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Influence of Systematic Training on Morpho-physiological and Motor Ability Profiles of Indian Young Female Rowers, Kayakers, and Canoers

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ABSTRACT

International Journal of Exercise Science 16(6): 744-755, 2023. Our study was carried on junior female athletes (22 rowers, 11 kayakers and 7 canoers) adopting systemic training to explore the possible training manipulation that can be implicated in these three kinds of water sports, might be in a different way. Several morpho-physiological parameters and motor ability profiles were measured by standard methods. Accordingly, body weight (kg), performing time of 2.4 km run (sec), 6×10 meters shuttle run/agility (sec) of female rowers were reduced progressively and significantly from Preparatory Period (PP1) to General Practice Period (GPP) i.e., from (59.41±4.84) to (52.23±5.34), (773.04±92.64) to (566.19±80.84) and (17.91±0.96) to (14.79±0.6) respectively. In case of kayakers, the time to cover 6×10 meters shuttle run was decreased from (18.42±0.63) to (16.61±0.79) and standing vertical jump (cm) was increased from (24.64±4.65) to (38.18±5.65) significantly from initial PPI to final GPP with considerable changes in between the phases. Body weight (kg), performing time of 60 meters standing start (sec), 2.4 km run (sec) and 6×10 meters shuttle run of female canoers were found to be decreased maximally from PP1 to GPP, following eight successive training phases from (58.56±3.98) to (49.88±4.39), (10.96±0.42) to (9.35±0.29), (802.57±32.40) to (632.57±57.38) and (10.96±0.42) to (9.35±0.29) respectively and also decreased considerably between other training phases. Standing broad jump (cm), standing vertical jump (cm), sit up/min, and push up/min performance were also found to be increased maximally from PP1 to GPP i.e., from (180.71±9.01) to (252.12±7.76), (27±4.16) to (41.14±1.86), (43±7.72) to (96±15.13) and from (34.43±7.50) to (88.28±4.85) respectively and also considerably between other training phases. Training as designed and incorporated in the present study significantly improves motor ability in all three groups. More discrete training can be prescribed for better fitness.

KEYWORDS: Anthropometry, fitness, agility, water-sports

INTRODUCTION

Water is involved in innumerable sports. Most of these need motor skills and power. Rowing, canoeing and kayaking are not exempted from those excellences (17, 18, and 19). Among all competitive endurance sports, rowing is one of the most unique and well-known. It includes two or more athletes who work together in a rhythmic and synchronous style. Strength testing and training play a vital role in the physical and physiological preparation of rowers (8).

Participants in water sports are categorized by sex, age and weight. Rowing is well known for its excessive muscular power generation and energy expenditure in a very short duration. Rowing is mainly divided into two categories, a) Sweep Rowing and b) Sculling. In sweep rowing, each rower holds one oar, with both of their hands. In sculling two oars are used in two hands (4). Kayak boats can move faster due to their design (2). Movements in kayaking mainly involved a double-bladed paddle with cyclic motion in each part of the boat, by maintaining coordination through movements of the paddle and rotation of the trunk in a seated position. Canoe boats have a paddle with a single blade and cyclic movements of paddles are performed on the same side of the boat in a kneeled posture. Canoeists have to improve their maximal aerobic power to achieve success by withstanding the force of water. Speed training in a canoe involves a high-intensity session, of 70. During this time, energy is utilized aerobically instead, the body receives energy anaerobically from ATP and lactic acid at this time highest intensity of paddling is reached. Australia Canoeing recommended in 2004, 3 to 4 on-water sessions of training for inefficient athletes; for elite ones 10 to 20 total sessions in each week (2).

Endurance athletes are required to elevate their load, of training for victory by maintaining proper balance. Although extensive physiological studies have been done on the rowers, very little information is there, especially on Indian female kayakers and canoers. So, it is of great interest for the present study to explore some basic physiological and motor skill differences among these water sports particularly in females.

METHODS

Participants

Our study was carried out on 40 junior female athletes (n=22 rowers, age=14.71±2.09 years, n=11 kayakers, age=13.89±7.03 years, and n= 7 canoers, age=13.57±1.06 years). All these athletes belonged to the Sports Authority of India (SAI), Jagatpur, and Odisha, India having 4–5 years of formal training experience. We followed all the ethical guidelines as per the standards of the International Journal of Exercise Science (14) and suggestions of the World Medical Association (21). Accordingly, there was no discrimination in subject recruitment; only the age group and physical capability to withstand the training were considered. Necessary consents both from the participants and their guardians were taken by the authorities of SAI prior to their joining. Ethical clearance for the study was also taken from the concerned University. All participants are having similar nutrition, and the same training regimen under the same climatic conditions and are considered homogenous subjects.

