Risk of Injuries Among Children Playing Organized Soccer : A Prospective Cohort Study, aim of the study was to find out how often injuries happen and how serious they are among children aged 6 to 12 years playing organized soccer, as well as to compare their injury risk with that of older players aged 13 to 16 years. The result of the study found that young children playing soccer (ages 6–12) have a very low risk of injury, especially compared to teenagers and adult players. Most injuries in the younger age group were mild, and serious injuries were very rare.

The chance of getting injured was higher in matches than during practice, but overall, playing soccer is safe for children, with most injuries being minor bumps or strains. The results suggest that parents need not worry much about serious injuries if their children are playing organized soccer, as the activity is generally safe for kids.

3. A study done in 2020 by Alejandro López-Valenciano, Iñaki Ruiz-Pérez<sup>1</sup>, Alberto Garcia-Gómez et al. on Epidemiology of injuries in professional football: a systematic review and meta-analysis, aim of the study was to systematically review and analyze the frequency and types of injuries that professional male football players sustain, including when and where these injuries happen, and how severe they are, to help improve injury prevention strategies. The result of the study found that professional male football players face a high risk of injuries, particularly during matches, where injuries are about ten times more common than in training. Most injuries affect the leg, especially the thigh and knee, with muscle or tendon strains being the most frequent type. While many injuries cause only minor time off, new injuries happen more often than repeated ones. The study also showed that injury rates are similar across top European leagues and other professional leagues worldwide. Overall, the findings highlight that football players are vulnerable to injuries and that better preventive measures—especially focusing on muscle and tendon injuries—are needed to protect players and help teams perform better.
4. A review published in 2021 by Gabriele Thiebat, Andrea Spreafico et al. on Incidence of injuries in young soccer players: epidemiological study in an Italian elite club, aim of the study was to analyze the types and frequency of injuries in young soccer players from an Italian professional club over three seasons, focusing on different age groups and periods during the season. The result of the study found

that young soccer players get injured quite often, with older players (around 16-17 years old) being more prone to injuries than younger ones. Injuries to the thigh were common in older kids, while younger players mostly hurt their feet and ankles. Injuries were more frequent during the preseason and the end of the season. Most injuries happened during training rather than official matches. The study highlights the importance of injury prevention programs tailored to the age of the players and the time of the season to keep young athletes healthy and playing safely.

5. A review published in 2021 by Roland Rössler, Astrid Junge, Jiri Chomiak et al. on Risk factors for football injuries in young players aged 7 to 12 years, aim of the study was to identify and analyze the risk factors for football injuries in young players aged 7 to 12 years by collecting injury and exposure data prospectively over two seasons in Switzerland and the Czech Republic. The results of the study found that the risk of injury in young football players increases as they get older, with taller children having a higher risk of getting injured. Players who prefer their left foot also had a higher chance of training injuries. Playing on artificial turf increased the injury risk compared to natural grass, while playing indoors lowered the risk. Additionally, players who spent relatively more time training compared to match play tended to have fewer injuries during matches. The study suggests coaches should pay special attention to taller players, girls, left-footed players, and playing surfaces when planning training and injury prevention to keep young players safer.
6. A review published in 2022 by Francisco Javier Robles-Palazón ,Alejandro López-Valenciano, Raya-González, García-Gómez et al. on Epidemiology of injuries in male and female youth football players: A systematic review and meta-analysis, aim of the study was to systematically review and analyze the injury rates and patterns in male and female youth football (soccer) players under 19 years old,

comparing differences by sex, age groups, injury types, locations, severity, and levels of play. The results of the study found that youth soccer players, both boys and girls, face a high risk of injuries, especially during matches compared to training. Boys tend to get more muscle injuries, mainly in the thigh, while girls have more joint and ligament injuries, particularly in the knee and ankle. Injury rates increase as players get older, with older teens having more injuries than younger children. Elite players also tend to have higher injury rates in matches than less competitive players. Most injuries are to the lower body, like thighs, knees, and ankles. Importantly, many injuries are minor, but some can be severe, causing them to miss over a month of play. The findings highlight the need for injury prevention programs tailored by sex and age to keep young players safe and support healthy development in their sport.

7. A review published in 2023 by Johannes Weishorn, Ayham Jaber et al. on Injury Patterns and Incidence in an Elite Youth Football Academy—A Prospective Cohort Study of 138 Male Athletes, aim of the study was to investigate injury patterns, incidence, overuse and trauma-related injuries during the season, and the risk of re-injury in male players from an elite youth football academy in Germany. The result of the study found that in a team of 25 players, about 20 injuries happen in a season, causing players to miss nearly a quarter of the season on average due to injury. Most injuries affect the lower limbs, especially the ankle, thigh, and knee. Ligament sprains and muscle strains are the most common injuries, while growth plate (physeal) injuries are a major cause of severe injury and require special attention. Injuries happen more often during training than matches, but injuries during matches result in longer recovery times. Re-injuries are rare but cause much longer absences than first-time injuries. The findings highlight the importance of

monitoring growth, managing training loads carefully, and focusing on prevention programs to reduce injury risk and protect the development of young players.

## **SECTION 2: LITERATURE REGARDING BRAIN GYM EXERCISES**

8. A study done in 2015 by José María Cancela, M Helena Vila et al. on Efficacy of Brain Gym Training on the Cognitive Performance and Fitness Level of Active Older Adults: A Preliminary Study, aim of the study was to evaluate the efficacy of Brain Gym training on the cognitive performance and fitness level of active older adults. The result of the study found that Brain Gym exercises, when performed alone or combined with other exercise programs, did not significantly improve cognitive functions such as attention, memory, or overall performance in older adults compared to traditional exercise programs. However, all exercise programs, including Brain Gym, helped improve physical fitness aspects like balance, agility, and aerobic capacity. Thus, Brain Gym was as effective as traditional exercises in maintaining or enhancing fitness levels, but it did not show additional benefits for cognitive performance in healthy, active older adults. The authors suggest that Brain Gym may have more potential benefits in populations with cognitive impairments and recommend further research with different populations and longer interventions.
9. A study done in 2020 by Cancela et al. published in Asian Journal of Gerontology & Geriatrics, aim of the study was to compare the effects of Brain Gym (BG) exercises and standard exercise (SE) on cognitive function, functional independence, physical fitness, and quality of life among institutionalized older adults with cognitive impairment. Participants were randomly assigned to either the BG or SE group and participated in two 1-hour sessions per week for 10 weeks. The

result of the study indicated that both BG and SE had similar effects on cognitive function, functional independence, quality of life, and fitness levels among participants. Neither exercise program significantly improved cognitive levels or functional independence, suggesting that both approaches may be equally beneficial for this population in maintaining their current cognitive and physical status.

10. A study done in 2021 by Nikita seth et al. on Efficacy of brain gym exercises for improving quality of sleep in physiotherapy students aim of the study was to assess whether doing brain gym exercises could help improve the quality of sleep in physiotherapy students who have insomnia. The researchers wanted to see if this non-drug, physical activity intervention could be effective for those with mild to moderate sleep problems. The result of the study was that practicing brain gym exercises regularly may help students sleep better and lower their insomnia. The exercises are thought to encourage relaxation, better brain function, and an overall improvement in sleep quality. The authors suggest that brain gym is a safe, practical way to tackle sleep issues in students without relying on medication
11. A study done in 2022 by Lina, R., & Kurniawan, G. on Brain Gym Exercise Give Benefit to Improve Cognitive Function among Elderly: A Systematic Review, aim of the study was to explores the effectiveness of Brain Gym exercises in improving cognitive function among the elderly, particularly in Indonesia, where cognitive impairment is a growing concern due to an aging population. The systematic review analyzed multiple studies and found that Brain Gym exercises significantly improve cognitive function in elderly participants, with statistical evidence supporting these findings ( $p < 0.05$ ). Additionally, the exercises were associated with reduced stress levels and improved physical activity. The authors recommend further research to

explore the long-term effects of Brain Gym interventions and their applicability in various settings to optimize cognitive health in older adults.

12. A study done in 2022 by Łukasz Bojkowski, Paweł Kalinowski et al. on The Importance of Selected Coordination Motor Skills for an Individual Football Player's Effectiveness in a Game, aim of the study to investigate the relationship between two key coordination motor skills—adaptability and complex reaction time—and the effectiveness of individual football players in attack, defense, and overall performance during one-on-one game situations. The result of the study found that both adaptability (the ability to quickly adjust movements) and complex reaction time (the speed of responding to varied stimuli) are important for a football player's success during one-on-one situations. Players who were quicker to react and better at adapting performed more effectively in offensive and comprehensive tasks, and reaction time was especially critical for defensive success. The study suggests that training programs should focus on developing these coordination skills to enhance player effectiveness. However, the authors also noted that these skills explain only a portion of a player's performance, indicating that other factors also contribute to success on the field. They recommend further research including more diverse variables and broader populations.

13. A study done in 2023 by Manjula S, Senthil Selvam P et al. on Effects of Brain Gym Exercises in Improving Memory among Adults, aim of the study was to investigate the effects of neuroplasticity-based brain gym exercises on improving attention among adults aged 30-40 years. Thirty participants with attention deficits were divided into an experimental group receiving brain gym exercises and a control group receiving aerobic exercises for six weeks. The experimental group performed exercises like cross crawls, "Think of X," lazy eights, neck rolls, and

brain buttons for 30 minutes daily, five days a week. The control group engaged in 30 minutes of aerobic exercises. The outcome measure was the Attention Control Scale. The result of the study was analyzed via a paired t-test, indicated that the brain gym exercises significantly improved attention in the experimental group compared to the control group ( $p < 0.001$ ). The study concluded that brain gym exercises are effective in improving attention among adults.

14. A study done in 2023 by Silvia Varela, PhD et al. on The effect of Brain Gym on cognitive function in older people: A systematic review and meta-analysis, the study aim to investigates the effectiveness of Brain Gym exercises in enhancing cognitive function among older adults. Given the rising incidence of cognitive decline and dementia, there is a pressing need for effective interventions to maintain cognitive health. The systematic review and meta-analysis analyzed multiple studies on this topic. While some positive changes in cognitive function were observed within the Brain Gym groups, these improvements were not statistically significant compared to control groups. The result of the study was that Brain Gym exercises do not lead to meaningful enhancements in cognitive function for elderly individuals, whether they have cognitive impairments or not. They recommend further research to explore other exercise modalities to improve cognitive health in older adults.

15. A review published in 2023 by Pazare, Fernandes, and Sadawarte et al. in Journal of Pediatric Physical Therapy, The study investigates the effectiveness of Brain Gym exercises on improving balance in preschool children and study aimed to determine if these exercises could enhance balance skills, which are crucial for physical development and motor skills in early childhood. The result of the study revealed that Brain Gym exercises significantly improved balance in preschool

children compared to the control group. After a structured intervention over several weeks, the participants showed marked improvements in balance assessments. The authors suggest incorporating Brain Gym into early childhood education programs to enhance physical abilities and promote overall motor development. They recommend further research to explore the long-term effects of these interventions on children's physical development.

16. A review published in 2023 by Dr. Shamla Pazare, Florine Fernandes et al. on The Effect of Brain Gym Exercises on Cognition among Geriatrics, aim of the study was to evaluate the impact of Brain Gym exercises on cognitive function in elderly individuals. The research sought to determine if these exercises could enhance cognitive abilities and overall mental health in older adults, especially those experiencing cognitive decline. The result of the study found that Brain Gym exercises significantly improved cognitive functions such as memory, attention, and problem-solving skills among the participants after a structured program over a specified period. The authors advocate for the inclusion of such non-pharmacological interventions in managing cognitive impairment in geriatrics, suggesting that it could lead to better mental health and quality of life. They also recommend further research to examine the long-term effects and to establish optimal exercise protocols for various populations.
17. A study done in 2024 by Aliaa A. Goda, Mohamed B. Ibrahim et al. on effect of brain gym exercises on postural stability in children with down syndrome, aim of the study was to investigate the effect of Brain Gym exercises on postural stability in children aged 6 to 12 years with Down Syndrome (DS). The result of the study found that Brain Gym exercises significantly improved postural stability, balance, and functional movement in children with Down Syndrome compared to traditional

balance programs. The children who performed Brain Gym exercises showed notable enhancements in single-leg stance, functional mobility (measured by the Timed Up and Go test), and overall balance as assessed by the Pediatric Balance Scale. The researchers concluded that Brain Gym is an effective and practical intervention to help improve balance and motor skills in children with DS, potentially leading to better physical functioning and quality of life. The study also suggests that Brain Gym exercises are easy to administer and can be integrated into therapy programs for children with developmental challenges.

18. A study done in 2024 by David Friebe, Winfried Banzer et al. on Effects of 6-Week Motor-Cognitive Agility Training on Football Test Performance in Adult Amateur Players – A Three-Armed Randomized Controlled Trial, aim of the study was to examine the effects of three different training approaches—change of direction (COD) training, agility training, and dual-task agility training integrating multiple object tracking (DT-Agility)—on football-specific and agility performance in adult amateur soccer players. The result of the study found that all training methods improved players' ability to change direction and dribble without additional cognitive challenges. However, only the agility and dual-task agility trainings led to improvements in football-specific skills that require decision-making and multitasking, such as dribbling with cognitive distractions and reactive agility. There were no significant differences between the agility and dual-task agility groups, suggesting that adding the cognitive task of multiple object tracking did not provide extra benefits beyond traditional agility training. Importantly, training with cognitive components not only enhanced performance but also maintained higher enjoyment and controlled exertion better than change of direction training alone.

The authors recommend incorporating cognitive challenges into agility training to better prepare soccer players for the complex demands of real game situations.

