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CORRELATION OF SELECTED KAYAK PRO PARAMETERS IN-LAND AND IN BOAT

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ABSTRACT

There is no adequate research on the validity of rowing ergometers in measuring paddling performance of Paradragon Boat paddlers. This study then aimed to determine the validity of a specific rowing ergometer in measuring paddling performance. This study used a prospective correlational research design. The study was conducted in a sea channel and a university gym. Ten paddlers in a non-profit organization paddled on a rowing ergometer and in-boat on actual seawater. The time duration, number of strokes, and speed of each subject per 200 m, 500 m, and 2000 m were recorded. Pearson Correlation Coefficient was used to determine the correlational relationship between paddling parameters in-land and in-boat. Validity coefficients showed strong positive relationship between ergometer and in-boat performance in all assessed technical parameters: time (200 m: r = 0.89; 500 m: r = 0.90; 2000 m: r = 0.84), number of strokes (200 m: r = 0.88; 500 m: r = 0.91; 2000 m: r = 0.82), and speed (200 m: r = 0.87; 500 m: r = 0.89; 2000 m: r = 0.82). Therefore, the rowing ergometer is a valid tool in assessing paddling performance of Paradragon boat paddlers.

INTRODUCTION

Tracing its origin from China, Dragon boat racing is a competitive water sport that typically comprises groups of 18-20 paddlers, a drummer, and a steerer coordinating to propel a standard size Dragon boat across distances that range from 200 m to 2000 m [1]. Ever since the establishment of the International Dragon Boat Federation in 1991, Dragon Boat sport has been increasingly emerging as a recognized competitive sport across the world [2]. Dragon boat racing has already been in the sports world for several years, but it has only recently opened its doors to adaptive sports category, Paradragon Boat racing. A Paradragon boat team is similar to a Dragon boat team in terms of positions, but the participants consist of PWDs or "Persons with Disabilities," which are described by the IDBF as "paddlers who have some form of physical, psychological, neurological, sensory, developmental or intellectual impairment" [1].

Dragon Boat racing has only been developing for a number of years since getting recognition with its international competition only launched in 1995, hence, there is limited research on the scientific facet of this sport. Scientific research would then play a crucial responsibility in the further development as taking up a scientific approach towards analysis of performance and research can profoundly facilitate in attaining sporting success [2].

Quantifying and evaluating work output has been proven critical to the understanding of sports such as Dragon Boat racing, especially with the limited research on the sport. This evaluation can be carried out through assessment with field tests (saltwater or freshwater environment in an actual boat) or under simulated conditions in laboratory environment using specific ergometers [3].

Ever since Pyke and company designed and created a kayak ergometer in 1973, a number of researchers and engineers alike have tried to create a simulation of the real conditions of paddling of flat-water kayaking sport [3]. Studies conducted have substantiated the reliability of this kayak ergometer in evaluating flat-water kayaking performance as these studies have explored the analysis of

technical actions on these ergometers, which have suggested high levels of coincidence between ergometer and flat-water paddling with reference to biomechanics (positions and motions of different parts of the body) and physiological variables (cardiopulmonary components) [4, 5, 6, 7].

Despite all of the abovementioned studies, all of which explored the specific field of flat-water kayaking and kayak ergometers, there remains very limited research and information on the field of Dragon Boat rowing/ paddling and the technical parameters of rowing/ paddling, most especially in Paradragon boat. Considering the novelty of this adaptive sport, the lack of scientific exploration makes sense. There has not been a lot of studies made on the validity of rowing ergometers in evaluating rowing/ paddling performance in terms of technical parameters.

Therefore, this paper will determine the validity of Kayak Pro rowing ergometer in defining rowing performance by establishing the correlational relationship of selected technical parameters (time duration, number of strokes, speed) per 200 m, 500 m, and 2000 m in a Kayak Pro rowing ergometer and in an actual boat on saltwater of the adaptive paddlers in a non-profit organization. It was hypothesized that there would be a relationship between the ergometer parameters in-land and the parameters in-boat (or on saltwater).

Literature Review

Dragon Boat Racing as a Competitive Sport

Dragon boat racing can be traced back to the culture-laden history of Southern China as far back as 2,500 years ago. It has already been around since the Warring States Period (402-221 BC). However, Dragon boating as a sport only first emerged in 1976 when the first Hong Kong International Races was conducted, which now garnered its recognition as the beginning of the “Modern Era” of the sport that is Dragon boating [1].