Protocol

Total training of 10 to 11 sessions in a week was done and after 5 sessions one break was given. Kayaking mainly relies on upper body movements. Canoeing is a full-body activity. It requires strength, endurance and power. In the case of rowing the aerobic system fuels the majority of output beyond 2-3 minutes. Kayaking is a mixture of strength, power and endurance and uses both alactic, lactic and to a lesser extent the aerobic system. Canoeing requires a combination of aerobic and anaerobic exertion.

Training intensity is generated basically in "Heart rate" with an indicated "Target Zone", focused on the percentage of "Maximum Heart rate". Maximum heart rate is achieved by subtracting athletes' age from 220. The "Stroke rate" is very much related to the Heart rate, having its own technical effect. Our training was designed according to the need of each discipline as shown below:

Table 1. Training volume and distance covered.

	Phases	PP1 Sep - Dec.	PP2 Jan.- Mar.	PCP Apr.-Jun	CP1 Jul-Sep	CP2 Oct - Nov	R1 Dec	R2 Jan - March	GPP Apr.-June
	Categories	Strength, Endurance	Endurance, Muscular	Endurance, Boating/ Paddling Technique	Increased endurance	Peak Championship	Short-term recovery	Active Recovery	Moderate Strength, Endurance, Boating/ Paddling
Training Volume (minutes/ week)	Rowing Kayaking Canoeing	600 565 550	670 640 640	686 670 662	722 700 690	759 725 712	558 520 500	570 542 520	610 565 551
Distance covered (km)	Rowing Kayaking Canoeing	10,5 9.5 7.5	12.5 10 8	12.5-13 10-12 8-9	13.5-14.5 12.5-13.5 9.5-10.5	15-17 14-16 12-14	10 9 7	10.5 10 8	10.5-11.5 10.5-11 8.5-9.5

PP1-Preparatory Period 1, PP2-Preparatory Period 2, PCP -Pre-competitive Period, CP1-Competitive Period 1, CP2-Completive Period 2, R1-Recovery Period 1, R2- Recovery Period 2, GPP -General Practice Period

A) Anthropometric Measurements**:** Body height (cm), body weight (kg) and arm span (cm) were measured using an anthropometer /stadiometer, weighing pan and anthropometrical tape respectively.
B) Measurement of Strength**:** This is determined by tests like standing broad jump(in cm), standing vertical jump (in cm) (for lower body explosive strength), trunk flexibility (in cm), 6×10 meter shuttle run (sec)(agility), bench pull test / 4 min (upper body muscles), bench Press Test/4 min (chest muscles), sit-ups/min, pushups/min and medicine ball throw (cm) (upper body strength).
C) Assessment of Physiological Parameters**:** This includes aerobic power (VO_2 Max, measured in ml/kg/min) by Bleep Test (12), 60 meters standing start for anaerobic speed endurance, 2.4 kilometers (km) run to detect the development of the athlete's aerobic capacity (VO_2 max), hemoglobin (gm%) test was done using standard testing kits.

Statistical analysis
It was carried out with the help of Statistical Program for the Social Sciences (SPSS) version 26.0 for Windows (SPSS Inc., Chicago, Il, USA). Differences between training phases for all parameters of three different sports types were calculated using a one-way analysis of variance

(ANOVA), then Schiff`s Post hoc test was performed for multiple comparisons. Confidence levels at $p < 0.05$, $p < 0.01$, and $p < 0.001$ were taken the levels of significance.

RESULTS

Table 2. Effect of systematic training on female rowers.

