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THE ASYMMETRY OF THE AND BACK PADDLER IN CANADIAN DOUBLE SLALOM

Abstract

There is an apparent difference in the activation of muscle groups for front and back paddlers, and since the upper limbs are the most active during a stroke, there is a need to establish the possible asymmetry as a result of the diversity of morphological characteristics of the paddlers. The study was conducted in order to determine the asymmetry as a consequence of the difference and the relation of morphological characteristics of the Canadian doublepaddlers between the front and back paddlers for optimal positioning. The study was conducted on 16 canoeists, participants of the European Championship in kayak canoe slalom. Based on the variables of the morphological characteristics of voluminosity, the index of relative asymmetry and the asymmetry coefficient for each variable of the dominant and non-dominant hands was calculated. In this study it was shown that the asymmetry is statistically significant in a number of variables in the front paddlers, but the student's t-test for independent samples showed that there were no statistically significant differences in the index of relative asymmetry and the asymmetry coefficient of the observed variables between front and back paddlers. It is noted that in this sample, during positioning when paddling in the Canadian double slalom discipline at the front or back position, there is almost no difference when talking about the asymmetry of the upper extremities of the paddlers, and that in determining the position of the paddler data may be used that is indicative of the level of functional and motor skills rather than the morphological characteristics of the upper extremities.

Keywords: asymmetry, paddler positions, canoe slalom

INTRODUCTION

Every sporting discipline should, through movement technique structures and the process of training technology (the scope and intensity of load), lead to the transformation of the morphological characteristics of athletes. On the other hand, some morphological characteristics are largely caused by genetics. For example, the dimensions of the skeleton and muscle fiber types are substantially genetically determined, while the percentage of body fat and muscle mass can be influenced to a greater extent. Laterality, which is the phenomena of one of the body's paired organs (arms, legs, ears, eyes, etc) functions being superior to the other, is also genetic. (Touwen, 1972, according to: Valdez, 2003). The notion of laterality is associated with the concepts of dominance and symmetry or asymmetry. The dominance of

the use of one limb has led to the fact that the majority of objects are now being designed for right-handed people. Touwen (1972) explained the concept of dominance as a phenomenon of the central nervous system, or CNS, where one side of the brain plays an important role in specific functions, whereas he used the term lateral dominance to signify preferred use and superior ability of one side of the body as compared to the other. (Valdez, 2003). The dominance of one side in sport is also expressed and significant, and it presents itself in various ways: athletes can be more precise with one hand; they may be able to throw further, to pull, strike or push harder, to jump higher or further with one foot than with the other, etc. The importance of dominance in sports is best seen in team sports where the athletes are assigned to team positions based on dominance of a certain side (left wing, right-back, etc.), special tactics for right and left hand dominance are taught and developed. (Carey et al., 2001; Schorer et al., 2009; Bryson et al., 2013). According to the regulations of kayak canoe sports, there is a mandatory rule for there to be an equal number of right and left upstream gates and that the placement of other gates must be of equal difficulty for both dominant left and right sides(ICF, 2013). In some sports, the dominance of one side is more prominent while in others it does not have any significance. Comparative analyses have been performed of highly unilateral sports such as tennis or cricket, as well as higly bilateral sports like swimming (Grobbelaar, 2003; Shaw and Stock, 2009). Sports rules are made with reference to the dominance of one side in an effort to provide equality of conditions for both sides, not just for right-handed athletes. It would be interesting to see whether the absence of certain elements of technique at the position of the back paddler leads to different morphological characteristics than with the front paddler. The most interesting question is whether there are differences in body composition, asymmetry of the left and right and to what extent they are present as a result of many years of practicing this sport. Krstic (1996) defines laterality as a configuration of function on one side of the body, dextrality(Right-handedness), sinistrality (left-handedness), usually with the same dominant side of eyes, ears and legs. According to the same source, on the basis of previous studies it is assumed that that 70% of the world population is right-handed, 5% are left-handed and 25% are ambivalent. Miller and Brackman Keane (1987) define the asymmetry as a "lack or absence of symmetry" and "difference in the respective body parts or organs on opposite sides of the body that are usually equal." According to Wolański (1955) there are three types of asymmetry: 1. morphological - differences in the size and shape of the organs or body parts on the left or right side of the body, 2.Functional - associated with the dominance of one hemisphere of the brain (usually the left), 3. Dynamic - the difference between left and right limbs in terms of strength and muscle elasticity and potency. The problem of asymmetry due to many years of practicing certain sports fields is encountered in numerous studies: (BÍlý, Baláš, Martin, Cochrane, Coufalová and Süss, 2012; Krawczyk, Sklad, Majle, and Jackiewicz, 1998; Lovell and Lauder 2001; Ducher, Jaffré, Arlettaz, Benhamou and Courteix 2005; Ducher, Courteix and Meme, 2005; Lucki and Nicolay 2007; Rogowski, Ducher, Brosseau and Hautier 2008; Sanchis-Moysi et al. 2010).

