DETERMINATION THE MAIN INDICATORS OF SAILING PERFORMANCE IN OPTIMIST SAILOR'S

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The purpose of this study is to determine indicators of sailing performance of optimist sailors in Bulgaria by exploring the anthropometric, physical and motor coordination differences and factors that distinguish between elite and non-elite male optimist sailors. They performed a physical fitness test battery (EUROFIT), motor coordination test battery and the Bucket test. The sailors were divided into two subgroups (i.e. elites and non-elites) based on sailing expertise. The significant differences and factors distinguish between elite and non-elite optimist sailors were explored by means of multivariate analysis of covariance and discriminant analysis. Our results show us that 98.9% of elite optimist sailors could be classified by means of two motor coordination tests (i.e. side step (SS) and side jump (SJ)). These tests for strength- and speed-oriented motor coordination can be identified as indicators of sailing performance in young optimist sailors. Therefore, we believe that developing motor coordination skills is essential in training of optimist sailors.

Key words: Sailing, training, performance, strength, motor control

Introduction

Sailing is a sport where numerous factors such as morphology, physical fitness and well-developed technical and tactical skills determine performance (Bojsen-Møller, Larsson, Magnusson, & Aagaard, 2007). The basic actions for sailing include steering; hiking and sheeting (i.e. pulling on the ropes controlling the sails) and fitness requirements vary between boat classes. We found that in Bulgaria there are no studies have investigated influence of the anthropometric and physical characteristics to performance in youth sailors to get more light into the physical profile of young sailors and to improve training guidelines in youth sailing. From the theory of sailing sport is known, that the creation of an elite sailor is a long process with several stages of development. To evaluate the sailors' evolution from novice to high level elite, we use several validated test batteries to examine indicators of sailing performance throughout different stages of youth sailing. In order to get more insight into the characteristics of youth sailors and to improve the training guidelines, we aimed to determine indicators of sailing performance. This was done by investigating the anthropometric, physical and motor coordination differences and factors discriminating between elite and non-elite male optimist sailors.

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distinguish between elite and non-elite male optimist sailors.

Objectives of the study:

1. To investigate the anthropometric, physical and motor coordination differences.
2. To reveal the characteristics and factors discriminating between elite and non-elite male optimist sailors.

Methods

Sample and study design

Twenty six male youth sailors (aged 10–15 years) participated in this study. The sample was divided into two groups of youth sailors, i.e., elite optimist sailors ($n = 12$, mean $\pm$ SD age = 13.2 ± 1.6 years with a range from 10 to 15 years) and non-elite optimist sailors, which includes ($n = 14$, mean $\pm$ SD age = 11.4 ± 1.8 years with a range from 10 to 14 years). The youth sailors who were selected for the Bulgarian national team were assigned to the elite group. The subjects were instructed to perform no strenuous exercise 48 h before their visit to the lab. The visit to the lab, was organized as a rotation system, took 3 hour and started by filling in their training history. Anthropometric assessments were conducted followed by a standardized 10-min warming-up and evaluation of the gross motor coordination by the Körperkoordinationstest für Kinder (KTK) (Kiphard & Schilling, 2007). Further, overall physical fitness was evaluated by the EUROFIT test battery. About 4 min of recovery

was allowed between the different tests and at least 20 min of recovery was allowed before the Bucket test (Tan et al., 2006) and at least 20 min of recovery before the 20-m endurance shuttle run were performed.

Gross motor coordination (KTK)

Gross motor coordination was evaluated by the KTK (Kiphard & Schilling, 2007). The following KTK subtests were performed:

1. Walking backwards (WB) three times along each of three balance beams (3 m length; 6, 4.5 and 3 cm width, respectively; 5 cm height). A maximum of 24 steps (eight per trial) were counted for each balance beam, which comprises a maximum of 72 steps (24 × 3 beams) for this test. The number of steps were counted and summed over the nine travels.

2. Side step (SS): Moving across the floor in 20 s by stepping from one plate (25 × 25 × 5.7 cm) to the next, transferring the first plate, stepping on it, etc. The number of relocations was counted and summed over two trials.

3. Side jump (SJ): Jumping laterally as many times as possible over a wooden slat (60 × 20 × 5 cm each) in 15 s. The number of jumps over two trials was summed.

Physical fitness (EUROFIT)

The EUROFIT test battery (Council of Europe, 1988) was used to assess physical fitness. All tests were performed in bare feet (except the endurance shuttle run) following EUROFIT guidelines that are extensively described in the Council of Europe (1988).

Hiking endurance with incremental resistance (Bucket test)

This is a maximal incremental test of hiking endurance based on the protocol established by Blackburn and Tan (Blackburn, 2000; Tan et al., 2006). However, since we conducted this test to a pediatric population, starting load of the Bucket test was reduced from 15 kg to 0 kg. The subjects had to maintain a knee angle of >130° (the angle between the tibia and the bench) as 5 kg was added every minute until the subject could no longer hold it at the prescribed angle. The subjects braced

themselves by gripping the bench and were allowed to shift the load from one leg to another. The subjects' final endurance time was recorded to the nearest second.

