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Anthropometric Physical Fitness Measurements of Medalist and Non-Medalist Athletes in Self-Defense Sports in Aqaba, Jordan

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Abstract **Introduction:** This study investigates the anthropometric physical fitness measurements of athletes who have won medals and those who have not in self-defense sports, such as karate, Muay Thai, kickboxing, and taekwondo, in the context of Aqaba, Jordan. The objective of this research is to uncover the physical attributes that contribute to success in these sports. The study measured various anthropometric factors, including height, weight, BMI, body fat percentage, muscle mass, and flexibility, among a sample of athletes who had won medals and those who had not. The findings demonstrated notable differences in certain anthropometric characteristics between the two groups, highlighting the significance of specific physical attributes in achieving success in self-defense sports.Athletes in self-defense sports, such as karate, Muay Thai, kickboxing, and taekwondo, must possess a combination of physical conditioning, technical proficiency, and mental resilience to achieve success in competition. These athletes often engage in rigorous training regimens to enhance their performance and achieve victory at various levels. While technical competence and strategic insight are critical factors in achieving success, it is crucial to recognize the significance of anthropometric physical fitness measurements. Anthropometric measurements, including height, weight, body composition, and flexibility, can offer valuable information about the physiological characteristics that contribute to athletic success in self-defense sports. **Methodology:** The research evaluated the anthropometric characteristics of athletes participating in self-defense sports in Aqaba, Jordan. The sample included two groups of athletes based on their competitive accomplishments: those who had won medals (gold, silver, or bronze) at the national or international level, and those who had not. The study collected data on various anthropometric measures, such as height (in centimeters), weight (in kilograms), body mass index (BMI), body fat percentage (%), muscle mass (in kilograms), and flexibility (measured using the sit and reach test). **Results:** The findings of the study revealed significant disparities in specific anthropometric measures between athletes who earned medals and those who did not. When compared to non-medalist athletes, medalist athletes exhibited higher levels of muscle mass and lower body fat percentages. Additionally, medalist athletes demonstrated greater flexibility, as evidenced by their sit and reach test scores. However, no discernible differences were observed in the height, weight, or BMI of the two groups. Discussion: The results of this study emphasize the relevance of precise anthropometric physical fitness measurements in attaining success in self-defense sports. Successful athletes in these sports had favorable body composition characteristics, such as higher muscle mass and lower body fat percentages, which could contribute to increased strength-to-weight ratios and agility. Furthermore, greater flexibility among these athletes indicated improved range of motion and injury prevention, which are crucial in dynamic combat sports. These findings emphasize the importance of designing targeted strength and conditioning programs that cater to the physical demands of self-defense sports.. **Conclusion:** This study delivers essential information about the physical measurements of athletes in self-defense sports who won medals and those who did not in Aqaba, Jordan. The findings imply that specific physiological factors, including muscle mass, body fat percentage, and flexibility, can impact an athlete's success in competitions. Coaches and athletes can use this data to create personalized training regimens that focus on improving performance and achieving success in self-defense sports.

Key Words anthropometry, physical fitness, self-defense sports, karate, Muay Thai, kickboxing, taekwondo, Aqaba, Jordan

1. Introduction

The self-defense sports category includes martial arts, taekwondo, and judo and requires special sorts of characteristics, skill sets, and mental strengths so that the athletes attain excellence in their efforts [1], [2]. In such sports, success is not reliant only on technical skill, but it is closely associated with the physical fitness and the anthropometric characteristics of the athletes [3]–[5]. Thus, to develop training packages that can help in enhancing the performance of the athletes and will increase the possibility of winning medals and other recognition, it thus becomes imperative to understand in detail the interplay between these factors.

In the course of this realization and the process of recognition, the paper is motivated by the fact that though the variance in terms of athlete capabilities is too inherent and wide, there are common physical traits to medalists distinguishing them from their non-medalist counterparts in self-defense sports [6], [7]. While technical skill certainly is instrumental in the success, but there is no belittling the importance of preparedness of the athlete in terms of physical and anatomical characteristics as well [8]. This study will therefore explore this relationship; it will try to understand what is associated with success in self-defense sports in Aqaba, Jordan.

Over the years, the science behind athletic achievement has turned into interests the researchers and the practitioners in general who accept the fact that success in sports is multifaceted [9]. The present study falls in line with this wider trend, trying to fill in the gap in literature by focusing on the particular self-defense sports that have not enjoyed the same attention in a context as specific as the cultural and regional setting of Aqaba, Jordan The rich history of the region and commitment to the many martial traditions provide adistinctive backdrop against which to explore the physical dimensions that may influence an athlete's standing as a meduallist or non-medallist [10], [11].

Again, with the continuous development in sports science, anthropometric measurements and physical fitness assessment have become determinants of athletic success [12]. This, in turn, forms an understanding of what our study contributes to in the attempt to add empirical evidence to this pool of rising knowledge with a view to providing useful insight to coaches, trainers, and athletes alike [13]. We shall thus unravel the patterns that inform such training regimens aimed at the needs of athletes aspiring for success in self-defense sports by analysing in depth the physical attributes of the medalists and the non-medalists.

In Aqaba, Jordan area that is popular with its background and proud of dedication to combat sport like karate, muay thai kickboxing taekwondo there remains a problem the exploration of determinants for victory in these self defense crafts. However widely participated in these sports, and athletes involved therein notwithstanding; little research has accentuated on the physical qualities and fitness standards of an athlete in Aqaba city.