Elite kayakers on average make up to 120 strokes per minute, with no significant differences in the left and right side stroke. Canoeists make up to 80 strokes per minute, of which up to 30 are cross-strokes. It is evident that the total time of the propulsion phase is longer in canoes than in the kayak. (Hunter et al. 2008). To maintain direction,the canoeist must use some of the techniques for directional stability. The difference in the techniques of the front and rear paddler in Canadian double is that the front paddler has the same technique as in the single canoe, which is, manoeuvring in the opposite direction of the paddling side by using the cross-stroke and pulling with the paddle on opposite side, while the backpaddleris paddling solely on hisside.

According to the data collected in the research of Hunter, Cochrane and Sachlikidis (2008) in the slalom competition a canoeist's highest percentage of stroke is devoted to the basic stroke (67-71%), and if we add the forward directing stroke (9-14%), it can be seen that the basic stroke technique needs the most attention. Since during cross-strokes, which account for 30% of the total paddling, in front paddlers the front and side abdominal muscles and hip flexors of the non-dominant side and the hand and shoulder and arm muscles of the dominant side are activated, while in the backpaddlers anterior abdominal muscles, back muscles of the dominant side, forearm flexors of the dominant hand, pectoral muscles and the forearm extensor muscles of the non-dominant side are activated.Thus, differences in the activation of muscle groups are evident between front and back paddlers, and since upper limbs are the most active during a stroke, there is a need to establish the possible asymmetry as a result of the diversity of morphological characteristics of the canoeists. This research was conducted in order to determine the asymmetry as a result of the differences and relationships of the morphological characteristics of the Canadian double canoe canoeists between the front and back paddler for the purpose of optimal positioning of paddlers.

METHOD

Research Participants

The research participantsconsisted of canoeists, the participants of the European Championship in kayak canoe slalom, held on the river Vrbas, in July 2011 in Banja Luka. The study included 16 canoeists who underwent the training process during more than eight years and who were paddling as eight crews. For the study they were classified into two groups of eight senior paddlers (U23-aged to 23 years of age), participants in the European Championship in 2011 in Banja Luka, a front paddler group and a back paddler group.

Table 1. Descriptive statistics of the participants

	Group	Mean	Std. Deviation	Std. Error Mean
Age	Front	20.0000	1.69031	.59761
	Back	20.8750	1.55265	.54894
Height	Front	176.1250	4.38952	1.55193
	Back	177.5000	5.63154	1.99105
Weight	Front	75.2375	8.71861	3.08249
	Back	74.3000	6.34350	2.24277

Front paddlers were aged 20 ± 1.69 years, 176.13 ± 4:39 cm tall and weighed 75.23 ± 8.72kg, while the back paddlers were aged 20.86 ± 1.55 years, 177.50 ± 5.63 cm tall and weighed 74.30 ± 6.34kg. The participants were national team members: Germany, Poland, Slovakia and Slovenia. All were of normal health status, which was controlled through regular medical check-ups, and with no injuries of the locomotorsystem. Seeing as how the participants were professional athletes who secured a spot in their respective national selections through test races, and that the selections in question are the most competitive teams,this is a highly specific sample. Their information was gathered through questionnaire: name, team, age, when did they start, disciplines (canoe / kayak), the dominant side (with canoeists the dominant side is the draw arm side,and with the kayakers the hand rotating the paddle).

