COMPARISON OF ANTHROPOMETRIC PARAMETERS AND STRENGTH QUALIFICATIONS OF JUNIOR AND SENIOR REPRESENTATIVES OF THE CZECH REPUBLIC IN WHITEWATER SLALOM (CATEGORY C1).

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The aim of this study was to determine the differences between junior (n = 3) and senior (n = 3) representational racers white water slalom racers (catogory C1) of Czech Republic in terms of selected anthropometric, somatotype and strength assumptions. Performance athletes (n = 17) were tested 4 weeks before selection races to the national teams and to the Olympic Games. This study presents comparison of successful competitors, who have ben included in the national junior and senior teams. We found a few differences in the level of anthropometric and strength assumptions, which probably have a significant impact on performance in white water slalom. The applications of the results may facilitate searching and planning priorities in the management of training process.

INTRODUCTION TO THE ISSUE

Whitewater slalom numbers among one of the most successful sporting events in the Czech and Slovak Republics. If we look at the results of important international competitions, both Slovak and Czech racers regularly take the podium and dominate in the global competition. In the single-canoe category (C1), Slovakian paddlers have been more successful in the last 20 years. Slovaks Beňuš and Slafkovský rank first and second on the World Ranking Race (WRR) list, while whitewater slalom legend Martikán is placed seventh. The best three Czech racers on the WRR list rank between 10th and 20th. While the Slovaks have the three aforementioned paddlers in the top thirty, the Czechs have 5 (www.canoeicf.com), which is the most of all countries worldwide. The aforementioned Beňuš won a silver medal at the Olympic Games in Rio. Czech Gebas finished 2 seconds and 52 hundredths of a second behind him and placed 4th – exactly 13 hundredths of a second behind bronze-medallist Haneda from Japan, who has long trained in Liptovský Mikuláš. Here it is necessary to point out that both countries dominate not only in the senior category but also in the junior category (under 18). The winner of the World Junior Championships in Krakow, Poland was Slovak Mirgorodský; Czech Lhota took the silver. A month later they switched spots at the European Championship in Solkan, Slovenia (www.canoeicf.com).

Performance in whitewater slalom is determined by a range of factors, among them fitness and somatic factors, which are closely related to each other (Hohmann, Lames & Letzelter, 2010). According to a study conducted among experts, the most important fitness factors are strength parameters (Bílý, 2012).

While in canoe sprint, a number of studies have addressed anthropometric and strength parameters in top and high performance racers (e.g.: Van Someren & Howatson, 2008; Akca & Muniroglu, 2008; Ackland et al., 2003; Bishop, 2000), in whitewater slalom this has not yet been the case. Where certain studies have dealt with whitewater slalom racers, the research sets cannot be considered sufficiently homogenous in terms of performance (Vedat, 2012), they mix single and double canoeists together (Ridge et al., 2007), or they deal only with a highly restricted number of anthropometric parameters (Bílý et al., 2011). What is more, a comparison of elite senior and junior representatives, according to the information we have, has never been presented. Though the anthropometric parameters, somatotype and strength of junior racers may not have attained their definitive form (Sigmund et al., 2016), knowledge of potential differences could help coaches to more easily manage the training process and could be an appropriate indicator in the preparation of athletes. The differences between juniors and seniors could indicate what priority should be given to in the training process and what deserves only marginal attention (Hohmann, Lames & Letzelter, 2008).

OBJECTIVE

The objective of the presented study was to determine the differences between anthropometric parameters (AP), somatotype and selected strength parameters (SP) among racers in the junior and senior national teams (NT) of the Czech Republic (CR) in single-canoe whitewater slalom (C1).

METHOD

The research group was a total of 6 Czech C1 racers, of which, based on the final ranking of the selection races (SR), 3 were included in the senior NT and 3 in the junior NT (under 18). Along with other high-performance racers with the qualifications to be included in the CR NT, they were subjected to anthropometric examination and SP testing on a single day exactly 4 weeks before the SR for the NT and the Olympics in Rio de Janeiro (2016).

Measurement of AP and SP testing was carried out by experienced examiners from the Biomedical Laboratory of the

