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Influence of systematic training on morphophysiological and motor ability profiles of Indian young male kayakers

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Abstract:

CONTEXT: Little information is there on the training effect on junior Indian kayakers. Hence, it is of great interest to explore the influence of systematic training on morphophysiological and motor ability profiles of Indian young male kayakers.

AIMS: The aim of this study was to find out such a training intensity that would be suitable for junior athletes to reach the zenith of their success.

SETTINGS AND DESIGN: This was carried out in the center of Jagatpur, Sports Authority of India on 11 male kayakers. The training program was divided into eight phases.

MATERIALS AND METHODS: Body height, body weight, body mass index, standing broad jump, standing vertical jump, trunk flexibility, 6 m × 10 m shuttle run, bench pull test/4 min, bench press test/4 min, sit-ups/min, push-ups/min, medicine ball throw, maximal oxygen uptake, 60 m standing start for anaerobic speed endurance, 2.4 km run, and hemoglobin (g%) were measured by the standard procedures.

STATISTICAL ANALYSIS USED: Training phase differences were determined by analysis of variance, then Schiff's *Post hoc* test was performed with confidence levels at $P < 0.001$, $P < 0.01$, and $P < 0.05$.

RESULTS: Performing time of 60 m standing start (sec) and 6 m × 10 m shuttle run (sec) was significantly decreased at $P < 0.05$ and $P < 0.01$. Standing vertical jump performance (cm), sit up/min, and push-up/min were significantly increased at $P < 0.001$, $P < 0.05$, and $P < 0.05$, respectively. Bench press performance/4 min and hemoglobin content were significantly improved at $P < 0.001$.

CONCLUSION: Improvement and betterment were noted in performances even in formally trained athletes. A modified training protocol may be adopted for further improvement.

Keywords:

Flexibility, hemoglobin, kayakers, training

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Introduction

Kayaking is a popular water sport introduced in Olympics in 1936. It involves mostly the shoulder, upper back portion, and aerobic system.^[1] Kayak is a sleek boat, the movement of which mainly involves double-bladed paddle with cyclic motion by maintaining coordination and rotation of trunk in seated position. The Olympic events are

mostly 200 m (introduced at the London Olympic Games in 2012). The racing events are arranged in trial series before the main competition. As there are structural and physiological dissimilarities between upper-and lower-body musculature, the training regimen for kayaking is very much different from lower-body involved sports. Paddling technique in kayaking can be explained by event completion time, maximizing the average velocity of the kayak, generating high stroke average

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power, and by paddle blade greater average power forces during the propulsion of the kayak boat.^[2] Upper body strength and power training are of greater priority over the lower body of kayakers because of greater attachments in stroke rate. The aim of our present study was to find out the effect of systematic training on young male kayakers following strength, physical, and other physiological testing.

Materials and Methods

Participants

The study was conducted on 11 male kayakers (*n* = 11, age = 14.13 ± 1.40). All of them belonged to the Sports Authority of India, Jagatpur of Odisha, India. Each athlete was a state-level performer having 5 years of training experience. Ethical clearance from the concerned university and consent from the participant were taken. Similar nutritional status and similar training regimen were maintained during the training session, for a span of 22 months. For Ethical Clearance was obtained from the Ethical Committee Post-Graduate Department of Physiology, University of Burdwan with Ref no: HMC/IEC/BU/02/2022 dated 08.01.2022.

Training regimen

Total training of 10–11 sessions in a week was done, and after five sessions, one break was given. Kayaking mainly relies on upper body movements. Kayaking is a mixture of strength, power, and endurance and uses both alactic and lactic and to a lesser extent the aerobic system. Muscle requires energy to contract and perform.

Training Intensity

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 220 from athletes’ age-indicated stroke rate. 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 in Table 1.

Measured parameters

Anthropometric measurement

Body height (cm), body weight (kg), and arm span (cm) were measured using anthropometer/stadiometer, weighing pan, and anthropometrical tape, respectively.

