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Comparison of alternate hand-eye coordination by using head mounted reflex ball test between combat sports and non-combat sports players

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Abstract
Hand-eye coordination is pivotal for athletic performance, yet comparative analyses between combat and non-combat sports athletes are lacking. This study aimed to bridge this gap by comparing hand-eye coordination using the head-mounted reflex ball test.
Material & Methods: A total of 122 participants, including combat and non-combat sports players, underwent test. The head-mounted reflex ball test measured alternate hand-eye coordination by instructing participants to perform alternating hand punches on the reflex ball for 30 seconds.
Results: Statistical analysis showed a significant difference ($p < 0.05$) in coordination performance between combat and non-combat players. Combat players exhibited superior coordination, with a mean score of 63.52 repetitions compared to 44.31 repetitions by non-combat players.
Discussion & Result: Participation in combat sports appears to have enhanced hand-eye coordination compared to non-combat sports involvement. These findings emphasized the need to tailor training programs to the specific demands of different sports to optimize coordination skills. The study concluded with significant difference between scores of combat and non-combat players noting 63.52 & 44.31 repetitions respectively.

Keywords: Alternate hand-eye coordination, combat sports, non-combat sports, head-mounted reflex ball test, performance

Introduction

Combat sports are a category of competitive contact activities characterized by direct physical engagements between participants, where victory is determined by adhering to a set of specific criteria unique to each sport's rules. This category encompasses a variety of disciplines, each demanding a unique blend of physical attributes, skills, and strategic thinking, all aimed at achieving superiority in physical confrontations under a regulated framework. Combat sport is a term used to describe a wide range of competitive contact sports typically involving physical combat where the winner is determined by specific criteria depending on the rules of the sport [1].

The delineation between combat and non-combat sports is fundamentally rooted in the nature of the activities involved and the goals pursued within each sport. Combat sports, as defined within the New South Wales Legislation Act's Combat Sports Act of 2008, encompass a wide range of physical contests where direct physical confrontation and contact are central [2].

This combat sport includes boxing, kickboxing, martial arts, and any sport or activity that requires participants to strike, kick, hit, grapple with, throw, or punch opponents as part of competition or exhibition [3].

The aggression perceived in these sports, which can vary by discipline due to differing rules and philosophical approaches, often bears a stigma, despite research suggesting that high levels of expertise and long-term training in these sports may reduce aggression levels among athletes [3].

In contrast, non-combat sports focus on competition without direct physical confrontation between participants. These can include team sports like soccer and basketball, individual sports like swimming and running, and many others that emphasize skill, endurance, strategy, and sportsmanship in ways that do not involve physical strikes or grappling between opponents.

While combat sports demand a unique blend of physical aggression, combativeness, attention, impulse control, and mood regulation to optimize performance, non-combat sports often prioritize other aspects of physical fitness and mental strategy without the inherent aggressiveness or physical confrontation [4].

Non-combat sports players mostly include those who are in active phase of sporting scenarios in the manner of playing any sports rather than non-playing or recreational players.

Coordination is the ability to control movements of muscles via the nervous system and locomotive organs. Eye–hand coordination refers to a sequence in which the brain understands visual information from the eyes and guides hand movements efficiently [5]. Vision is considered as the main source of sensory information in controlling human's coordinated and voluntary movements [6].

Hand-eye coordination is crucial for daily life activities, which develops with age. Visual skills play an important role in enabling us to perform activities of daily living (ADL) efficiently. Visual information is acquired by the high-resolution images on retina and eye movements. The coordinated movement between the eye and the hand, known as eye–hand coordination, allows us to perform various tasks such as feeding, grooming, and playing sports.

The eyes fix the focus on an object prior than the hands. When eating gaze is directed at plate first, and then a hand makes move toward the plate [7].

In combat sports like boxing, karate, martial arts, etc. the player has to punch it with their fists to opponent's certain body parts to earn points in competition and/or punch it to target points for practice in which they should have proper hand-eye coordination to achieve tasks related to it.