Charles University Faculty of Physical Education and Sport. All anthropometric variables were measured on the right side of the body. The exception was the measurement of the forearm and biceps circumference, which was done on the dominant arm in terms of paddling strength. It is highly important to take into account the side on which a C1 canoeist paddles due to the differing distribution of muscle (Bílý et al., 2010); the paddling arm tends to be larger. For the anthropometric examination we used the standard procedure (Bloomfield et al., 2003) of the ISAK (International Society for the Advancement of Kinanthropometry), as used by Ridge et al. (2007) in a morphological study of whitewater slalom racers taking part in the Sydney Olympics in 2000. The somatotype was calculated using the method of Carter and Heath (1990). The body fat percentage was calculated by calipering 10 skinfolds in accordance with Pařízková (1977). To test the SP we used the bench-press, bench-pull, handgrip and Wingate test. For the bench-press and bench-pull we determined the maximum weight of the dumbbell which the athlete was able to perform 1 repetition (1RM) and we applied the standard procedure outlined in the study Akca & Muniroglu (2008). The athlete had to perform the repetition with maximum weight fully and in the precisely defined manner (Měkota & Blahuš, 1977). The dynamometry of maximum handgrip of the dominant (paddling) upper limb was conducted by the digital device Takei 5401 (http://www.takei-si.co.jp/en/). Athletes had 2 attempts at the maximum handgrip, of which one was counted. The Wingate test at a length of 30 seconds on a cycle ergometer adjusted for alternate work of the upper extremities was conducted with a load of 4W/kg in accordance with Heller & Vodička (2011).

Statistical analysis of the data was conducted in MS Excel 2010. For descriptive statistics, the mean, standard deviation, minimum and maximum values were used. Due to the small scope of the sample (Hendl, 2012) we did not make use of explorative statistics.

The study was approved by the Charles University Faculty of Sport Ethical Committee under no. 052/2016. All subjects and legal guardians agreed to the study and informed consent was obtained from them before it commenced.

RESULTS

Table 1: Values of anthropometric parameters of senior and junior racers.

	Competitors included in the senior national team (n = 3)		Competitors included in the junior national team (n = 3)	
	Mean and standard deviation	Range	Mean and standard deviation	Range
Age (years)	27.5 (± 4.7)	21 – 32	17.5 (± 0.5)	16.9 – 18.1
Weight [kg]	75.1 (± 4.6)	69.2 – 80.4	72.5 (± 4.4)	68.1 – 78.5
Height [cm]	179.1 (± 1.9)	176.6 – 181.1	180.0 (±2.8)	176.8 –

				183.7
BMI	23.5 (± 1.9)	21.2 – 25.7	22.4 (± 0.72)	21.8 – 23.4
Sitting height [cm]	93.1 (± 1.3)	91.8 – 94.9	92.7 (± 1.2)	91.1 – 94.1
Ratio of sitting height to body height (%)	51.9 (± 1)	50.5 – 52.9	51.5 (0.2)	51.2 – 51.7
Arm span [cm]	189.2 (± 4.7)	183.5 – 195.0	187 (±1.6)	185 – 189
Ratio of arm span to height (%)	105.7 (± 1.5)	104 – 107.7	103.9 (± 1.3)	102.9 – 105.8
Upper arm length [cm]	32.9 (± 1.9)	30.5 – 35.2	31.7 (± 1.3)	30.0 – 33.0
Forearm length [cm]	27.1 (± 2.3)	25.0 – 30.2	25.7 (± 0.5)	25.0 – 26.0
Thigh length [cm]	41 (± 3.5)	37 – 45.5	41.5 (± 1.1)	40 – 42.5
Length of lower leg [cm]	37.8 (± 3.3)	35 – 42.5	38.3 (± 0.6)	37.5 – 39.0
Should breadth [cm]	39.8 (± 0.4)	39.5 – 40.3	40.5 (± 1.5)	38.5 – 42.0
A-P chest depth [cm]	19.6 (± 1.3)	18.2 – 21.4	19.6 (± 1.1)	18.3 – 21.0
Humerus - breadth [cm]	7.4 (± 0.4)	6.8 – 7.8	6.8 (± 0.5)	6.1 – 7.2
Femur – breadth [cm]	10.3 (± 0.5)	9.6 – 10.7	9.5 (± 0.3)	9.1 – 9.9
Flexed dominant arm girth [cm]	35.4 (± 1.6)	33.1 – 37.6	32.3 (± 1.1)	30.5 – 33.5
Flexed dominant forearm girth [cm]	27.6 (± 0.5)	27.2 – 28.5	25.6 (± 0.6)	25 – 26.5
Chest girth [cm]	98.2 (± 3.0)	94 – 101	91.9 (± 2.9)	89.4 – 96.0
Waist girth [cm]	78.7 (± 1.4)	77.0 – 80.5	73.7 (± 3.3)	70 – 78
Hip girth [cm]	91.1 (± 2.6)	88.5 – 94.7	92.4 (± 1.6)	91 – 94.7
Thigh girth [cm]	49.8 (± 1.8)	47.5 – 52	48.5 (± 1.8)	47 – 51
Calf girth [cm]	35.2 (± 0.9)	34.0 – 36.2	33.1 (± 1.6)	31.5 – 35.2
Sum of 4 skinfolds[a] [mm]	19.3 (± 0.9)	18 – 20	25.0 (± 0.8)	24 – 26
Endomorphy	1.3 (± 0.2)	1.1 – 1.5	1.6 (± 0.1)	1.5 – 1.8
Mesomorphy	5.7 (± 1.2)	4.1 – 7.0	4.0 (± 0.6)	3.10 – 4.6
Ectomorphy	2.4 (± 0.9)	1.4 – 3.5	3.0 (± 0.1)	2.9 – 3.1
Sum of 10 skinfolds[b] [mm]	44 (± 3.7)	39.0 – 48.0	55.7 (± 1.3)	54.0 – 57.0
Body fat (%)	6.3 (± 1.1)	4.8 – 7.4	9.3 (± 0.3)	8.9 – 9.6

