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A profile of endurance paddle sport athletes and performance

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Abstract
The primary aim of this research was to develop an anthropomorphic profile of endurance paddle sport athletes to determine which of these characteristics best relates to race performance. Fifty (35 male and 15 female) volunteers (N = 50; age = 53.96yrs ± 17.37; height = 173cm ± 8.92; mass = 75.11kg ± 12.70; BMI = 25.32 ± 2.89 kg x m^{-2}, body fat % = 22.2 ± 6.3) provided informed consent prior to participation. Participants competed in the 2016 United States Canoe Association Marathon National Championships consisting of a 13-miles course on the Connecticut River in Northamptom, MA. Participant race finish times were used as the measure of performance. Participant age was the only variable that correlated significantly to race performance (r^2 = 0.540; p = 0.01), and remained the only variable significantly related to race performance when split by participant gender (Female: r^2 = 0.627; p = 0.01 and Male: r^2 = 0.648; p = 0.01). Based upon these results, it appears that age is the significant variable related to endurance paddle sport performance.

Keywords: Paddling, Endurance, Race, Performance, Canoe, Kayak

1. Introduction
The International Canoe Federation defines a canoe and/or kayak marathon as an event in which the competitor races over a designated long distance course on water subject to prescribed standards. The competitor must take the water as it is found and be prepared, if it is necessary, to carry his or her canoe around an impassable obstacle, or between two waterways [1]. Endurance paddle sport contests can range from 13 miles to 170 miles over several days and include sections of portage [2]. These rules and standards are generally held consistent for other paddle sports such as marathon kayak racing. Marathon paddling is a low impact, high aerobic sport. The sport also has significant technical components which include paddling efficiency, water knowledge, and navigation skills. Over time, athletes develop the ability to read different water conditions both to avoid obstacles and seek out faster water [3].

For endurance and ultra-endurance athletes, a variety of different anthropometric characteristics, training characteristics and physiological variables have been identified as possible important predictor variables for race performance [4]. However, these data have been almost exclusively collected on athletes competing in sports such as running and triathlon [5-7]. Limited information has been collected about the physical characteristics of endurance paddle sport athletes, specifically marathon canoe and kayak athletes.

The 2016 USCA Marathon National Championships took place in Northfield, Massachusetts, between August 11 and August 14, on the Connecticut River. This event provided an opportunity to collect body height, body mass, and bioelectrical impedance data on a respective sample of elite endurance paddle sport athletes. The race course was a 13-mile looped course that afforded athletes the opportunity to compete in a number of different events over the four days of competition including individual, pairs, and mixed pairs events. This event attracts some of the finest endurance canoeists and kayakers in the United States of America and Canada, allowing them to compete head-to-head [1].

The purpose of this report is to present age, height, mass, body fat, and body mass index (BMI) data of competitors in the 2016 USCA Marathon National Championships for physical characterization of participants in such an event and to demonstrate the relationship between these variables and performance.

2. Materials and Methods

2.1 Participants

USCA Marathon National Championship competitors were the study participants. Athletes were required to either register or check-in prior to the respective races in which they intend to compete throughout the four-day event. Following event registration, potential participants were queried regarding study participation. Following a brief explanation of the study parameters, interested participants read the informed consent form, and any additional questions posed by the participants were answered. All study participants signed the University Institutional Review Board approved informed consent form.

2.2 Protocol

Height and mass measurements were taken with calibrated measuring equipment during athlete check-in/registration at the championship event. Each of these measurements were obtained with the athlete removing their shoes for accuracy purposes. Additionally, during data collection, athletes provided their age and gender. From the information collected the individual participant's Body Mass Index (BMI) was determined. The participant's body composition was determined through bioelectrical impedance.

2.3 Statistical Analysis

Race results offered by race officials were used in the analysis of the relationship between anthropomorphic data and athlete performance. Pearson correlations were used to compare age, height, mass, BMI, and body composition values with finish time in the individual contest. Fisher's z transformation, 95% percentile confidence intervals (upper and lower limits), mean values and standard deviations were also determined. All calculations were performed using IBM SPSS software (version 24) with an a priori level of significance set at $p \leq 0.05$.

3. Results & Discussion

3.1 Results

A total of 252 athletes competed in event categories designated as either individual canoe or kayak classes. Of the 252 athletes, a total of 50 athletes participated in this study (19%). Of the 50 athletes who participated in data collection 15 were female (30%) and 35 were male (70%), which approximately reflects the overall event participation (72% male and 28% female). Mean finish times of the study participants were comparable to all race participants finish times. Characteristics of the participants in this study as a pooled sample are presented in Table 1. Table 2 offers the descriptive anthropomorphic characteristics of the study participants when dichotomizing the sample by gender.