Measurement of strength

This was determined by tests such as standing broad jump (in cm), standing vertical jump (in cm) for lower body explosive strength, trunk flexibility (in cm), 6 m × 10 m shuttle run (sec) for 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).

Table 1: Training protocol for male kayakers

Kayaking	Training phases								
	PP1	PP2	PCP	CP1	CP2	R1	R2	GPP	
	September-December	January-March	April-June	July-September	October-November	December	January-March	April-June	
Strength endurance	Endurance	Endurance muscular	Endurance paddling technique	Increased endurance	Peak champion-ship	Short-term recovery	Active recovery	Moderate strength endurance	paddling technique
Training volume (min/week)	565	640	670	700	725	520	542	565	
Distance covered (km)	9.5	10	10-12	12.5-13.5	14-16	9	10	10.5-11	
PP1: Preparatory period 1, PP2: Preparatory period 2, PCP: Precompetitive period, CP1: Competitive period 1, CP2: Competitive period 2, R1: Recovery period 1, R2: Recovery period 2, GPP: General practice per									

Assessment of physiological parameters

This includes aerobic power (maximal oxygen uptake [$\text{VO}_2 \text{ Max}$], measured in ml/kg/min) by bleep test.^[3] Sixty meters standing start for anaerobic speed endurance, 2.4 km run to detect the development of the athlete's aerobic capacity ($\text{VO}_2 \text{ max}$), and hemoglobin (g%) test were done using standard methods.

Statistical analysis

Statistical Program for the Social Sciences (SPSS) version 26.0 for Windows (SPSS Inc., Chicago, IL, USA) was used for statistical analysis. Differences between groups for all parameters according to different training phases were calculated using a one-way analysis of variance, then Schiff's *Post hoc* test was done for multiple comparisons between groups for all parameters according to different training phases. The level of significance was considered at $P < 0.05$, $P < 0.01$, and $P < 0.001$.

Results

Table 2 reflects that the performing time of 60 m run (sec) and 6 m $\times$ 10 m shuttle run (sec) of male kayakers had reduced progressively and significantly from preparatory period 1 (PP1) to general practice phase (GPP), i.e., from 9.04 ± 0.52 to 8.16 ± 0.42 and 16.40 ± 0.40 to 14.17 ± 0.83 , respectively at $P < 0.05$. All the variables were increased statistically and significantly improved except body height (cm), body weight, and arm span (cm) in the case of male kayakers at the final stage (GPP) as compared to the baseline (PP1).

Discussion

Training allows athletes to gain more knowledge of their sports, at the same time, makes them ready to learn about the importance of having a healthy mind and body. An elite kayaker requires powerful and skillful paddling to minimize negative drag forces. Table 2 depicts that the body height (174.15 ± 7.04) of male kayakers was higher than the females (165 ± 5) of previous research.^[4] Body height (cm) (174.15 ± 7.04) and body weight (kg) (66.24 ± 6.09) of our male kayakers are lower than that of the Polish study (184.9 ± 5.8) and (78.1 ± 4.9), respectively.^[5] Body mass index (kg/m^2) (20.11 ± 1.79) was also lower than those counterparts (22.8 ± 0.9). In our present study, standing vertical jump (cm) was found to significantly and progressively increased in the case of male kayakers, as shown in Table 2 and Figure 1 ($P < 0.001$). Kayaking is a sport with a paddle that immensely relies on a better balance of sitting demanding high metabolism. Leg explosive strength is very much important for kayakers. Sixty meters standing start performance time decreased significantly from 9.04 ± 0.52 to