While technical skill and strategic acuity are surely fundamental aspects of medalist victories in karate, Muay Thai, kickboxing or taekwondo the interrelationship between anthropometric measurements distinctive to gold-winning athletes rather than non-medallists has not been adequately examined within the frameworks derived from Aqaba Jordan [14] elucidating the nature of factors like cardiorespiratory endurance, muscular strength, flexibility and body composition as they affect these actual martial arts disciplines' performance is critical to improving training strategies for best possible competitive results.

Hence, the issue at hand is that there is a need to close this knowledge further gap by identifying the anthropometric measurements in karate, Muay Thai kickboxing, and Taekwondo for athletes in Aqaba Jordan. This study thus seeks to use this gap in research as a space into which evidence-based knowledge can help provide informed training approaches adapted for self- defense athletes peculiar interests and needs based on their competitive commitments while advancing career goals characteristic of Aqaba, Jordan.

The objectives, methods used, results, and the discussion in the following sections elaborate to enhance the understanding regarding the intricate relationship among physical fitness, anthropometric measurements, and success in self-defense sports.

A. Objectives

The objectives of this study are as follows;

1) To examine the selected anthropometric measurements of medalist and non-medalist athletes in self-defense Sports (karate, Muay Thai, kickboxing, and taekwondo) in Aqaba, Jordan
2) To examine the differences in the selected anthropometric measurements between a medalist and non-medalist athlete in self-defense Sports (karate, Muay Thai, kickboxing, and taekwondo) in Aqaba, Jordan.

2. Methods

A. Design of the Study

The purpose of this study was to investigate the association between selected anthropometric of medalist and non-medalist athletes in self-defense sports such as: Kickboxing, Karate, Muathai, and Takwando and to identify variables which are able to predict performance. To achieve the purpose of this research, an ex post facto research design was used. It is a method in which groups with qualities that already exist are compared on some dependent variables. Also known as "after the fact" research, an ex post facto design is considered quasi-experimental because the subjects are not randomly assigned - they are grouped based on a particular characteristic or trait. This method is selected with the hope that it will help achieve the objectives of the study as desired by the researcher via producing a pertinent data. Hence, the obtained data from tests is analyzed and interpreted.

B. Study Area (Climate and Temperature)

The study was conducted in Aqaba of Jordan. The study comprises of 4 athletics academies at different locations in Aqaba.

The first one is Academy World Champion Mohamed Salama located at Aqaba, Jordan. The second is Ayla Taekwondo Academy located at G2Q7+96R, Aqaba, Jordan. The third is Golden Fitness Time Gym located at Al-Hussien Bin Ali St., Aqaba, Jordan. The fourth is Horizon Kickboxing & Fitness Academy Aqaba - Qasabet Al Aqaba.

As for the average temperature of Aqaba, the hot season lasts for 4.0 months, between May 23 and September 23, with an average daily high temperature above 96°F. The hottest month of the year in Aqaba is July, with an average high of 103°F and low of 80°F. The cool season lasts for 3.1 months, between December 1 and March 4, with an average daily high temperature below 75°F. The coldest month of the year in Aqaba is January, with an average low of 50°F and high of 69°F (https://weatherspark.com/y/98737/Average-Weather-in-Aqaba-Jordan-Year-Round#Sections-Temperature).

3. Results and Discussion

A. Gender and status of the participants in the four sports are presented below

Table 1 presents data on the participation and status of male and female athletes across the four martial arts sports: Kickboxing, Karate, Muay Thai, and Taekwondo. The data presented in the table pertains to the number of male and female participants in various martial arts sports. In Kickboxing, there were 55 male participants and 24 female participants. This constitutes 69.6% and 30.4% of the total number of participants, respectively. In Karate, there were 27 male participants and 20 female participants, with 57.4% and 42.6% of the total number of participants, respectively. Muay Thai had 10 male participants and 27 female participants, representing 27.0% and 73.0% of the total number of participants, respectively. Taekwondo had 24 male participants and 23 female participants, with 51.1% and 48.9% of the total number of participants, respectively.

The table also provides information on the number of male and female medalists in each sport. In Kickboxing, 19 males (24.1% of total male participants) and 15 females (31.9% of total female participants) were medalists. In Karate, 15 males (31.9% of total male participants) and 16 females (43.2% of total female participants) won medals. In Muay Thai, 16 males (43.2% of total male participants) and 21 females (56.8% of total female participants) achieved medalist status. In Taekwondo, 21 males (44.7% of total male participants) and 26 females (55.3% of total female participants) were medalists. Overall, out of the total 210 participants, 71 (33.8%) were medalists, with 139 (66.2%) not achieving medalist status.

These findings suggest variations in participation rates and medalist distributions across different martial arts sports and between male and female athletes. For instance, while Muay Thai had the highest percentage of female participants, Taekwondo had nearly equal representation of males and females. Additionally, the percentage of female medalists exceeded that of male medalists in Karate, Muay Thai, and Taekwondo, which may indicate potential gender-based differences in performance or opportunities within these sports. Therefore, this interpretation provides deeper insights into the participation and medalist outcomes across different martial arts sports, emphasizing gender disparities and performance trends.

B. Descriptive statistics of the participants

Table 2 presents descriptive statistics for various physical fitness measurements among female participants in different martial arts, including Kickboxing, Karate, Taekwondo, and Muay Thai. These measurements cover a range of physical attributes and abilities, allowing for insights into the distinct fitness profiles within each martial art.