Variables	Training Phases								P value
	PP 1	PP2	PCP	CP1	CP2	R1	R2	GPP	
Age (years	14.71 ±2.09	15.0 ±1.59	15.1 ±2.02	15.2 ±3.71	15.3 ±3.93	15.6 ±3.93	15.8 ±3.94	16.1 ±3.93*	.021
Height (cm)	166.26 ±2.93	166.38 ±2.93	166.55 ±2.96	166.77 ±2.96	166.92 ±2.97	167.06 ±2.95	167.17 ±2.94	167.37± 2.94(ns)	.920
Weight (kg)	59.41 ±4.84	58.35 ±4.90	57.03 ±4.98	55.75 ±5.87	54.49 ±5.45	53.93 ±5.40	55.3 ±5.36^	52.23 ±5.34***	.000
60 m standing start (sec)	10.81 ±0.76	10.61 ±0.68	10.72 ±2.18	10.02 ±0.60	9.7 ±0.57	9.2 ±0.40	8.88 ±0.53	8.12± 2.01(ns)	.811
2.4 km run (sec)	773.04 ± 92.64	737.71 ±86.06	715.24 ±86.11	677.57 ±74.06	647.52 ±79.03$	629.09 ±74.98$	609.09 ±74.98$	566.19± 80.84***	.000
Stand. Broad Jump (cm)	182.81 ±21.65	189.28 ± 21.16	197.05 ±21.55	204.81 ± 2.48^	223.33 ±31.31^	243.38 ±37.76$	263.28 ±43.71$	297.43± 49.45***	.000
Stand. Vertical Jump (cm)	23.28 ±4.27	26.48 ±4.49	29.9 ±6.78$	33.38 ±4.78$	36.67 ±4.95$	39.76 ±4.18$	42.9 ±4.16$	45.95± 4.09***	.000
Sit-ups/min	43.33 ±9.77	57.33 ±9.14^	64.38 ±9.39#	73.86 ±8.96$	81.38 ±9.31$	90.81 ±8.496$	100.76 ±10.11$	123.43± 10.72***	.000
Push-ups/min	37.05 ±6.48	44.57 ±5.71	52.09 ±5.62$	57.86 ±8.13$	64.90 ±7.71$	70.86 ±7.68$	76.90 ±6.94$	83.09± 7.82***	.000
Arm span (cm)	176.62 ±5.34	176.72 ±5.33	176.89 ±5.34	177.08 ±5.40	177.18 ±5.41	178.01 ±2.09	178.34 ±3.33	179.02± 4.43(ns)	.843
Bench Press /4 min	62.48 ±6.4	70.05 ±6.82	79.38 ±6.44#	95.57 ±9.33$	105.42 ±10.58$	123.9 ±7.99$	125.33 ±15.34$	190.14± 6.57***	.000
Bench Pull /4 min	85.48 ±13.97	95.52 ±16.70	105.76 ± 8.09^	118.62 ±19.63$	134.04 ±19.45$	161.9 ±16.12$	179.95 ±12.48$	199.14± 6.57***	.000
6×10 m shuttle run (sec)	17.91 ±0.96	17.43 ±0.83	17.03 ±0.70^	16.58 ±0.69^	16.19 ±0.67^	15.77 ±0.72^	15.34 ±0.67^	14.79± 0.64***	.000
Overhead ball throw (cm)	342.9 ±60.10	380.52 ±47.19	419.52 ±45.48	439.0 ±44.20	460.52 ±51.40#	490.52 ±51.40$	588.14 ±84.81$	602.67± 86.72***	.000
VO2Max (ml/kg/min)	40.24 ±5.70	41.31 ±5.53	43.55 ±4.69	44.47 ±4.16	45.12 ±4.10	45.6 ±3.97^	46.06 ±3.86^	46.46± 3.88***	.000
Flexibility (cm)	16.01 ±4.47	17.24 ±4.54	19.49 ±4.59	20.91 ±4.06	21.43 ±4.03^	21.97 ±4.00#	22.39 ±3.99#	23.01± 4.24***	.000
Haemoglobin (gm %)	11.27 ±0.76	11.63 ±0.78	11.98 ±0.77	12.32 ±0.68#	12.57 ±0.64$	12.88 ±0.58$	13.13 ±0.62$	13.42± 0.65***	.000

Values are shown in (mean ± standard deviation); (*) denotes significant at $p < 0.05$, (**) at $p < 0.01$, (***) at $p < 0.001$, at final phase (GPP); (^) denotes those values of different variables are shown in (mean ± standard deviation) are significant at $p < 0.05$, (#) at $p < 0.01$ and ($) at $p < 0.001$ from training phase 1 i.e., from preparatory period 1 (PP1) (the baseline data) and (ns) denotes values are not significant.

Table 2 reflects that all the parameters except body height (kg), 60 meters standing start (sec) and arm span (cm) have improved significantly from PP1 to GPP. Body weight reduction is

advantageous for female rowers. 2.4 km run time and 6x10 meters shuttle run time have been decreased significantly from PP1 to GPP indicating their elevation in aerobic power and agility as their required time in covering the given distances has been decreased which is a positive effect.