19. A study done in 2025 by Manjula S. and Dr. P. Senthil Selvam et al. on Effects of neuroplasticity-based brain gym exercises on concentration among college students, aim of the study was to assess the effects of neuroplasticity-based Brain Gym exercises on concentration among college students aged 18 to 22 years. The result of the study found that students who performed Brain Gym exercises daily for eight weeks showed significant improvement in their concentration compared to those who only received awareness training about Brain Gym exercises. The exercises included specific movements like cross crawls, "Think of X," lazy eights, neck rolls, and brain buttons, which are designed to stimulate brain function and enhance focus. The researchers concluded that Brain Gym exercises are effective and more beneficial in boosting concentration levels in college students.

### **SECTION 3: LITERATURE REGARDING SELECTION OF OUTCOME MEASURE**

20. A study done in 2017 by Yassine Negra, Helmi Chaabene et al. on Evaluation of the Illinois Change of Direction Test in Youth Elite Soccer Players of Different Age, aim of the study was to evaluate the reliability, usefulness, and relationship with body size of the Illinois Change of Direction Test (ICODT) in young elite soccer players across different age groups (U8, U10, U12, U14). The result of the study found that the ICODT is a highly reliable test for measuring change of direction (COD) ability in young soccer players. It effectively distinguishes performance differences between age groups, showing that older players tend to perform better due to developmental factors. Importantly, the test scores were not influenced by players' body size (height or weight), indicating that the test does not

require adjustments based on these factors. The ICODT was able to detect small changes in performance in younger age groups (U10 and U12), making it useful for tracking progress. Overall, the study supports using the Illinois COD test as a standard measure in youth soccer to assess and monitor agility and COD without being biased by body size differences.

21. A study done in 2022 by Issam Makhoulf, Amel Tayech et al. on Reliability and validity of a modified Illinois change-of-direction test with ball dribbling speed in young soccer players, aim of the study was to evaluate the reliability, validity, and discriminative ability of a modified Illinois change-of-direction test with ball dribbling speed (ICODT-BALL) in young soccer players of varying biological maturity and playing levels. The researchers also examined the relationships between this test and other performance measures such as sprint speed, muscle strength, power, and balance. The result of the study found that the ICODT-BALL is a highly reliable and valid test for assessing young soccer players' ability to quickly change direction while dribbling a ball. The test effectively distinguishes between players of different ages, maturity levels, and skill levels, with elite and more mature players performing better. The ICODT-BALL showed strong links to sprinting speed and moderate connections to muscle strength and jumping power, indicating these physical qualities support good performance in the test. The authors conclude that coaches can use the ICODT-BALL to monitor players' progress, identify talented athletes, and tailor training programs to improve dribbling and agility skills specific to soccer.
22. A study done in 2024 by Dimitris Chatzopoulos, Zoi Papageorgaki et al. on Reliability and Validity of Soccer Tests for Novice Elementary School Children, aim of the study was to examine the reliability and validity of a set of soccer skill

tests (passing, dribbling, juggling, and shooting) designed specifically for novice elementary school children who have little or no prior soccer training. The goal was to develop tests suitable for school settings that are easy to administer, affordable, and motivating for young beginners. The result of the study found that the ICODT is a highly reliable test for measuring change of direction (COD) ability in young soccer players. It effectively distinguishes performance differences between age groups, showing that older players tend to perform better due to developmental factors. Importantly, the test scores were not influenced by players' body size (height or weight), indicating that the test does not require adjustments based on these factors. The ICODT was able to detect small changes in performance in younger age groups (U10 and U12), making it useful for tracking progress. Overall, the study supports using the Illinois COD test as a standard measure in youth soccer to assess and monitor agility and COD without being biased by body size differences.

23. A study done in 2024 by Xiaoxiao Dong, Xiang Gui, Sebastian Klich et al. on The effects of football juggling learning on executive function and brain functional connectivity, aim of the study was to investigate how learning football juggling over 70 sessions affects executive function (EF)—which includes cognitive skills like inhibition, working memory, and shifting—and brain functional connectivity in young adults. They compared participants who learned football juggling with a control group that did not engage in such motor learning. The result of the study found that practicing football juggling significantly improved certain cognitive functions, especially the ability to suppress distractions (inhibition) and switch between tasks (shifting), more than doing no activity. Additionally, juggling training enhanced the communication between key brain areas involved in

movement and cognition, particularly between regions in the temporal lobe and cerebellum. This strengthening of brain connections was linked to the cognitive improvements observed. The study suggests that learning complex motor skills like juggling can promote brain plasticity and cognitive enhancement, highlighting its potential as a useful approach for improving mental functions.

24. A study done in 2016 by EVANGELOS BEKRIS, ARISTOTELIS GIOLDASIS et al. on juggling test battery, aim of the study was to develop and validate a battery of juggling tests with increasing difficulty to evaluate soccer players' ability to juggle a ball using the dominant foot, incorporating movements that simulate actual soccer conditions, the researchers created a series of juggling tests that progressively became harder by adding elements like zigzag movements, hurdles, and using multiple body parts in specific sequences. The result of the study found that these tests are reliable and valid for assessing juggling skills relevant to soccer. The difficulty levels were effectively increased, allowing coaches to distinguish players' juggling abilities better. This battery of tests can help coaches design training programs focused on improving players' coordination, balance, and ball control, thereby enhancing overall soccer skills in athletes.
25. A study done in 2016 by Zbigniew Bujak, Dariusz Gierczuk et al. on Criteria of assessing quick reaction in taekwondo athletes aged 12-25, aim of the study was to evaluate the reliability and diagnostic validity of selected quick reaction tests included in the Batak Lite system for use with taekwondo athletes aged 12 to 25 years and to develop norms for assessing reaction performance across different ages, genders, and skill levels. The result of the study found that four of the Batak Lite quick reaction tests demonstrated good reliability and validity when measuring the reaction speed of taekwondo athletes. The tests were particularly effective in

assessing both simple and choice reaction times, which are important for the rapid decision-making and physical responses required in taekwondo. Based on the results, the study provided normative data to help coaches and trainers evaluate and monitor athletes' reaction abilities according to their age, gender, and level of competition. These tools can assist in optimizing training programs to improve reaction skills, which are critical for successful performance in martial arts.

26. A study done in 2014 by *dariusz gierczuk, zbigniew bujak et al.* on reliability and accuracy of *batak lite* tests used for assessing coordination motor abilities in wrestlers, aim of the study was to evaluate the reliability and accuracy of selected *Batak Lite* motor tests as tools for assessing coordination motor abilities in Greco-Roman wrestlers. The researchers wanted to determine whether these tests could effectively monitor coordination skills important in combat sports. The result of the study found that four of the *Batak Lite* tests showed good reliability and diagnostic accuracy for measuring coordination abilities in wrestlers. These tests were particularly effective in assessing quick reaction, spatial-temporal orientation, and movement coordination—key abilities for wrestling performance. The study concluded that these *Batak Lite* tests are useful and practical tools that coaches can use to track the development of coordination skills in wrestlers during training and selection. They also recommended that these tests could be applied in other combat sports to improve training and athlete evaluation.

## **METHODOLOGY & PROCEDURE**

## METHODOLOGY & PROCEDURE

- **STUDY DESIGN:** A Two group Pre-test Post-test Randomized controlled Trial
- **STUDY POPULATION:** Healthy Developmental school going children
- **SAMPLE SIZE:** 96
- **SAMPLING TECHNIQUE:** Purposive sampling
- **STUDY SETTING:** Mother's Public School, Pahala
- **STUDY DURATION:** 1 year
  - Ethical clearance, Protocol work: within 6 months
  - Sample selection, data collection: 4 months
  - Statistical analysis, results analysis, discussion: 2 months
- **MATERIALS USED:**
  - Agility cones
  - Measuring tape
  - Batak lite
  - Football
  - Performance scoring sheet
  - Stopwatch

➤ **INCLUSION CRITERIA:**

1. Age group - 06-12 years.
2. Both Male & Female
3. MMSE Score- 24-30
4. Able to follow commands related to study

➤ **EXCLUSION CRITERIA:**

1. Clinically diagnosed with Mental Disorders
2. Currently going through any Musculoskeletal Injuries
3. Pre-existing cognitive impairments

➤ **OUTCOME MEASURES:**

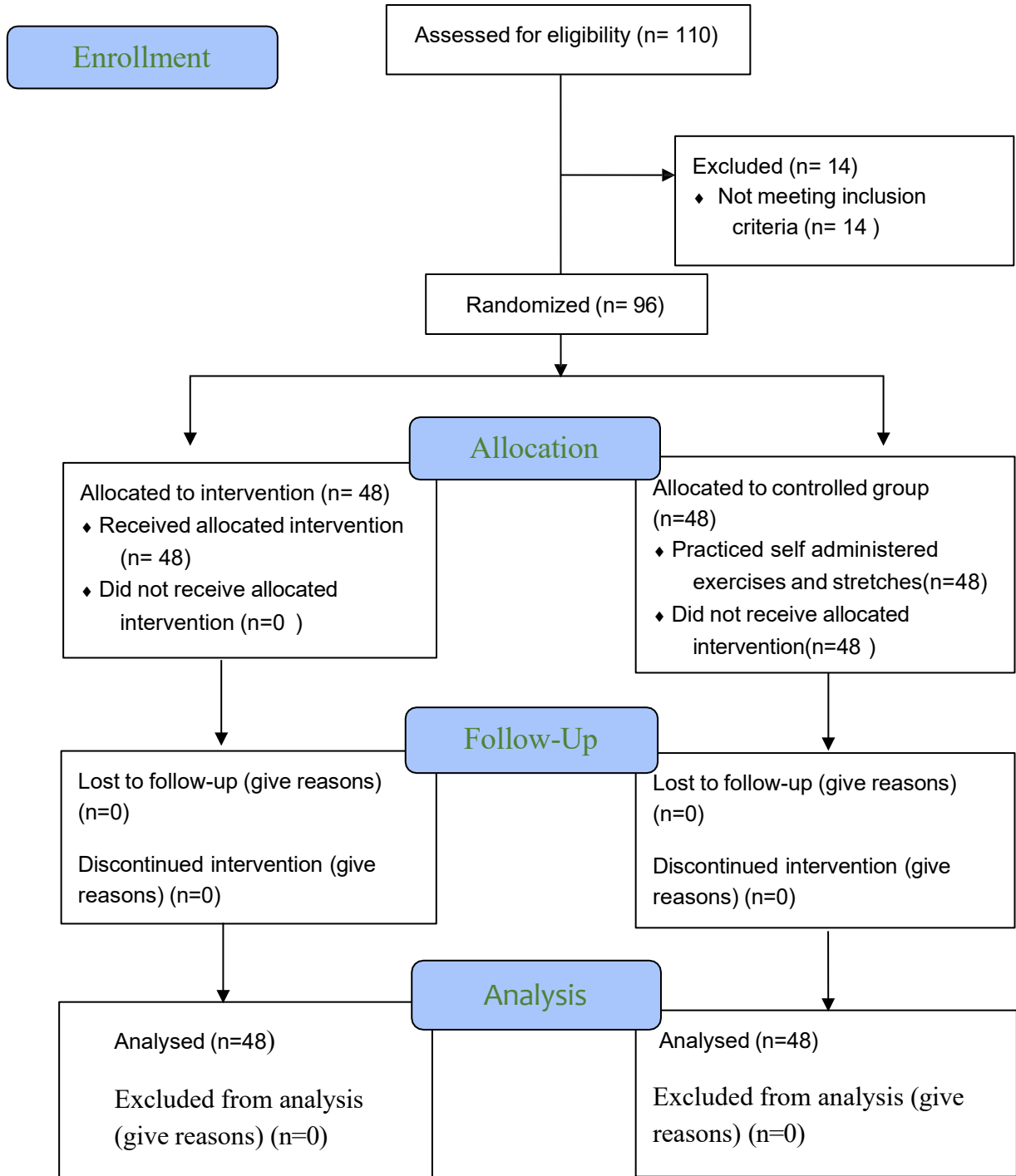
Primary Outcome Measures:

1. Illinois Change of direction Test (ICODT)
2. Batak Lite Reaction Test

Secondary Outcome Measures:

3. Juggling test

**FIGURE 1.1: CONSORT 2010 Flow Diagram**



➤ **PROCEDURE**

- An experimental study was undertaken at Mother's Public School, Pahala, Odisha. 96 participants were selected based on the inclusion and exclusion criteria.
- A brief demographic data of all the participants was obtained, Permission from school authority was taken, written consent was taken from all the participants, and the experimental protocol was explained with its benefits and Precautions. The study duration was 4 weeks which included 12 sessions of experimental protocol. 96 Participants, who cleared the inclusion criteria were divided to interventional and control group.
- Interventional group underwent Brain gym exercises and Control group underwent self-administered stretches and strengthening exercises. Coordination, Agility and Reaction time were assessed for each participant by Juggling test, Illinois change of direction test (ICODT) and Batak lite reaction test. These outcome measures were assessed prior to the commencement of the study and after 4 weeks.
- There were no adverse events during the training sessions.