In terms of sitting height, Kickboxing participants exhibited an average height of 82.215 cm (SD = 3.3892), which was slightly higher than the average for Karate (M = 82.190 cm, SD = 2.7589), Taekwondo (M = 80.371 cm, SD = 3.6291), and Muay Thai (M = 78.789 cm, SD = 2.7208) practitioners. Additionally, armspan measurements showed variability, with Taekwondo practitioners having the longest average armspan (M = 162.947 cm, SD = 8.0904), followed by Kickboxing (M = 161.946 cm, SD = 9.7059), Karate (M = 157.160 cm, SD = 7.0234), and Muay Thai (M = 160.044 cm, SD = 7.2069) participants.

In terms of explosive power, the groups differed in their vertical jump heights, with Taekwondo practitioners achieving the highest average vertical jump (M = 18.1176 inches, SD = 2.89346), followed by Muay Thai (M = 18.5919 inches, SD = 2.16210), Kickboxing (M = 17.2885 inches, SD = 1.67035), and Karate (M = 17.625 inches, SD = 1.87171) participants. Similarly, in standing broad jump distances, Taekwondo participants exhibited the longest average distance (M = 186.250 cm, SD = 27.5753), followed by Muay Thai (M = 183.981 cm, SD = 27.6118), Kickboxing (M = 190.000 cm, SD = 34.1364), and Karate (M = 184.625 cm, SD = 30.3770) practitioners.

The table also presents data on other physical fitness measures such as medicine ball throw distance, sit-and-reach flexibility, balance, cardiovascular endurance, muscular endurance, handgrip strength, predicted VO2 max, level of expertise, and shuttle run performance across the different martial arts disciplines.

Overall, these results illustrate the diverse physical attributes and capabilities of female participants in various martial arts disciplines, emphasizing the importance of tailored training programs to optimize performance and fitness outcomes within each discipline.

Table 3 presents descriptive statistics for various physical measurements among male participants in different sports categories. The table includes the number of participants (N), mean, standard deviation (Std. Deviation), standard error (Std. Error), and 95% confidence intervals for the mean for each sports category. Additionally, it presents the minimum and maximum values for each measurement across different sports.

Sports	Male	%	Female	%	Total	Medalists	%	Non-medalists	%
Kickboxing	55	69.6	24	30.4	79	19	24.1	60	75.9
Karate	27	57.4	20	42.6	47	15	31.9	32	68.1
Muathai	10	27.0	27	73.0	37	16	43.2	21	56.8
Takwando	24	51.1	23	48.9	47	21	44.7	26	55.3
Total	116	55.2	94	44.8	210	71	33.8	139	66.2

Table 1: Shows detailed information of the participants in Jordan

In terms of Sitting Height (cm), Male participants in Taekon had the highest mean sitting height (M = 85.058 cm), followed by MUAY (M = 85.570 cm), Kickboxing (M = 83.725 cm), and Karate (M = 83.022 cm). With regards to Arm span (cm), Muay participants demonstrated the highest mean arm span (M = 178.000 cm), followed by Kickboxing (M = 172.454 cm), TAEKON (M = 172.113 cm), and Karate (M = 171.126 cm). When considering Vertical Jump (inch), TAEKON participants displayed the highest mean vertical jump (M = 25.5535 inches), followed by MUAY (M = 25.4750 inches), KARAT (M = 24.9715 inches), and Kickboxing (M = 23.7917 inches). For Standing Broad Jump (cm), MUAY participants had the highest mean standing broad jump (M = 193.050 cm), followed by Kickboxing (M = 198.458 cm), TAEKON (M = 180.891 cm), and KARAT (M = 168.648 cm). Lastly, in terms of Medicine Ball Throw (m), participants in Kickboxing recorded the highest mean distance in the medicine ball throw (M = 5.0674 m), followed by TAEKON (M = 4.3964 m), MUAY (M = 4.6490 m), and KARAT (M = 4.1514 m).The sixth measure assessed was the Sit and Reach (cm), where male participants in TAEKON exhibited the highest mean sit and reach distance (M = 35.1047 cm), followed by Kickboxing (M = 35.9250 cm), MUAY (M = 34.7200 cm), and KARAT (M = 34.2294 cm). Seventh, in terms of the Standing Stork Balance (s), MUAY participants demonstrated the longest mean standing stork balance duration (M = 40.4405 seconds), followed by Kickboxing (M = 27.1213 seconds), TAEKON (M = 24.8146 seconds), and KARAT (M = 21.2828 seconds). Eighth, for the 20 Meter Run (s), TAEKON participants had the lowest mean time in the 20-meter run (M = 3.6042 seconds), followed by MUAY (M = 3.5475 seconds), Kickboxing (M = 3.6102 seconds), and KARAT (M = 3.9849 seconds). Ninth, in the T-Test (s), participants in KARAT had the highest mean time (M = 12.9911 seconds), followed by MUAY (M = 12.4650 seconds), TAEKON (M = 11.8047 seconds), and Kickboxing (M = 11.6225 seconds). Lastly, for the 1 Min Sit-Up, participants in TAEKON exhibited the highest mean number of sit-ups in one minute (M = 38.127), followed by Kickboxing (M = 38.854), MUAY (M = 34.800), and KARAT (M = 35.889).

