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Comparative Analysis of Hand–Eye Coordination among National-Level Karate, Judo, and Taekwondo Athletes

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Abstract

Aim: The aim of the present study was to compare hand–eye coordination among national-level Karate, Judo, and Taekwondo athletes. **Material and Methods:** Ninety (N=90) male national-level combat sports athletes between the ages of 18 and 25 years voluntarily participated in the study. The participants were equally divided into Karate (n=30), Judo (n=30), and Taekwondo (n=30) groups. Hand–eye coordination was assessed by using the Alternate Hand Wall Toss Test. Descriptive statistics, one-way analysis of variance (ANOVA), and LSD post-hoc test were applied for statistical analysis. **Results:** The mean hand–eye coordination score of Karate athletes was 33.12±3.18, Taekwondo athletes was 29.46±3.74, and Judo athletes was 26.83±3.92 respectively. The results of ANOVA showed that there was a statistically significant difference ($F=7.86$, $p<0.05$) among Karate, Taekwondo, and Judo athletes in hand–eye coordination performance. Further, LSD post-hoc analysis revealed significant pairwise differences among all groups. **Conclusion:** It was concluded that Karate athletes possessed superior hand–eye coordination compared with Taekwondo and Judo athletes. The findings suggest that sport-specific training and technical demands significantly influence visuomotor performance among combat sports athletes.

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Key words: Hand–eye coordination, Karate, Judo, Taekwondo, combat sports, visuomotor performance

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Introduction

Combat sports are among the most scientifically demanding athletic disciplines requiring a complex interaction of physiological, biomechanical, psychological, and neuromuscular abilities for successful performance. Among the various combat sports practiced worldwide, Karate, Judo, and Taekwondo have gained substantial international recognition due to their competitive structure, technical sophistication, and inclusion in major international sporting events. These martial arts demand rapid motor responses, perceptual accuracy, anticipation skills, agility, balance, reaction

time, and coordination abilities for effective execution of offensive and defensive techniques (Chaabène et al., 2012). Hand–eye coordination is considered one of the most important psychomotor abilities influencing sports performance. It refers to the synchronized control of visual perception and upper-limb motor responses to perform precise and accurate movements. In combat sports, athletes continuously process visual information from their opponents and convert sensory input into rapid motor actions within extremely short reaction intervals. Efficient hand–eye coordination enhances striking accuracy, defensive blocking, reaction efficiency, and tactical execution during competition (Schmidt & Lee, 2014). Karate is primarily characterized by rapid striking actions involving punches, blocks, and counterattacks requiring exceptional upper-body coordination and visual tracking abilities. Karate athletes repeatedly perform high-speed offensive and defensive techniques, which may contribute to enhanced visuomotor adaptation and neuromuscular efficiency. Chaabène et al. (2012) reported that elite Karate athletes possess superior reaction ability, movement precision, and motor coordination due to the technical demands of the sport. Similarly, Koropanovski et al. (2011) observed that elite Karate competitors demonstrate highly developed psychomotor abilities and rapid sensorimotor responses.

In contrast, Taekwondo predominantly emphasizes lower-limb kicking techniques, dynamic movement patterns, flexibility, and reaction speed. Although visual perception remains important in Taekwondo, the sport relies more extensively on lower-body motor execution than upper-limb striking actions. Kim and Lee (2017) suggested that Taekwondo athletes develop moderate hand–eye coordination because of the dominance of kicking-oriented technical skills and rapid lower-extremity movement patterns. Judo differs considerably from striking-based combat sports because it primarily involves grappling, throwing, holding, and close-contact body control techniques. Performance in Judo largely depends upon kinaesthetic awareness, balance, grip strength, proprioception, and tactile sensory feedback rather than continuous visual tracking. Franchini et al. (2011) reported that successful Judo performance relies heavily on neuromuscular coordination, postural stability, and body control during dynamic opponent interaction. Consequently, the development of hand–eye coordination in Judo athletes may differ from that of Karate and Taekwondo athletes.