TABLE NO.2.1: REPRESENTS GROUP SPECIFIC ALLOCATION WITH INTERVENTION

EXPERIMENTAL GROUP	CONTROL GROUP
<p>BRAIN GYM EXERCISES</p> <p>(n=48)</p>	<p>SELF ADMINISTERED STRETCHES AND SELF-ADMINISTERED STRENGTHENING EXERCISES</p> <p>(n=48)</p>
<p>THIS GROUP UNDERWENT BRAIN-GYM EXERCISES</p>	<p>THIS GROUP UNDERWENT SELF ADMINISTERED STRETCHES AND SELF-ADMINISTERED STRENGTHENING EXERCISES</p>
<ol style="list-style-type: none"> <li>1. PRE-INTERVENTION SCORING</li> <li>2. 10 BRAIM-GYM EXERCISES FOR 40 MIN/SESSION- <ul style="list-style-type: none"> <li>• Spot marching- Warm up (15 Minutes)</li> <li>• Hook-ups- Helps in mind and body relaxation</li> <li>• Positive points- Helps to improve memory and reduce stress levels</li> <li>• The active arms- Helps in activating brain for diaphragm relaxation, improves hand eye co-ordination and tool controlling skills</li> </ul> </li> </ol>	<ol style="list-style-type: none"> <li>1. PRE-INTERVENTION SCORING</li> <li>2. WARM-UP – 15 MINUTES</li> <li>3. INTERVENTION – 40 MIN/SESSION</li> <li>4. 3DAYS/WEEK FOR 4 WEEKS</li> <li>5. POST-INTERVENTION SCORING</li> </ol>

- Earth buttons- Helps in improving mental alertness and whole-body orientation
- The energy yawns- Perfect exercise to improve oxygenation
- A lazy 8's- Helps in boosting eye muscle control, balance and concentration
- Gravity glider- Improving the blood and oxygen flow. It boosts confidence and improves stability
- Foot flex- Improves posture and socialization, and also relaxation
- The energizer- It helps in improving posture, keeps the back muscle toned and the spine supple, flexible and relaxed

**3. 3DAYS/WEEK FOR 4 WEEKS**

**4. POST-INTERVENTION SCORING**

**PRE-POST INTERVENTION SCORING WAS**

**DONE BY:**

1. Illinois Change of direction Test (ICODT)

2. Batak Lite Reaction Test

3. JUGGLING TEST

**PRE-POST INTERVENTION SCORING WAS**

**DONE BY:**

1. Illinois Change of direction Test (ICODT)

2. Batak Lite Reaction Test

3. JUGGLING TEST



FIG-2.1



FIG- 2.2



FIG-2.3

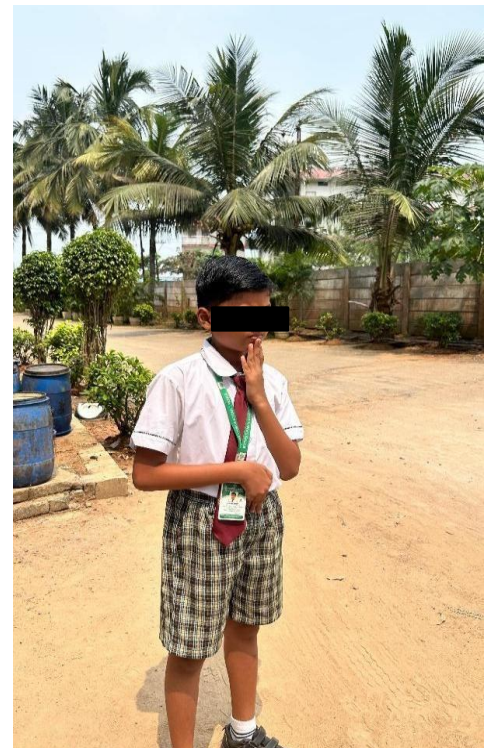


FIG-2.4



FIG-2.5



FIG-2.6



FIG-2.7



FIG-2.8

## **OUTCOME MEASURES:**

### **ILLINOIS CHANGE OF DIRECTION TEST (ICODT):**

ICODT Widely used to measure athletes agility such as ability to accelerate, decelerate and COD quickly, monitor training progress and for designing agility improvement programs.

It is suitable for both youth and adults but valuable for tracking development in children and teenagers, especially important in team sports where players have to sprint, stop, turn and start again in different directions.

#### **Procedure**

##### **Setup:**

- Four cones mark a rectangular area (10 meters long × 5 meters wide).
- Four additional cones are set in the center, each 3.3 meters apart.

##### **Execution:**

- The athlete starts from a designated line, sprints 10 meters forward, returns to the start, weaves in and out of the central cones, then finishes with a second 10-meter straight sprint.
- If a cone is missed or knocked down, the run is repeated.

Timing is recorded with a stopwatch; the test is repeated three times, and the fastest time is recorded as the score (Faster time: better agility)

##### **Rest:**

- Three minutes of passive recovery separates each trial to minimize fatigue effects.

Studies reported ICODT as highly reliable for both young and adult athletes. Scientific studies report excellent reliability scores with ICC consistently above 0.9. And the test is valid because it measures the agility component as well as change of direction.

Another study states that the test has ecological validity as it closely mimics the real demands of sports like soccer where quick, repeated change in direction are needed.

### **BATAK LITE REACTION TEST:**

Batak lite reaction test, usually used for upper limb coordination and quickness, but can be adapted for lower limb (leg/foot) reaction testing , participants need to hit the buttons with their feet instead of hands when it turns on, as soon as the light is hit another one lights up in a new random spot and the sequence continues for a set time (30 seconds) the score is the total number of correctly hit lights during the time period.

(Higher score indicates better lower limb reaction speed, coordination and accuracy)

### **Procedure**

**Setup:** The participant stands in front of the Batak Lite device, equipped with a panel of lighted buttons arranged in a framework controlled by a microcomputer, which controls the random illumination sequence.

**Execution:** When a button lights up, the participant must quickly press it with their foot. Upon successful press, another light randomly illuminates, and the participant continues responding as fast as possible.

**Duration:** The test is usually timed for 30 seconds, although variations exist (e.g., 2-minute versions for endurance).

**Scoring:** The total count of lights successfully pressed during the test period is recorded. More presses reflect better reaction speed and coordination.

This test is especially suitable for the sports which require fast footwork, agility and reacting to visual cues.

Studies on athletes, especially combat sport practitioners like wrestlers and taekwondo athletes, demonstrate that selected Batak Lite tests have reliability coefficients ranging from 0.50 to 0.88, meeting accepted standards for sports testing.

Validity analyses show clear correlations (validity coefficients  $>0.30$ ) with other standard psychomotor tests such as those from the Vienna Test System, particularly relating to quick reaction, choice reaction, and motor response.

### **JUGGLING TEST:**

The juggling test for lower limb usually known as football juggling test or soccer juggling test, it is usually used to assess skills in soccer players (such as- participant technique, coordination, ball control and foot eye reaction skills)

Aim in this test is how many consecutive touches the participant can achieve, within a set timeframe (i.e. 30secs) or up to a fixed number of touches recorded. Two or three tries for familiarization and then the best score is recorded

### **Procedure**

**Execution:** Upon the signal, the participant begins juggling the ball using primarily the dominant foot, aiming to keep the ball in the air by tapping it consecutively without letting it touch the ground.

**Duration:** The test is generally performed either as a maximum number of touches within 30 seconds or until a maximum allowable number of touches (such as 100) is reached.

**Scoring:** The total count of successful touches without losing control of the ball is recorded. If the ball drops, the participant may resume juggling, but only touches during uninterrupted juggles count.

**Trials:** Participants are given a few practice attempts to get familiar with the test. Then, multiple formal trials are recorded, and the best score is considered for evaluation.

Chatzopoulos D, Papageorgaki Z et al. reported that juggling test has high reliability if an individual repeats the test under same conditions, result is often similar over time.

The test-retest reliability coefficient ( $r$ ) was above 0.77 for children and above 0.80 for soccer academy players

# **STATISTICAL ANALYSIS**

## STATISTICAL ANALYSIS

Mathematical evaluation for the present study was performed manually and also by using Statistical Product and Service Solution 27 Version so as to authenticate the results found. The data was filled into an excel sheet and then tabulated which was then subjected for evaluation for the same. Numerous mathematical calculations such as mean, median, standard deviation were employed. A total of 96 participants were analyzed (Experimental group = 48; Control group = 48). Baseline characteristics were comparable across groups. Normality of the distributions was assessed using the Shapiro–Wilk test. Most change scores deviated from normality ( $p < 0.05$ ), hence non- parametric tests (Wilcoxon signed-rank for within-group; Mann–Whitney U for between-group) were primarily used. Where normality was satisfied, t-tests were reported with Cohen’s d effect sizes and 95% confidence intervals.

## **RESULTS**

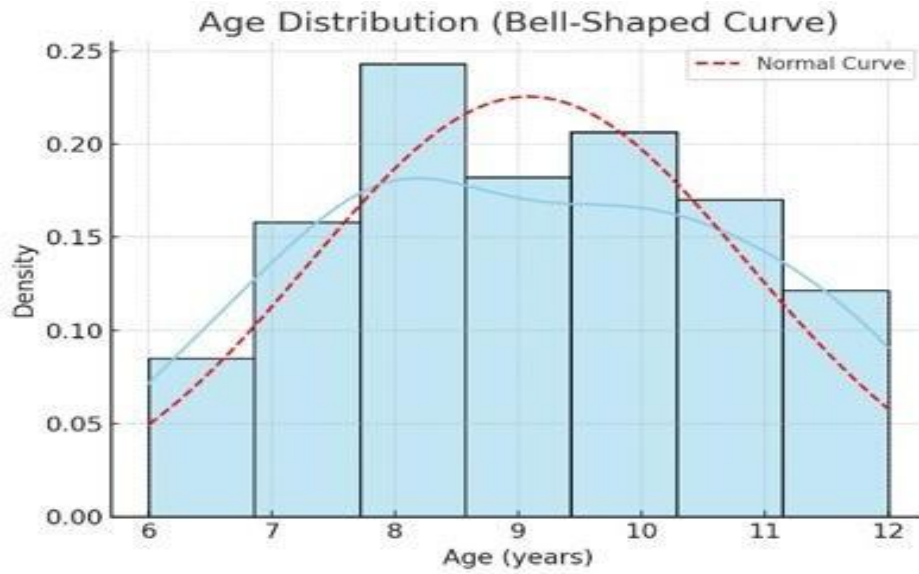
## RESULTS

In the present study, “IMPACT OF BRAIN GYM EXERCISES ON SKILL RELATED COMPONENTS AMONG DEVELOPMENTAL FOOTBALL PLAYERS” included 96 subjects in 2 specific groups who received group specific intervention and scored after 4 weeks of post intervention. The pre and post test results were based on outcome measures JUGGLING TEST, ICODT, and BATAK LITE REACTION TEST. The analyses were conducted at a significance level of 0.05 (95% confidence level)

### DEMOGRAPHIC DETAILS

Total number of participants 96, EG consisted of 48 children (19 male & 29 female), CG consisted of 48 children (28 male & 20 female) with mean age ( $9.08 \pm 1.77$ ) years, ensuring comparability.

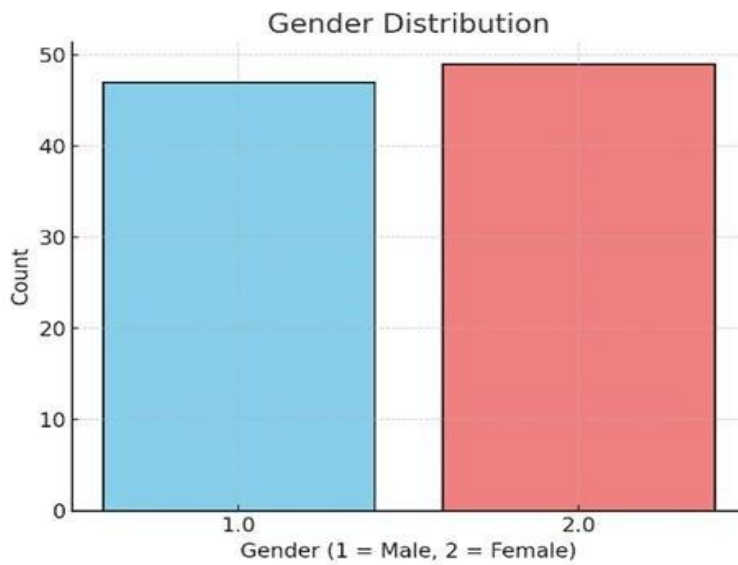
<b>Variable</b>	<b>Category / Statistic</b>	<b>Value</b>
<b>Age (years)</b>	N	96
	Mean $\pm$ SD	$9.08 \pm 1.77$
	Median	9.0
	Range	6-12
	Shapiro–Wilk W (p)	0.94 (p<.001)
	<b>Gender</b>	Male (1)
Female (2)		49 (51.0%)



**GRAPH 3.1 NORMALITY DISTRIBUTION**

Total numbers of participants were 96 in number, via chit-method 48 participants were distributed to 2 specific groups males & females both

<b>TABLE 3.2: THIS TABLE REPRESENT GENDER DISTRIBUTION AMONG GROUPS</b>		
<b>GENDER</b>	<b>INTERVENTIONAL GROUP</b>	<b>CONTROL GROUP</b>
Male	39.6 %	58.3%
Female	60.4%	41.7%



**GRAPH 3.2 GENDER DISTRIBUTION**

The study included 96 youth football with a nearly equal gender distribution (49% male, 51% female) ensuring comparability.