Dragon boat racing reflects an extremely energetic and vigorous type of physical activity. Training programs of paddlers can incorporate strong degrees of physical exercise a day, especially in preparation for major international tournaments. Dragon boat racing has continuously developed and grown in the world of competitive sports. Across China, Southeast Asia and beyond, various people form different teams to compete in national and international competitions. Similar to other competitive racing water sports, Dragon boating maximizes full-body use in performing high intensity exercise. Making use of trunk flexion and rotation and the upper extremities in maneuvering the paddle, and the lower extremities in anchoring the body to support the upper half movement, paddlers propel the boat in forceful repetitive motions [2]. The participants, which are paddlers, a drummer, and a steerer, all combine efforts in precise coordination to efficiently displace the boat across the water. With this, Dragon boating is also recognized as a means of nurturing teamwork among athletes with its being a team-building physical activity [8]. It is that type of sport whose ultimate challenge essentially boils down to achieving and maintaining an effective group dynamics. This is crucial since even at least one inconsistency within the group could already influence the general performance.

Comprising a dragon boat crew are 20 paddlers, 1 drummer, and 1 steer, and races are held in men’s, women’s, and mixed divisions. Official distances of races for International Dragon Boat Federation World Championship activities usually range from 200 m to 2000 m, and the most common race distances are 200 m, 500 m, and 1000 m [3].

A dragon boat moves by generating power from each of the paddlers, which is transformed into the boat's forward propulsion through the blade through its interaction with the water, and through the contact of each paddler with the boat at their feet and seat. The sum of all the stroke power achieved by each paddler would then cause the boat to displace forwards. [3]

Dragon Boat Racing as an Adaptive Sport

Dragon boat racing has already been in the world of sports for several years, but opening its doors to adaptive sports has only been done just recently. An adaptive sport is basically the accessibility of appropriate sporting equipment and integrate corresponding modifications to cater to the needs of athletes with disabilities and to enable the athlete to participate as much individually as possible. Considering this, it can be said that Dragon boat racing is ideal for an adaptive sports program, because it places disabled people on an equal footing with professional athletes as a seated sport.

Essentially, Paradragon boat racing is a novel event as it has only been recently included as a category in Dragon boat sports. Similar to a regular Dragon boat team, a Paradragon boat team is comprised of set of paddlers, a drummer, and a steerer, but the participants consist of PWDs or “persons with disabilities.” This particular category is inclusive of, but not limited to the following: individuals with lower extremity amputation, hearing impairment, sight impairment, cleft palate, feet deformities from fractures and degenerative joint disease, and congenital lower limb deficiency. It is unfortunate to say this, but, attitude towards individuals with disabilities are influenced by a variety of factors including, but not limited to stigma, ignorance, neglect, superstition, and communication barriers [11]. These factors have generally resulted in attitudes that are negative towards individuals with disabilities. This is primarily why persons of this population are one of the most misunderstood by society. The new addition to the categories goes a long way in incorporating ways to raise awareness of and participation in adaptive sports, and most especially in promoting better and greater understanding and inclusiveness of the PWDs population through adaptive sports. Participating in adaptive sports provides the perfect opportunity for PWDs to prove themselves

that no form of disability and impairment can hinder them from doing what they love, from doing what others can, with an even better performance.

Subsequently, it was in October 2017 when the International Dragon Boat Federation-Para Athlete Commission (IDBF-PAC) was established for the purpose of formulating a set of rules and regulations specifically applicable to the Paradragon boat category [1].

Determinants of Paddling Performance

Current scientific work in dragon boat racing does not give out detailed explanations on the dynamics of paddle and boat propulsion. Therefore, there is no conclusive evidence on factors that lead to the good performance of dragon boat paddlers. However, despite this, there are still other sets of parameters that can be used to assess paddling performance. These include technical parameters of spatial and temporal of sorts.

In the field of kayaking (a sport also involving paddling/rowing) according to Michael and company in 2009, the time taken to complete each race distance in a competition is used as the ultimate criterion of kayak performance. To maximize kayak velocity, the paddler is required to generate high average power during each stroke and large average forces on the paddle blade as well as display sound technical skills and utilize their large metabolic capacity for a maximum of 1 min 37 s or 3 min 26 s (the time to complete 500 m and 1000 m in competition respectively at the 2008 Beijing Olympic Games) [12].

Expended in maintaining the boat's relatively constant velocity (power = drag force x kayak velocity) is the major factor of the paddler's power output. Thus, the power output required from the paddler is directly proportional to the kayak velocity cubed. The small degrees of inconsistencies and fluctuations in velocity also have an effect on output of but to a much lesser extent than what is previously described above. Albeit no previous studies have studied the particular forces developed within the kayak on the components of footbar and seat, previous work analysing the technique or movement patterns of the paddler throughout the stroke are immensely helpful in developing a scientific technique description. There is, therefore, a need for a comprehensive review to ultimately address the gap between sport scientists and athletes/coaches [12].