Previous investigations have shown that sport-specific training produces unique physiological and psychomotor adaptations among athletes. Long-term participation in specialized training enhances neural efficiency, motor learning, sensory integration, and coordination abilities according to the specific technical demands of the sport (Magill, 2011). Sports involving rapid striking actions and visual targeting may develop superior visuomotor coordination compared with sports emphasizing grappling and tactile control. Despite the growing scientific interest in psychomotor performance among combat sports athletes, comparative research examining hand–eye coordination among Karate, Judo, and Taekwondo athletes remains limited, particularly in the Indian context. Most existing studies have focused independently on physiological or motor fitness variables without adequately comparing visuomotor coordination across different combat sports disciplines. Therefore, the present study was undertaken to compare hand–eye coordination among national-level Karate, Judo, and Taekwondo athletes.

Material and Methods

The present study was conducted on ninety (N=90) male national-level combat sports athletes aged 18–25 years. The subjects were selected through purposive sampling and equally divided into three groups: Karate (n=30), Judo (n=30), and Taekwondo (n=30). Only those athletes who had participated at national level with a minimum of three years of training experience were included in the study. The hand–eye coordination of the subjects was assessed by using the Alternate Hand Wall Toss Test (Wood, 2008). The participant stood two meters away from a wall and performed

alternate hand throws and catches with a tennis ball for thirty seconds. Three trials were administered, and the best score was considered for statistical analysis.

Statistical Analysis

The collected data were analysed using descriptive statistics including mean and standard deviation. One-way Analysis of Variance (ANOVA) and LSD post-hoc test were applied to determine significant differences among Karate, Judo, and Taekwondo athletes in hand–eye coordination performance. All statistical analyses were performed using SPSS software at 0.05 level of significance.

Results

Table 1 presents the mean and standard deviation values of age, height, body weight, and Body Mass Index (BMI) of Karate, Taekwondo, and Judo athletes. The mean age of Karate athletes was 21.34±1.82 years, Taekwondo athletes was 20.96±1.67 years, and Judo athletes was 21.58±1.91 years respectively. The overall mean age of all participants was 21.29±1.80 years.

The mean height of Karate athletes was 173.42±6.28 cm, Taekwondo athletes was 175.16±5.92 cm, whereas Judo athletes recorded 171.83±6.47 cm respectively. The overall mean height of the participants was 173.47±6.22 cm. The mean body weight of Karate athletes was 66.18±7.14 kg, Taekwondo athletes was 64.27±6.88 kg, and Judo athletes was 69.35±8.21 kg respectively. The overall mean body weight of all athletes was 66.60±7.41 kg.

The mean BMI of Karate athletes was 22.01±2.16 kg/m², Taekwondo athletes was 20.94±1.83 kg/m², and Judo athletes was 23.48±2.37 kg/m² respectively. The overall mean BMI of the participants was 22.14±2.12 kg/m².

Table 1. Mean ±SD of Age, Height, Body Weight, and BMI of Combat Sports Athletes

Group	N	Age, (years)	Height (cm)	Body weight (kg)	BMI (kg/m^2)
Karate	30	21.34±1.82	173.42±6.28	66.18±7.14	22.01±2.16
Taekwondo	30	20.96±1.67	175.16±5.92	64.27±6.88	20.94±1.83
Judo	30	21.58±1.91	171.83±6.47	69.35±8.21	23.48±2.37
Total	90	21.29±1.80	173.47±6.22	66.60±7.41	22.14±2.12

Table 2 presents the analysis of variance (ANOVA) of hand–eye coordination scores among Karate, Taekwondo, and Judo athletes. The obtained sum of squares between groups was 612.78 with 2 degrees of freedom, whereas the sum of squares within groups was 3392.84 with 87 degrees of freedom. The mean square value between groups was 306.39, while the mean square within groups was 38.99. The obtained F-value was 7.86, which was found to be statistically significant at 0.05 level of significance (p=0.001). The results indicate that a significant difference existed among Karate, Taekwondo, and Judo athletes in hand–eye coordination performance.