According to the data provided, the Eleventh measure of Max Push-Up Participants in Kickboxing achieved the highest average number of maximum push-ups (M = 39.04), followed by TAEKON (M = 38.35), MUAY (M = 36.00), and KARAT (M = 29.41). Additionally, participants in Kickboxing exhibited the highest average handgrip strength (M = 35.7646 Kg), followed by TAEKON (M = 34.6891 Kg), KARAT (M = 33.6278 Kg), and MUAY (M = 33.4650 Kg). Furthermore, participants in KICKBOXING had the highest average predicted VO2 max (M = 40.2792), followed by MUAY (M = 40.3700), TAEKON (M = 36.6000), and KARAT (M = 31.4253). Moreover, participants in TAEKON showed the highest average fitness level (M = 7.4727), followed by MUAY (M = 7.9185), Kickboxing (M = 7.2083), and KARAT (M = 7.0741). Lastly, participants in KARAT achieved the highest average shuttle run score (M = 4.8519), followed by TAEKON (M = 4.2182), Kickboxing (M = 4.0833), and MUAY (M = 3.4685). These data indicate that male participants in different sports categories displayed variations in physical measurements, with some sports showing superior performance levels in specific metrics compared to others.

C. ANOVA for Female participants

A series of one-way ANOVA tests were conducted to examine the differences in various physical fitness measures among female participants.

Table 4 displays the results of a one-way ANOVA for female participants. The analysis revealed significant differences in sitting height ($F(3, 90) = 5.762$, $p = .001$) and predicted VO2 max ($F(3, 90) = 3.855$, $p = .012$) among the different groups. Specifically, there was a significant impact of group membership on sitting height, with a large effect size ($\eta^2 = .161$), indicating that variations in sitting height were significantly influenced by different group memberships. Similarly, there was a significant impact of group membership on predicted VO2 max, although the effect size was smaller ($\eta^2 = .113$). However, no significant differences were found in arms pan ($F(3, 90) = 2.441$, $p = .069$), vertical jump ($F(3, 90) = 1.158$, $p = .330$), standing broad jump ($F(3, 90) = .139$, $p = .937$), medicine ball throw ($F(3, 90) = .967$, $p = .412$), sit and reach ($F(3, 90) = .750$, $p = .525$), standing stork balance ($F(3, 90) = 1.411$, $p = .245$), 20 meter run ($F(3, 90) = 2.039$, $p = .114$), t-test ($F(3, 90) = 1.198$, $p = .315$), 1 min sit up ($F(3, 90) = 2.062$, $p = .111$), max push up ($F(3, 90) = 1.665$, $p = .180$), handgrip ($F(3, 90) = .312$, $p = .816$), level ($F(3, 90) = 1.062$, $p = .369$), and shuttle ($F(3, 90) = .913$, $p = .438$). These results indicate that among female participants, sitting height and predicted VO2 max are significantly influenced by different group memberships, while other physical fitness measures do not vary significantly across different groups.

Sitting Height (inches): There was a considerable difference in sitting height among female participants belonging to various groups ($F(3, 90) = 5.762$, $p = .001$).Post-hoc

