

Physiological Profiles in different levels of Hong Kong Windsurfers

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Introduction Since the sanction of sail pumping in all Olympic windsurfing competitions in 1993, windsurfing has become a physically demanding sport^[1]. Since then, many scholars have strived to showcase the basic attributes required in windsurfing at a professional level in their researches. Some of them focused on the technical, tactical, and training aspect of these windsurfers. No researchers raised a more fundamental question as to what physical and physiological attributes of elite windsurfers set them apart from sub-elite players. As there is limited information on the physiological profiles of windsurfers at different levels available in the public domain, our study below mainly focused on the physiological attributes of the windsurfers at different levels with a view to bridging the information gap between the athletes and the academics, and facilitate talent identification as well as targeted training. We believe that the findings in this study can further enhance the development of training programmes of windsurfers at different levels in the near future.

Methodology

Subjects A total of 82 male windsurfers has participated in the study and was divided into four groups namely the Elite Senior ("ES"), Elite Junior ("EJ"), Sub-Elite Junior ("SEJ"), Novice Junior ("NJ") according to their competitive levels. ES and EJ athletes were the representatives of National Squad (NSQ) and Junior Squad (JSQ) of the Hong Kong Windsurfing Team, respectively, whilst SEJ athletes were the representations of Development Squad (DSQ). NJ refers to the male windsurfing players who have not been selected for the NSQ, JSQ or DSQ. The distribution, age and training history of the subjects are shown in Table 1. They were free from extremity injury before the test. All the subjects were informed of the procedures and assessments to be carried out. They were asked to report on the number of training years.

Table 1: Distribution, age and training history of the subjects. Mean \pm SE

Competitive levels	No of subjects	Age (years)	Training history (years)
ES	5	22.8 \pm 2.31	9.00 \pm 0.55
EJ	15	15.9 \pm 0.38	5.34 \pm 0.38
SEJ	11	14.0 \pm 0.30	3.38 \pm 0.29
NJ	51	13.5 \pm 0.09	3.36 \pm 0.17

Study design All subjects were required to participate in the assessment of anthropometry and physical fitness on two separate sessions with one week apart. In the first session, anthropometric evaluations on height, body mass, arm span and leg length were conducted. This is followed by sit & reach, vertical jump, handgrip strength and 1-minute sit-ups assessments. The second test session consisted of torso pull, 1-minute push-ups, hanging and 20-m multi-stage shuttle run tests. None of the windsurfers had undergone any physical training 24 hours prior to the testing sessions.

Statistical Analysis Descriptive statistics were calculated for all variables. One-way analysis of variance was used to determine any anthropometric variables and physical fitness testing parameters are different between competitive levels. Bonferroni multiple comparison tests were used when there were significant differences between groups. The level of significance was set at $p < 0.05$.

Results and Discussions Descriptive statistics of the anthropometric characteristics, physical fitness measurements for different levels of windsurfers are presented in Table 2 and 3, respectively. Our study shows that improvement in physiological characteristics of windsurfers at higher competitive level reflects a normal adaptation associated with the onset of puberty and moderate increase in age, with progressive improvement from greater training experience.

Consistent with Castagna's study, the estimated VO_{2max} values from the 20-m multi-stage shuttle-run test on ES and EJ players were significantly higher than SEJ and NJ players that sailing can be considered physical task associated with a high-level aerobic demand.^[2] The estimated VO_{2max} (57.2 ml/kg/min) of the ES players in this study was considerably lower than previous reported for Castagna's study (65.1 ml/kg/min), Australian (65.8 ml/kg/min) and Tunisian and Turkish (62.5 ml/kg/min) elite windsurfers.^[3,4] The lower estimated VO_{2max} in ES might suggest that aerobic fitness training was less in order to train other physiological parameters such as forearm muscular endurance, low back muscular strength. On the other hand, Stickland indicated that the 20m-shuttle run test might systematically underestimated VO_{2max} value but a standardized laboratory VO_{2max} test is time expensive.^[5] Therefore, the estimated VO_{2max} by 20m-shuttle run test are still widely used and easy to conduct by coaches so that we could extend the findings from elite windsurfers to different level of players to further enhance the development of training programmes of windsurfers in different levels.

In terms of muscular endurance, windsurfers have to compete with a constant grip position during prolong sailing to sustain involvement of

upper body muscles in windsurfing race.^[6] fatigue appeared first in the forearm and the grip positions.^[6] Specific endurance ability is beneficial for improving competition performance as windsurfers possess in greater forearm endurance ability, which is the only indicator among the test items that shows significantly higher values in ES players of reflecting the importance of endurance ability in elite level.