[a] Sum of 4 skinfolds according to Carter and Heath (1990): triceps, scapula, calf and supraspinale. Measurement conducted to calculate somatotype.
[b] Sum of 10 skinfolds according to Pařízková (1977): cheek, chin, chest I, triceps, back, abdomen, chest II, hip, thigh, calf. Measurement conducted to establish % body fat.

Racers included in the senior NT are very similar to the juniors in terms of body height, weight, arm span, sitting height and limb length. There are however evident differences in the flexed girth of the arm (35.4 ± 1.6 vs. 32.3 ± 1.1) and forearm (27.6 ± 0.5 vs. 25.6 ± 0.6) of the dominant upper limb (in terms of paddling). The seniors also differed from the juniors in a greater chest girth (98.2 ± 3.0 vs. 91.9 ± 2.9). The senior representatives also had a lower sum of 10 skinfolds (44 ± 3.7 vs. 55.7 ± 1.3) and total body fat percentage (6.3 ± 1.1 vs. 9.3 ± 0.3). In terms of overall somatotype calculated as per Carter and Heath (1990), both juniors and seniors can be labelled ectomorphic mesomorphs. The seniors however have a higher mesomorphic component (5.7 ± 1.2 vs. 4.0 ± 0.6) and lower ectomorphic component (2.4 ± 0.9 vs. 3.0 ± 0.1). They can thus be considered more distinctly mesomorphic. Though the seniors have greater muscle mass in the arms and chest, the differences in the lower extremities are minimal. The seniors managed to successfully avoid hypertrophy of the muscles in the lower limbs and thus maintain a low body weight.

Table 2: Resulting absolute and relative values of selected strength parameters: bench-press, bench-pull and hand dynamometry

	Competitors included in the senior national team (n = 3)		Competitors included in the junior national team (n = 3)	
	Mean and standard deviation	Range	Mean and standard deviation	Range
Bench-press (1RM) [kg]	114 (± 14.5)	95 – 130	80.7 (± 0.9)	80 – 82
Bench-press (1RM/weight of competitor)	1.51 (± 0.1)	1.37 – 1.62	1.12 (± 0.05)	1.04 – 1.17
Bench-pull (1RM) [kg]	98 (± 8.5)	86 – 104	85 (± 2.94)	81 – 88
Bench-pull (1RM/weight of competitor)	1.30 (± 0.05)	1.24 – 1.37	1.18 (± 0.06)	1.1 – 1.24
Takei Handgrip Dynamometer [N]	54.1 (± 4.2)	48.3 – 52.0	44.9 (± 2.3)	42.3 – 49.7

Table 3: Resulting absolute and relative values of selected strength parameters: Wingate test of upper extremities at length of 30 seconds

	Competitors included in the senior national team (n = 3)		Competitors included in the junior national team (n = 3)	
	Mean and standard deviation	Range	Mean and standard deviation	Range
Peak power [W]	763.5 (± 76.3)	656.8 – 831	664.4 (± 28.7)	634.6 – 703.2
Relative peak power [W/kg]	10.2 (± 0.6)	9.5 – 11.0	9.2 (± 0.8)	8.3 – 10.3
Average power [W]	603.4 (± 54.7)	537.6 – 671.5	539.1 (± 19.4)	511 – 555.1
Relative average power [W/kg]	8.0 (± 0.3)	7.8 – 8.4	7.5 (± 0.5)	7 – 8.2
Minimum power [W]	453.1 (± 42.2)	419.9 – 512.6	402.9 (± 25.4)	368.3 – 428.6

The absolute and relative results for the selected strength parameters confirm to a large extent the anthropometric values. The senior NT racers achieved better results in all tests. During the bench-press exercise, the seniors lifted a dumbbell 42% heavier (114 ± 14.5 vs. 80.7 ± 0.9 kg), during the bench-pull exercise, the difference in favour of the seniors was 15% (98 ± 8.5 vs. 85 ± 2.9 kg) and the seniors also achieved 20% better results in the hand dynamometry (54.1 ± 4.2 vs. 44.9 ± 2.3). In sports where the athlete must work with their own body weight, the relative ratio of power to the athlete's weight is relatively traditional (Zatsiorsky & Kraemer, 2014). We should add that the difference in mean body weight between senior and junior racers was only 2.6 kg and thus the seniors also had higher relative indicators of strength parameters. The differences between seniors and juniors are also evident in the Wingate test. The seniors achieved an average peak power of nearly 100 W (14%) more than the juniors; their power in relation to body weight was also greater (10.2 ± 0.6 vs. 9.2 ± 0.8). What is interesting is that for the Wingate test, the difference in values is highest for the absolute and relative peak power indicator, which to a large extent reflects the level of explosive strength of an athlete (Heller & Vodička, 2011), while for indicators that attest more to the level of strength endurance and anaerobic endurance, the differences are lesser.

