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The impact of high-intensity interval training on reaction time and agility in women KHO-KHO players on varied surfaces

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Abstract
To evaluate the effect of high-intensity interval training (HIIT) on reaction time and agility in female Kho-Kho players on various surfaces. Data were obtained within Ernakulam, Kerala. Forty-five female Kho-Kho players aged 18 to 23 were divided into three groups: two experimental groups (HIIT Mud and HIIT Mat) and one control group (CG). The data for these groups was analysed using analysis of covariance (ANCOVA). Female Kho-Kho players showed significant improvement in reaction time (F (2,41) = 17.716, p=.000, µ2 =.464) and agility (F (2,41) = 11.307, p=.000, µ2 =.355) after HIIT on different surfaces compared to the control group (CG) and the experimental groups (HIIT Mud and HIIT Mat). The HIIT Mud group demonstrated moderate improvement in response time and agility when compared to the HIIT Mat groups. The findings reveal that both surfaces are equally essential, even though the mud has a greater effect in HIIT on the response time and agility of female Kho-Kho athletes. The empirical evidence supports this study.

Keywords: High-intensity Interval Training (HIIT), reaction time, agility, varied surface, ANCOVA

Introduction
A traditional game of unified India known as Kho-Kho probably derives from a Mahabharata battle known as Kurukshetra [1]. Two teams of nine players compete in a rectangular playfield, who must run, dodge, tag, and turn quickly and accurately. Kho-Kho is not only an enjoyable and thrilling game, but it also preserves and promotes India's cultural heritage [2]. Chasers are the players who actively try to catch the defenders in the game. Defenders are the players who are trying to escape or abstain from being captured by the chasers [1]. Performance and physical fitness are essential components in various sports, including Kho-Kho [3]. To increase these abilities, we need to undergo training, such as interval training. A workout that involves low- to high-intensity activities with a rest period or recovery time between each repetition is called interval training. Interval training involves increasing levels of intensity (low to high) followed by rest periods [4]. In addition, interval training allows many athletes to train simultaneously [5]. The HIIT training procedure includes high-intensity activities coupled with brief rest intervals [6].
Athletes who participate in Kho-Kho must be physically fit [7]. In order to achieve peak performance in sports such as Kho-Kho, participants must possess exceptional speed, agility and reaction time [8]. Athletes work diligently to improve their reaction time and agility because it is a critical aspect of their overall performance. The field of play can be a factor that influences reaction time and agility, at different playing surfaces, such as mat and clay. It can affect an athlete's ability to engage in high-intensity interval training and, in turn, can impact their fitness or performance level [3]. Developing targeted training plans that take the playing surface into account can also help improve reaction time and agility performance. Kho-Kho game requires extraordinary agility and that demands rapid reflexes. Body coordination is required for agility, which involves changing direction quickly and accurately. Agility plays an important role in Kho-Kho, moreover, quick start, stops and turns are crucial for athletic performance in various game situations, it allows athletes to perform well [7]. A person's agility is enhanced by sequential movements in opposite directions. Walking in a zigzag pattern fosters agility, as it allows a person to change directions quickly. In agility, body position can

be rapidly changed with balanced movements, and the direction of movement can be promptly initiated, halted, and altered [2]. The agility of a sports player can be influenced by the playing surface, which has been proven to be an important factor. Different surfaces, such as mud and mats, can affect an athlete's ability to perform HIIT, which may ultimately affect their agility and reaction time.

The time between the onset of a response and the presentation of a stimulus is known as reaction time [9]. Kho-Kho requires quick reactions to be successful and avoid being caught by opponents. To strategize effectively and out maneuver the opposing team, Kho-Kho requires swift thinking and quick decision-making skills [10]. The surface on which professional tournaments are played determines how well a player performs. clay courts, players are afforded the ability to run. The primary factor determining court speed is the friction between the player and the court surface [11]. Clay surface is found to be more effective for barefoot running since the muscles that aren't often used become more activated [11]. Activating the muscles may help to enhance the reaction time of Kho-Kho players, they can engage in targeted training exercises that focus on developing speed, agility, and reaction time. These exercises should be designed to challenge their reflexes and require rapid decision-making, thereby improving their ability to respond quickly to various situations.

The game Kho-Kho is highly dependent on agility and reaction time. Kho-Kho players with greater agility have better reaction times on the field simply because they can react to their opponent's movements more quickly. The transition from a traditional mud surface to a soft mat as the playing surface in Kho-Kho reflects the game's evolution and the need for players to adapt to modern times. Although the popularization and organization of international Kho-Kho events is a positive development, Indian Kho-Kho must also evolve to keep up with changing rules and the modern environment of the sport [12]. By specifically focusing on the effects of various playing surfaces, such as mud and mat, this study aims to explore the connection between HIIT agility performance and reaction time in the Kho-Kho game. This study highlights the efficacy of HIIT in improving agility and reaction time for female Kho-Kho players. By investigating the impact of HIIT on mud and mat surfaces, valuable insights can be gained to optimize training programs, and enhance performance. The findings will contribute to the existing knowledge of HIIT's advantages in sports settings and benefit coaches, trainers, and athletes in making informed decisions about training methods and surface selection.