Although no previous studies used torso-pull test to test the low back strength for comparing with others international windsurfers, evident from recent research suggests a very high incidence of new and recurrent lower back muscle strain, which is about 28% of all lower body soft tissue injuries, was occurred in windsurfers.^[7] Specific muscular training and flexibility exercises focused on the trunk and back muscles are needed.^[8]

To conclude, the present study shows that there is a progressive improvement in the physiological capacities of windsurfers as the playing level increases. It extends the scope of study on the elite windsurfers by providing normative data and performance standard for elite, sub-elite and novice junior players. We look forward to the sports scientists and coaches adopting the findings of our study as a tool for talent identification and training program.

Table 2: Anthropometric characteristics of novice, sub-elite, elite junior and elite senior windsurfers.

	NJ	SEJ	EJ	ES
Age (years)	13.45 \pm 0.09	14.00 \pm 0.30	15.93 \pm 0.38 [#]	22.80 \pm 2.31 [#]
Training Experience (years)	3.36 \pm 0.17	3.38 \pm 0.29	5.34 \pm 0.38 [#]	9.00 \pm 0.55 [#]
Height (cm)	165.08 \pm 1.02	169.43 \pm 1.28	173.83 \pm 0.76 [^]	175.80 \pm 1.50 [#]
Body Mass (kg)	52.13 \pm 1.12	54.69 \pm 1.37	61.97 \pm 1.41 [^]	68.60 \pm 1.80 [#]
Body Mass Index	19.03 \pm 0.27	19.03 \pm 0.32	20.49 \pm 0.37 [^]	22.20 \pm 0.56 [#]
Arm Span (cm)	172.21 \pm 1.16	178.38 \pm 1.20 [^]	183.01 \pm 1.03 [#]	184.00 \pm 2.66 [^]
Arm / Height (%)	104.32 \pm 0.28	105.32 \pm 0.75	105.29 \pm 0.55	104.66 \pm 1.06
Leg Length (cm)	81.60 \pm 0.60	83.41 \pm 1.02	86.03 \pm 0.79 [^]	86.70 \pm 3.21
Leg / Height (%)	49.43 \pm 0.16	49.26 \pm 0.70	49.49 \pm 0.34	49.28 \pm 1.45

Table 3: Physical fitness variables of novice, sub-elite, elite junior and elite senior windsurfers.

	NJ	SEJ	EJ	ES
Sit & Reach (cm)	28.04 \pm 1.05	37.05 \pm 1.57 [^]	36.38 \pm 1.16 [^]	35.76 \pm 4.27
Handgrip Strength (kg)	64.45 \pm 1.94	77.23 \pm 2.77 [^]	87.97 \pm 2.10 [#]	98.60 \pm 5.53 [^]
Vertical Jump (inch)	18.52 \pm 0.48	19.00 \pm 1.09	21.63 \pm 0.73 [^]	21.90 \pm 1.00
Torso Pull (kg)	94.50 \pm 2.96	114.68 \pm 4.70 [^]	128.05 \pm 4.28 [^]	155.10 \pm 8.69 [#]
Sit-ups (times/min)	36.71 \pm 0.97	44.55 \pm 1.50 [^]	46.60 \pm 1.39 [^]	49.00 \pm 1.76 [^]
Push-ups (times/min)	27.90 \pm 1.53	34.45 \pm 2.22	50.13 \pm 1.59 [#]	50.80 \pm 1.32 [#]
Estimated VO_{2max} (ml/kg/min)	45.30 \pm 0.90	47.60 \pm 1.29	52.97 \pm 0.91 [#]	57.15 \pm 2.00 [#]
Hanging (seconds)	84.89 \pm 5.00	126.09 \pm 11.44 [^]	130.67 \pm 13.03 [^]	246.80 \pm 29.71 [#]

[^] Significant difference with NJ (novice junior) ($p < 0.05$)

[#] Significant difference with SEJ (sub-elite junior) ($p < 0.05$)

^{*} Significant difference with EJ (elite junior) ($p < 0.05$)

NJ: Novice Junior (n=51); **SEJ:** Sub-Elite Junior (n=11);

EJ: Elite Junior (n=15); **ES:** Elite Senior (n=5)

Data are reported as Mean \pm SE

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