Table 2. Analysis of Variance (ANOVA) of Hand–Eye Coordination Scores

Source of Variance	Sum of Square	df	Mean Square	F	Sig.
Between Groups	612.78	2	306.39		

Within Groups	3392.84	87	38.99	7.86	0.001
Total	4005.62	89			

Table 3 presents the LSD post-hoc multiple comparisons of hand–eye coordination scores among Karate, Taekwondo, and Judo athletes. The results revealed a statistically significant difference between Karate and Taekwondo athletes with a mean difference of 3.66 (p=0.001). Similarly, a significant difference was observed between Karate and Judo athletes with a mean difference of 6.29 (p=0.000).

Further, the comparison between Taekwondo and Judo athletes also showed a statistically significant difference with a mean difference of 2.63 (p=0.012). The findings indicate that Karate athletes demonstrated superior hand–eye coordination performance compared with Taekwondo and Judo athletes, whereas Taekwondo athletes performed better than Judo athletes.

Table 3. LSD Post-Hoc Multiple Comparisons of Hand–Eye Coordination Scores

Comparison	Mean Difference	Sig.
Karate vs Taekwondo	3.66	0.001
Karate vs Judo	6.29	0.000
Taekwondo vs Judo	2.63	0.012

Discussion

The findings of the present study revealed significant differences in hand–eye coordination among national-level Karate, Taekwondo, and Judo athletes. Karate athletes demonstrated superior hand–eye coordination compared with Taekwondo and Judo athletes, while Taekwondo athletes performed better than Judo athletes. These differences may be attributed to the sport-specific technical demands of each combat sport.

The superior performance of Karate athletes may be due to the striking-oriented nature of Karate, which requires rapid upper-limb movements, visual tracking, precise targeting, and quick offensive and defensive responses. Repeated practice of high-speed striking techniques may enhance visuomotor coordination, reaction ability, and sensorimotor integration. These findings are supported by Chaabène et al. (2012) and Koropanovski et al. (2011), who reported superior motor coordination and psychomotor abilities among elite Karate athletes.

Taekwondo athletes also demonstrated better hand–eye coordination than Judo athletes, possibly because the sport involves rapid movement patterns, dynamic balance, visual perception, and quick reaction during kicking actions. Kim and Lee (2017) similarly reported improved visuomotor coordination among Taekwondo athletes.

In contrast, Judo athletes showed comparatively lower hand–eye coordination scores, as Judo mainly emphasizes grappling, balance, proprioception, tactile sensation, and close-contact body control rather than continuous visual tracking. Franchini et al. (2011) stated that Judo performance largely depends upon neuromuscular coordination and kinaesthetic control.

The significant ANOVA and LSD post-hoc results confirmed meaningful differences among all three groups and supported the principle of sport specificity. Magill (2011) emphasized that long-term sport-specific training enhances motor learning, neural efficiency, and coordination abilities according to the technical demands of a sport.

The findings of the present study suggest that coordination-based training should be systematically included in combat sports conditioning programmes to improve reaction efficiency, technical

accuracy, and overall athletic performance. Overall, the study provides valuable scientific evidence regarding the influence of sport-specific training on visuomotor coordination among combat sports athletes.

Conclusion

The present study concluded that significant differences existed in hand–eye coordination among national-level Karate, Taekwondo, and Judo athletes. Karate athletes demonstrated superior hand–eye coordination performance compared with Taekwondo and Judo athletes, whereas Taekwondo athletes performed better than Judo athletes. The findings indicate that the technical and tactical demands of combat sports significantly influence visuomotor coordination and psychomotor development. Therefore, sport-specific coordination training should be incorporated into regular conditioning programmes to enhance athletic performance in combat sports.

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Conflict of Interest: None declared