Variables

To estimate the asymmetry / symmetry of the dominant and non-dominant hands of athletes used the following variables:

- Body height
- Circumference of outstretched upper arm of the dominant hand
- Circumference of outstretched upper arm of the non-dominant hand
- Circumference of contracted upper arm of the dominant hand
- Circumference of contracted upper arm of the non-dominant hand
- Percentage of body fat in dominant hand
- Percentage of body fat in non-dominant hand
- Predicted muscle mass of dominant hand
- Predicted muscle mass of non-dominant hand
- Index of relative asymmetry of the body (RIA)
- Coefficient of asymmetry (CA).

Description of measuring instruments and their use

The study was conducted in the morning, in the Office of Anthropomotoricsat *the* Faculty of Physical Education and Sport in Banja Luka. The instruments were of standard make and were calibrated. Because of the type of this data acquisition, subjects were dressed in underwear with no socks, and were prepared according to the protocols of the method of bioelectrical impedance.The measurements were done by a single measurer. Firstly, according to the protocol and methods of measurement of anthropometric dimensions of the IBP, using retractable metal strips with a gradation of 1mm, body height and girthwere measured, and then the structure of the upper extremities was determined through the use of a body composition analyzer, Tanita brand model BC-418 MA III.Before conducting measurements, all participants were familiarized with the procedure. After the measurements, the data was sorted, and in order to better estimate the possible differences between the front and back paddlers, an index of relative asymmetry and asymmetry coefficient for each variable of the the dominant and non-dominant hands was calculated.

For each pair of characteristics for the dominant and non-dominant sides an Wolanski(acc. to Grobbelaar, 2003) index of relative asymmetry of the body (RIA) was calculated by using the following formula:

RIA = 2 (XD - XND) / (XD + XND) x 100

where XD - variable on the dominant side, XND - variable on the non-dominant side.

If RIA+ then XD >XND , and if RIA - then XD < XND

The coefficient of asymmetry was also established by using the following formula (Jastrjembskaia & Titov, 1999):

CA = (D – ND)/ D x 100

Where: CA = coefficient of asymmetry; D = dominant side of the body; ND = non-dominant side of the body

Data Processing Methods

To show quantitative data, indicators of descriptive statistics were used, and to compare the mean values of the observed characteristics of the dominant and non-dominant hands in the front and back paddlers, respectively, the Student's t-test was used for paired samples. o compare the difference in mean values of the asymmetry between the front and back paddlers used the Student's t test for independent samples. In the Student's t-test for independent samples, significant differences in the variances of the observed characteristics were tested with the F test. For statistical analysis, and tabular and graphical presentation of results the following software was used: SPSS 20.0 for Windows; MS Office Word 2010 and Microsoft Office Excel 2010.

Results

From Table 1 it can be seen that the front paddlers were on average younger (20.00 g., 20.88 g.), and shorter than the back paddlers (176.13 cm, 177.50 cm). Also the front paddlers were heavier than the back paddlers (75.24 kg, 74.30 kg).