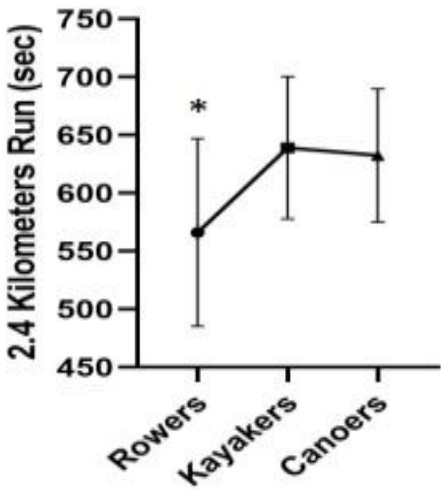

Figure 1. Comparison of 2.4 Kilometres Run (sec) (aerobic power), (values in mean ± standard deviation) of female Rowers, Kayakers and Canoers at GPP. (***) denotes ($p < 0.001$). The performance of female rowers for the 2.4 km run at GPP (final training phase) was higher than kayakers and canoers as they have taken less time to cover the given distance

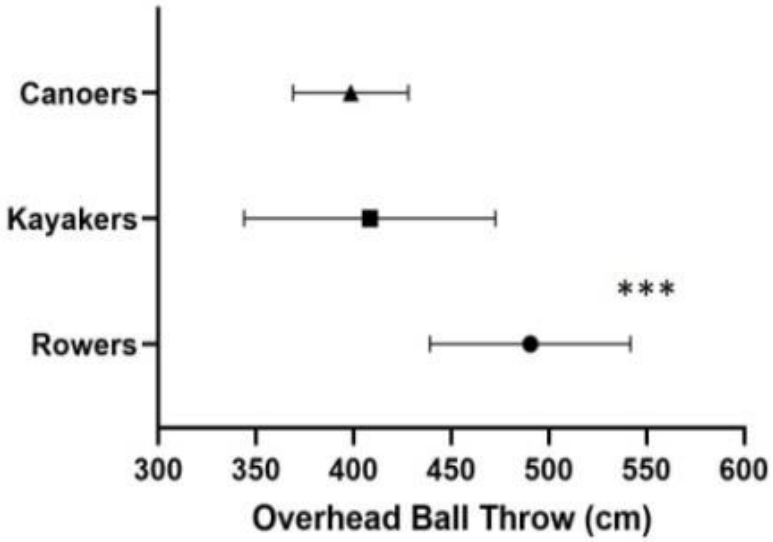

Figure 2. Comparison of overhead ball throw performance (cm) (upper body strength), (values in mean ± standard deviation) of female Rowers, Kayakers and Canoers at GPP. (*) denotes ($p < 0.05$). The overhead ball throw performance at GPP of female rowers was greater than kayakers and canoers.

Table 3. Effect of systematic training on female kayakers.