Variables		N	Mean	Std. Deviation	Std. Error	95% Confidence Interval for Mean		Minimum	Maximum
						Lower Bound	Upper Bound		
Sitting height (cm)	KICKBOXING	13	82.215	3.3892	.9400	80.167	84.263	77.2	88.3
	KARAT	20	82.190	2.7589	.6169	80.899	83.481	76.6	86.8
	TAEKON	34	80.371	3.6291	.6224	79.104	81.637	73.5	90.5
	MUAY	27	78.789	2.7208	.5236	77.713	79.865	73.0	84.0
	Total	94	80.559	3.4144	.3522	79.859	81.258	73.0	90.5
Armspan (cm)	KICKBOXING	13	161.946	9.7059	2.6919	156.081	167.811	147.0	178.0
	KARAT	20	157.160	7.0234	1.5705	153.873	160.447	144.8	170.2
	TAEKON	34	162.947	8.0904	1.3875	160.124	165.770	145.0	181.4
	MUAY	27	160.044	7.2069	1.3870	157.193	162.895	148.0	182.8
	Total	94	160.744	8.0536	.8307	159.094	162.393	144.8	182.8
Vertical jump (inc)	KICKBOXING	13	17.2885	1.67035	.46327	16.2791	18.2978	13.75	19.50
	KARAT	20	17.6250	1.87171	.41853	16.7490	18.5010	13.50	21.25
	TAEKON	34	18.1176	2.89346	.49622	17.1081	19.1272	13.00	24.00
	MUAY	27	18.5919	2.16210	.41610	17.7366	19.4472	15.00	21.75
	Total	94	18.0344	2.35796	.24320	17.5514	18.5173	13.00	24.00
Standing broad jump (cm)	KICKBOXING	13	190.000	34.1364	9.4677	169.372	210.628	142.5	242.5
	KARAT	20	184.625	30.3770	6.7925	170.408	198.842	114.0	237.0
	TAEKON	34	186.250	27.5753	4.7291	176.629	195.871	123.0	255.0
	MUAY	27	183.981	27.6118	5.3139	173.059	194.904	150.0	260.5
	Total	94	185.771	28.7340	2.9637	179.886	191.657	114.0	260.5
Medicine ball throw (m)	KICKBOXING	13	4.7604	1.16351	.32270	4.0573	5.4635	3.20	6.54
	KARAT	20	5.1472	1.12719	.25205	4.6196	5.6747	3.41	7.35
	TAEKON	34	4.6965	.72706	.12469	4.4428	4.9502	3.38	6.90
	MUAY	27	4.7150	1.15736	.22273	4.2572	5.1728	2.96	7.22
	Total	94	4.8065	1.01411	.10460	4.5988	5.0142	2.96	7.35
Sit and reach (cm)	KICKBOXING	13	35.6346	7.36007	2.04132	31.1870	40.0823	21.25	45.05
	KARAT	20	33.2904	6.04662	1.35207	30.4605	36.1203	21.60	48.20
	TAEKON	34	35.9504	6.57986	1.12844	33.6546	38.2463	19.55	54.50
	MUAY	27	35.9241	7.61950	1.46637	32.9099	38.9382	23.00	51.75
	Total	94	35.3332	6.87049	.70864	33.9260	36.7404	19.55	54.50
Standing stork balance (s)	KICKBOXING	13	32.7385	33.19205	9.20582	12.6807	52.7962	4.71	130.74
	KARAT	20	22.8970	18.40071	4.11452	14.2852	31.5088	5.88	66.89
	TAEKON	34	19.8043	13.99728	2.40051	14.9204	24.6881	2.27	49.20
	MUAY	27	23.4706	16.90280	3.25294	16.7840	30.1571	1.77	61.13
	Total	94	23.3041	19.43423	2.00449	19.3236	27.2847	1.77	130.74
20 meter run (s)	KICKBOXING	13	3.6990	.35302	.09791	3.4857	3.9124	3.18	4.31
	KARAT	20	3.4469	.33446	.07479	3.2903	3.6034	2.80	3.99
	TAEKON	34	3.6609	.31901	.05471	3.5496	3.7722	3.09	4.38
	MUAY	27	3.6103	.37435	.07204	3.4622	3.7584	2.99	4.31
	Total	94	3.6061	.34927	.03602	3.5346	3.6776	2.80	4.38
T-test (s)	KICKBOXING	13	12.3042	1.20996	.33558	11.5731	13.0354	10.83	15.05
	KARAT	20	12.0400	.80195	.17932	11.6646	12.4153	9.74	13.27
	TAEKON	34	11.7599	1.34928	.23140	11.2891	12.2307	9.32	17.25
	MUAY	27	12.2253	.93136	.17924	11.8569	12.5937	10.68	14.26
	Total	94	12.0285	1.12120	.11564	11.7988	12.2581	9.32	17.25
1 min sit up -1-	KICKBOXING	13	34.462	7.0073	1.9435	30.227	38.696	20.0	45.0
	KARAT	20	40.200	10.2885	2.3006	35.385	45.015	20.0	52.0
	TAEKON	34	40.588	9.1622	1.5713	37.391	43.785	21.0	58.0
	MUAY	27	37.333	6.7368	1.2965	34.668	39.998	22.0	49.0
	Total	94	38.723	8.6763	.8949	36.946	40.500	20.0	58.0
Max push up -1-	KICKBOXING	13	30.38	17.590	4.879	19.75	41.01	7	70
	KARAT	20	44.65	28.684	6.414	31.23	58.07	10	105
	TAEKON	34	39.00	14.329	2.457	34.00	44.00	11	70
	MUAY	27	37.11	12.451	2.396	32.19	42.04	15	64
	Total	94	38.47	18.499	1.908	34.68	42.26	7	105
Handgrib (Kg)	KICKBOXING	13	34.9846	8.46910	2.34890	29.8668	40.1024	21.40	47.85
	KARAT	20	35.3625	8.40535	1.87949	31.4287	39.2963	22.70	49.70
	TAEKON	34	33.0471	10.59619	1.81723	29.3499	36.7442	8.20	56.50
	MUAY	27	33.4500	9.93550	1.91209	29.5196	37.3804	15.90	48.40
	Total	94	33.9234	9.59562	.98971	31.9580	35.8888	8.20	56.50
Predicted VO2 Max	KICKBOXING	13	34.5372	7.77972	2.15771	29.8359	39.2384	21.30	44.00
	KARAT	20	36.7641	7.59023	1.69723	33.2118	40.3165	26.80	55.10
	TAEKON	34	41.5971	6.98611	1.19811	39.1595	44.0346	30.30	63.00
	MUAY	27	37.8395	6.94796	1.33714	35.0910	40.5880	25.90	52.30
	Total	94	38.5131	7.54123	.77782	36.9685	40.0577	21.30	63.00
Level	KICKBOXING	13	5.8462	2.23033	.61858	4.4984	7.1939	3.00	11.00
	KARAT	20	7.1500	1.46089	.32667	6.4663	7.8337	4.00	9.00
	TAEKON	34	6.5588	2.75451	.47240	5.5977	7.5199	2.00	14.00
	MUAY	27	6.2359	1.97393	.37988	5.4551	7.0168	3.00	11.00
	Total	94	6.4933	2.24311	.23136	6.0339	6.9527	2.00	14.00
Shuttle	KICKBOXING	13	4.2308	2.68185	.74381	2.6101	5.8514	1.00	10.00
	KARAT	20	5.5500	3.05175	.68239	4.1217	6.9783	1.00	11.00
	TAEKON	34	5.4706	3.41330	.58538	4.2796	6.6615	1.00	12.00
	MUAY	27	4.5693	2.81609	.54196	3.4553	5.6833	1.00	12.00
	Total	94	5.0571	3.07591	.31726	4.4271	5.6871	1.00	12.00

Table 2: Showing descriptive statistics for various physical measurements among female participants in different sports categories