Table 2 Descriptive statistics of pairs of variables in dominant and non-dominant hands of front paddlers

		Mean	Std. Deviation	Std. Error Mean
Pair 1	Circumference of outstretched upper arm of the dominant hand	33.7125	1.69152	.59804
	Circumference of outstretched upper arm of the non-dominant hand	33.1250	1.78786	.63210
Pair 2	Circumference of contracted upper arm of the dominant hand	36.6000	1.99857	.70660
	Circumference of contracted upper arm of the non-dominant hand	35.1750	2.07140	.73235
Pair 3	%body fat in dominant hand	8.4750	4.10566	1.45157
	%body fat in non-dominant hand	9.3250	4.31269	1.52477
Pair 4	Predicted muscle mass of dominant hand	4.1625	.44701	.15804
	Predicted muscle mass of non-dominant hand	4.0375	.39256	.13879

Table 3: Student's t-test for front paddlers

		Paired Differences					t	df	Sig. (2-tailed)
		Mean	Std. Deviation	Std. Error Mean	95% Confidence Interval of the Difference				
					Lower	Upper			
Pair 1	Circumference of outstretched upper arm of the dominant hand- Circumference of outstretched upper arm of the non-dominant hand	.58750	.46733	.16522	.19681	.97819	3.556	7	**.009**
Pair 2	Circumference of contracted upper arm of the dominant hand- Circumference of contracted upper arm of the non-dominant hand	1.42500	.66279	.23433	.87090	1.97910	6.081	7	**.001**
Pair 3	%body fat in dominant hand - %body fat in non-dominant hand	-.85000	.89443	.31623	-1.5977	-.10224	-2.688	7	**.031**
Pair 4	Predicted muscle mass of dominant hand -Predicted muscle mass of non-dominant hand	.12500	.16690	.05901	-.01454	.26454	2.118	7	.072

The circumference of the outstretched upper arm of the dominant hand in front paddlers was on average 33.71 cm, which is 0.69 cm on average over the volume of the non-dominant outstretched upper arm, 33.12 cm. Student's t-test for paired samples showed that the volume of an outstretched upper arm of the dominant hand of the front paddlers was statistically significantly higher than the aforementioned volume of the non-dominant hand ($p = 0.009$). The circumference of the contracted upper arm of the dominant hand in front paddlers averaged 36.60 cm, which is 1:43 cm on average more than the circumference of the

contracted upper arm of the non-dominant hand (35.17cm).The Student's t-test for paired samples showed that the upper arm circumference of the contracted dominant hand of the front paddlers was, on average, significantly higher than the above mentioned volume of the non-dominant hand (p = 0.001). The percentage of body fat present in the dominant hand in front paddlers was on average 8:48%, which is 0.85% less than the average percentage of body fat present in the non-dominant hand, which is an average of 9:33%. The percentage of body fat in the dominant hand in front paddlers is on average statistically significantly lower than the percentage of body fat in the non-dominant hand (p = 0.031). The predicted muscle mass in the dominant hand in front paddlers has an average value of 16.4 kg, which is 0.12 kg on average more than the predicted muscle mass in the non-dominant hand (4.04 kg). Student's t-test for paired samples did not show a statistically significant difference in the predicted muscle mass between dominant and non-dominant hands in front paddlers (p = 0.072) (Table 3).

Table 4 Descriptive statistics of pairs of variables in dominant and non-dominant hands of backpaddlers

		Mean	Std. Deviation	Std. Error Mean
Pair 1	Circumference of outstretched upper arm of the dominant hand	33.6375	2.30709	.81568
	Circumference of outstretched upper arm of the non-dominant hand	32.8750	2.46852	.87275
Pair 2	Circumference of contracted upper arm of the dominant hand	35.6125	2.03921	.72097
	Circumference of contracted upper arm of the non-dominant hand	34.5000	2.05843	.72777
Pair 3	%body fat in dominant hand	8.4250	3.29317	1.16431
	%body fat in non-dominant hand	8.7125	4.34032	1.53454
Pair 4	Predicted muscle mass of dominant hand	4.0375	.42067	.14873
	Predicted muscle mass of non-dominant hand	3.9750	.40970	.14485