Statistical analysis

Collected survey data were statistically processed with specialized program SPSS version 19.0. Multivariate analysis of covariance (MANCOVA) was used to identify the significant differences in the anthropometric, physical fitness and motor coordination parameters between elite and non-elite optimist sailors (Callewaert et al., 2014). For the sailing-specific Bucket test, a univariate analysis of covariance was used for the same purpose. Furthermore, we made a stepwise discriminant analysis with sailing level as the grouping variable and the significantly different anthropometric, physical fitness and motor coordination variables as the independent variables, was conducted to identify the most discriminating variables in classifying youth sailors by their sailing expertise level. The discriminating variables with their respective Wilks' lambda and p-value, canonical discriminant function coefficients, canonical correlation (rc) and classification percentages were denoted (Vandorpe et al., 2011). Significance level was set at $p < 0.05$.

Results

Elite optimist sailors were significantly older (13.2 ± 1.6 vs. 11.4 ± 1.8 years) ($p = 0.002$, $t = 3.462$) than the non-elite optimist sailors. Therefore, age were taken into account as covariate in the MANCOVAs. Results from the MANCOVAs are presented in Table I. It was indicated that elites sailed significantly more (hours per week) ($p = 0.036$). However, experience did not differ significantly between elites and non-elites. Furthermore, there were no significant differences between elites and non-elites in anthropometric variables and physical fitness. In addition, elite optimist sailors show a significant better score on the KTK SS ($p = 0.007$) and SJ test ($p = 0.015$), compared to the non-elite optimist sailors. As last, the sailing-specific Bucket test demonstrated that elite optimist sailors show a significantly higher knee-extension strength endurance time than non-elite optimist sailors ($p = 0.050$).

Table I. Significant differences of studied indicators between elite and non-elite optimist sailors.

Indicator	Mean $\pm$ SD		MANCOVA	
	elite	non-elite	p	F
Experience (years)	4.3 $\pm$ 1.4	3.6 $\pm$ 1.8	n.s.	-
Practice (hours per /week) *	9.8 $\pm$ 1.2	5.3 $\pm$ 1.9	0.036	4.910
Height (cm)	156.8 $\pm$ 7.6	146.5 $\pm$ 10.9	-	-
Weight (kg)	45.7 $\pm$ 6.5	37.6 $\pm$ 7.3	-	-
Fat percentage (%)	13.3 $\pm$ 2.5	16.3 $\pm$ 3.8	-	-
Sitting height (cm)	80.8 $\pm$ 3.4	75.4 $\pm$ 5.1	-	-
Flamingo balance (n)	7.1 $\pm$ 3.9	11.9 $\pm$ 4.8	-	-
Plate tapping (n)	12.2 $\pm$ 1.0	14.0 $\pm$ 2.9	-	-
Sit and reach (cm)	28.1 $\pm$ 3.0	19.9 $\pm$ 5.4	-	-
Standing broad jump (cm)	175.7 $\pm$ 13.4	157.5 $\pm$ 22.5	-	-
Handgrip (kg)	31.4 $\pm$ 4.0	25.5 $\pm$ 8.1	-	-
Sit-up (n)	31.9 $\pm$ 3.8	28.4 $\pm$ 5.0	-	-
Bent arm hang (s)	27.9 $\pm$ 16.9	15.1 $\pm$ 13.1	-	-
Shuttle run 5 m (s)	20.6 $\pm$ 0.8	21.9 $\pm$ 1.4	-	-
Shuttle run 20 m (min)	8.1 $\pm$ 0.8	7.3 $\pm$ 1.2	-	-
Walking backwards (n)	56.1 $\pm$ 9.1	53.3 $\pm$ 12.7	-	-
Side step (n) *	62.6 $\pm$ 5.3	48.4 $\pm$ 6.9	0.007	8.896
Side jump (n) *	82.3 $\pm$ 7.1	67.1 $\pm$ 7.5	0.015	6.974
Bucket test (s)	409.4 $\pm$ 51.1	301.3 $\pm$ 67.7	0.050	3.212

*p < 0.05;

Table II shows the results of the stepwise discriminant analyses revealing the characteristics discriminating between elite and non-elite optimist sailors. 98.9% of the elite sailors could be correctly classified by means of the motor coordination tests SS and SJ.

Table II. Factors discriminating elite optimist sailors from non-elite optimist sailors (rc = canonical correlation coefficient)

	Wilks' lambda	p	Function coefficients	rc	Classification percentage
Side step	0.453	0.000	0.112	0.832	98.9% correctly classified
Side jump	0.309	0.000	0.097		+
Constant			-12.845		

Discussion

The present study aimed to determine indicators of sailing performance of youth sailors in Bulgaria by investigating the anthropometric, physical and motor coordination differences and factors discriminating between elite and non-elite male optimist sailors. The main results indicated that 98.9% of the elite optimist sailors could be correctly classified by means of two motor coordination tests (i.e. SS and SJ). As such, strength- and speed oriented motor coordination can be identified as indicators of sailing performance in young optimists.