Methods and Materials

Forty-five female Kho-Kho players, ages ranging from 18 to 23, comprise the sample randomly selected from Ernakulam, Kerala. The study was restricted to chosen variables such as agility and reaction time. The subjects' reaction time was determined using the Ruler Drop Test in centimeters [13]. To measure agility in seconds, a T-test is used in this study [14]. After being advised of the research protocols, each participant signed a written consent form to take part in the study. All participants received appropriate training about the study's purpose. The subjects were equally divided into three groups: Experimental Group 1 (HIIT Mud Group), Experimental Group 2 (HIIT Mat Group), and the Control Group. The time assigned to groups was the same, the experimental groups underwent HIIT on Mud and Mat respectively, and the control group underwent only routine training. The training period for this study is 3 days per week, for a total of 12 weeks of HIIT training. Prior to the test, each participant received the appropriate orientation from the investigator, which inspired them to put up their best effort when demonstrating reaction time and agility. Pre and Post tests were conducted before and after the 12 weeks of training.

Statistical analysis

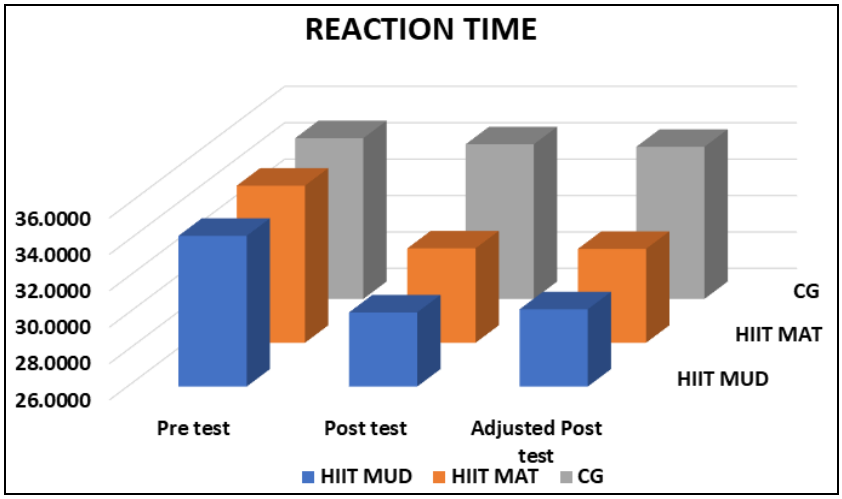
ANCOVA was carried out to compare the mean reaction time and agility performance scores between the three groups (HIIT MUD group, HIIT MAT group and control group) and whether there are any key differences in the groups. The post hoc test (Bonferroni) is used to determine which specific group(s) show significant differences in reaction time and agility performance, specifically comparing the HIIT Mud group and the HIIT Mat group against each other, and the control group. A significance level of 0.05 is used and to analyse the data, IBM SPSS has been used in this study.

Table 1: Analysis of covariance on pre-test, post-test and adjusted post-test means for reaction time

Test		HIIT MUD	HIIT MAT	CG	Source of variance	Df	Sum of squares	Mean squares	F-ratio
Pre-test	Mean	34.28	34.63	34.83	B.G	2	2.36	1.18	0.104
	SD	3.74	2.37	3.78	W.G	42	474.73	11.30	
Post test	Mean	30.07	31.19	34.50	B.G	2	159.07	79.53	10.760*
	SD	1.30	2.69	3.64	W.G	42	310.45	7.39	
Adjusted post	Mean	30.24	31.16	34.36	B.G	2	139.62	69.81	17.716*
					W.G	41	161.56	3.94	

*0.05 level, df (2, 42) and (2, 41), 3.23 * HIIT MUD - High-intensity interval training on Mud surfaces, * HIIT MAT - High-intensity interval training on Mat surfaces

The analysis of a one-way between two ANCOVA was carried out to determine the effect of HIIT on the reaction time of women Kho-Kho players. The test result revealed that there is a significant change in the effect of HIIT on the reaction time of women Kho-Kho players. $F (2,41) = 17.716$, $p=.000$, $\mu^2 =.464$. Additionally, the main effect of the covariant was also statistically significant: $F (2,42) = .104$, $p< .901$, $\mu^2 =.480$.