		N	Mean	Std. Deviation	Std. Error	95% Confidence Interval for Mean		Minimum	Maximum
						Lower Bound	Upper Bound		
Sitting height (cm)	Kickboxing	24	83.725	4.0043	.8174	82.034	85.416	77.1	92.0
	Karat	27	83.022	8.6479	1.6643	79.601	86.443	43.5	93.5
	Taekon	55	85.058	4.2849	.5778	83.900	86.217	67.6	93.2
	Muay	10	85.570	4.3045	1.3612	82.491	88.649	79.0	92.0
	Total	116	84.353	5.5724	.5174	83.328	85.377	43.5	93.5
Armspan (cm)	Kickboxing	24	172.454	9.2475	1.8876	168.549	176.359	160.0	192.0
	Karat	27	171.126	8.0552	1.5502	167.939	174.312	150.0	186.0
	Taekon	55	172.113	10.0251	1.3518	169.403	174.823	130.0	186.0
	Muay	10	178.000	7.6565	2.4212	172.523	183.477	165.4	187.8
	Total	116	172.461	9.3112	.8645	170.749	174.174	130.0	192.0
Vertical jump (inc)	Kickboxing	24	23.7917	3.45205	.70465	22.3340	25.2493	17.25	31.50
	Karat	27	24.9715	3.94279	.75879	23.4118	26.5312	18.25	32.75
	Taekon	55	25.5535	3.36776	.45411	24.6431	26.4639	16.00	32.75
	Muay	10	25.4750	3.95539	1.25081	22.6455	28.3045	18.25	28.75
	Total	116	25.0468	3.59402	.33370	24.3858	25.7077	16.00	32.75
Standing broad jump (cm)	Kickboxing	24	198.458	41.0127	8.3717	181.140	215.776	125.0	254.0
	Karat	27	168.648	43.2928	8.3317	151.522	185.774	104.0	251.0
	Taekon	55	180.891	31.9021	4.3017	172.267	189.515	114.0	254.0
	Muay	10	193.050	30.5727	9.6679	171.180	214.920	142.0	223.5
	Total	116	182.724	37.6864	3.4991	175.793	189.655	104.0	254.0
Medicine ball throw (m)	Kickboxing	24	5.0674	1.39156	.28405	4.4798	5.6550	2.66	8.10
	Karat	27	4.1514	1.13827	.21906	3.7011	4.6017	2.80	7.05
	Taekon	55	4.3964	.68794	.09276	4.2104	4.5823	3.03	6.66
	Muay	10	4.6490	1.40598	.44461	3.6432	5.6548	2.29	6.26
	Total	116	4.5000	1.07701	.10000	4.3019	4.6980	2.29	8.10
Sit and reach (cm)	Kickboxing	24	35.9250	4.09979	.83687	34.1938	37.6562	27.10	44.00
	Karat	27	34.2294	5.78851	1.11400	31.9395	36.5193	22.50	48.50
	Taekon	55	35.1047	4.19520	.56568	33.9706	36.2388	26.40	48.50
	Muay	10	34.7200	5.06207	1.60077	31.0988	38.3412	26.75	44.75
	Total	116	35.0375	4.64062	.43087	34.1841	35.8910	22.50	48.50
Standing stork balance (s)	Kickboxing	24	27.1213	18.84023	3.84575	19.1657	35.0768	4.22	75.91
	Karat	27	21.2828	16.66198	3.20660	14.6915	27.8740	2.55	64.07
	Taekon	55	24.8146	20.75387	2.79845	19.2041	30.4252	3.07	95.61
	Muay	10	40.4405	19.58398	6.19300	26.4310	54.4500	12.57	65.16
	Total	116	25.8169	19.75559	1.83426	22.1835	29.4502	2.55	95.61
20 meter run (s)	Kickboxing	24	3.6102	.34636	.07070	3.4640	3.7565	3.03	4.23
	Karat	27	3.9849	.47113	.09067	3.7985	4.1713	3.37	5.27
	Taekon	55	3.6042	.27300	.03681	3.5303	3.6780	2.72	4.23
	Muay	10	3.5475	.48045	.15193	3.2038	3.8912	2.89	4.36
	Total	116	3.6891	.39278	.03647	3.6169	3.7614	2.72	5.27
T-test (s)	Kickboxing	24	11.6225	1.49475	.30512	10.9913	12.2537	10.00	14.77
	Karat	27	12.9911	2.18315	.42015	12.1275	13.8547	9.47	17.59
	Taekon	55	11.8047	.97056	.13087	11.5423	12.0671	9.47	14.74
	Muay	10	12.4650	1.71273	.54161	11.2398	13.6902	10.47	15.72
	Total	116	12.1001	1.57595	.14632	11.8102	12.3899	9.47	17.59
1 min sit up -1-	Kickboxing	24	38.854	9.3686	1.9124	34.898	42.810	17.0	56.0
	Karat	27	35.889	10.6891	2.0571	31.660	40.117	12.0	60.0
	Taekon	55	38.127	8.5202	1.1489	35.824	40.431	23.0	60.0
	Muay	10	34.800	9.2712	2.9318	28.168	41.432	17.0	49.0
	Total	116	37.470	9.2744	.8611	35.764	39.176	12.0	60.0
Max push up -1-	Kickboxing	24	39.04	15.922	3.250	32.32	45.77	14	70
	Karat	27	29.41	14.859	2.860	23.53	35.29	10	65
	Taekon	55	38.35	13.431	1.811	34.71	41.98	6	70
	Muay	10	36.00	16.411	5.190	24.26	47.74	18	70
	Total	116	36.21	14.870	1.381	33.47	38.94	6	70
Handgrib (Kg)	Kickboxing	24	35.7646	9.53800	1.94694	31.7370	39.7921	18.35	54.45
	Karat	27	33.6278	10.47991	2.01686	29.4821	37.7735	21.30	53.55
	Taekon	55	34.6891	9.78658	1.31962	32.0434	37.3348	18.20	55.90
	Muay	10	33.4650	9.08408	2.87264	26.9666	39.9634	17.45	42.95
	Total	116	34.5591	9.75071	.90533	32.7658	36.3523	17.45	55.90
Predicted VO2 Max	Kickboxing	24	40.2792	9.50185	1.93956	36.2669	44.2914	23.80	61.20
	Karat	27	31.4253	7.03591	1.35406	28.6420	34.2086	21.80	50.60
	Taekon	55	36.6000	7.30903	.98555	34.6241	38.5759	24.70	53.20
	Muay	10	40.3700	7.28790	2.30464	35.1566	45.5834	29.60	50.80
	Total	116	36.4817	8.29606	.77027	34.9560	38.0075	21.80	61.20
Level	Kickboxing	24	7.2083	2.81269	.57414	6.0206	8.3960	3.00	13.00
	Karat	27	7.0741	2.20010	.42341	6.2037	7.9444	2.00	11.00
	Taekon	55	7.4727	2.03538	.27445	6.9225	8.0230	4.00	14.00
	Muay	10	7.9185	2.41747	.76447	6.1892	9.6479	4.00	11.00
	Total	116	7.3637	2.26638	.21043	6.9468	7.7805	2.00	14.00
Shuttle	Kickboxing	24	4.0833	2.85774	.58333	2.8766	5.2901	1.00	12.00
	Karat	27	4.8519	3.10958	.59844	3.6217	6.0820	1.00	10.00
	Taekon	55	4.2182	3.03493	.40923	3.3977	5.0386	1.00	10.00
	Muay	10	3.4685	1.75261	.55422	2.2148	4.7223	1.00	7.00
	Total	116	4.2731	2.92041	.27115	3.7360	4.8103	1.00	12.00