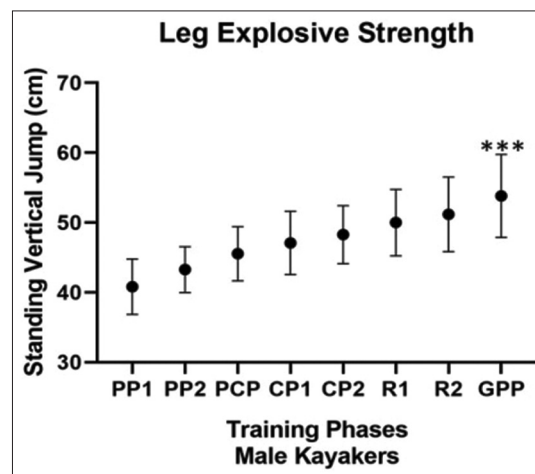


Figure 1: Standing vertical jump (cm) of male kayakers. Values = mean $\pm$ standard deviation. (***) denotes $P < 0.001$

8.16 ± 0.42 ($P < 0.05$), as shown in Table 2 and Figure 2. The sit-up performance was found to be significantly and progressively improved from PP1 (53.36 ± 7.06) to the final phase, GPP (126.27 ± 15.08). Push-up the performance of kayakers was increased from 47.55 ± 7.70 to 108.09 ± 16.43 ($P < 0.05$). Increasing athletic and sport-specific performance rely on specific and sufficient training stimulus. Push-ups such as body weight 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. 6 m $\times$ 10 m shuttle run performance (sec) (16.40 ± 0.40) of male kayakers was significantly increased from PP1 to GPP (14.17 ± 0.83), as shown in Table 2 and Figure 3 ($P < 0.01$). As the lower body's work is an initial part of the load imposed by paddling, kayaker's running training is always beneficial.^[6] Bench press/4 min, flexibility (cm), and hemoglobin (g %) were progressively improved in male kayakers, as shown in Table 2 and in Figures 4-6. Their bench press/4 min performance (155.64 ± 16.77) was found to be higher than their international male counterparts (83.8 ± 18.6).^[7] 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 high aerobic capacity for greater metabolic demands to give better performance in competitive events. Hemoglobin percentage is greatly responsible for endurance performance and $\text{VO}_2 \text{ Max}$ of in athletes in aerobic kind of sports.^[8] Elite endurance athletes have higher hemoglobin content than less well-trained endurance athletes.^[9] Effect of detraining