*HIIT MUD - High-intensity interval training on Mud surfaces, *HIIT MAT - High-intensity interval training on Mat surfaces *CG – Control group

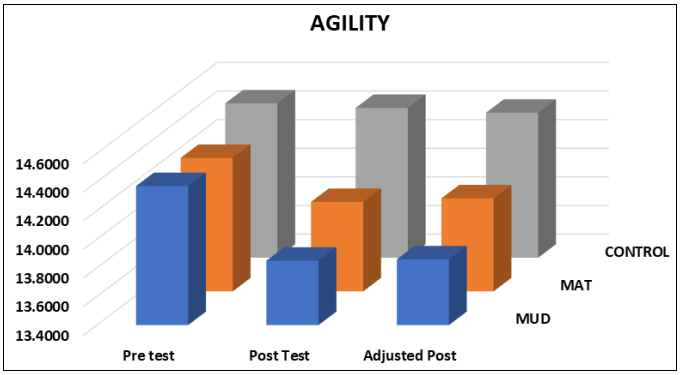
Fig 1: Reaction time pretest, post test and adjusted post test scores

Table 2: Analysis of covariance on pre-test, post-test and adjusted post-test means for agility

Test		HIIT MUD	HIIT MAT	CG	Source of variance	Df	Sum of squares	Mean squares	F- ratio
Pre test	Mean	14.37	14.33	14.48	B. G	2	0.17	0.09	0.384
	SD	0.42	0.43	0.55	W.G	42	9.39	0.22	
Post test	Mean	13.85	14.03	14.45	B.G	2	2.82	1.41	10.273*
	SD	0.42	0.37	0.32	W.G	42	5.77	0.16	
Adjusted Post	Mean	13.85	14.05	14.41	B.G	2	2.34	1.17	11.307*
					W.G	41	4.25	0.10	

*0.05 level, df (2, 42) and (2, 41), 3.23 * High-intensity interval training on Mud surfaces: HIIT MUD, * High-intensity interval training on Mat surfaces: HIIT MAT.

The Analysis of a one-way between two ANCOVA is carried out to determine the effect of HIIT on the agility of women Kho-Kho players. The test result revealed that there is a significant change in the effect of HIIT on the agility of women Kho-Kho players. F (2,41) = 11.307, p=.000, μ^2 = .355. Additionally, the main effect of the covariant was also statistically significant: F (2,42) = 0.384, p<.0.683, μ^2 = .264.



* HIIT MUD - High-intensity interval training on Mud surfaces, * HIIT MAT - High-intensity interval training on Mat surfaces * CG – Control group

Fig 2: Agility pretest, post test and adjusted post test scores

Result and Discussion

The present study HIIT on women Kho-Kho players on Mud and Mat surfaces shows significant improvement in reaction time and agility. The reaction time and agility pretest score are included as a covariant in the model. The subsequent Pos Hoc pairwise comparison based on Bonferroni correction revealed that there is a significant improvement in the reaction time and agility of the women Kho-Kho players who received HIIT on mat and mud surfaces compared to the control group. The HIIT Mud group showed a moderate improvement over the HIIT Mat group in reaction time and agility. The result suggests that both surfaces are equally important, even though the mud shows more effectiveness in HIIT on the reaction time and agility of the women Kho-Kho players. The empirical evidence supports this study.

In many sports that emphasize agility, pivoting on the ground during cutting maneuvers is a key element, and the playing surface significantly impacts motor and technical skills. Previous studies have also shown significant variations in these skills across different surfaces [12]. Studies have also shown, that HIIT through a 50m drill significantly enhanced aerobic capacity in male state-level Kho-Kho players; high-intensity drills have proved most effective [15]. Male Kabaddi players' motor coordination ability was examined by a previous study. The study included 80 male Kabaddi players between 18 and 25. A clay surface provided better shuttle run performance than a mat surface for male Kabaddi players. Male Kabaddi players' motor coordination ability is significantly affected by the playing surface [8]. The process of adjusting to various playing surfaces is challenging for male Kabaddi players. Particularly when they move from clay to a mat surface, the friction and traction differences create a hindrance to their performance. Because clay and mat have

different coefficients of friction and their feet will experience less friction. According to other studies, male Kabaddi state-level players' motor coordination abilities are affected by the playing surface. Clay and mat surfaces, specifically, influence sport-level male players' motor coordination ability, with mat surfaces influencing motor coordination less than clay surfaces [16].

Comparison between inter-varsity Kabaddi and Kho-Kho players revealed significant differences in agility, diastolic pressure, and explosive strength [17]. Junior female Kho-Kho and Kabaddi participants show significant differences in reaction abilities and explosive strength, favouring Kho-Kho players [18]. Kabaddi players' agility is influenced by the playing surface, emphasizing the need for synthetic mats for improved international performance [12]. Interval training on Kabaddi floor mats and Kabaddi clay court improved reaction time and agility in Kabaddi participants, while the control group didn't [11]. Present study results were justified by the above-supporting studies that HIIT on women Kho-Kho players on Mud and Mat surfaces show significant improvement in reaction time and agility.

Conclusion

The current objective of this study is HIIT interventions and their impact on reaction time and agility in Kho-Kho on mud and mat surfaces. After performing a statistical analysis of the data, it was discovered that the reaction time and agility of HIIT mud and mat players, as evaluated by ANCOVA, differed significantly compared to the control group. The findings suggest that the HIIT mud group exhibits greater agility and reaction time on the mud surface compared to the mat surface. This may be attributed to the traction, grip, or friction of the foot/shoe with the surface. When a Kho-Kho player moves from a muddy surface to a mat surface, their performance can be adversely affected by the difference in friction/traction. The lack of adaptation to the new surface can result difficulty in maintaining balance and executing movements effectively.

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