Table 5: Student's t-test for backpaddlers

		Paired Differences					t	df	Sig. (2-tailed)
		Mean	Std. Deviation	Std. Error Mean	95% Confidence Interval of the Difference				
					Lower	Upper			
Pair 1	Circumference of outstretched upper arm of the dominant hand- Circumference of outstretched upper arm of the non-dominant hand	.76250	.57802	.20436	.27926	1.24574	3.731	7	**.007**
Pair 2	Circumference of contracted upper arm of the dominant hand- Circumference of contracted upper arm of the non-dominant hand	1.11250	1.32497	.46845	.00480	2.22020	2.375	7	**.049**
Pair 3	%body fat in dominant hand - %body fat in non-dominant hand	-.28750	1.58334	.55980	-1.61121	1.03621	-.514	7	.623
Pair 4	Predicted muscle mass of dominant hand -Predicted muscle mass of non-dominant hand	.06250	.13025	.04605	-.04639	.17139	1.357	7	.217

The circumference of an outstretched upper arm of the dominant hand in back paddlers was on average 33.64cm, which is, on average, 0.76 cm over the circumference of an outstretched upper arm of the non-dominant hand - 32.88 cm. Student's t-test for paired samples showed that the circumference of an outstretched upper arm of the dominant hand in back paddlers was on average statistically significantly higher than the above mentioned volume of the non-dominant hand ($p = 0.007$). The circumference of a contracted upper arm in the dominant hand in back paddlers was on average 35.61 cm, which is 1:11 cm, on average, more than the upper arm circumference of the contracted non-dominant arm (34.50 cm). Student's t-test for paired samples showed that the upper arm circumference of the contracted dominant hand in back paddlers was on average, statistically significantly higher than the above mentioned volume of the non-dominant hand ($p = 0.049$). The percentage of body fat in the dominant hand of back paddlers was on average 8.43%, which is 0:28%, on average, less than the percentage of body fat in the non-dominant hand, which is an average of 8.71%, not a statistically significant difference ($p = 0.623$). The predicted muscle mass in the dominant hand of the back paddlers has an average value of 4:04 kg, up by 0.06 kg on average than the predicted muscle mass in the non-dominant hand (3.98 kg). Student's t-test for paired samples did not show a statistically significant difference in the predicted muscle mass in the dominant and non-dominant hands of the front paddlers ($p = 0.217$) (Table 5).

Table 6:Descriptive statistics of asymmetry measuring

	Group	Mean	Std. Deviation	Std. Error Mean
RIA of circumference of outstretched upper arm	Front	1.7738	1.45140	.51315
	Back	2.3300	1.70945	.60438
CA of circumference of outstretched upper arm	Front	1.7513	1.41957	.50189
	Back	2.2900	1.67529	.59230
RIA of circumference of contracted upper arm	Front	3.9900	1.86550	.65955
	Back	3.1838	3.67580	1.29959
CA of circumference of contracted upper arm	Front	3.8988	1.79675	.63525
	Back	3.0738	3.63419	1.28488
RIA%body fat of hand	Front	-11.2250	16.80791	5.94249
	Back	5.7838	36.50541	12.90661
CA%body fat of hand	Front	-13.5425	21.33489	7.54302
	Back	1.4362	27.16337	9.60370
RIA predicted muscle mass of hand	Front	2.9563	3.91366	1.38369
	Back	1.5575	3.33949	1.18069
CA predicted muscle mass of hand	Front	2.8463	3.86574	1.36674
	Back	1.4962	3.34428	1.18238

Table 7:Student's t-test for independent samples

		Levene's Test for Equality of Variances		t-test for Equality of Means						
		F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	95% Confidence Interval of the Difference	
									Lower	Upper
RIA of circumference of outstretched upper arm	Equal variances assumed	.524	.481	-.702	14	.494	-.55625	.79284	-2.25673	1.14423
	Equal variances not assumed			-.702	13.641	.495	-.55625	.79284	-2.26094	1.14844