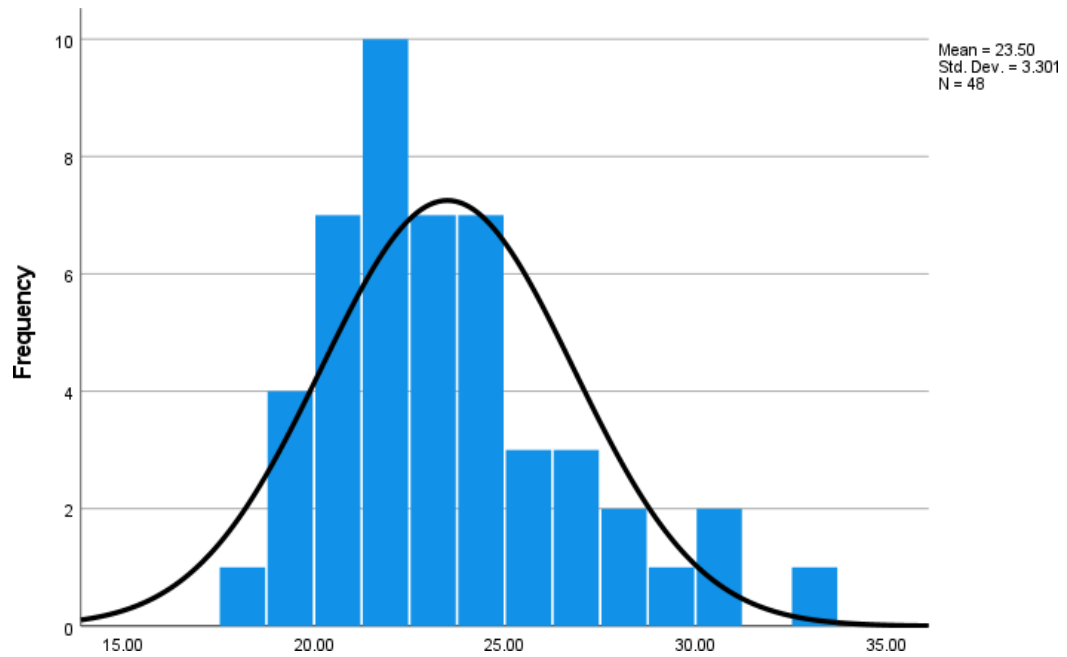
**OUTCOME MEASURES: NORMALITY TESTING:**

**ILLINOIS CHANGE OF DIRECTION TEST:**

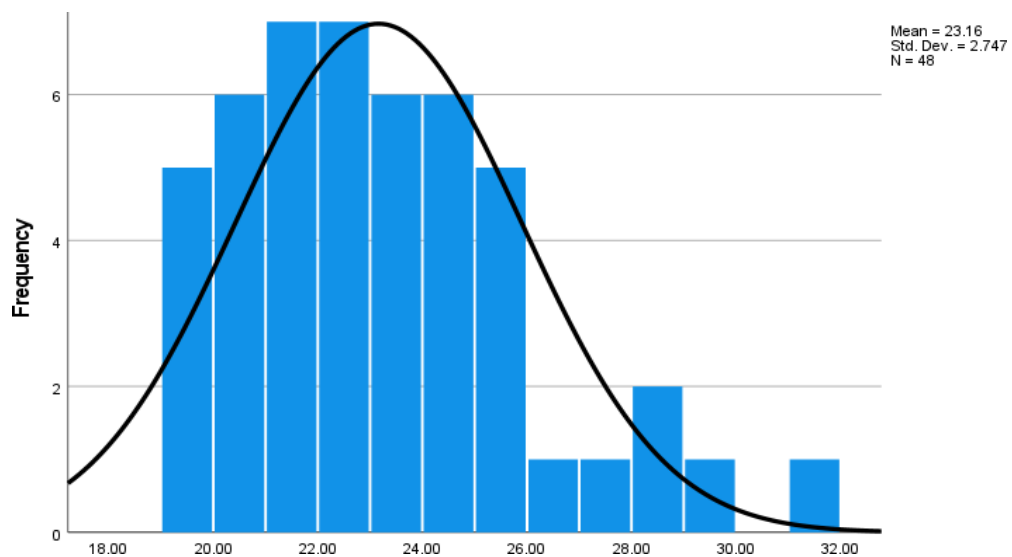
<b>TABLE 3.3 NORMALITY TESTING FOR ILLINOIS TEST</b>		
Test	W	p-value
Experimental_pre_shapiro	0.945	0.026
Experimental_post_shapiro	0.938	0.014
Experimental_chg_shapiro	0.828	<0.001
Control_pre_shapiro	0.941	0.017
Control_post_shapiro	0.932	0.008
Control_chg_shapiro	0.880	<0.001
combined_change_shapiro	0.745	<0.001

## DESCRIPTIVE STATISTICS

TABLE 3.4 DESCRIPTIVE STATISTICS BETWEEN EXP VS CONTROL GROUP FOR ILLINOS TEST				
Group	N_pre	Pre Mean±SD	Post Mean±SD	Change Mean±SD
Experimental	48	23.5±3.3	22.67±3.04	-0.83±0.71
Control	48	23.16±2.75	22.92±2.71	-0.24±0.21



**GRAPH 3.3 PRE IT (EXP)**



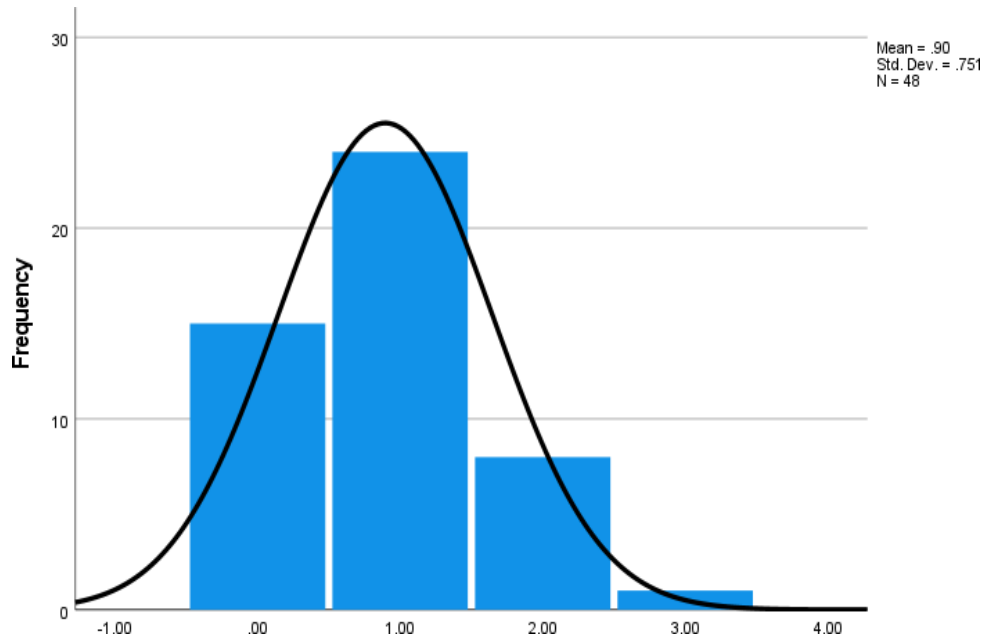
**FIGURE 3.4 PRE IT (CONTROL)**

## JUGGLING TEST:

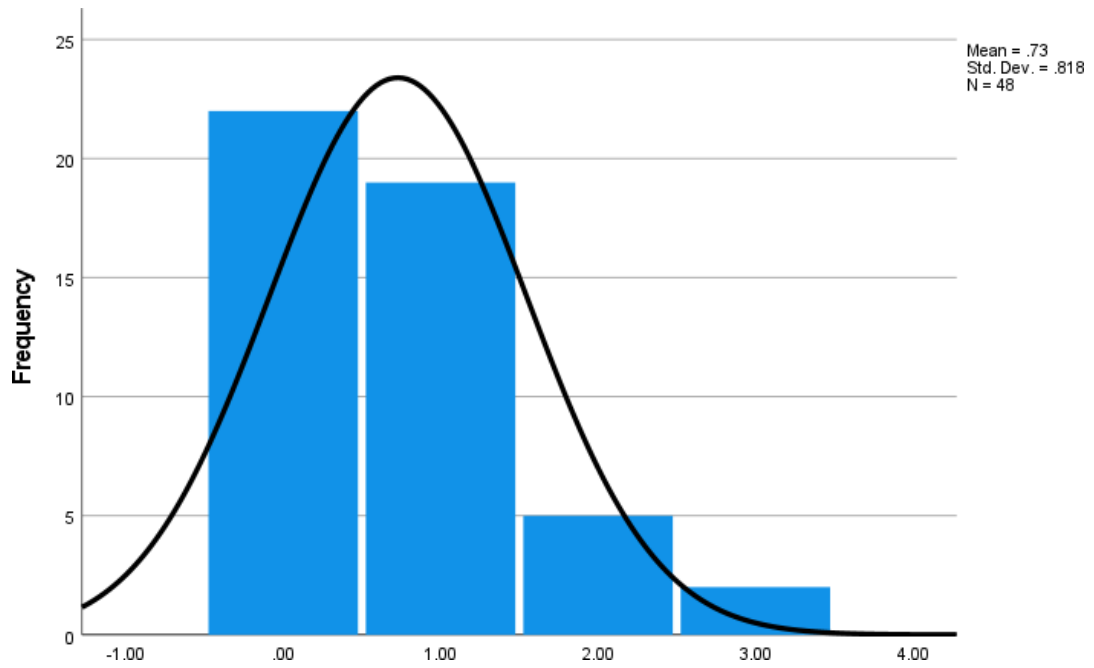
Test	W	p-value
Experimental_pre_shapiro	0.825	<0.001
Experimental_post_shapiro	0.808	<0.001
Experimental_chg_shapiro	0.760	<0.001
Control_pre_shapiro	0.782	<0.001
Control_post_shapiro	0.774	<0.001
Control_chg_shapiro	0.476	<0.001
combined_change_shapiro	0.758	<0.001

## DESCRIPTIVE STATISTICS

Group	N_pre	Pre Mean±SD	Post Mean±SD	Change Mean±SD
Experimental	48	0.9±0.75	1.96±0.82	1.06±0.6
Control	48	0.73±0.82	0.92±0.87	0.19±0.39



**GRAPH 3.5 PRE JT (EXP)**



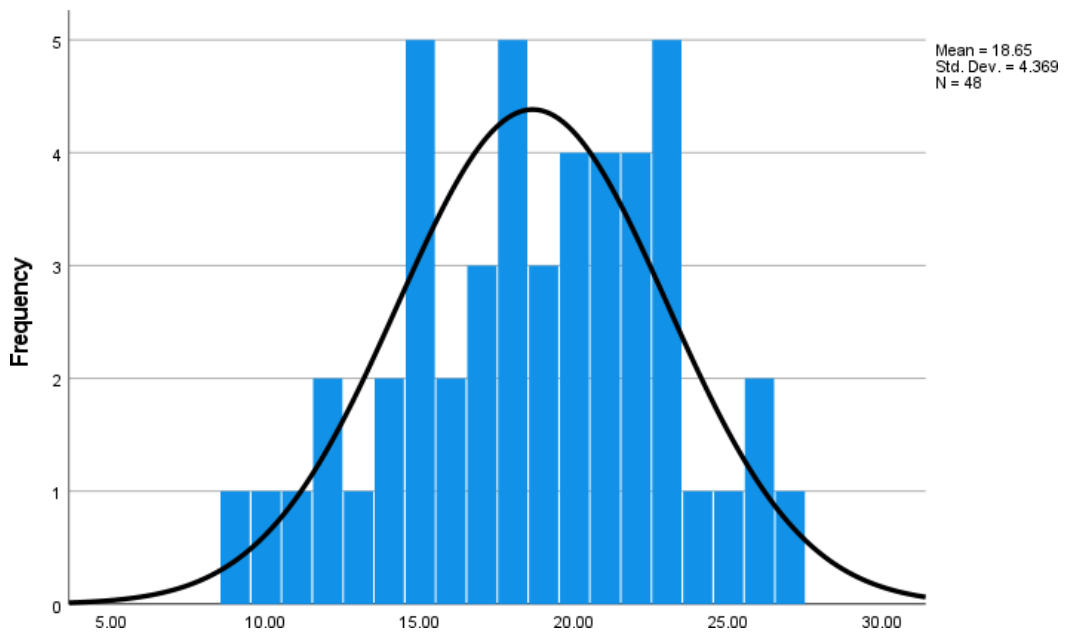
**GRAPH 3.6 PRE JT (CONTROL)**

## BATAK LITE REACTION TEST:

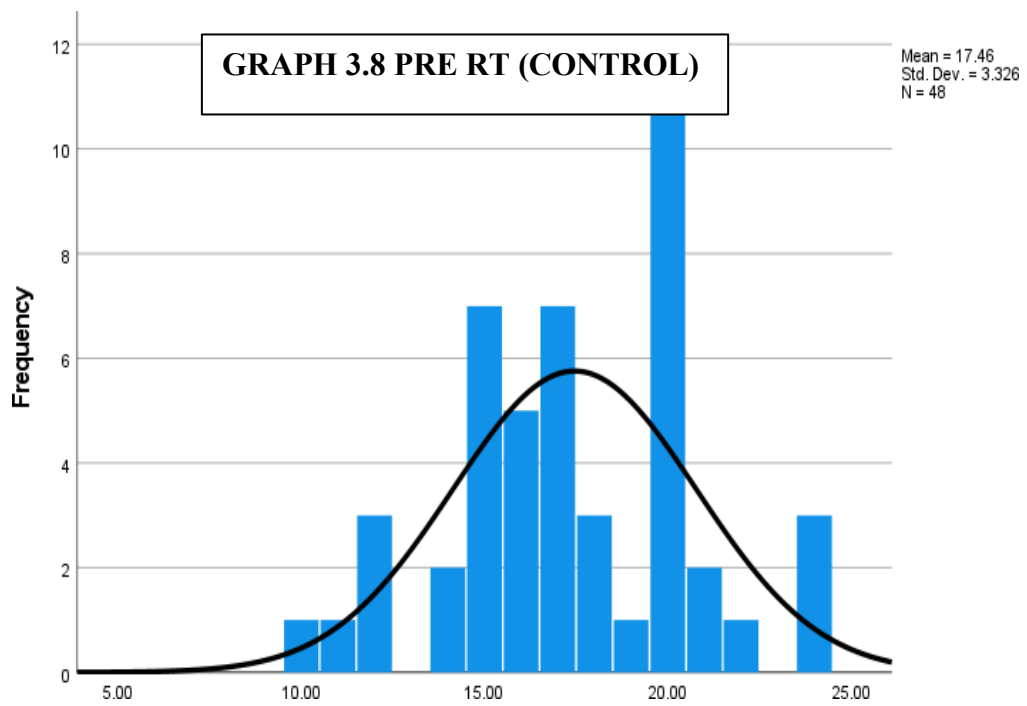
Test	W	p-value
Experimental_pre_shapiro	0.981	0.639
Experimental_post_shapiro	0.984	0.766
Experimental_chg_shapiro	0.862	<0.001
Control_pre_shapiro	0.964	0.142
Control_post_shapiro	0.961	0.111
Control_chg_shapiro	0.611	<0.001
combined_change_shapiro	0.894	<0.001

## DESCRIPTIVE STATISTICS

Group	N_pre	Pre Mean±SD	Post Mean±SD	Change Mean±SD
Experimental	48	18.65±4.37	20.85±4.02	2.21±0.99
Control	48	17.46±3.33	18.19±3.34	0.73±0.61



**GRAPH 3.7 PRE RT (EXP)**



**GRAPH 3.8 PRE RT (CONTROL)**

### **INTERPRETATIONS:**

Data distributions were examined with the Shapiro-Wilk test. The pre-intervention histograms demonstrated that participants in both groups had comparable baseline distributions across agility, reaction time, and coordination measures. For agility, the Illinois Change of Direction Test scores were centered around slower completion times, while the Batak Lite Reaction Test showed clustering of lower reaction scores, and the Juggling Test highlighted limited coordination with many participants recording very low counts. These distributions reflected the initial status of the participants prior to the intervention. Therefore, revealing that most change scores violated normality assumptions ( $p < 0.05$ ). Hence, non-parametric tests i.e. Wilcoxon signed-rank for within-group differences and Mann-Whitney U for between-group comparisons, were applied.