Table 2: Effect of systematic training on male kayakers

Variables	Training phases								P
	PP1	PP2	PCP	CP1	CP2	R1	R2	GPP	
Age (years)	14.13±1.40	14.65±1.41	14.9±1.41	15.46±1.34	15.88±1.40	16.38±1.51	16.64±1.50	16.69±1.41	0.229 (ns)
Height (cm)	172.18±6.98	172.59±6.92	173.00±6.98	173.23±6.91	173.46±6.93	173.65±6.97	173.88±7.02	174.15±7.04	0.987 (ns)
Weight (kg)	66.24±6.09	65.09±7.08	64.88±6.17	64.51±6.67	63.59±6.67	63.05±7.41	61.65±8.55	60.11±8.46	0.889 (ns)
60 m standing start (s)	9.04±0.52	8.82±0.454	8.69±0.36	8.50±0.37	8.45±0.37	8.36±0.43	8.31±0.40	8.16±0.42	0.034*
2.4 km run (s)	669.82±48.01	650.73±42.48	639.55±38.38	627.73±36.39	608.64±33.67	585.27±29.95	569.09±28.17	553.00±25.90	0.053
Standing broad jump (cm)	213.73±64.79	237.64±18.25	239.82±18.55	244.91±15.97	251.55±14.75	254.91±15.14	258.82±16.17	265.73±17.91	0.085 (ns)
Standing vertical jump (cm)	40.82±3.97	43.27±3.29	45.55±3.88	47.09±4.53	48.27±4.15	50.00±4.75	51.18±5.34	53.82±5.95	0.000***
Sit up/min	53.36±7.06	64.18±8.57	72.00±8.17	81.73±8.32	89.82±8.60	98.91±12.14	108.73±14.42	126.27±15.08	0.002*
Push-up/min	47.55±7.70	56.73±8.11	64.82±8.96	72.45±8.73	79.64±8.03	85.73±8.03	91.55±9.73	108.09±16.43	0.013*
Arm span (cm)	180.08±8.85	180.45±8.73	180.66±8.76	180.7±9.00	181.13±8.84	181.35±8.78	181.66±8.80	182.08±8.49	0.645 (ns)
Bench press/4 min	65.91±16.70	77.09±18.72	90.64±21.86	104.82±26.35	118.91±25.92	135.09±23.01	143.45±22.00	155.64±16.77	0.000***
Bench pull/4 min	72.45±24.11	83.00±26.22	90.73±26.75	103.91±28.94	120.09±31.58	133.64±29.21	146.27±25.28	161.55±21.73	0.225
6x10 m shuttle run	16.40±0.40	15.84±0.51	15.66±0.40	15.37±0.30	15.24±0.39	14.93±0.37	14.71±0.50	14.17±0.83	0.008**
Overhead ball throw (cm)	481.64±56.10	505.0±59.66	521.36±59.82	531.55±60.61	538.55±61.47	552.18±62.12	563.00±59.52	569.36±66.79	0.521 (ns)
Vo2 Max mL/kg/min	44.15±4.80	45.65±4.30	46.96±3.10	48.74±3.40	49.98±3.04	51.18±2.90	53.01±4.18	54.35±4.72	0.184 (ns)
Flexibility (cm)	12.66±2.48	15.62±4.73	16.75±4.59	17.32±4.77	18.38±4.56	19.77±4.60	20.59±4.80	21.68±4.93	0.032*
Hemoglobin (g %)	11.56±0.76	11.80±0.80	12.14±0.69	12.35±0.63	12.63±0.62	12.96±0.62	13.19±0.58 [^]	13.45±0.55	0.000***

*Significant at $P<0.05$, **At $P<0.001$, ***At $P<0.0001$, at final phase; [^]Those values of different variables are shown in (mean±SD) are significant at $P<0.05$, from training phase 1 i.e., from preparatory period 1 (the baseline data) and ns. Values are shown in (mean±SD), ns: Not significant. SD: Standard deviation, PP1: Preparatory period 1, PP2: Preparatory period 2, PCP: Precompetitive period, CP1: Competitive period 1, CP2: Competitive period 2, R1: Recovery period 1, R2: Recovery period 2, GPP: General practice per

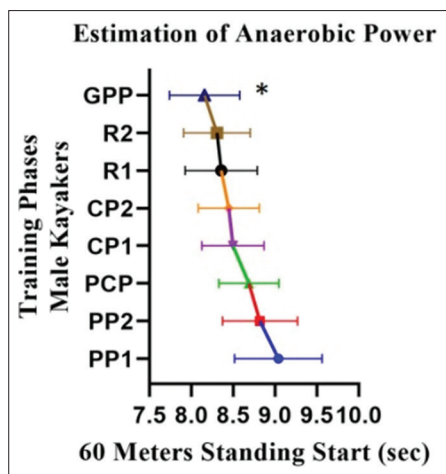


Figure 2: Sixty meters standing start (sec) performance of male kayakers. Values = mean $\pm$ standard deviation. (*) denotes $P < 0.05$