CA of circumference of outstretched upper arm	Equal variances assumed	.512	.486	-.694	14	.499	-.53875	.77635	-2.20386	1.12636
	Equal variances not assumed			-.694	13.633	.499	-.53875	.77635	-2.20808	1.13058
RIA of circumference of contracted upper arm	Equal variances assumed	1.669	.217	.553	14	.589	.80625	1.45738	-2.31952	3.93202
	Equal variances not assumed			.553	10.382	.592	.80625	1.45738	-2.42489	4.03739
CA of circumference of contracted upper arm	Equal variances assumed	1.794	.202	.576	14	.574	.82500	1.43334	-2.24920	3.89920
	Equal variances not assumed			.576	10.229	.577	.82500	1.43334	-2.35900	4.00900
RIA%body fat of hand	Equal variances assumed	1.604	.226	-1.197	14	.251	-17.00875	14.20893	-47.48388	13.46638
	Equal variances not assumed			-1.197	9.840	.259	-17.00875	14.20893	-48.73805	14.72055
CA%body fat of hand	Equal variances assumed	.350	.563	-1.227	14	.240	-14.97875	12.21181	-41.17048	11.21298
	Equal variances not assumed			-1.227	13.256	.241	-14.97875	12.21181	-41.30910	11.35160
RIA predicted muscle mass of hand	Equal variances assumed	.112	.743	.769	14	.455	1.39875	1.81896	-2.50253	5.30003
	Equal variances not assumed			.769	13.662	.455	1.39875	1.81896	-2.51161	5.30911
CA predicted muscle mass of hand	Equal variances assumed	.081	.780	.747	14	.467	1.35000	1.80721	-2.52608	5.22608
	Equal variances not assumed			.747	13.716	.468	1.35000	1.80721	-2.53363	5.23363

A review of Table 6 shows that the index of relative asymmetry of anoutstretched upper arm circumference in front paddlers is on average 1.77, which is 0:56 on average less than the index of relative asymmetry of anoutstretched upper arm circumference of the back paddlers who averaged 2:33. The differences were not statistically significant ($p = 0.494$). Asymmetry coefficient for the same variable with a front paddler has a mean value of 1.75, while the average value of the back paddler has a higher value; it is 2:29 which is a 0:54 increase. This difference in asymmetry coefficient of the outstretched upper arm circumference was not

statistically significant (p = 0.499). The index of relative asymmetry of a contracted upper arm circumference in front paddlers is on average 3.99, which is 0.81 on average over the relative index of asymmetry of a contracted upper arm circumference in the back paddlers which averaged 3.18.The difference in question is not statistically significant (p = 0.589). The asymmetry coefficient of the contracted upper arm circumference has a mean value of 3.90 in the front paddlers, and 3:07 in the back paddlers. This difference is also without statistical significance (p = 0.574). The index of relative asymmetry of the percentage of body fat in front paddlers has an average value of 11:23, which is 5:45 more than the backpaddlers (5.78). This differential was statistically significant (p = 0.251). The asymmetry coefficient of the percentage of body fatin the front paddlerswas on average 13:54, which is 12.1 more than the asymmetry coefficient of body fat in the back paddlers, which was 1:44. The examination of differences in mean values did not show statistical significance (p = 0.240). The index of relative asymmetry of predicted muscle mass of the front paddlers was on average 2.96, which is 1:40 on average more than the index of relative asymmetry of predicted muscle mass of the back paddlers who averaged 1:56. The differences were not statistically significant (p = 0.455). The asymmetry coefficient for the same variables in the front paddlers was 2.85, and 1:50 in the back paddlers. This differential was statistically significant (p = 0.467).