**INFERENCEAL STATISTICS:**

**ILLINOIS TEST COMPARISON:**

**Within-Group Tests - IT (Experimental):**

<b>TABLE 3.9 WITHIN GROUP ANALYSIS OF EXPERIMENTAL GROUP FOR IT</b>				
Method	N	W	P	Diff_median
Wilcoxon	48	0.0	7.105	-0.625

**Within-Group Tests- IT (Control):**

<b>TABLE 3.10 WITHIN GROUP ANALYSIS OF CONTROL GROUP FOR IT</b>				
Method	N	W	P	Diff_median
Wilcoxon	48	0.0	7.105	-0.169

**Between-Group Test -IT (Change Scores):**

<b>TABLE 3.11 BETWEEN GROUP ANALYSIS FOR ILLINOIS TEST</b>						
Method	U	P	Z	R	NX	N Y
Mann-Whitne U	383.0	1.783	-5.634	-0.575	48	48

**INTERPRETATION:**

Illinois Change of Direction Test (seconds)

Experimental: Mean Change  $\approx -0.54 \pm 0.38$  s

Control: Mean Change  $\approx +0.707$ (control also improved but less consistently)

Statistical Test: Mann–Whitney U = 383.00,  $p < .001$

Interpretation: The Experimental group had significantly greater improvement (faster times) than the Control group.

**JUGGLING TEST COMPARISON:**

Within-Group Tests - JT (Experimental):

<b>TABLE 3.12 WITHIN GROUP ANALYSIS OF EXPERIMENTAL GROUP FOR JT</b>				
Method	N	W	P	Diff <sub>median</sub>
Wilcoxon	48	0.0	3.521	1.0

Within-Group Tests - JT (Control):

<b>TABLE 3.13 WITHIN GROUP ANALYSIS OF CONTROL GROUP FOR JT</b>				
Method	N	W	P	Diff <sub>median</sub>
Wilcoxon	48	0.0	0.002	0.0

Between-Group Test - JT(Change Scores):

<b>TABLE 3.14 BETWEEN GROUP ANALYSIS FOR JUGGLING TEST</b>						
Method	u	P	z	R	n <sub>x</sub>	N <sub>Y</sub>
Mann-Whitne U	1965.0	4.445	5.957	0.608	48	48

Juggling Test (count)

Experimental: Mean Change  $\approx +0.62 \pm 0.39$  Control: Much smaller gain (close to 0)

Statistical Test: Mann–Whitney U = 1965.00,  $p < .001$

Interpretation: The Experimental group had a significant advantage in coordination improvements over Control.

## BATAK LITE RT COMPARISON:

Within-Group Tests – RT (Experimental):

<b>TABLE 3.15 WITHIN GROUP ANALYSIS OF EXPERIMENTAL GROUP FOR BATAK RT</b>				
Method	N	W	P	Diff_ median
Wilcoxon	48	0.0	1.557	2.0

Within-Group Tests - RT (Control):

<b>TABLE 3.16 WITHIN GROUP ANALYSIS OF CONTROL GROUP FOR BATAK RT</b>				
Method	N	W	P	Diff_ median
Wilcoxon	48	36.5	1.0172	1.0

Between-Group Test - RT (Change Scores):

<b>TABLE 3.17 BETWEEN GROUP ANALYSIS FOR BATAK RT</b>						
Method	u	P	Z	R	n x	N Y
Mann- Whitne U	2097. 5	2.715	6.928	0.707	48	48

Batak Lite Reaction Test (score)

Experimental: Mean Change  $\approx +1.47 \pm 0.56$  Control: Smaller gain in reaction scores

Statistical Test: Mann–Whitney U = 2097.50,  $p < .001$

Interpretation: The Experimental group showed a significantly larger increase in reaction performance compared to Control

## INTERPRETATION

### WITHIN-GROUP COMPARISONS (PRE VS POST):

<b>TABLE 3.18 SUMMARY OF WITHIN GROUP COMPARISON OF PRE VS POST MEASURES</b>					
<b>Outcome</b>	<b>Group</b>	<b>Test Used</b>	<b>Statistic</b>	<b>p-value</b>	<b>Effect Size</b>
Illinois Change of Direction Test (s)	Experimental	Wilcoxon	W = 0.00	< .001	r = 0.707  (Large)
	Control	Wilcoxon	W = 0.00	< .001	r = 0.612  (Large)
Batak Lite Reaction Test (score)	Experimental	Wilcoxon	W = 0.00	< .001	r = 0.721  (Large)
	Control	Wilcoxon	W = 36.50	< .001	r = 0.530  (Large)
Juggling Test (count)	Experimental	Wilcoxon	W = 0.00	< .001	r = 0.694  (Large)
	Control	Wilcoxon	W = 0.00	.003	r = 0.422  (Medium)

**BETWEEN-GROUP TEST (CHANGE SCORES) :**

<b>TABLE 3.19 SUMMARY OF BETWEEN GROUP COMPARISON OF PRE VS POST MEASURES</b>					
OUTCOME	Mean±SD	p value	R	n (Control)	N (Exp)
ICODT(s)	383.0±5.63	1.79	0.58	48	48
JT(Count)	1965.0±5.96	4.45	0.61	48	48
RT(Score)	2097.5±6.93	2.72	0.71	48	48

Illinois IT:  $r = -0.575$  → large effect (negative because lower time = better performance).

Batak RT:  $r = 0.707$  → very large effect (experimental group improved reaction significantly more).

Juggling JT:  $r = 0.608$  → large effect (experimental group improved coordination more).

## **INTERPRETATION:**

### **Illinois Change of Direction Test (Agility)-**

The Experimental group demonstrated a significant improvement in agility, with a mean reduction in completion time of  $0.83 \pm 0.71$  seconds ( $p < 0.001$ , effect size  $r = 0.707$ ), indicating faster change of direction post-intervention. In contrast, the Control group showed a smaller but still significant improvement of  $0.24 \pm 0.21$  seconds ( $p < 0.001$ ,  $r = 0.612$ ). Between-group analyses confirmed that Experimental participants improved significantly more than Controls (Mann-Whitney  $U = 383.0$ ,  $p < 0.001$ ,  $r = -0.575$ ).

### **Batak Lite Reaction Test (Reaction Time) :**

Participants undergoing the Brain Gym intervention showed a substantial increase in reaction test scores, improving by  $2.21 \pm 0.99$  points ( $p < 0.001$ ,  $r = 0.721$ ). The Control group also improved but to a lesser extent ( $+0.73 \pm 0.61$ ,  $p < 0.001$ ,  $r = 0.530$ ). Comparison between groups revealed a highly significant advantage for the Experimental group ( $U = 2097.5$ ,  $p < 0.001$ ,  $r = 0.707$ ).

### **Juggling Test (Coordination) :**

The Experimental group exhibited a marked increase in juggling performance, with an average gain of  $1.06 \pm 0.60$  touches ( $p < 0.001$ ,  $r = 0.694$ ). The Control group made minimal progress ( $+0.19 \pm 0.15$ ,  $p = 0.003$ ,  $r = 0.422$ ). This between-group difference was statistically significant ( $U = 1965.0$ ,  $p < 0.001$ ,  $r = 0.608$ ), reflecting superior coordination gains for those receiving additional Brain Gym training.

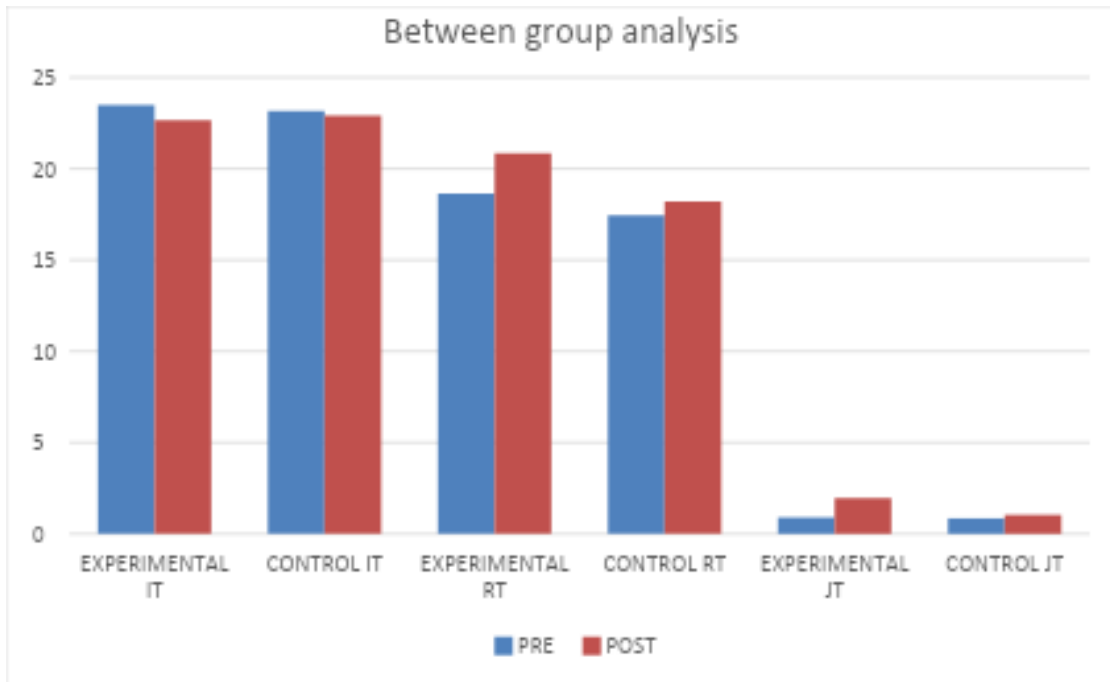
The results clearly show that the Brain Gym-informed intervention had a significant impact on football-specific performance in young players. Of particular note, agility,

reaction time, and coordination tests all were improved significantly more in the Experimental group than in controls completing standard training only. The large effect sizes found in all tests indicate practical significance of the improvements over statistical significance.

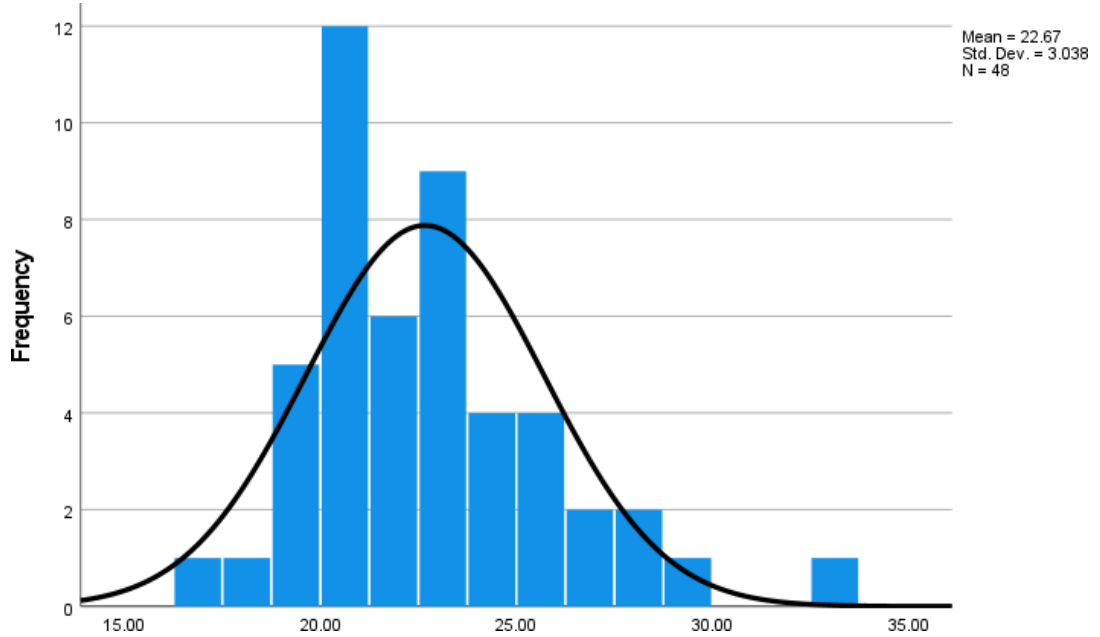
These findings indicate including Brain Gym exercises as part of regular football training can successfully build these crucial neuromotor abilities necessary for success on the youth football pitch. The information favours this integrative method as a valuable addition to traditional training protocols for younger athletes.