DISCUSSION

In terms of body height, sitting height, arm span or limb length, the elite senior and junior racers differ only minimally, not only from each other, but also from reference samples of the non-sporting population (Riegerová et al., 2010; Norton & Olds, 1996). Canoeists do not differ in a distinct manner from the reference population in the way that, for example, swimmers (Thorland et al., 1983) or rowers (Rakovac et al., 2011) do. Both the junior and senior monitored racers can be labelled ectomorphic mesomorphs of average body height, relatively low body weight and low body fat levels. This finding is in line with earlier published studies (e.g. Ridge et al., 2007; Sidney & Shephard, 1973). In comparison with the juniors, however, senior racers were more mesomorphic

(5.7 ± 1.2 vs. 4.0 ± 0.6) and less ectomorphic (2.4 ± 0.9 vs. 3.0 ± 0.1). Elite Czech seniors in fact have a somatotype very similar to elite international canoe sprinters (1.6 ± 0.5 – 5.7 ± 0.8 – 2.2 ± 0.7) from the Sydney Olympics (Ackland et al., 2003).

Senior NT racers had an average of 3.1 cm greater circumference of the upper arm, 2 cm larger forearm and 6.3 cm larger chest than the juniors. The differences in the girth of the lower extremities was minimal, which we attribute to the attempt to minimise hypertrophy in order to keep body weight low. The body weight of seniors was on average 2.6 kg greater than that of juniors, with 3% lower body fat based on the methodology of Pařízková (1977). The differences in key girths for whitewater slalom performance are no doubt tied to the differences in the strength tests. The seniors achieved higher values in all tests. For the bench-pull exercise, the seniors lifted an average weight 13 kg heavier, while for the bench-press the difference was nearly 31 kg. Both exercises are a traditional component of the strength training of canoeists (Folgar et al., 2015) and are frequently used in testing (e.g.: Van Someren & Palmer, 2003; Akca & Muniroglu, 2008; McKean & Burkett, 2009; McKean & Burkett, 2013). The dynamometry of the handgrip conducted on the dominant paddling upper limb also speaks in favour of the seniors, as does the Wingate test. For the Wingate test, the greatest difference between juniors and seniors was recorded for the indicator of absolute and relative peak power, which speaks conclusively to the level of explosive strength (Heller & Vodička, 2011). The performance achieved during the Wingate test on the upper extremities and torso demonstrably improves not only through training but also with age (Sitkowski & Grucza, 2009). Certain anthropometric parameters of juniors have likely not reached their final form (Sigmund et al., 2016) and it can be expected that along with them improvement in strength parameters will also come.

CONCLUSION

Despite the fact that the body height, weight and BMI of elite senior and junior NT racers was nearly identical, several parameters were found that qualitatively differentiate the seniors from the juniors. The senior racers had a greater circumference of the forearm, upper arm and chest, while differences in the waist and lower extremities were minimal. The greater girth dimensions of the arm and torso are undoubtedly tied to the greater strength parameters of the senior racers. The seniors achieved better results in all strength tests performed. The most marked difference was found for the bench-press exercise, where the seniors lifted a weight 42% higher than the juniors (114 ± 14.5 vs. 80.7 ± 0.9 kg). The seniors also displayed a somatotype with a more pronounced metamorphic component (5.7 ± 1.2 vs. 4.0 ± 0.6) and also a less pronounced ectomorphic (2.4 ± 0.9 vs. 3.0 ± 0.1) and endomorphic (1.3 ± 0.2 vs. 1.6 ± 0.1) component. Senior racers are more distinctly mesomorphic and also showed a lower body fat percentage (6.3 ± 1.1 vs. 9.3 ± 0.3).

The presented study could also be an appropriate indicator of what level of anthropometric and strength parameters the training of junior racers should target. Elite international adult whitewater slalom racers must excel in their strength parameters – especially fast and explosive power – while keeping a relatively low body weight. Of course peak power is also closely tied to fast and explosive power (Zatsiorsky & Kraemer, 2014). A strength programme focused on developing maximum, fast and explosive power can be recommended for junior racers. It is naturally necessary to take into consideration not only the biological age of racers, their posture and general preparedness, but also the possibility of losing a "feel for the water" in the case of excessive focus on strength development.

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