Table 3: Showing descriptive statistics for various physical measurements among male participants in different sports categories

Variables		Sum of Squares	df	Mean Square	F	Sig.
Sitting height (cm)	Between Groups	174.676	3	58.225	5.762	.001
	Within Groups	909.532	90	10.106		
	Total	1084.208	93			
Armspan (cm)	Between Groups	453.919	3	151.306	2.441	.069
	Within Groups	5578.152	90	61.979		
	Total	6032.071	93			
Vertical jump (inc)	Between Groups	19.212	3	6.404	1.158	.330
	Within Groups	497.864	90	5.532		
	Total	517.077	93			
Standing broad jump (cm)	Between Groups	353.029	3	117.676	.139	.937
	Within Groups	76431.803	90	849.242		
	Total	76784.832	93			
Medicine ball throw (m)	Between Groups	2.987	3	.996	.967	.412
	Within Groups	92.657	90	1.030		
	Total	95.643	93			
Sit and reach (cm)	Between Groups	107.024	3	35.675	.750	.525
	Within Groups	4282.917	90	47.588		
	Total	4389.941	93			
Standing stork balance (s)	Between Groups	1577.617	3	525.872	1.411	.245
	Within Groups	33547.487	90	372.750		
	Total	35125.104	93			
20 meter run (s)	Between Groups	.722	3	.241	2.039	.114
	Within Groups	10.623	90	.118		
	Total	11.345	93			
T-test (s)	Between Groups	4.489	3	1.496	1.198	.315
	Within Groups	112.420	90	1.249		
	Total	116.909	93			
1 min sit up -1-	Between Groups	450.142	3	150.047	2.062	.111
	Within Groups	6550.666	90	72.785		
	Total	7000.809	93			
Max push up -1-	Between Groups	1673.111	3	557.704	1.665	.180
	Within Groups	30152.294	90	335.025		
	Total	31825.404	93			
Handgrib (Kg)	Between Groups	88.223	3	29.408	.312	.816
	Within Groups	8474.841	90	94.165		
	Total	8563.064	93			
Predicted VO2 Max	Between Groups	602.302	3	200.767	3.855	.012
	Within Groups	4686.626	90	52.074		
	Total	5288.928	93			
Level	Between Groups	16.004	3	5.335	1.062	.369
	Within Groups	451.931	90	5.021		
	Total	467.935	93			
Shuttle	Between Groups	25.974	3	8.658	.913	.438
	Within Groups	853.917	90	9.488		
	Total	879.891	93			

Table 4: Analysis of Variance (ANOVA) for Female Participants in different sports categories

tests would be necessary to ascertain which groups differ significantly from each other. The effect size (η^2 = .161) implies that approximately 16.1% of the variance in sitting height can be accounted for by the differences in group membership.

Predicted VO2 Max: A significant difference was observed in predicted VO2 max among female participants from different groups (F(3, 90) = 3.855, p = .012).Post-hoc tests would help identify which groups have significantly different predicted VO2 max values. The effect size (η^2 = .113) suggests that roughly 11.3% of the variance in predicted VO2 max can be ascribed to differences in group membership.

Other Physical Fitness Measures: No significant differences were detected in armspan, vertical jump, standing broad jump, medicine ball throw, sit and reach, standing stork balance, 20-meter run, t-test, 1-minute sit-up, max push-up, handgrip, level, or shuttle among female participants from different groups. The lack of significant differences indicates that group membership did not influence the observed variations in these physical fitness metrics among female participants.

Therefore, the results indicate that sitting height and predicted VO2 max are the two physical fitness measures that are significantly impacted by different group memberships among female participants. Further analyses, such as post-hoc tests, can provide more in-depth insights into the specific group differences within these measures. Additionally, the effect sizes provide information about the practical relevance of the observed differences.

D. ANOVA for Male participants

A series of one-way ANOVA tests were conducted to examine the differences in various physical fitness measures among male participants.

Table 5 demonstrates the outcomes of the analysis of vari-

ance (ANOVA) for various physical measurements among male participants in different sports categories. The table includes the sum of squares, degrees of freedom (df), mean square, F-statistic, and p-value (Sig.) for each physical measurement.