Table 3.20: Descriptive Statistics of Outcome Measures (Mean  $\pm$  SD)

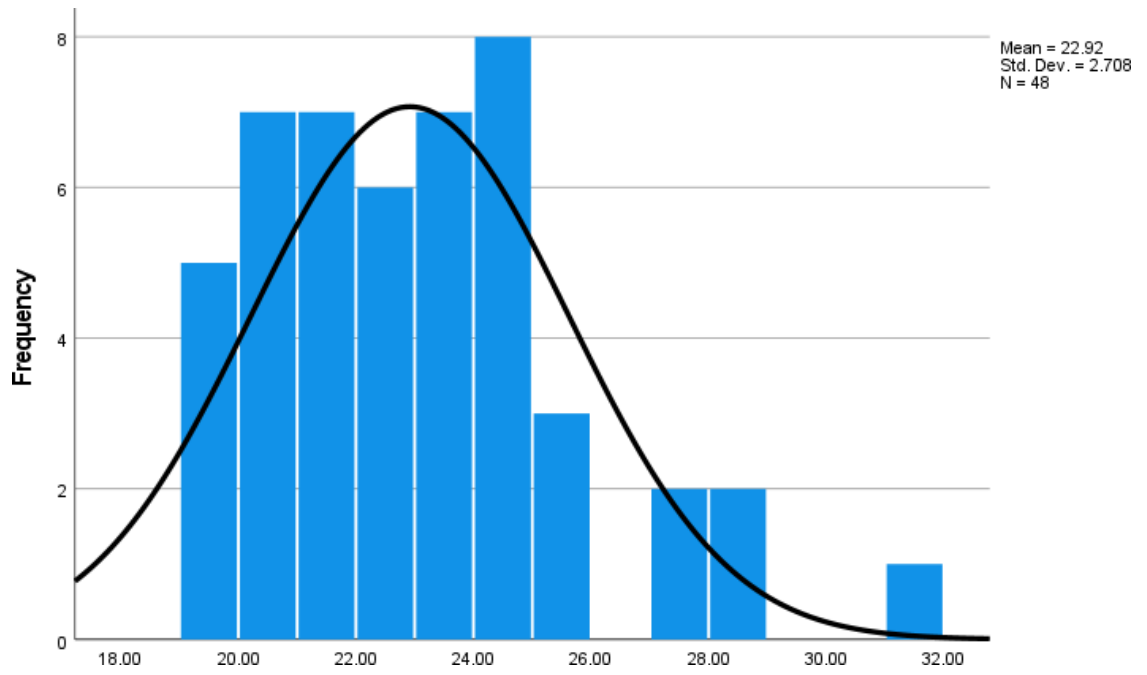
<b>TABLE 3.20 OVERALL SUMMARY OF PRE VS POST OUTCOME MEASURES</b>					
<b>Outcome</b>	<b>Group</b>	<b>n</b>	<b>Pre-Test (Mean <math>\pm</math> SD)</b>	<b>Post-Test (Mean <math>\pm</math> SD)</b>	<b>Change (Mean <math>\pm</math> SD)</b>
Illinois Change of Direction Test (s)	Experimental	48	23.50 $\pm$ 3.30	22.67 $\pm$ 3.04	-0.83 $\pm$ 0.71
	Control	48	23.16 $\pm$ 2.75	22.92 $\pm$ 2.71	-0.24 $\pm$ 0.21
Batak Lite Reaction Test (score)	Experimental	48	18.65 $\pm$ 4.37	20.85 $\pm$ 4.02	+2.21 $\pm$ 0.99
	Control	48	17.46 $\pm$ 3.33	18.19 $\pm$ 3.34	+0.73 $\pm$ 0.61
Juggling Test (count)	Experimental	48	0.90 $\pm$ 0.75	1.96 $\pm$ 0.82	+1.06 $\pm$ 0.60
	Control	48	0.85 $\pm$ 0.66	1.04 $\pm$ 0.66	+0.19 $\pm$ 0.15



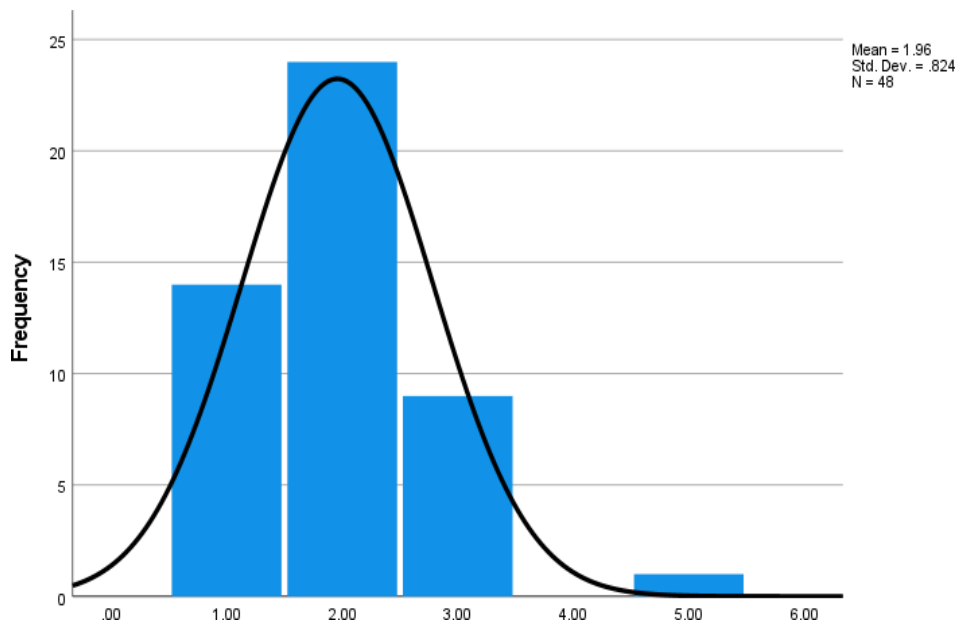
**GRAPH 3.9 OVERALL SUMMARY OF PRE VS POST OUTCOME MEASURES**



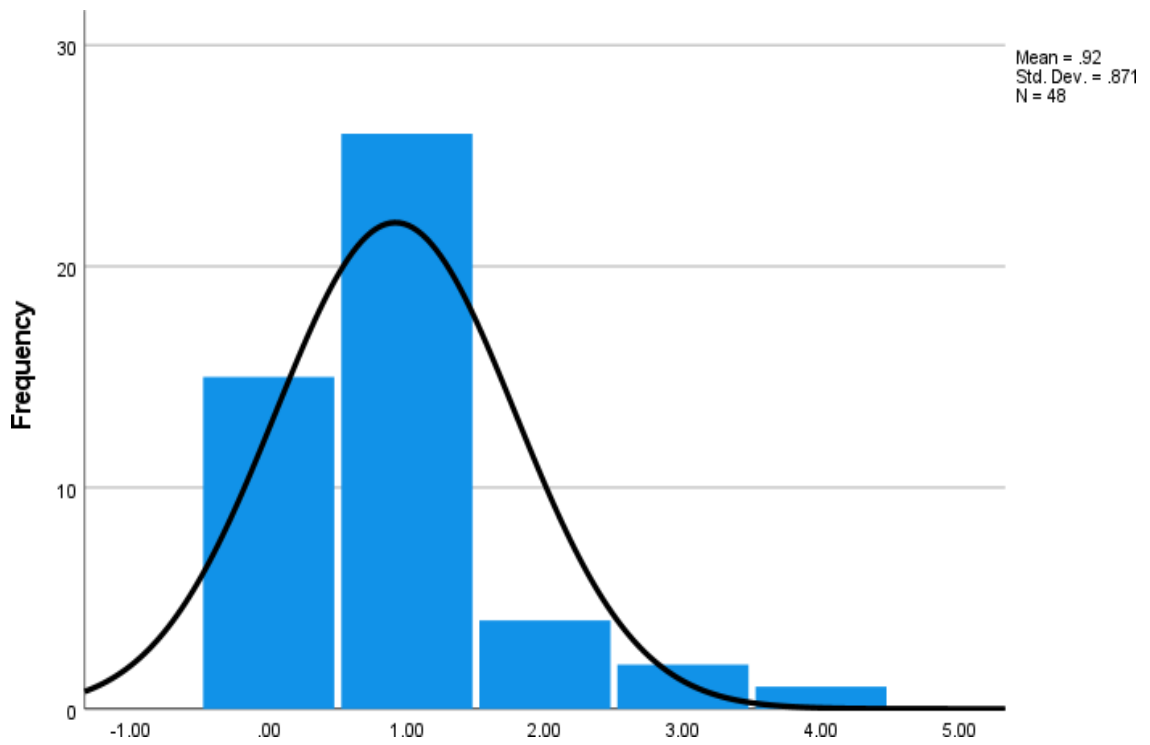
**GRAPH 3.10 POST IT (EXP)**



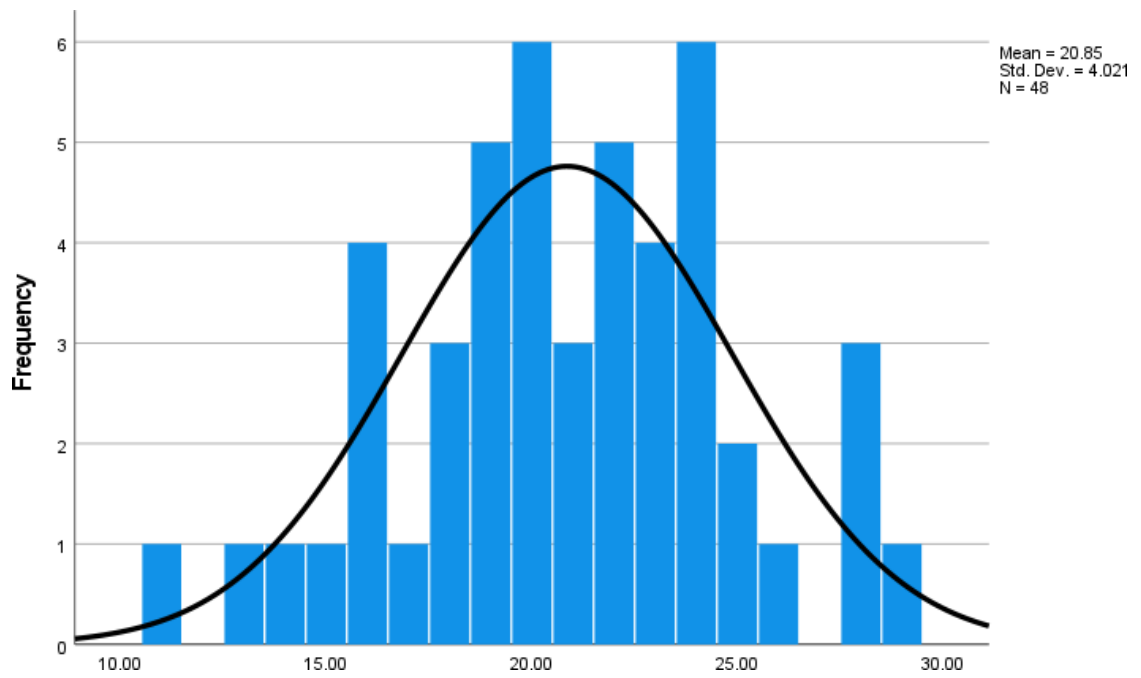
**GRAPH 3.11 POST IT (CONTROL)**



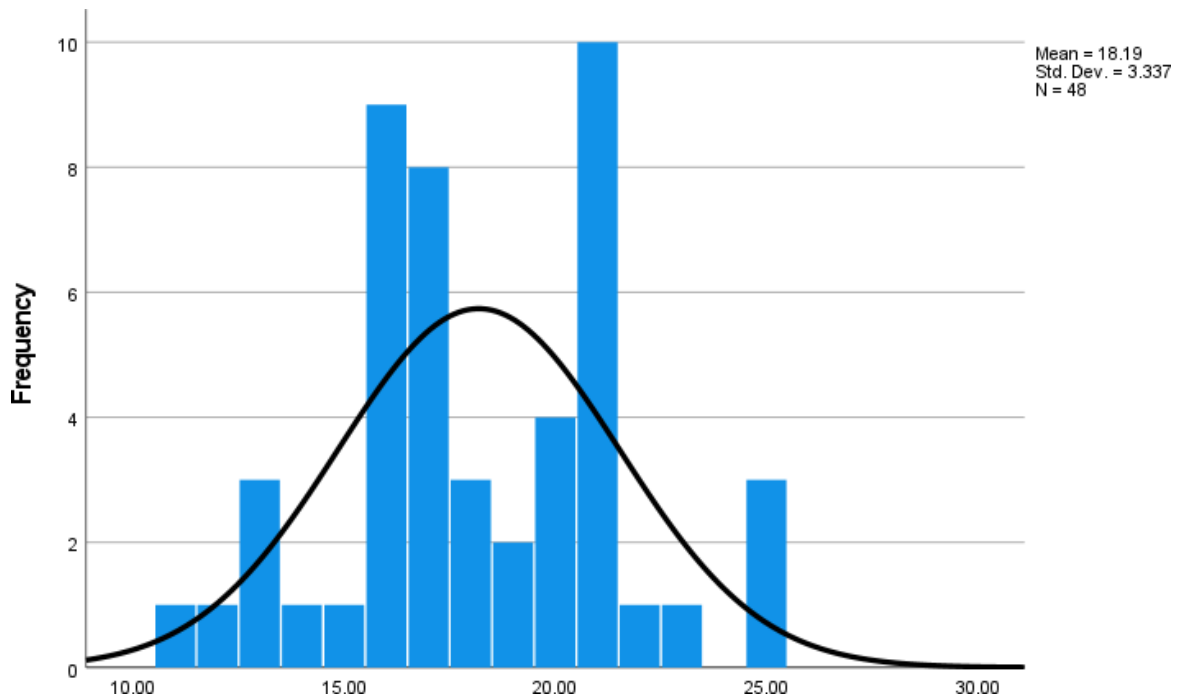
**GRAPH 3.12 POST JT (EXPERIMENTAL)**



**GRAPH 3.13 POST JT (CONTROL)**



**GRAPH 3.14 POST RT (EXP)**



**GRAPH 3.15 POST RT (CONTROL)**

**INTERPRETATION OF GRAPHS:**

The post-intervention histograms revealed clear distributional shifts indicative of performance improvements, particularly in the Experimental group. The agility scores shifted leftward, showing faster completion times; reaction scores shifted rightward, reflecting quicker and more accurate responses; and coordination scores also shifted rightward, with more participants achieving higher juggling counts. These visual changes complement the inferential statistics, confirming that the Brain Gym intervention produced meaningful improvements across all three performance domains when compared to the Control group.