Combat sports are physically demanding, requiring a diverse physical and physiological profile to be successful in competition. Striking movements such as punches and kicks require explosive strength and power [8, 9], while grappling movements can require a greater emphasis on isometric and concentric strength [10, 11, 1].

Additionally, combat sports are comprised of many different sports-specific movements which will influence the physical load. For instance, sports such as boxing exert a greater demand on the upper limbs [12, 13, 14].

Even differences in equipment requirements may influence the physical demands of the sport, such as the use of a kimono in Brazilian Jiu-Jitsu and judo increasing the use of the forearm muscles [15, 1].

The specific skills and rulesets of a combat sport will significantly influence the energy cost of competition [1]. In the sports assessment, hand-eye coordination is noted as skill-related component which is essential for combat sports. Thus, in this study checking and comparing the hand-eye coordination by using alternate hands are assessed for their best result by doing punching via head-mounted reflex ball by aiming the results in the parameters of maximum numbers of repetition.

Hand-eye coordination is a fundamental skill influencing athletic performance, yet there's a noticeable gap in comparative analysis between combat and non-combat sports athletes. This study seeks to fill this gap by employing a novel assessment method, the head-mounted reflex ball test, to measure and compare hand-eye coordination across these two athlete groups.

Given the distinct demands of combat versus non-combat sports, understanding how these disciplines differently impact and develop hand-eye coordination is essential. This knowledge not only advances academic understanding but also has practical implications for designing targeted training programs to enhance athlete performance. Thus, the study addresses a critical need for insights into the specific coordination skills of athletes in varied sports, offering potential benefits for training strategies and athletic performance optimization.

Materials and Methods

Observational cross-sectional study was conducted to investigate the alternate hand-eye coordination in combat and non-combat players. A convenience sampling technique was employed to select participants from Aastha Academy, Surat, the Surat District Karate Association, Ashihara Karate International, and SPB Physiotherapy College, all located in Surat. The study population included both combat and non-combat players. Although the initial sample size calculation, based on G*Power software analysis, indicated a need for 134 participants, only 122 could be recruited due to the limited availability of combat sports players.

The study spanned six months, during which data were collected from participants meeting the inclusion criteria: individuals aged 18 years and above, both male and female, with a playing experience of one year or more. Exclusion criteria included individuals below 18 years of age, those with less than one year of competitive playing experience, anyone with musculoskeletal injuries or complaints of blurred vision in the last three months, recreational players, non-players, and athletes unwilling to participate.

The instruments used in the study included a stopwatch, non-slippery surface, measuring tape, marker tape, a reflex ball attached with a head-mounting strap, player information sheets, consent forms, and writing materials. The primary outcome measure was the number of alternate hand repetitions or successive alternate hand punches completed in 30 seconds, indicating hand-eye coordination.

The procedure for the test was as follows:

Participants were introduced to the Alternate Hand-Eye Coordination Test with a Head-Mounted Reflex Ball. They were instructed to stand within a designated 2x2 lined frame or box to ensure a consistent testing environment. The goal was to punch the reflex ball as many times as possible in 30 seconds, using alternating hands for each punch. Points were awarded for each successful punch (+1 point) and deducted for consecutive punches with the same hand or missed punches (-1 point). Participants were encouraged to maintain a consistent and alternating punching pattern, emphasizing speed, accuracy, and hand-eye coordination. The test aimed to push participants to their limits, with results recorded and noted within the 30-second timeframe.

Fig 1: Reflex ball and head mounted Velcro strap attached with elastic thread

Fig 2: Player is performing alternate hand-eye coordination test using head mounted reflex ball by punching the ball in this specific marked squared area

Fig 3: Player is performing alternate hand-eye coordination test using head mounted reflex ball by punching the ball

Data analysis and Results

The data obtained were analysed with IBM SPSS v16® statistical software. The data obtained were analysed with IBM SPSS v16 ® statistical software.

Following statistical analysis was done:

The data regarding alternate hand-eye coordination test using head mounted reflex ball in combat players and non-combat players showed non-normal distribution within the use of Shapiro-wilk test which is given below in table 1.