- Sitting Height (cm)
  No considerable variation in sitting height was observed among different sports categories, as the results showed no significant difference ($F(3, 112) = 1.069$, $p = .365$).
- Armspan (cm)
  Similarly, there was no notable difference in armspan among the various sports categories, as the analysis revealed no significant difference ($F(3, 112) = 1.405$, $p = .245$).
- Vertical Jump (inch)
  Moreover, there was no apparent difference in vertical jump performance among different sports categories, as the results indicated no significant difference ($F(3, 112) = 1.406$, $p = .245$).
- Standing Broad Jump (cm)
  Nevertheless, a considerable variation in standing broad jump performance was found among different sports categories, as the analysis showed a significant difference ($F(3, 112) = 3.105$, $p = .029$). To determine which specific groups differ from each other, post-hoc tests may be conducted.
- Medicine Ball Throw (m)
  A considerable variation in medicine ball throw performance was also observed among different sports categories, as the results demonstrated a significant difference ($F(3, 112) = 3.630$, $p = .015$).
- Sit and Reach (cm)
  On the other hand, no considerable variation in sit and reach performance was observed among different sports categories, as the analysis revealed no significant difference ($F(3, 112) = .579$, $p = .630$).
- Standing Stork Balance Performance (s)
  Although not statistically significant, there appeared to be a trend towards a difference in standing stork balance performance across various sports categories ($F(3, 112) = 2.474$, $p = .065$).
- 20 Meter Run Performance (s)
  There was a statistically significant difference in 20-meter run performance among different sports categories ($F(3, 112) = 7.933$, $p < .001$).
- T-Test Performance (s)
  Similarly, there was a statistically significant difference in T-test performance among different sports categories ($F(3, 112) = 4.884$, $p = .003$).
- 1 Min Sit-Up Performance
  There was no statistically significant difference in the number of sit-ups performed in one minute among different sports categories ($F(3, 112) = .804$, $p = .494$).
- Max Push-Up Performance
  Although not statistically significant, there appeared to be a trend towards a difference in the maximum number of push-ups performed among different sports categories ($F(3, 112) = 2.663$, $p = .051$).
- Handgrip Strength (Kg)
  There was no statistically significant difference in handgrip strength among different sports categories ($F(3, 112) = .245$, $p = .865$).
- Predicted VO2 Max Performance
  There was a statistically significant difference in predicted VO2 max among different sports categories ($F(3, 112) = 6.596$, $p < .001$).
- Level of Fitness
  There was no statistically significant difference in fitness level among different sports categories ($F(3, 112) = .420$, $p = .739$).
- Shuttle Run Performance
  There was no statistically significant difference in shuttle run performance among different sports categories ($F(3, 112) = .641$, $p = .590$).

4. Conclusion

In summary, while some physical measurements showed statistically significant differences among different sports categories, others did not. These results suggest that certain sports may have an impact on specific physical attributes. Further investigation may be needed to understand the underlying factors contributing to these differences.

Conflict of interest

The authors declare no conflict of interests. All authors read and approved final version of the paper.

Authors Contribution

All authors contributed equally in this paper.

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		Sum of Squares	df	Mean Square	F	Sig.
Sitting height (cm)	Between Groups	99.443	3	33.148	1.069	.365
	Within Groups	3471.446	112	30.995		
	Total	3570.889	115			
Armspan (cm)	Between Groups	361.603	3	120.534	1.405	.245
	Within Groups	9608.693	112	85.792		
	Total	9970.295	115			
Vertical jump (inc)	Between Groups	53.916	3	17.972	1.406	.245
	Within Groups	1431.534	112	12.782		
	Total	1485.450	115			
Standing broad jump (cm)	Between Groups	12542.236	3	4180.745	3.105	.029
	Within Groups	150788.436	112	1346.325		
	Total	163330.672	115			
Medicine ball throw (m)	Between Groups	11.821	3	3.940	3.630	.015
	Within Groups	121.572	112	1.085		
	Total	133.394	115			
Sit and reach (cm)	Between Groups	37.792	3	12.597	.579	.630
	Within Groups	2438.774	112	21.775		
	Total	2476.566	115			
Standing stork balance (s)	Between Groups	2789.651	3	929.884	2.474	.065
	Within Groups	42092.950	112	375.830		
	Total	44882.601	115			
20 meter run (s)	Between Groups	3.109	3	1.036	7.933	.000
	Within Groups	14.632	112	.131		
	Total	17.742	115			
T-test (s)	Between Groups	33.041	3	11.014	4.884	.003
	Within Groups	252.576	112	2.255		
	Total	285.617	115			
1 min sit up -1-	Between Groups	208.529	3	69.510	.804	.494
	Within Groups	9683.115	112	86.456		
	Total	9891.644	115			
Max push up -1-	Between Groups	1693.121	3	564.374	2.663	.051
	Within Groups	23735.913	112	211.928		
	Total	25429.034	115			
Handgrib (Kg)	Between Groups	71.195	3	23.732	.245	.865
	Within Groups	10862.583	112	96.987		
	Total	10933.778	115			
Predicted VO2 Max	Between Groups	1188.372	3	396.124	6.596	.000
	Within Groups	6726.465	112	60.058		
	Total	7914.837	115			
Level	Between Groups	6.576	3	2.192	.420	.739
	Within Groups	584.117	112	5.215		
	Total	590.693	115			
Shuttle	Between Groups	16.547	3	5.516	.641	.590
	Within Groups	964.267	112	8.610		
	Total	980.815	115			

Table 5: Showing Analysis of Variance ANOVA for Male participants in different sports categories

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