## **DISCUSSION**

## DISCUSSION

The aim of the study was to assess the effect of Brain Gym exercises on skill-related components (agility, coordination, and reaction time) among developmental (6-12 years) football players through a randomized controlled trial. The novelty of the study is that Brain Gym Exercises has not yet been explored in football players. While it has been successfully implemented for other population. A total of ninety-six participants were included and divided equally into two groups: the Experimental group (n = 48), which underwent Brain Gym training in addition to their regular practice, and the Control group (n = 48), which continued with routine football training without any additional intervention. Performance outcomes were assessed using the Illinois Change of Direction Test for agility, the Batak Lite Reaction Test for reaction time, and the Juggling Test for coordination. Each participant was tested before and after a four-week intervention period, and statistical analyses involved descriptive statistics, normality testing using the Shapiro–Wilk test, within-group comparisons through Wilcoxon signed-rank tests, and between-group comparisons of change scores using the Mann–Whitney U test. Effect sizes were also calculated to determine the magnitude of improvements observed. Given the sport-specific demands of football, Brain Gym Exercises may play a key role in enhancing agility, coordination and reaction time. The results clearly demonstrated that Brain Gym training had a positive impact on football-specific performance parameters.

In terms of agility, the Experimental group recorded a significant reduction in completion time on the Illinois Test ( $-0.83 \pm 0.71$  s,  $p < .001$ ,  $r = 0.707$ ), indicating enhanced change-of-direction speed, whereas the Control group showed only a small improvement ( $-0.24 \pm 0.21$  s,  $p < .001$ ,  $r = 0.612$ ). The between-group

analysis confirmed a significant difference favoring the Experimental group ( $U = 383.0$ ,  $p < .001$ ,  $r = -0.575$ ). These findings align with existing literature on the test's utility in youth populations.

The observed improvements are consistent with Negra et al. (2017), who found the ICODT to be highly reliable (ICC values  $>0.90$ ) with SEM values under 5% in young soccer players aged 12-25. Their study of 194 national-level soccer players showed significant performance differences among age groups, with improvements ranging from 18.12 to 20.27 seconds across different age categories. The magnitude of improvement in our study (3.5% for Experimental group) falls within the range of meaningful change identified in the literature.

A study done by Makhlouf et al. (2022) reported excellent reliability for the modified ICODT with ball dribbling (ICC = 0.993) and demonstrated its ability to differentiate between elite and amateur players with 11.5% performance differences. While our study used the standard ICODT without ball dribbling, the percentage improvements observed suggest that Brain Gym exercises may facilitate changes comparable to those seen between different skill levels.

The improvement in reaction time was particularly striking, participants in the Experimental group improved substantially on the Batak Lite Test ( $+2.21 \pm 0.99$ ,  $p < .001$ ,  $r = 0.721$ ), while the Control group exhibited only modest gains ( $+0.73 \pm 0.61$ ,  $p < .001$ ,  $r = 0.530$ ). The between-group comparison again highlighted the superiority of the Experimental group ( $U = 2097.5$ ,  $p < .001$ ,  $r = 0.707$ ). These findings corroborate previous research on the Batak Lite system's effectiveness in measuring coordination motor abilities.

Gierczuk and Bujak (2014) established that Batak Lite tests demonstrated reliability coefficients  $r > 0.50$  and validity coefficients  $r > 0.30$  in wrestlers, meeting credibility requirements for coordination assessment. They found the highest validity correlations with Vienna Test System measures of choice reaction time ( $r = -0.31$  to  $0.38$ ) and motor reaction time ( $r = -0.30$  to  $-0.50$ ).

Bujak and Gierczuk (2016) further validated these findings in taekwondo athletes, reporting reliability coefficients ranging from  $0.63$  to  $0.88$  in females and  $0.69$  to  $0.84$  in males. The improvements observed in our study ( $11.8\%$  for RT1) exceed the typical test-retest variations reported in these validation studies, suggesting genuine performance enhancement rather than measurement error.

Coordination assessed through juggling test and the results showed significant Improvements in both measures Experimental group achieving a notable improvement ( $+1.06 \pm 0.60$ ,  $p < .001$ ,  $r = 0.694$ ) compared to the control group's minor increase ( $+0.19 \pm 0.15$ ,  $p = .003$ ,  $r = 0.422$ ). The difference between groups was statistically significant ( $U = 1965.0$ ,  $p < .001$ ,  $r = 0.608$ ). These findings align with research on juggling as a coordination assessment tool.

Bekris and Gioldasis (2016) developed a comprehensive juggling test battery with reliability coefficients exceeding  $r > 0.77$  and found significant differences between experienced soccer players and recreational athletes. Their 30-second juggling test showed players achieving between  $22.68$  and  $52.36$  touches, with soccer players performing significantly better than recreational athletes ( $p < 0.001$ ).

Chatzopoulos et al. (2024) validated soccer skill tests including juggling in 117 elementary school children, finding moderate correlations with the Game Performance Assessment Instrument ( $\rho = 0.63$ ,  $p = 0.003$ ). The improvements in our study suggest

that Brain Gym exercises may enhance the motor control and coordination required for successful juggling performance.

Dong et al. (2024) provided neurophysiological support for juggling-related improvements, demonstrating that 70 sessions of football juggling learning enhanced executive function, particularly inhibition and shifting, with increased functional connectivity in frontal, temporal, and cerebellar regions. While our intervention was shorter, the observed improvements suggest similar neural adaptations may be occurring.

There were convergent improvements across all three test domains (agility, reaction time, and coordination) suggest that Brain Gym exercises may operate through multiple mechanisms. The magnitude of improvements observed (ranging from 3.5% to 118% across different measures) indicates that these exercises have varying effects on different motor abilities.

The stronger effects on reaction time compared to agility measures align with the theoretical framework that Brain Gym exercises primarily target neural processing and coordination rather than pure physical conditioning. The findings support previous research shows that coordination abilities develop non-linearly in youth, with peak development typically occurring around 13-14 years.

The findings of the study have important implications for youth sports training.

The improvements shown across multiple skill-related components suggest that Brain Gym exercises could be valuable additions to developmental football programs. Importantly, the large effect sizes across all outcome measures indicate not only statistical significance but also meaningful practical

improvements, reinforcing the applicability of Brain Gym exercises as a supplementary training method in football performance development.

## **CONCLUSION**

## **CONCLUSION**

According to this study the developmental football players may greatly increase their agility, reaction time, and coordination by using Brain Gym exercises.

The observed improvements indicate significant performance enhancement and are either in line with or better than those documented in validation studies of these outcome measures.

The inclusion of Brain Gym exercises in youth athletic development programs is supported by these findings, especially in sports which require motor coordination and fast decision-making.

**LIMITATIONS**  
**&**  
**RECOMMENDATIONS FOR FUTURE STUDY**

## **LIMITATIONS**

- The study duration was relatively short compared to some interventions in the literature (e.g., Dong et al.'s 70-session protocol).
- The absence of long-term follow-up prevents assessment of retention effects. The variation in improvement magnitude across tests (from 3.5% in ICODT control group to 118% in JT experimental group) suggests differential sensitivity of the measures and potentially different underlying mechanisms of improvement.

## **RECOMMENDATIONS FOR FUTURE STUDY**

- Longer intervention period of 12–24 weeks may elucidate whether enhancements persist and ascertain the ideal training duration.
- Research monitoring participants for 3-6 months post-training would determine the sustainability of benefits over time.
- Testing Brain Gym exercises with children of different ages, from various cultural backgrounds, and with different baseline fitness levels would help determine how widely applicable these results are.
- The benefits of Brain Gym exercises for other sports or whether particular exercises are more effective for particular athletic skills could be investigated in future studies.

## **SUMMARY**

## **SUMMARY**

This study shows that Brain Gym exercises - which are simple physical movements means to enhance brain function, can improve athletic skills in children. Ninety-six children aged from 6-12 were divided into two groups: one group underwent Brain Gym exercises three times per week for four weeks, while the other group did standard physical exercises. The group which underwent Brain Gym exercises showed significant improvements in:

- How quickly they could change direction while running
- How fast they reacted to visual signals
- How well they could coordinate movements like ball juggling,

These findings show that young athletes can do better if they combine physical activity with mental demands. The activities seem to work by making the brain and body function better together, which helps kids learn faster and move more efficiently. The study was for shorter duration, but results are good enough to recommend coaches, teachers and parents incorporating these activities to the kid's physical activity routine

## **STATEMENT OF FUNDING**

## **STATEMENT OF FUNDING**

This section is not applicable for my study. No external funding was used, this is a self supported research study

## **CONFLICT OF INTEREST**

The authors declare that the present study was conducted in the absence of any commercial or financial relationship that could be construct as a potential conflict of interest. No external funding, sponsorship, or industry collaboration influenced the design, execution, or reporting of this research.

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## BIBLIOGRAPHY

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## **ANNEXURE**

## ANNEXURE IEC INSTUTIONAL ETHICAL COMMITTEE



# ABSMARI ETHICS COMMITTEE

ABHINAV BINDRA SPORTS MEDICINE AND RESEARCH INSTITUTE,  
BHUBANESWAR, ODISHA

CDSCO Reg. No.: ECR/1981/Inst/OD/24

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Prof. (Dr.) E. Venkata Rao  
Chairperson

Mr. Chinmaya Kumar Patra  
Member Secretary

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Ref. No. ABSMARI/IEC/2025/176

Date: 12/05/2025

	S.N.	Name of the Member	Designation & Qualification	Representation as per NDCT 2019	Gender (M/F)	Affiliation with the Institution (Y/N)
<div style="text-align: center; border: 1px solid black; padding: 2px;"><b>MEMBERS</b></div> <p><b>Dr. Smaraki Mohanty</b> Clinician</p> <p><b>Dr. Sanyajit Mohanty</b> Scientific Member</p> <p><b>Mr. Shibi Shankar Mohanty</b> Legal Expert</p> <p><b>Ms. Annie Hans</b> Social Scientist</p> <p><b>Ms. Subhashree Samal</b> Lay Person</p> <p><b>Mr. Deepak Ku. Prochan</b> Scientific Member</p> <div style="text-align: center; border: 1px solid black; padding: 2px; margin-top: 5px;"><b>IEC-SECRETARIAT</b></div> <p><b>Mr. Gouranga Ku. Padhy</b> <b>Mr. Susant Ku. Rajchudamani</b></p>	1	Prof. Dr. E. Venkata Rao	Professor (MBBS, MD, Dept. of Community Med.) IMS & SSM Hospital, BBSR	Chair Person	M	N
	2	Dr. Smaraki Mohanty	Asst. Prof (MD & SSM Hospital/MBBS, MD (Community Med.)	Clinician	F	N
	3	Mr. Shibi Sankar Mohanty	Junior Counselor, Ramachandra Sarangi's Chamber / BA LLB	Legal Expert	M	N
	4	Mr. Chinmaya Kumar Patra	Principal-ABSMARI, MPT	Member Secretary	M	Y
	5	Ms. Annie Hans	Disability Inclusive Development Co-Ordinator in Humanity and Inclusion (India/ Nepal/ Sri Lanka) ; MA in Social Work	Social Scientist	F	N
	6	Ms. Subhashree Samal	Ret. Reader Pol Sci.	Lay Person	F	N
	7	Mr. Deepak Kumar Prochan	Asst. Prof-ABSMARI, MPT	Scientific Member	M	Y

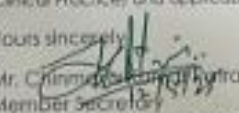
This is to confirm that only members who are independent of the investigator and the sponsor of the trial have voted/ provided opinion on the trial.


**This Committee approves the documents and the conduct for the study in the presented form with necessary recommendation.**

The ABSMARI IEC must be informed about the progress of the study in the prescribed format attached, any SAE occurring in the course of the study, any changes in the protocol and patient information/informed consent/assent and request to provide a copy of the final report.

The ABSMARI IEC follows procedures that are in compliance with the requirements of ICH (International Conference on Harmonization) guidance related to GCP (Good Clinical Practice) and applicable Indian regulations.