Table 1: Test of normality

Tests of Normality						
	Kolmogorov-Smirnova			Shapiro-Wilk		
	Statistic	df	Sig.	Statistic	df	Sig.
Results	.081	122	.046	.954	122	.000
a. Lilliefors Significance Correction						

Table 2: Descriptive analysis

Descriptive Statistics					
	N	Mean	Std. Deviation	Minimum	Maximum
Results	122	63.52	12.178	23	86
Groups	122	1.43	.498	1	2

Table 3: Test ranks

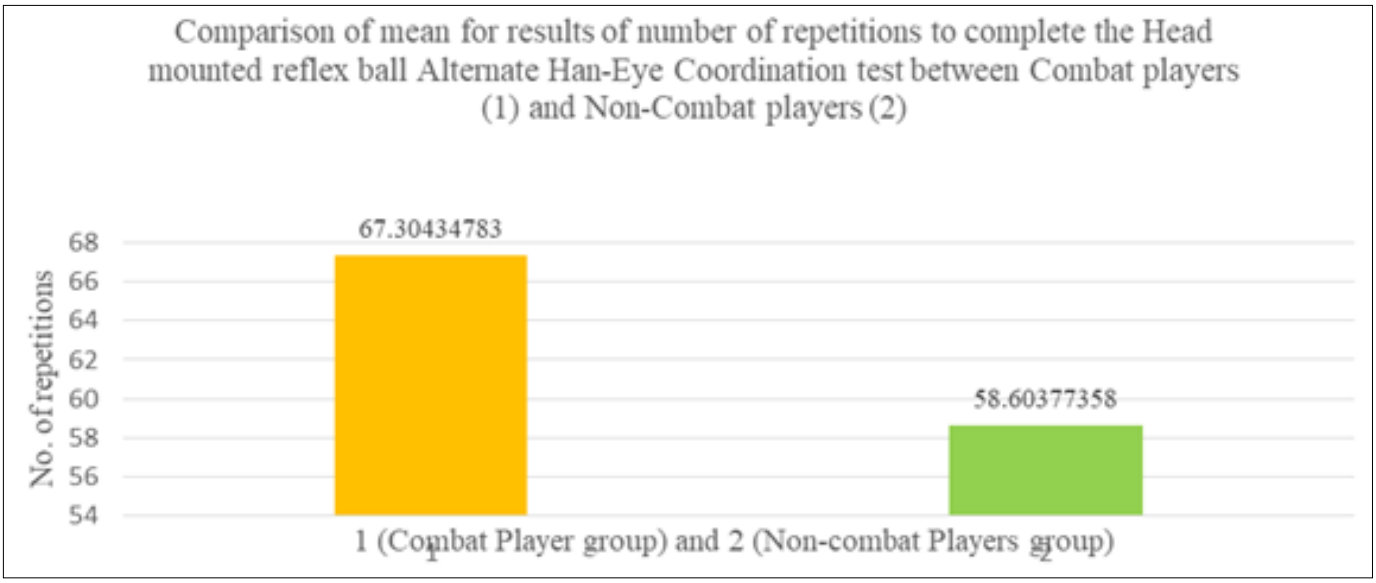
Ranks				
	Groups	N	Mean Rank	Sum of Ranks
Results	1	69	74.70	5154.50
	2	53	44.31	2348.50
	Total	122		