In a competition, paddler paddle their kayaks with maximal effort throughout the length of the competition distance. Basically, it can be inferred from a run that the mean velocity for each stroke is the mean velocity for the total race distance. During each stroke of a race, the kayak's velocity fluctuates due to the resulting constant dynamic movement of the paddler and the different degrees of application of force and power output via the paddle in each of the paddler's strokes. Contrary to the relationship of velocity and power output, the average velocity of the kayak is inversely proportional to the time duration taken to finish the race.[12]. Time taken to cover the racing distance directly influences the velocity of the boat. This then stresses how time parameter should be always considered in the overall evaluation of paddling performance.

With a combined understanding of the forces acting on the kayak (kinetics), along with analysis of the movement of the kayak and paddler (kinematics), their effects on kayak velocity can then be determined and certain ways to maximize kayak paddling performance can then be identified and applied [12].

Rowing Ergometers

The problems associated with measuring on-water rowing performance and efficiency have resulted in the widespread use of stationary rowing ergometers that simulate on-water rowing action and context. Rowing ergometers are basically machines integrating parts and components that aim to replicate or simulate on-water paddling/rowing. Its main parts consist of a shaft as the paddle connected to a part that controls resistance via a rope, seat bench, footboard, and a built-in device that indicates the distance covered after performing a rowing session [13].

In 2019, Zanevskyy et al. explored the concept of creating a model of validity on the basis of the relationship between the ergometer and on-water performance competition rowing. The author stressed how initially, paddling ergometers were specifically designed to simulate indoor paddling exercises, and that during the last several years, these ergometers have transformed and have played a huge role in modernizing performance testing and training kayak athletes [3-8]. Sportsmen mainly use kayak ergometers to acquire a simulation of the environment, and the biomechanical and physiological conditions associated with kayaking. This simulation enables the athletes to train for kayaking indoors [9].

The study acquired the results by randomly dividing participants into two groups: a control group which consisted of 9 rowers, and an experimental group which consisted of 10 rowers. The control group underwent a training program in accordance with the curriculum that comprises exercises and strength training involving pressing and pulling of a rod, pulling and jerking of the weight, bars exercises, and multijoint barbell exercises. The experimental group underwent the same program as the control group, but a portion of the exercises was substituted with high-intensity strength training ergometer rowing 2 times a week. However, the amount of strength load of both groups remained equal.

The two groups were assessed by measuring the number of maximal intensity double strokes with the ergometer in one minute, and by measuring the time of 500 m kayak competition on flat water rowing just before and after the off-season. Results revealed a strong significant correlation between competition performance of on-water kayak and ergometer rowing before and after off-season ($r = -0.892$, $r = -0.902$, respectively). Furthermore, the correlation analysis suggested a good prognostic factor of the ergometer performance on the on-water performance of kayak [9].

After raising the concern of discrepancy between properties of on-water and ergometer techniques including the resulting physiological stress, Sarabon et al. addressed this issue by garnering results indicating significant differences in rowing techniques in different compliance levels of rowing ergometers [9].

Methodology

This study started on the third week of January 2020 and ended on the first week of March 2020. Correlational research design was used, specifically, prospective research design. Ten (10) paddlers were recruited from a non-profit organization. Informed consent was obtained and an explanation of the risks, benefits, and compensation was provided. The venues where the study was conducted were as follows: a sea channel where the participants held in-boat paddling and a university gym where the Kayak Pro rowing ergometer paddling was held.

The researchers utilized a Kayak Pro rowing ergometer with built-in parameters that determined the distance covered, time duration, number of strokes, and speed performance of the subjects. The researchers used a high-resolution camera to document the performance of the subjects during in-boat paddling. Data collection started on the third week of January 2020 and ended on March 7, 2020. The subjects received initial assessment of vital signs before their training. The researchers set distances to be reached in both the Kayak Pro ergometer and in-boat paddling. The said distances were: 200 meters, 500 meters, and 2,000 meters. The time it took for each subject to cover the distance in seconds and the number of strokes was recorded. The data collected was gathered and analyzed to determine the correlational relationship of selected parameters between Kayak Pro ergometer paddling and actual in-boat paddling.

Statistical Analysis

A Pearson correlation coefficient was used to analyze and determine e correlational relationship of selected parameters between KayakPro ergometer paddling and actualin-boat paddling.