Variables	Training Phases								P value
	PP 1	PP2	PCP	CP1	CP2	R1	R2	GPP	
Age (years)	13.89 ±7.03	14.39 ±1.99	14.64 ±1.99	15.38 ±1.99	15.39 ±2.03	16.11 ±1.99	16.38 ± 1.99	16.64 ±1.99*	.014
Height cm)	161.64 ± 61.16	161.74 ±6.26	161.99 ±6.34	162.27 ±2.45	162.55 ±6.44	162.74 ±6.35	163.15 ±6.43	163.33 ± 6.46(ns)	.987
Weight (kg)	57.56 ±5.77	56.16 ±5.60	55.86 ±5.26.	54.65 ±5.46	43.35 ±5.56	52.05 ±5.07	52.13 ±5.30	49.21 ±5.28(ns)	.889
60 m standing start (sec)	11.03 ±0.68	10.75 ±0.60	10.6 ±0.53	9.71 ±2.88	9.62 ±2.12	9.41 ±0.52	9.38 ±2.32	9.11 ±0.12(ns)	0.34
2.4 km run (sec)	815.64 ±54.07	796.18 ±39.11	777.91 ±41.94	776.09 ±57.14	748.54 ±49.75	723.45 ±45.27^	688.91 ±55.46$	639.18 ±61.43(ns)	0.53
Standing Broad Jump (cm)	170.54 ± 26.42	176.54 ±11.84	178.91 ±11.95	185.02 ±11.37	187.91 ±14.71	192.18 ±15.21	192.18±1 5.21	197.03 ±11.93(ns)	.085
Stand. Vert. Jump (cm)	24.64 ±4.65	25.82 ±4.79	27.91 ±4.68	30.54 ±3.07	31.82 ±3.46	34.45 ±4.39#	37.18 ±8.05$	38.18 ±5.65***	.000
Sit up/min	41.45 ±8.09	49.82 ±6.49	54.54 ±5.50^	62.01 ±6.82$	68.45 ±7.89$	76.45 ±7.51$	82.09 ±7.65$	91.82 ±8.26**	.002
Push up/min	30.09 ±4.07	37.18 ±5.13	44.36 ±5.64$	51.91 ±5.73$	56.82 ±5.88$	61.73 ±6.31$	67.45 ±6.85$	69.73 ±4.31***	.000
Arm span (cm)	168.14 ±7.10	168.48 ±7.23	168.95 ±7.10	169.24 ±7.10	169.48 ±7.08	169.85 ±7.11	170.09 ±7.08	170.34 ±7.10(ns)	.645
Bench Press/4min	56.82 ±10.40	63.82 ±10.40	72.64 ±10.97	81.91 ±13.1	96.18 ±17.97$	106.45 ±22.50$	119.64±2 1.62$	135.73 ±12.71***	.000
Bench Pull /4 min	74.36 ±26.32	82.73 ±29.23	92.45 ±34.66	101.73 ±32.94	113.27 ±31.34	122.54 ±30.05	133.36±2 7.22	149.09 ±21.90	.225
6×10 m shuttle run (sec)	18.42 ±0.63	17.9 ±0.50	17.54 ±0.60	17.36 ±0.68	17.18 ±0.75^	16.99 ±0.78#	16.82 ±0.76$	16.61 ±0.79**	.008
Overhead ball throw (cm)	326.18 ±46.93	335.18 ±47.26	344.64 ±46.04	354.64 ±46.72	335.64 ±11.14	371.18 ±46.99	385.54±4 4.87	408.36 ±64.40(ns)	.521
VO2 Max (ml/kg/min)	35.39 ±3.07	37.41 ±3.07	38.47 ±2.78	39.21 ±2.63	40.29 ±2.52^	41.3 ±2.91#	4.63 ±2.68$	44.84 ±2.82***	.184
Flexibility (cm)	13.76 ±2.76	14.83 ±3.48	16.53 ±4.48	17.54 ±4.55	18.68 ±4.00	19.04 ±3.87	20.84 ±3.496^	22.09± 3.67*	.032
Haemoglobin (gm %)	11.52 ±1.14	11.75 ±1.14	11.98 ±1.07	12.2 ±1.03	12.5 ±1.01	12.68 ±0.97	13.08 ±0.89	13.32 ±0.86***	.000

Values are shown in (mean ± standard deviation); (*) denotes significant at $p < 0.05$, (**) at $p < 0.01$, (***) at $p < 0.001$, at final phase (GPP); (^) denotes those values of different variables are shown in (mean ± standard deviation) are significant at $p < 0.05$, (#) at $p < 0.01$ and ($) at $p < 0.001$.

Table 3 shows that all the variables of female kayakers were found to be significantly improved except body weight (kg), 60-meter standing start (sec), 2.4 km (sec), standing Broad Jump (cm), arm span (cm), bench pull/4min and overhead ball throw (cm). The performing time of the 6 × 10 meters shuttle run (sec) was found to significantly decrease from (18.42±0.63) to (16.61±0.79). Most of the parameters of performance were found to be enhanced at the final stage (GPP) as compared to the (baseline) (PP1).

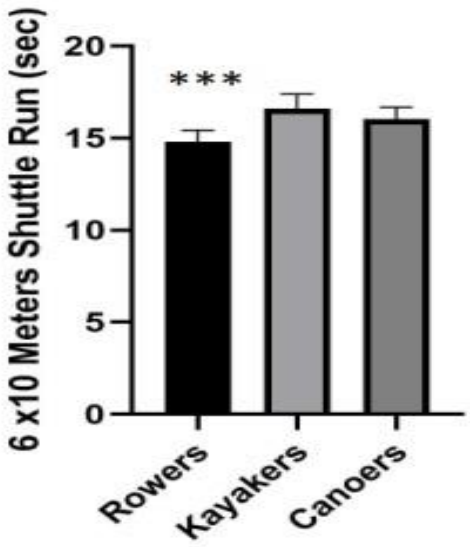

Figure 3. Comparison of 6 × 10 meters shuttle run (sec) (agility), (values in mean± standard deviation) of female rowers, kayakers and canoers in GPP, (***) denotes significance at ($p < 0.001$). The performance of female rowers for the 6 x 10 meters shuttle run of at GPP (final training phase) was higher than kayakers and canoers as they have taken less time to cover the given distance