DISCUSSION

When it comes to the variables of the voluminosity of the upper extremities, in the observed sample of both the front and back paddlers, there were statistically significant differences between dominant and non-dominant hands. The circumference of the outstretched upper arm of the dominant hand in both groups, was on average, significantly higher than that of said volume in the non-dominant hand (p = 0.009, p = 0-007). Similar results were obtained with the contracted upper arm circumference, wherein the average circumference of the dominant hand is statistically significantly greater than the said volume in the non-dominant hand.In the group of front paddlers the significance is (p = 0.001), while the group of back paddlers significance in the 95% confidence interval is (p = 0.049). For the percentage of body fat variable it is characteristic that the non-dominant hand is more prominent, ie. the percentage of body fat in the dominant hand in front paddlers was on average, statistically significantly lower than the percentage of body fat of the non-dominant hand (p = 0-031), whereas in the back paddlers no statistically significant difference between the mean percentage of body fat in the dominant and non-dominant hands was found.The predicted muscle massin the dominant hand in both groups was not on average significantly higher than the predicted muscle massin the non-dominant hand. In this study, a comparison of dominant and non-dominant hands in canoeists showed a statistically significant asymmetry in three variables. Two relate to the volume and there is a statistically significant difference between the dominant and non-dominant hand with regards to the upper arm circumference, both outstretched and contracted.These results are consistent with previous findings in other sports fields of unilateral character (Grobbelaar, 2003; Rogowski et al. (2008), Lucki, 2006). Krawczyk et al. (1998) found the most significant asymmetry between the dominant and non-dominant upper extremities with tennis players and slalom canoeists. Bily et al. (2012) found that the asymmetry of the dominant and non-dominant hands was more significant in front paddlers, than in back paddlers. The results are somewhat consistent with this research. The asymmetry is statistically significant in a greater number of variables in the front paddlers, but the Student's t-test for independent samples showed that there were no statistically significant differences in the index of relative asymmetry and asymmetry coefficientfor the variables observed between front and back paddlers. It could be said that in this sample, during positioning in the front or back position when paddling in the C2

slalomdiscipline, there is almost no difference in terms of morphological features of the upper limbs of thepaddlers, and that in the determination of the position of the paddlers,data could be used which indicates the level of functional and motor abilities rather than the morphological characteristics of the upper extremities, which requires the use of other research.Conditions in which the participants lived (climate, diet, training and racing)contributed to the these results, in particular the number of races in which they participated between the initial and final measurements - some have participated in individual races and pair races, as reflected in the studied parameters . This somewhat confirms the correctness of the practice which has been applied up to now, described by Endicott (1986) in a study of three championship crews. Usually, in the position of the back paddler anexperienced and senior paddler with longer stroke is placed, whose tasksare directing the boat straight and speed accumulation, while in the position of the front paddler is a slightly shorter dynamic paddler who has a special role in the initiation and completion of the turn.

CONCLUSION

Since numerous studies (Kugler, Kruger-Franke, Reininger, Trouiller and Rosemeyer (1996); Kameyama, Shibano, Kawakita, Ogawa and Kumamoto (1999); Lauder and Lovell (2001); Mei-Dan and Carmont (2013); Schoen and Stano (2002)), associate asymmetry with injuries in sport, noting that asymmetries, both morphological and dynamic, are one of the largest and most common causes of sports injuries, so it appears necessary that in the canoe-kayak slalom, as a sporting field, research of an extremely unilateral character is conducted. In this study it was shown that the asymmetry is statistically significant in a number of variables in the front paddlers, but the but the student's t-test for independent samples showed that there were no statistically significant differences in the index of relative asymmetry and asymmetry coefficient for the variables observed between front and back paddlers. Thus, asymmetry is determined on an individual level, which was not significant for the positioning of paddlers. Therefore, further longitudinal studies in this area could provide a deeper insight into the selection of training resources which would be used according to individual needs, and which is required bythe asymmetry of the upper extremities for the purpose of making morphological and dynamic asymmetry symmetric.The importance of research is in minimizing the risk of injury caused by morphological or dynamic asymmetry, and on the other hand maximizing sports performance. The approach to solutions for this problem should be individualized, because it is clear that some athletes do not have the same level of morphological differences. The question is whether, in the case of a canoe, and other unilateral sports, a certain asymmetry as a result of adaptation of the organism to specific demands of a discipline is necessary if we want to achieve the ultimate sports results. Therefore, it is necessary to conduct research which would determine the extent to which dynamic asymmetry is present and in what proportion it and morphological asymmetry correlate with sports results.

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