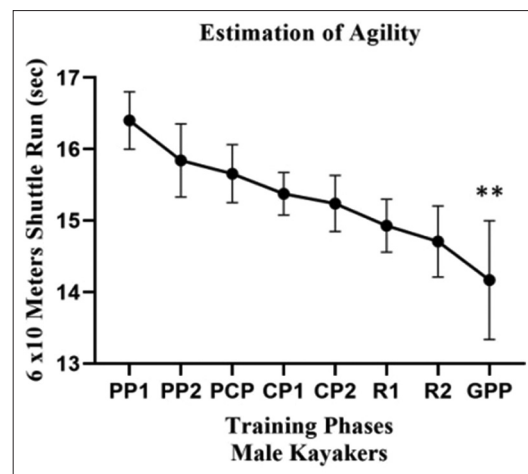


Figure 3: 6 x 10 meters shuttle run (sec) of male kayakers. Values = mean $\pm$ standard deviation. (**) $P < 0.01$, (***) denotes $P < 0.00$

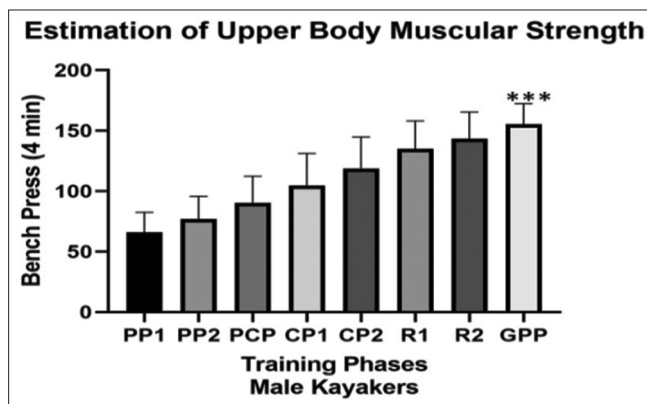


Figure 4: Standing Bench press performance (4 min) of male kayakers. Values = mean $\pm$ standard deviation. (***) denotes $P < 0.001$

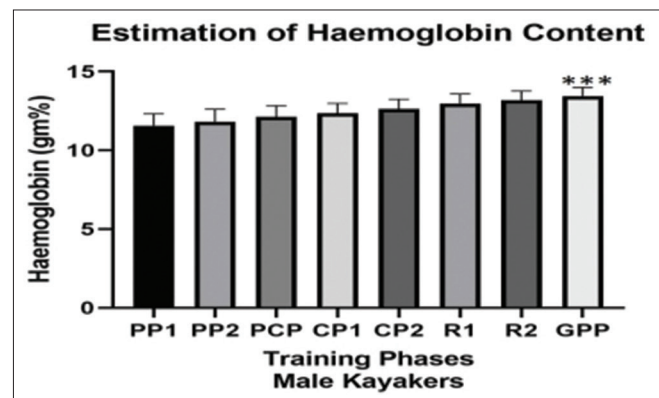


Figure 5: Hemoglobin content (g%) of male kayakers. Values = mean $\pm$ standard deviation. (**) $P < 0.01$, (***) denotes $P < 0.00$

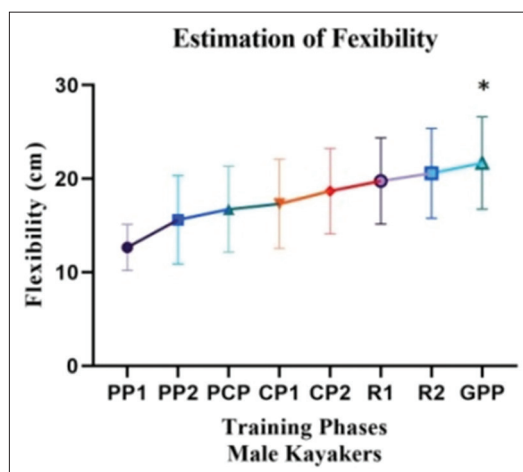


Figure 6: Flexibility (cm) of male kayakers. Values = mean $\pm$ standard deviation. (*) denotes $P < 0.05$

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.

Conclusion

- Performance of kayakers has improved significantly after systematic training
- Along with training of an athlete proper care should have to be taken for rest between training sessions to avoid overtraining oxidative stress.

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Conflicts of interest

There are no conflicts of interest.

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