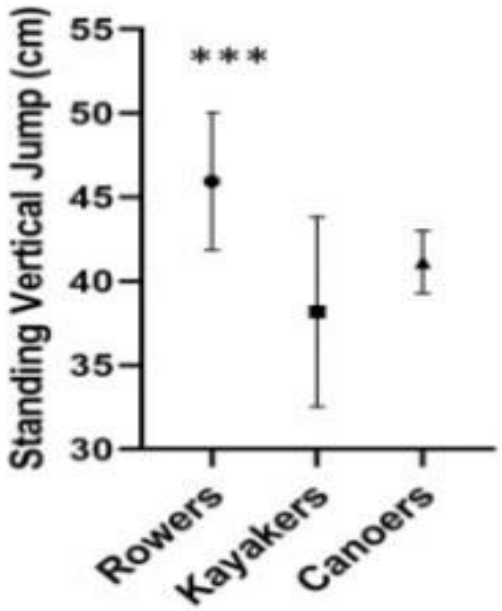

Figure 4. Standing vertical jump performance (cm) (explosive strength), (values in mean± standard deviation) of female rowers, kayakers and canoers in GPP, (***) denotes significance at ($p < 0.001$). The standing vertical jump performance at GPP of female rowers was greater than kayakers and canoers.

Table 4. Effect of systematic training on female canoers.

Variables	Training Phases								P value
	PP 1	PP2	PCP	CP1	CP2	R1	R2	GPP	
Age (years)	13.57± 1.06	14..03± 0.51	14.07± 1.06	14.32± 1.06	15.06± 1.07	15.3± 1.08	15.79± 1.06	16.05± 1.06***	.000
Height (cm)	159.94± 3.28	160.18 3.26	160.6± 3.29	160.9± 3.29	161.2± 3.35	159.97 2.62	161.2± 3.35	161.38± 3.33(ns)	.993
Weight (kg)	58.56± 3.98	56.61± 3.59	55.5± 3.21	54.58± 3.72	54.08± 3.76	53.02± 4.01	51.76± 4.43	49.88± 4.39**	.005
60 m standing start (sec)	10.96± 0.42	10.48± 0.19	10.41± 0.28	10.16± 0.38^	10.07± 0.36#	9.84± 0.23$	9.76± 0.38$	9.35± 0.29***	.000
2.4 km run (sec)	802.57± 32.40	788.28 ±38.94	753.14 ±49.32	740.4± 61.05	714.86± 41.11	694.8± 40.41^	667.4± 47.37$	632.57± 57.38***	.000
Stand. Broad Jump(cm)	180.71± 9.01	185± 8.10	199.4± 9.50	200.0 ±8.15	207.31± 7.72	231.43± 8.32^	240.32 ±8.13#	252.12± 7.76***	.000
Stand. Vertical Jump (cm)	27.02± 4.16	29.14± 3.29	31.14± 2.97	32.43± 2.07	34.02± 2.58#	35.57± 1.57$	37.43± 2.37$	41.14± 1.86***	.000
Sit up/min	43.12± 7.72	52.14± 7.62	60.28± 7.36	67.71± 6.16#	73.02± 6.11$	78.57± 6.7$	86.14± 12.78$	96.03± 15.13***	.000
Push up/min	34.43± 7.50	42.28± 8.60	53.28± 6.39$	61.03± 5.38$	67.57± 6.02$	74.71± 5.94$	82.01± 5.77$	88.28± 4.85***	.000
Arm span (cm)	167.74± 4.70	168.07 ±4.60	168.46 ±4.64	168.64 ±4.58	168.93± 4.55	169.98± 4.57	170.1± 4.44	172.1± 3.89(ns)	.995
Bench Press/4 min	57.28± 10.73	58.43± 11.48	68.14± 13.93	78.57± 10.34	85.14± 11.77	97.14± 16.16#	108.2± 18.32$	127.14± 17.95***	.000
Bench Pull /4 min	70.71± 15.38	94.01± 27.12	105.43 ±30.70	112.14 ±31.57	135.4± 22.74#	147.5± 19.74$	155.7± 17.34$	176.85± 18.88***	.000
6 x 10 meters shuttle run	10.96± 0.42	10.48± 0.19	10.41± 0.28	10.16± 0.38	10.07± 0.36	9.84± 0.23	9.76± 0.38	9.35± 0.29(ns)	.086
Over Head Ball Throw (cm)	322.71± 40.01	328.43 ±44.36	337.71 ±43.63	344.28 ±44.38	355.28± 42.15	368.57± 32.25	378.71 ±28.99	398.57± 29.44**	.007
VO2 Max (ml/kg/min)	34.36± 4.33	35.58± 3.83	36.8± 3.57	38.07± 3.49	39.04± 2.86	40.03± 2.87	42.87± 3.18^	45.01± 3.85***	.000
Flexibility (cm)	10.84± 1.80	12.14± 2.53	13.57± 2.88	14.76± 2.53	15.92± 2.23	17.17± 2.27^	19.56± 3.72^	21.3± 3.74***	.000
Haemoglobin (gm%)	10.86± 0.39	11.1± 0.44	11.4± 0.47	11.68± 0.48	11.91± 0.45^	12.24± 0.46$	12.54± 0.50$	13.06± 0.39***	.000