Table 4: Test statistics

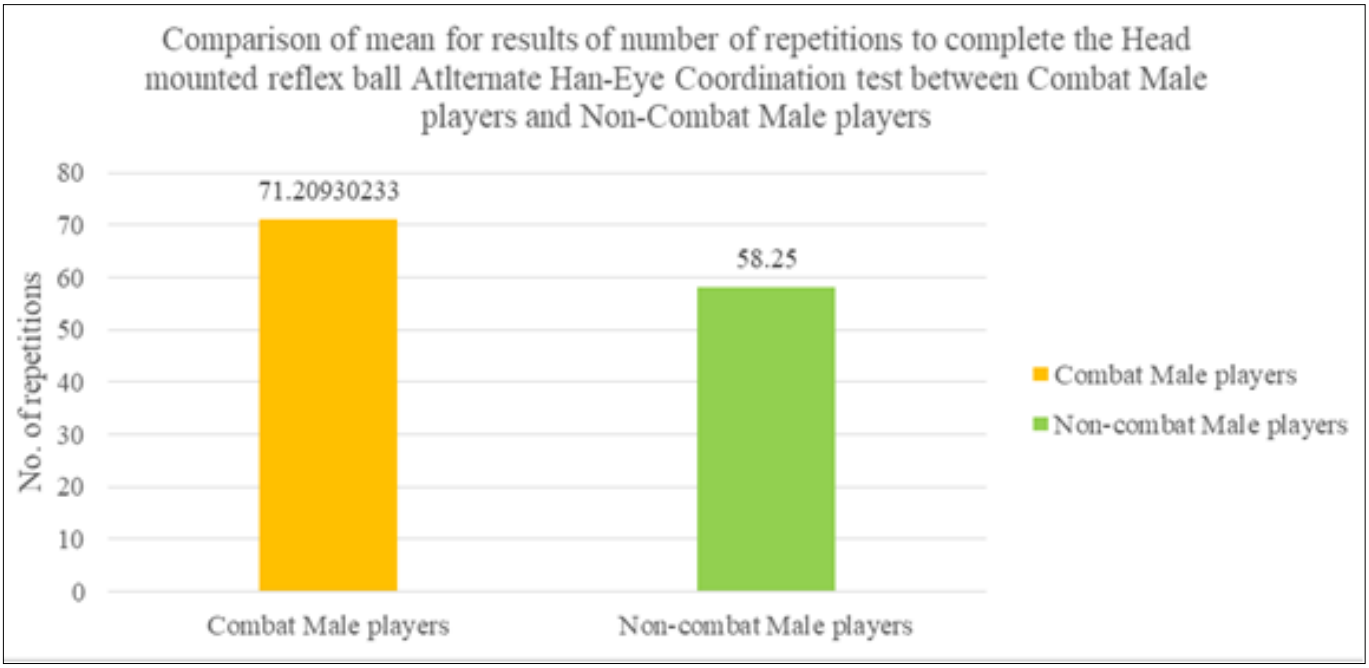
Test Statistics	
	Results
Mann-Whitney U	917.500
Wilcoxon W	2.348E3
Z	-4.710
Asymp. Sig. (2-tailed)	.000
a. Grouping Variable: Groups	

Our results from above tables noted that because of non-normal distribution of results, non-parametric test which is Mann-Whitney U test was used to check the comparative measurements. Statistics revealed a statistically significant difference (.000) between Combat players and non-combat players ($p < 0.05$), indicating that Combat players scored higher on the alternate hand-eye coordination test than non-combat players by using head mounted reflex ball.

This bar chart shows comparison of mean for results of number of repetitions to complete the Head mounted reflex ball Alternate Han-Eye Coordination test between 1 (Combat players) and 2 (non-combat players).