Table 1: Participant characteristics

Variable	Minimum	Maximum	Mean	SD
Age (years)	21	94	53.96	17.37
Height (cm)	156.21	193.04	173.58	8.92
Weight (kg)	55.34	115.67	75.11	12.71
BMI	20.41	32.21	24.85	2.92
Body Fat %	6.41	35.61	22.21	6.31
Finish Time (mins)	119.15	169.57	135.75	13.33

Table 2: Participant characteristics by gender

	Variable	Minimum	Maximum	Mean	SD
Female (n=15)	Age (years)	23.00	76.00	50.86	17.26
	Height (cm)	156.21	177.8	165.59	6.60
	Weight (kg)	55.79	85.00	63.81	7.48
	BMI	20.40	32.20	23.72	2.98
	Body Fat %	17.01	35.61	25.86	6.47
	Finish Time (mins)	119.65	154.45	133.99	11.52
Male (n=35)	Age (years)	21.00	94.00	55.14	18.02
	Height (cm)	160.02	193.04	176.81	7.87
	Weight (kg)	55.34	115.67	79.78	11.88
	BMI	20.40	32.00	25.32	2.89
	Body Fat %	6.41	32.10	20.82	5.83
	Finish Time (mins)	119.15	169.57	135.98	14.27

Tables 3, 4, and 5 offer the correlational relationship between the descriptive variables and race finish time for the pooled, female and male participants respectively.

Table 3: Correlational relationships of variables to finish time (All Participants)

Variable	r^2 value	95% CI Upper Limit	95% CI Lower Limit
Age	0.540*	0.711	0.308
Height	0.071	NA	NA
Weight	0.103	NA	NA
BMI	0.139	NA	NA
Body Fat %	0.036	NA	NA
* indicates statistical significance at p = 0.01			

Table 4: Correlational relationships of variables to finish time (Females only)

Variable	r^2 value	95% CI Upper Limit	95% CI Lower Limit
Age	0.627*	0.862	0.170
Height	-0.212	NA	NA
Weight	0.002	NA	NA
BMI	0.402	NA	NA
Body Fat %	-0.051	NA	NA
* indicates statistical significance at p = 0.01			

Table 5: Correlational relationships of variables to finish time (Males only)

Variable	r^2 value	95% CI Upper Limit	95% CI Lower Limit
Age	0.648*	0.806	0.402
Height	0.102	NA	NA
Weight	0.131	NA	NA
BMI	0.144	NA	NA
Body Fat %	0.130	NA	NA
* indicates statistical significance at p = 0.01			

The association of BMI with finish time did not reach statistical significance (p=0.073) when analyzing pooled data (both female and male athletes), nor was statistical significance observed when splitting the data between female and male participants (p=0.50 and p=0.97, respectively). Body fat percentage was not statistically significantly related to race performance either (p=0.84 pooled, p=0.88 female and 0.25 male).

The relationship between participants age and finish time did yield a statistically significant correlation (r^2=0.540; p = 0.01) when analyzed as pooled. Additionally, when the pooled sample was analyzed as a dichotomous sample based on participant sex statistical significance remained for age and finish time (Female: r^2=0.627; p=0.01 and Male: r^2=0.648; p=0.01).

3.2 Discussion

Athletes participating in this 13-mile marathon paddle event were found to vary considerably in body composition. For example, BMI values ranged from 21.40 to 32.00 kg x m^{-2} and body fat ranged from 6.40 to 32.10% for men. For women, BMI values ranged from 17.00 to 35.60 kg x m^{-2} and body fat ranged from 17.00 to 35.60%.

Results from this study are somewhat similar to those examining other endurance sport participants, namely ultra-endurance runners. Hoffman *et al* [7], assessed body mass and body fat of ultramarathon athletes. Knechtle and colleagues [8, 9] measured BMI and percent body fat in a small group of men competing in a 24-hour run and a run of 1200 km over 17 consecutive days. The BMI and body fat values reported in these studies did not differ dramatically from those found in the current study. While Hoffman *et al* reported statistically significant correlation between body fat percentage and finish time among male athletes [7], no other report of statistical significance was made in regard to BMI, body fat percentage, and race finish time [8, 9]. Interestingly, the variable that displayed statistical significance in the current study was the age of the athlete participating in the contest.

In regard to the current study, physiologic variables not yielding statistical significance and a chronological variable showing statistical significance may speak to the role experience plays in an athlete's finishing position. As mentioned earlier, an athlete's performance in any given race may very well hinge on their ability to navigate the ever changing conditions of the water. Developing this understanding, combined with technical expertise, seems to be an influential factor associated with performance. An additional factor that may need to be considered when developing a better understanding of the athletes assessed in this particular study, is the environment in which the contest was held. During the period of time this contest was held the daily high temperature ranged from 32.78 ◦C to 34.44 ◦C. Therefore, a greater amount of experience acquired over a number of years participating in paddle-sports may have benefited the athlete beyond factors traditionally associated with youth. Endurance paddlers that take the time to develop both fitness and technical skills can excel regardless of age or gender [3].

The present investigation was conducted during a well-attended event, however, because it was a national championship event, many athletes declined to participate in data collection for fear of adverse impact on their impending race performances. Additionally, the information reported in this study is derived from a greater collection effort which included functional movement screening [10] and paddle stroke power output. These assessments also may have added to the athletes' hesitancy to exert themselves prior to their respective races. Future investigations of this nature should take these factors into consideration in an effort to yield greater research participation. Nonetheless, given the relatively small sample size, this study demonstrates that there are wide variations in BMI and body fat percentage in endurance paddle-sport athletes and that more successful athletes tend to be older, possibly due to a greater amount of experience in the sport.

4. Conclusions

Endurance paddle sports involve a number of dynamic variables not in the control of the athlete. Race distance, race day weather, water conditions, and other event related elements must be considered when an athlete designs a strategy for race success. Based on the results offered in this study, athlete age and an associated amount of endurance paddle-sport experience play a large role in performance.

5. Acknowledgment

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