Values are shown in (mean ± standard deviation); (*) denotes significant at $p < 0.05$; (**) at $p < 0.01$, (***) at the final phase, (^) denotes those values of different variables are shown in (mean ± standard deviation) are significant at $p < 0.05$, (#) at $p < 0.01$ and ($) at $p < 0.001$ from training phase 1 i.e., from preparatory period 1 (PP1) (the baseline data) and (ns) denotes values are not significant.

Table 4 shows that body weight (kg), performing time of 60 meters standing start (sec), and 2.4 kilometers run (sec) of female canoers were found to be significantly decreased from PP1 to GGP, following 8 successive training phases. The bench press/4 minutes and bench pull/ 4 minutes performance were found to be significantly increased from (57.28±10.73) to

(127.14±17.95) and (70.71±15.38) to (176.85±18.88) respectively from the training phase 1 i.e., from preparatory period 1 (PP1) (the baseline data) and (ns) denotes values are not significant.

DISCUSSION

Training allows athletes to gain more knowledge of their sports and at the same time makes them ready to learn about the importance of having a healthy mind and body. In our present study, table 2 reflects that the body weight (kg) of female rowers began to reduce in R1, and reduced more significantly in GPP. The performing time of 2.4 km run (sec) was decreased in CP2, R1, R2, and GPP, this is a positive effect of training as they are covering given distances in lesser time i.e., more quickly which signifies good aerobic power development after systematic training. 6 x10 meters shuttle run (sec) performance time of female rowers started to decrease in PCP and become pronounced in GPP. This is a beneficial effect of training as they can cover the given distance quickly, which signifies their agility. The 2.4 kilometers run (sec) and overhead ball throw performance (cm) of female rowers were found to be better than kayakers and canoers as depicted in figures 1, and 2, the 2.4 kilometers run timing was lower in rowers this conveys that they are covering the distance more quickly and efficiently than other two disciplines. The body height (cm) and body weight (kg) of female rowers in our present study were found to be lower than that of previous research (20). However, bench pull/ 4 min (kg) was found to be higher than that of the previous study (20).

In our present study, the standing broad jump (cm), and standing vertical jump (cm) of female rowers was found to be significantly improved as shown in Table 2. It has been found that the amount of muscle involvement in rowing stroke is 60% legs, 20% core and 20% arms. Legs are the biggest tool to accelerate the rowing boat during the drive (3). 6 × 10 meters shuttle run (sec) performance and standing vertical jump (cm) performance of female rowers was higher than kayakers and canoers as shown in figure 3, 4. Push-up exercise helps in shoulder coordination in rowers by maintaining more stable handle control and stroking technique by preventing injury of the shoulder (5). Sit up helps in toning the rectus abdominis, and oblique in addition to hip flexors, chest and neck of female rowers (7). Bench press/ 4 min and bench pull/4 min and flexibility (cm) performance of female rowers were found to significantly improve in GPP and it has also improved in between phases like R1 and R2. Bench press helps to restore balance for rowers who primarily use pulling muscles. VO2 max (ml/kg/min) of female rowers started to improve in R1 and haemoglobin content (gm %) begins to improve in CP1 and both of these were greater pronouncedly in GPP. Rowing is a well-known aerobic sport with moderate stress also the involvement of anaerobic energy in it (1). So, VO2 max (ml/kg/min) and haemoglobin content (gm %)are very much important. The framing of our training program is mainly based on the physical and physiological necessity of the particular game and therefore, training for these disciplines emphasizes endurance capabilities as well as those exercises that help to develop lower body explosive power, speed and agility. Female rowers have also improved their overhead ball throw (cm) performance and flexibility (cm). Overhead ball throw improves cardiorespiratory fitness along with toning muscles. A rower has

to be much more flexible to prevent injuries to overstretching and tensed muscles as they cover a distance of 2000 meters (12).