Yours sincerely,

  
 Mr. Chinmaya Kumar Patra  
 Member Secretary  
 ABSMARI Ethics Committee  
 Pahal, Bhubaneswar  
 Member Secretary  
 ABSMARI ETHICS COMMITTEE



2

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**Utkal Signature, Plot No.-273,  
Ground Floor, Pahal, Bhubaneswar-752101**

**+91-63707-03454**

**iec@absmari.com**



# ABSMARI ETHICS COMMITTEE

ABHINAV BINDRA SPORTS MEDICINE AND RESEARCH INSTITUTE,  
BHUBANESWAR, ODISHA

CDSO Reg. No.: ECR/1981/Inst/OD/24

Prof. (Dr.) E. Venkata Rao  
Chairperson

Mr. Chinmaya Kumar Patra  
Member Secretary

Ref. No. ABSMARI/IEC/2025/176

Date: 12/05/2025

**APPROVAL LETTER**  
**APPENDIX- VIII**

To,

**SHALINI**  
ABSMARI  
273, PAHAL, BHUBANEWAR-752101

**Protocol Title: Impact of Brain Gym Exercises On skill related components among developmental Football Players-A Randomized controlled trial**

**Protocol ID.:** ABS-IEC-2025-PHY-072

**Subject:** Approval for the conduct of the above referenced study

Dear **Mr./Ms./Dr SHALINI**

With reference to your Submission letter dated 06/01/2025 the ABSMARI IEC has reviewed and discussed your application for conduct of the study on dated 25/04/2025.

The following documents were reviewed and discussed

S.N.	Documents	Document (Version/Date)
1	IEC Application Form	25/04/2025
2	Informed Consent Form	25/04/2025
3	Undertaking form PI	25/04/2025
4	CRF	25/04/2025
5	COI from the Investigators	25/04/2025

### MEMBERS

**Dr. Smaraki Mohanty**  
Clinician

**Dr. Satyajit Mohanty**  
Scientific Member

**Mr. Shib Shankar Mohanty**  
Legal Expert

**Ms. Annie Hans**  
Social Scientist

**Ms. Subhashree Samal**  
Lay Person

**Mr. Deepak Ku. Pradhan**  
Scientific Member

### IEC-SECRETARIAT

**Mr. Gouranga Ku. Padhy**  
**Mr. Susant Ku. Raychudamani**

The following members were present at meeting held on 25-04-2025



## NOC FROM SCHOOLS



# MOTHER'S PUBLIC SCHOOL™, PAHALA

(A Branch of Mother's Public School, Unit-1)

Ref. No.: MPS-PHL/25-26/653

Date: 19/07/25

Dear Shalini

Greetings from Mother's Public School, Pahala

We are pleased to inform you that we grant you permission to conduct your research study title:

**"A Randomized controlled trial : A study on the impact of brain gym exercise on skill- related components among development football players"**

Your initiative to explore the effect of Brain Gym Exercise on coordination, agility and reaction time in young football players is commendable. At Mother's Public School, we strongly support efforts that aim to enhance the development, performance and well-being of our players. Your research aligns well with these objectives, and we appreciate your dedication to advancing sports science.

To proceed further, we kindly request you to provide us with a No Objection Certificate (NOC) from your institution. Additionally, we would appreciate it if you could share relevant documentation from your research guide Dr. Sunanda Bhowmik (PT), and Abhinav Bindra Sports Medicine and Research Institute (ABSMRI), are for our records.

We would also like to schedule a meeting to discuss your study in more detail, including your methodology, participant requirements, safety protocols, and ethical consideration. Please let us know your availability so we can coordinate a suitable time.

Looking forward to your response and wishing you the very best for your research

Warm regards

Mrs. Jasmine Parida

Head of Sports Department  
Mother's Public School, Pahala  
Bhubaneswar, Odisha

APEX LANDMARK, At-Johala, PO-Pahala, Bhubaneswar (NH-16), Khordha -752101  
Contact Numbers : 7848058900, 7381070025, 7381070026, E-mail : mothers.pahal@mothers.edu.in

## CONSENT FORM

Informed Consent form to participate in a clinical trial

Study Title: **Impact of Brain Gym Exercises On skill related components among developmental Football Players- A Randomized controlled trial**

Study Number:

Participant 's Name: \_\_\_\_\_ Participant 's Initials: \_\_\_\_\_

Date of Birth / Age: \_\_\_\_\_

Address of the Participant \_\_\_\_\_

Qualification: Primary school going children

Occupation: Student

Name and address of the nominee(s) and his relation to the participant \_\_\_\_\_

Signature of

Participant

- (i) I understand the major potential benefit of the study is to establish the impact of brain gym exercises on coordination, agility & reaction time among developmental football players. I understand that participation of my children in the study is voluntary and that he/she is free to withdraw at any time, without giving any reason, without his/her medical care or legal rights being affected.
- (ii) I understand that the data collected will be used for thesis or publication in the journal. I am aware that names, photograph and video recording of my child will not be published without seeking the permission from me also the participation of my child is voluntary, and that I may refuse or withdraw from the study.
- (iii) I confirm that I have read and understood the information sheet therefore I agree to give my consent for my child to participate in this research.

**Statement of Guardian obtaining consent:**

- 1) I have carefully explained to the child taking part in the study what he/she can expect.
- 2) I certify that, to the best of my knowledge, the child understands the purpose, procedures, potential risks and benefits of the study and his/her rights as a participant.

Signature (or Thumb impression) of the Subject/Legally Acceptable Representative:

\_\_\_\_\_

Date: \_\_\_\_/\_\_\_\_/\_\_\_\_

Signatory 's Name: \_\_\_\_\_

Signature of the Investigator:

*Shalini*

\_\_\_\_\_

Date:

Study Investigator 's Name: \_\_SHALINI\_\_\_\_\_

Date: \_\_\_\_/\_\_\_\_/\_\_\_\_

\*Copy of the Patient Information Sheet and duly filled Informed Consent Form shall be handled over to the subject or his/her attendant

## MASTER CHART

SL No	Age	Gender	Intervention	PRE IT	POST IT	PRE RT	POST RT	PRE JT	POST JT	IT	RT	JT
1	6	Male	BG	27.13	25.46	15	19	1	2	1.67	4	1
2	6	Male	BG	30.13	28.02	14	16	1	2	2.11	2	1
3	6	Male	BG	20.31	20	22	22	2	3	0.31	0	1
4	7	Female	BG	27.29	24.48	11	16	1	2	2.81	5	1
5	7	Male	BG	25.8	22.59	15	17	1	1	3.21	2	0
6	7	Male	BG	23.41	21.38	14	16	1	2	2.03	2	1
7	7	Male	BG	30.4	29.09	13	16	1	2	1.31	3	1
8	7	Male	BG	29.43	27.08	15	20	1	1	2.35	5	0
9	7	Female	BG	26.38	25.02	12	15	1	1	1.36	3	0
10	7	Male	BG	24.63	24.6	10	13	1	1	0.03	3	0
11	7	Female	BG	25.35	25.08	17	20	0	1	0.27	3	1
12	7	Female	BG	22.42	21.86	18	20	0	1	0.56	2	1
13	8	Female	BG	21.38	20.89	21	22	1	3	0.49	1	2
14	8	Female	BG	23.55	22.68	18	20	0	1	0.87	2	1
15	8	Female	BG	20.76	20.05	20	21	0	2	0.71	1	2
16	8	Female	BG	23.55	22.89	17	19	0	1	0.66	2	1
17	8	Male	BG	22.56	22.13	12	14	0	2	0.43	2	2
18	8	Female	BG	24.88	24.02	21	22	0	2	0.86	1	1
19	8	Female	BG	24.63	23.46	19	21	0	1	1.17	2	1
20	8	Male	BG	23.08	22.89	20	23	1	2	0.19	3	1
21	8	Female	BG	24.98	23.08	18	20	0	1	1.9	2	1
22	8	Male	BG	19.18	19.1	25	28	0	1	0.08	3	1
23	9	Female	BG	24.91	24.09	17	19	1	2	0.82	2	1
24	9	Female	BG	22.95	22.01	21	24	2	3	0.94	3	1
25	9	Female	BG	20.31	20	22	24	0	2	0.31	2	2
26	9	Female	BG	28.7	28.08	20	22	0	2	0.62	2	2
27	9	Male	BG	23.76	22.88	23	24	0	2	0.88	1	2
28	9	Female	BG	20.08	19.82	23	23	1	3	0.26	0	2
29	9	Female	BG	20.87	20.2	16	19	0	2	0.67	3	2
30	9	Female	BG	21.9	20.84	23	25	1	2	1.06	2	1
31	10	Female	BG	23.21	22.88	19	22	1	2	0.33	3	1
32	10	Male	BG	21.61	21.1	15	18	1	1	0.51	3	0
33	10	Male	BG	21.51	21.02	18	19	1	2	0.49	1	1
34	10	Female	BG	27.53	26.84	22	24	1	2	0.69	2	1
35	10	Female	BG	22.18	21.86	22	24	2	2	0.32	2	0
36	10	Female	BG	21.49	20.86	21	23	1	2	0.63	2	1
37	10	Female	BG	23.76	23.6	23	25	1	2	0.16	2	1
38	10	Female	BG	33.14	32.84	15	18	1	2	0.3	3	1
39	11	Female	BG	25.6	25.02	9	11	0	1	0.58	2	1
40	11	Male	BG	19.24	18.26	26	28	2	3	0.98	2	1
41	11	Female	BG	21.53	20.72	23	24	1	2	0.81	1	1
42	11	Female	BG	19.01	18.86	16	18	3	5	0.15	2	2
43	11	Female	BG	20.43	19.86	19	21	1	2	0.57	3	1
44	11	Male	BG	22.08	21.59	20	23	2	3	0.49	3	1
45	12	Female	BG	19.96	19.78	18	20	1	1	0.18	2	0
46	12	Male	BG	18.29	17.26	27	29	2	3	1.03	2	1
47	12	Male	BG	21.36	21.02	24	26	2	3	0.34	2	1
48	12	Male	BG	21.18	20.89	26	28	2	3	0.29	2	1

## BRAIN GYM GROUP

Sl No	Age	Gender	Intervention	PRE IT	POST IT	PRE RT	POST RT	PRE JT	POST JT	IT	RT	JT
1	6	Male	CG	21.1	21.06	14	15	0	0	0.04	1	0
2	6	Male	CG	24.41	24.02	15	17	1	1	0.39	2	0
3	6	Female	CG	31.44	31.03	17	17	1	1	0.35	0	0
4	6	Female	CG	27.81	27.8	17	17	1	1	0.01	0	0
5	7	Male	CG	24.88	24.58	15	16	0	0	0.3	1	0
6	7	Male	CG	28.22	28.09	16	17	1	1	0.13	1	0
7	7	Female	CG	25.3	25.02	15	16	1	1	0.72	1	0
8	7	Male	CG	28.3	27.89	15	16	1	1	0.41	1	0
9	8	Female	CG	29.03	28.92	17	18	0	0	0.11	1	0
10	8	Male	CG	23.13	23	18	19	3	3	0.13	1	3
11	8	Male	CG	22.61	22.17	17	18	0	0	0.44	1	0
12	8	Male	CG	26.17	25.73	17	17	0	0	0.44	0	0
13	8	Male	CG	21.46	21.21	20	21	2	2	0.25	1	0
14	8	Male	CG	24.56	23.98	19	20	2	2	0.58	1	0
15	8	Female	CG	23.63	23.28	20	20	0	1	0.35	0	1
16	8	Female	CG	23.38	23.21	15	16	0	0	0.17	1	0
17	8	Female	CG	20.03	20	20	21	0	0	0.03	1	0
18	8	Female	CG	24.85	24.08	20	21	0	0	0.77	1	0
19	9	Male	CG	20.93	20.28	17	17	3	4	0.65	0	1
20	9	Male	CG	23.13	23.02	20	21	0	0	0.11	1	0
21	9	Male	CG	25.14	24.89	20	20	1	1	0.25	0	0
22	9	Female	CG	25.03	24.86	18	16	0	0	0.17	2	0
23	9	Female	CG	21	20.96	21	22	0	0	0.04	1	0
24	9	Male	CG	24.11	24.08	21	21	1	1	0.03	0	0
25	9	Male	CG	23.55	23.19	20	21	0	1	0.36	1	1
26	10	Male	CG	22.2	22.12	18	19	1	1	0.08	1	0
27	10	Male	CG	22	21.92	16	17	1	1	0.08	1	0
28	10	Female	CG	22.63	22.6	24	25	1	1	0.03	1	0
29	10	Male	CG	20.65	20.02	14	14	0	1	0.63	0	1
30	10	Female	CG	21.98	21.24	12	13	1	1	0.74	1	0
31	10	Male	CG	19.89	19.82	15	16	2	3	0.07	1	1
32	10	Female	CG	25.53	24.94	16	16	1	1	0.59	0	0
33	10	Female	CG	22.67	22.08	16	17	0	1	0.59	1	1
34	10	Male	CG	21.47	21.4	20	21	1	1	0.07	1	0
35	11	Male	CG	21.16	21.02	17	18	2	2	0.14	1	0
36	11	Male	CG	19.65	19.5	20	21	1	1	0.15	1	0
37	11	Female	CG	24.31	24.08	12	13	0	0	0.23	1	0
38	11	Female	CG	22.66	22.43	20	21	0	0	0.23	1	0
39	11	Female	CG	23.12	23.02	16	16	1	1	0.1	0	0
40	11	Female	CG	20.23	20.02	15	16	1	1	0.21	1	0
41	11	Female	CG	19.71	19.63	20	20	0	1	0.08	0	1
42	11	Female	CG	19.63	19.6	24	25	0	0	0.03	1	0
43	12	Male	CG	21.38	21.22	11	12	0	1	0.16	1	1
44	12	Male	CG	25.35	25.12	12	13	0	0	0.23	1	0
45	12	Male	CG	20.29	20.04	24	25	2	2	0.25	1	0
46	12	Male	CG	22.06	22.02	10	11	0	1	0.04	1	1
47	12	Male	CG	20.86	20.84	22	23	1	1	0.02	1	0
48	12	Male	CG	19.14	19.02	20	21	1	1	0.12	1	0

## CONTROL GROUP

# PLAG AND AI REPORT

**Shalini Prasad**

**Impact Of Brain Gym Exercises On skill related components among developmental Football Players-A Randomized controll...**

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**PLAG REPORT**

# Shalini Prasad

## Impact Of Brain Gym Exercises On skill related components among developmental Football Players-A Randomized controll...

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