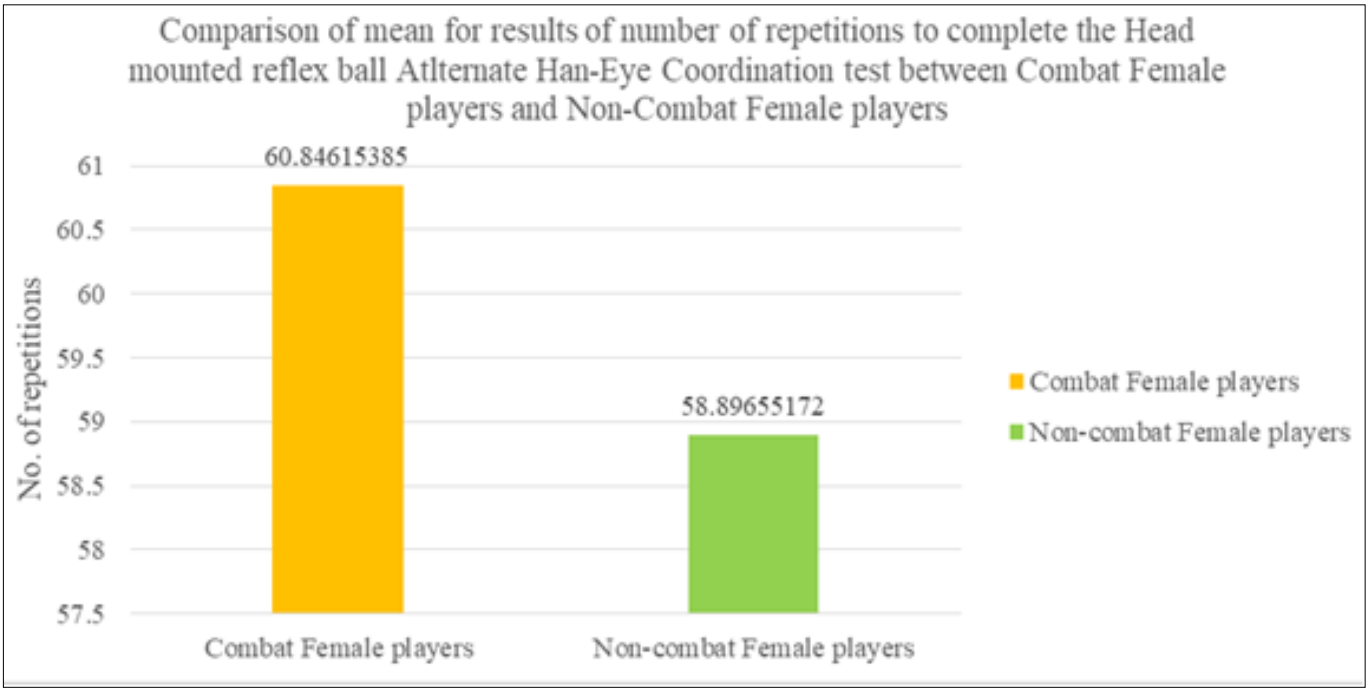


Chart/Graph 1: Mean comparison between Group 1 (Combat players) and Group 2 (Non-combat players) scoring results.



Chart/Graph 2: Mean comparison between Combat Male players and non-combat male players scoring results.

This bar chart shows comparison of mean for results of number of repetitions to complete the Head mounted reflex ball Alternate Han-Eye Coordination test between Combat male players and non-combat male players.



Chart/Graph 3: Mean comparison between Combat Female players and non-combat female players scoring results.

This bar chart shows comparison of mean for results of number of repetitions to complete the Head mounted reflex ball Alternate Han-Eye Coordination test between Combat female players and non-combat female players.

Discussion

In 21st century, there are numbers of tests which can be done to check hand-eye coordination. In this study, the head mounted reflex ball is a punching device which is generally made up of Velcro-strap that can be worn on head as headband and from one end elastic thread attached with hook on that strap as well as other end of elastic thread attached with reflex ball made up of sponge has been used for testing alternate hand and eye coordination. It is used nowadays to workout punching manner with alternate hands.

Appropriate perception of depth in players is essential for the motor system to position the body before the hit. Further to make the proper hit the sensory visual and motor system must be well coordinated. This is what signifies the eye hand coordination [16].

Good eye hand coordination increases the player's ability to perform complex movement, respond effectively to external stimuli and create fluent movement.

In general, an analysis of the structure of coordination along with the methodology of the testing and development of this quality indicates the need to develop specific tests that correspond to the specific features of combat sports and martial arts as it is one of the oldest one-on-one or one to one sport which is having different combating approaches [17].

For coordination, specific motor actions, the time required for mastering technical skills and motor actions; the time required for the restructuring of motor activity in response to a changed situation; the accuracy of motor actions evaluated using dynamic, spatial, and temporal characteristics; the ability to maintain stability after a balance disturbance; the consistency of motor action performance in varied situations (various positions of the body, objects, functional states, etc.) [17].

Coordination abilities should be tested with sport-specific tasks, which are organically related to the content of training and competitive activities. For the same reason specific to that, alternate hand-eye coordination test had been done by using the head mounted reflex ball which can be done as a test and can be used as per training perspectives.