Elite optimist sailors displayed a significantly older age than non-elite. Despite their age difference, it was surprising that they did not indicate more years of experience in comparison to non-elite. However, the elites reported to practice significantly

more hours per week (Table I), which suggests that elite youth sailors gained more sailing experience (boat handling, tactical skills and environmental knowledge) in the same time period than non-elite by spending more hours on the water. Therefore, we can suggest that "practice hours per week" is probably an important factor related to youth sailing success.

Because sailing is a weight-supported and weight dependent activity, specific height and body mass ranges for each Olympic class have been associated with success (Verdon, Lee, & Blackburn, 2012). However, our results do not reveal significant differences in height or weight between elite and non-elite youth sailors. Nevertheless, the elite optimist sailors tend to be somewhat taller and heavier than their non-elite peers.

Table III. Mean values $\pm$ SD (and range) from literature compared to those found in our study

Reference	Sailing level	n	Age (years)	Weight (kg)	Height (cm)	Start age (years)	Parents Sailors.	Handgrip (kg)	Sit and reach (cm)	Sit-ups
Present study	Non-elite optimist sailors	14	11.4 $\pm$ 1.8	37.6 $\pm$ 7.3	146.5 $\pm$ 10.9	8.1 $\pm$ 1.1	40%	25.5 $\pm$ 8.1	19.9 $\pm$ 5.4	28.4 $\pm$ 5.0
Present study	Elite optimist sailors	12	13.2 $\pm$ 1.6	45.7 $\pm$ 6.5	156.8 $\pm$ 7.6	8.6 $\pm$ 1.2	70%	31.8 $\pm$ 3.5	25.1 $\pm$ 4.0	30.4 $\pm$ 4.2
The ideal size for the Optimist (2002)	2002 Worlds top 10	10	(12–15)	46.3 $\pm$ 4.9	159.8 $\pm$ 6.9					
Gonzalez Munoz (2003)	2003 Worlds top 20	16	13.9	48.6	159.8		50%	32.8	23	27.1
Top 10 at the 2007 worlds (2007)	2007 Worlds top 10	10	14.6 $\pm$ 0.7	47.3 $\pm$ 4.5	161.5 $\pm$ 3.8	8.6 $\pm$ 2.1	60%			
Top 10 at the 2011 worlds (2011)	2011 Worlds top 10	10	14.3 $\pm$ 0.8	49.7 $\pm$ 4.3	165.7 $\pm$ 5.7	7.9 $\pm$ 1.7	70%			
Margot Callewaert (2014)	Elite optimist sailors	24	13.6 $\pm$ 1.2	46.4 $\pm$ 7.4	157.1 $\pm$ 8.7	9.3 $\pm$ 1.0		31.4 $\pm$ 4.0	28.1 $\pm$ 3.0	31.9 $\pm$ 3.8

It is important to mention that our elite Bulgarian optimist sailors are still quite young compared to world's top 20 elite optimists (Table III). Moreover, we can assume that years of experience is sufficient since earlier research showed that it is not too late to start optimist sailing at 10 or 11 years old (Top 10 at the 2007 worlds, 2007; Top 10 at the 2011 worlds, 2011). However, the Bulgarian elite optimist sailors clearly show too low practice amount (9.8 ± 2.2 hours per week) in comparison to the world's top 20 optimist sailors in 2003 (mean of 12.4 hours per week). This suggestion underlines once more the crucial role of practicing hours on the water for performance in optimist sailing. On the physical fitness tests, the elite optimist sailors did not score significantly better than their non-elite counterparts (Table I). This could be related with their general sports participation, although we did not dispose over this information. In comparison to the world's top 20 optimist sailors from 2003 (Gonzalez Munoz, 2003), these Bulgarian elite optimist sailors turned out to perform equally on the handgrip test and even better on sit and reach and sit-up test (Table III), indicating that the static strength, flexibility and core stability is well-developed in our elite optimist sailors. Furthermore, the significant differences in SS (i.e. a more coordinative task) and SJ (i.e. a more strength hand speed-orientated test) in our study indicate the importance of strength- and speed-oriented coordination for optimist sailing performance. Moreover, based on SS and SJ tests, it is even possible

to discriminate the better from the inferior optimist sailors, classifying the elite optimist sailors for 100.0% in the correct group. Therefore, we suggest that strength- and speed oriented coordination is an important indicator of optimist sailing performance.

As expected, elite optimist sailors outperformed non-elites on the Bucket test, measuring the knee-extension strength endurance capacity. Since the elite youth sailors clearly showed more practice hours per week than their inferiors, it could be argued that this is due to a training adaptation.

Conclusion

Resulting data give us grounds to assert, that the practice hours, knee-extension strength endurance and strength- and speed-oriented coordination are most important of factors that are related to performance in optimist sailing. Furthermore, the strength- and speed-oriented coordination can discriminate the elite from the non-elite optimist sailors and are therefore indicators of optimist sailing performance. Therefore, we believe that developing motor coordination skills is essential in training of optimist sailors in order to increase their isometric knee-extension strength endurance. In conclusion, we also recommend aerobic fitness training and core-stability training as these parameters are fundamental for the further development of an athlete's physical capacity up to elite adult sailor.

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