The height (cm) of our female kayakers was found to be shorter than the females in a previous study (11). In our present study, standing vertical jump (cm) was found to significantly and progressively increase in the case of female kayakers as shown in Table 3. Kayaking is a sport with paddles that immensely relies on a better balance of sitting demanding high metabolism. Leg explosive strength is very much important for kayakers. The sit-up performance was found to be significantly and progressively improved from Preparatory Period 1(PP1) to the final phase, General Practice Phase (GPP), and this significant improvement started from the third phase i.e., from Pre Competitive Phase (PCP). Push-up the performance of female kayakers was also found to be higher than their international male counterparts, depicted by Table 3 (9). Increasing athletic and sport-specific performance relies on specific and sufficient training stimuli. Push-ups like bodyweight training involve a group of muscles around the hips, torso, pelvis and lower back. This exercise increases the balancing power of kayakers along with their muscle strength. The sit-up performance of kayakers was found to be higher than their international counterparts (9) as shown in Table 3. Bench press /4 min, flexibility (cm) and haemoglobin (gm %) were found to be significantly and progressively increased in the case of female kayakers. Their bench press / 4 min performance was found to be higher than their international male counterparts (9). Bench presses are mainly used to tone the muscles of the upper body including the pectorals major, arms and shoulders which are mainly involved in rotating, flexing, and extending, regardless of the paddling intensity of the kayak boat. Flexibility is very much essential for a kayaker as a flexible kayaker can reach easily to the stern for a rudder stroke. Kayakers can have a vertical paddle stroke when they want to move sideways. Kayakers must develop a high aerobic capacity to respond to the high metabolic demands raised by flat-water racing distances. Haemoglobin percentage is greatly responsible for endurance performance and maximal oxygen uptake (VO2Max) of athletes in aerobic kind of sports (6). Elite endurance athletes have higher haemoglobin content than less well-trained endurance athletes (10). The body height (cm) of kayakers and canoers and body weight (kg) of kayakers and canoers in our present study were found to be higher than their female counterparts (15) according to Tables 2 and 3.

In our present study, table 4 depicts that body weight (kg), performing time of 60 meters standing start (sec), 2.4 kilometers run (sec) and 6×10 meters shuttle run of female canoers were found to be significantly and progressively decreased in 8 successive training phases. Training phases has helped canoeist to endow with a greater number of type IIa muscle fibers having a higher ability to supply aerobic power while paddling (16). The height (cm) of canoeists in our present study was found to be shorter than that of their elite male counterparts (9). Standing broad jump (cm), standing vertical jump (cm), sit up/ min, and push up/min performance were found to be increased significantly and progressively in the case of our canoers. As canoe is performed in a kneeling position with a paddle having one blade these exercises are very much important to paddle at maximal intensity for 90 to 120 seconds, physical skills are greatly required such as aerobic and anaerobic power, strength, coordination, and speed (22).The sit-up

performance of our female canoers after 8 successive tastings was found to be higher than that of their international male counterparts as shown in Table 4.

The flexibility of female canoeists has increased significantly after training but was found to be lower than their male international counterparts as shown in table 4. The bench pull/4 minutes of female cancers begin to improve in CP2 and the bench press/ 4 minutes performance in R1 both of these were pronounced in GPP. Their bench press /4 minutes (kg) performance was found to be higher than the studies of others (9) shown in Table 4. The performance time of 6 x10 meters shuttle run (sec) which reflects the agility was progressively decreased fromPP1 to GPP. The performance of overhead ball throw (cm), VO2 max (kg/ml/min), and haemoglobin (gm %)were found to be significantly and progressively increased in different training phases. The aerobic capacity (ml/kg/min) of our canoers was found to be higher than that of their female counterparts (1). The effect of detraining is totally absent and improvements are noticed also in the recovery period and after that as they are in proper schedule of exercise and rest.

It appears that systematic and graded training is essentially required for the improvement of tactical efficiency. Training allows the athlete's body to gradually build up strength, endurance, skill levels, motivation, ambition and confidence by enhancing the chances of success in competition.

Conclusions: a) Performance of Rowers, kayakers and canoers has improved significantly after systematic training. b) Further attention and modified training are needed for kayakers and canoers for more improvement. c) Weight training plays a pivotal role to protect them from muscle injury. d) In our present study effect of overtraining and detraining was absolutely absent as proper rest was given between training sessions.

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