In this study 122 players who were noted 69 combat sports players and 53 non-combat sports players as per inclusion and exclusion criteria. By consent and introducing the test to them, they were told to punch as fast as possible to complete the test in 30 second.

In this study, combat sports players (group1) were compared with non-combat sports players (group 2). As mentioned in statistical analysis, for checking the significance difference of the result measurement, non-parametric test was used.

As per result, Mann-Whitney U-test at 95% of confidence interval, there were statistically significant difference ($p<0.05$) found as per number of repetitions (no. of alternate successive punches) (sig. difference = 0.000) between combat sports players (males and females) and non-combat sports players (males and females).

There was one study aimed to assess agility in combat sports and martial arts through a comprehensive analysis of existing tests and the development of new ones. It involved 16 hand-to-hand combat athletes from various competitive levels and employed diverse research methods.

Results revealed a clear distinction between agility and coordination, highlighting the shortcomings of many existing tests in neglecting key aspects of agility, such as handling unexpected situations. While some tests allowed for agility assessment, they often lacked specificity to combat sports.

Additionally, the study found computer-based techniques ineffective for assessing agility, prompting the proposal of three specialized tests tailored to hand-to-hand combat scenarios. Overall, the study demonstrated significant improvements in agility levels over six months with the proposed training program, as evidenced by the results of all three tests [17].

As compared to above mentioned study, this study noted combat sports and martial arts together as martial arts noted the part of combat sports because of way of approach and movements as well as they focused on agility and coordination training program where as in this study by far, alternate hand-eye coordination test had been focused which was compared between combat sports players and non-combat sports players.

There was another study done to check alternate hand-eye coordination by using alternate hand wall toss test buzz wire task in comparison between university volleyball players vs non-volleyball players in which study concluded with the result of significant difference between the both group that showed university volleyball players had good alternate hand-eye coordination than university's non-volleyball players [7].

In comparison to above mentioned study, alternate hand-eye coordination tested but alternate hand punching on reflex ball used for alternate hand-eye coordination unlike of hand wall toss test via ball between comparison of combat vs non-combat sports players. Though, results showed similar to above study that there was significant difference between combat players and non-combat players in which combat players had better results of alternate hand-eye coordination than non-combat sports players.

Within this types of comparison, sports specific training should be far more noted in advantage of certain activities even if other sports had been pursued and same kind of specific activity done.

There are so many studies which noted significantly far better performance between sports players than non-players but over here in this study, it was also noted that, even if there were players who were non-combat but sports players but they had less alternate hand-eye coordination than combat sports players.

In summarization, when compared results related to alternate hand-eye coordination had been seen significantly higher in combat sports players than non-combat sports players by done with head mounted reflex ball.

Conclusion

This test showed fairly difference in AHEC (alternate hand-eye coordination) performance values in number of repetitions between combat sports and non-combat sports players.

The study also found significant difference in comparing alternate hand-eye coordination performance values between combat sports and non-combat sports players by using head mounted reflex ball alternate hand-eye coordination test.

Limitation and future scope

For limitation scenarios regarding;

Limited sample and diversity: The study's sample size and reliance on convenience sampling may not fully capture the diversity within combat and non-combat sports, potentially affecting the generalizability of results.

Assessment Method: Using only the head-mounted reflex ball test to measure hand-eye coordination may not encompass all aspects of this complex skill.

External Variables: Factors like participants' lifestyle and psychological state, which can influence performance, were not controlled.

Cross-Sectional Design: The inability to track changes over time or establish causality due to the study's design.

For the future scope regarding;

Investigating External Influences: Future research could explore the impact of external factors such as nutrition, psychological state, and other lifestyle factors on hand-eye coordination performance.

Comparative Studies across More Sports: Expanding the range of sports examined could uncover more nuanced

differences in hand-eye coordination skills, potentially leading to sport-specific training recommendations.
Training Intervention Studies: Investigating the effects of specific training programs designed to enhance hand-eye coordination in combat and non-combat sports athletes could offer practical applications for coaches and athletes.

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Conflicts of interest
None declared.

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