Results and Discussion

Each subjects' time duration (in minute) per 200 m, 500 m, and 2000 m both in Kayak Pro ergometer and in boat were recorded and collated (Refer to Table 1). The same paddlers were assessed and evaluated. The number of strokes per 200 m, 500 m, and 2000 m both in Kayak Pro ergometer and in boat were recorded and collated (Refer to Table 2). The subjects' speed (meters/second) per 200 m, 500 m, and 2000 m both in Kayak Pro ergometer and in boat were recorded and collated (Refer to Table 3).

A Pearson Correlation Coefficient was conducted to determine the correlation relationship between the subjects' paddling performance on Kayak Pro rowing ergometer and in-boat on actual saltwater in terms of time, number of strokes, and speed in each of the predetermined distances of 200 m, 500 m, and 2000 m. Validity coefficient showed strong positive relationship between ergometer and in-boat performance in all assessed technical parameters: time (200m: r 0.89; 500 m: r= 0.90; 2000 m: r= 0.84), number of strokes (200 m: r= 0.88; 500 m: r= 0.91; 2000 m: r= 0.82), and speed (200 m: r= 0.87; 500 m: r= 0.89; 2000 m: r= 0.82).

The limitations of the study were that it only involved measuring the time, number of strokes, and speed at a predetermined distance at a constant resistance level and the assessment of the participants' performance were limited to the given parameters.

Conclusion

The results revealed a strong positive relation between Kayak pro rowing ergometer and in-boat performance in terms of time, number of strokes, and speed in each of the predetermined distances of 200 m, 500 m, and 2000 m. This means that the rowing ergometer was able to precisely measure the technical parameters of paddling in a simulated context. Therefore, the Kayak pro rowing ergometer is a valid tool in assessing paddling performance of Paradragon Boat paddlers.

With this, the Kayak Pro rowing ergometer can then be considered a deterministic model for paddling performance for an adaptive paddling team by defining said ergometer as reference from which the team can base-off their testing and training. This would present an opportunity for further improvement of the team's performance and achievement of sporting success.

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Table 1. Time duration (in minutes) per 200 m, 500 m, 2000 m in Kayak Pro ergometer and in-boat.

Subjects	200 m		500 m		2000 m	
	Ergometer	In-Boat	Ergometer	In-Boat	Ergometer	In-Boat
1	00:47.5	00:53.3	2:09.5	2:15.9	10:27.1	10:56.2
2	00:49.0	00:52.0	2:18.3	2:27.6	11:15.0	11:35.3
3	00:51.6	00:55.1	2:09.5	2:22.5	10:31.5	10:55.5
4	00:54.8	01:01.3	2:35.3	2:43.2	13:09.4	13:47.6
5	00:45.4	00:49.1	2:06.7	2:11.2	10:21.9	10:44.6
6	00:49.1	00:53.6	2:22.4	2:29.5	11:05.3	11:25.7
7	01:03.0	01:10.5	2:54.8	3:20.2	14:19.5	14:53.8
8	0:55.8	01:00.5	2:40.8	2:46.6	11:02.1	11:37.2
9	00:52.7	00:57.9	3:00.6	3:08.3	11:25.5	11:44.9
10	00:46.1	00:52.4	2:06.9	2:13.9	10:51.9	11:26.3

Table 2. Number of strokes per 200 m, 500 m, and 2000m in Kayak Pro ergometer and in-boat.

Subjects	200 m		500 m		2000 m	
	Ergometer	In-Boat	Ergometer	In-Boat	Ergometer	In-Boat
1	58	65	144	159	596	615
2	58	67	145	159	598	618
3	57	67	137	154	565	585
4	61	70	150	164	610	625
5	55	63	139	153	581	588
6	57	65	138	151	569	587
7	64	75	152	169	610	639
8	55	64	134	147	545	562
9	59	67	145	160	605	619
10	58	67	142	156	586	594

Table 3. Speed (meter/second) per 200 m, 500 m, and 2000 m in Kayak Pro ergometer and in-boat.

Subjects	200 m		500 m		2000 m	
	Ergometer	In-Boat	Ergometer	In-Boat	Ergometer	In-Boat
1	4.21	3.75	3.86	3.68	3.19	2.98
2	4.08	3.85	3.62	3.34	2.97	2.63
3	3.88	3.63	3.86	3.51	3.17	2.75
4	3.65	3.26	3.22	3.06	2.53	2.10
5	4.41	4.07	3.95	3.81	3.23	3.02
6	4.07	3.73	3.51	3.34	3.01	2.71
7	3.17	2.84	2.86	2.49	2.33	1.69
8	3.58	3.31	3.11	3.02	3.02	2.84
9	3.80	3.45	2.77	2.65	2.92	2.63
10	4.34	3.82	3.94	3.73	3.07	2.79