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RELATIONSHIPS AMONG HAND DOMINANCE, COMPETITION SUCCESS RANKINGS AND ISOMETRIC ELBOW AND KNEE STRENGTH IN PREPUBERTAL NOVICE WRESTLERS

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ABSTRACT

This study aims to investigate relationships between hand dominance, competition success rankings and isometric elbow and knee strength in 12 years old male novice wrestlers. For this study, body height, body weight, right and left elbow and knees' isometric flexion and extension strength measurements were taken from 379 voluntary subjects during the talent identification scouting for the Wrestling Education Centers of Turkey in 2002. A lateralization inventory was also applied to determine hand preference of novice wrestlers. To investigate the differences among variables, two-way ANOVA and t-tests were performed while correlation coefficients were also calculated between variables. Results of this study showed that finalists were taller, heavier and stronger than others. Significant strength differences were observed between right and left of elbow and knee joints regardless of handedness. Wrestling success ranking were well correlated with all strength variables not handedness. Right knee flexion strength of right handers was significantly higher than left handers while left handers had a smaller strength differences between right and left side in elbow extension and knee flexion. Although left and right handers had a very similar physical size, left handers had a symmetric strength between right and left side except knee extension while right handers had an asymmetry in all strength variables. In the selection of talented wrestlers, it is impossible to find the successful wrestlers of future by overemphasizing strength instead of psychological predisposition to wrestling and trainability in developmental stages. In sports where both of right and left arm strength have equal importance it seems very important to improve training programs for preventing asymmetric strength development in novice wrestlers.

Key Words: talent identification, handedness, elbow, knee, isometric strength, novice wrestlers.

INTRODUCTION

The human brain consists of two different hemispheres with special functions. Hand dominance, or preference, provides the information about brain hemispheric dominance. It is the most obvious behavioral asymmetry in human behaviors. The term hand dominance means using one hand more than the other, or it expresses asymmetric performance differences in tasks performed by hand (14, 1, 23, 19). So far many studies have reported that there were higher proportions of left-handedness among top athletes in individual sports such as baseball (15), tennis (2, 15), fencing (5), cricket (26) and in combative sports such as boxing (13) and wrestling (27). Researchers have also reported that more left-handed athletes were observed in interactive sports than in non-interactive sports (20). Advantages of being left-handed depend on the sport. There are claims about left-handed people having an inherent advantage in terms of spatial-motor skills when compared with right-handed people (11). On the other hand, Wood and Aggleton (26) claimed that the fact that there are more left handers in various sport branches is not the result of a neurological superiority, but it is the result of the characteristics of that sport. According to Dane and Erzurumluoğlu (8), left handers were superior to right handers in terms of visual reaction time in handball. Ziyagil (28) reported that right-handed prepubertal boys had better sprint and multiple sprint performance than left handers during repeated five sprints.

Strength differences are more obvious between the right and the left side of the body during prepubertal period. Sanchis-Moysi et al. (21) observed that tennis participation at prepubertal age led to significant muscular hypertrophy in the dominant arm (+13%), much greater than observed in non-active controls (+3%) depending on selective loading of arm muscles. Asymmetric strength development can hinder a child from reaching his biological potential and it may not be compensated enough in the future developmental periods (3). Children's training is based on factors such as age, gender, physical condition and training history (6). In this period, hand

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dominance can be considered in organizing individual training programs. Symmetric strength development can be achieved by making the weak side stronger with new training programs.

Understanding children's strength development based on hand dominance can help early detection of deficiencies and compensation of these disabilities. There are no studies about the difference between the physical performances of prepubertal right and left hander athletes in competition sports such as wrestling. In the period of 12 years, age is a very sensitive period for skills development especially in boys. Asymmetric strength development based on hand dominance can affect skills development negatively (3). Because motor-skill learning needs harmony of several elementary motor components, such as adequate power, appropriate speed and accuracy with the visuomotor integration between the brain hemispheres (4*).This study aims* to investigate the relationship between hand dominance, competition success rankings and strength in the selection of talented wrestlers.

METHODS

Selection of Subjects

379 novice wrestlers with the mean age of 12 years from 34 cities of Turkey were tested during the talent identification scouting for Wrestling Education Centers of Turkey in 2002. They also went through a medical examination before the study. The body height of the subjects was measured by a metal scale with 0.1 cm sensitivity, and the body weight measurement was taken by a digital weight with a 0.1 kg sensitivity. The average body weight and height of subjects were 37.41±9.14 kg and 144.43±8.03 respectively.

Hand Preference

For the determination of the subjects' hand preferences, all subjects received a Turkish adaptation of Oldfield's questionnaire (18) modified by Geschwind and Behan (11). The questions related to which hand was used by the subject for writing, throwing, scissors, toothbrush, knife (without fork), spoon, holding the handle for a shovel, striking a match, and twisting off the lid of a jar. The columns "always right," "usually right," "either hand," "always left," "usually left" were scored as + 10, + 5, 0, - 10, and - 5, respectively. Following Geschwind's suggestion (24), the laterality score was taken as the sum of all these scores, and no quotient was calculated. Tan also reported that in memory of Norman Geschwind, this laterality score was called the "Geschwind score" (24). A score of -100 indicated that the subject responded "always left" on all items, and a score of + 100 indicated "always right" on all items. Hand dominance distribution is measured as such; (1) strong right hander, (between +80 and + 100 points), (2) weak right hander (between +20 and +75 points), (3) ambidextrous (between -15 and + 15 points), (4) weak left hander (between -20 and -75 points) and (5) strong left hander (between -80 and -100 points) (24).Subjects were assigned to right- and left-hand preference groups with respect to Gescwind scores. Ambidextrous, weak left handers and strong left handers were accepted as a left handed group, while strong and weak right handers composed to right handed group (7). All these mixed-handers were placed with the left-handers.

Measurements of Strength

Elbow strength measurements were taken with Nicholas MMT (01160 Model Nicholas Manual Muscle Tester) when the subjects were lying on their backs. The device was applied to the front and back of the wrist and during the three-second long contractions, isometric elbow flexion and extension strengths were measured. While the subjects were sitting on the bench with their feet not touching the ground, the device was applied to the front and back of their ankles and during the three-second long contractions, isometric knee flexion and extension strengths were measured (25).

Statistical Analyses

SPSS 15.0 package program was used for the statistical analysis. Two-way ANOVA and t-test were used for the change in strength based on hand dominance and competition success. Post hoc Scheffe test was used to determine the origin of difference among groups. Correlation coefficients between variables were measured. A 0.05 and 0.01 were considered to be the significance level in the determination of differences and relations.

RESULTS

The subjects were divided into three groups as the finalists in the last eight, those who had a rank between 9th and 20th and those eliminated. Results of this study showed finalists were higher, heavier and stronger than others. Mean body height, mean body weight and body mass index (BMI) were gradually differentiated from eliminated to finalist wrestler groups. There was linear relationship between success rankings and all strength variables. All strength scores were highest in the finalists, it was moderate in those who had a rank between 9th and 20th and it was the lowest in those who were eliminated (Figures 1 and 2). Strength level tended to increase from the wrestlers eliminated to the finalists while no significant strength differences were observed between right and left side in elbow and knee joints among three groups. Isometric elbow and knee strength seems to be related to wrestling success in prepubertal children (Table 1). In generally, physical size and strength level had an effect on wrestling success in prepubertal children.

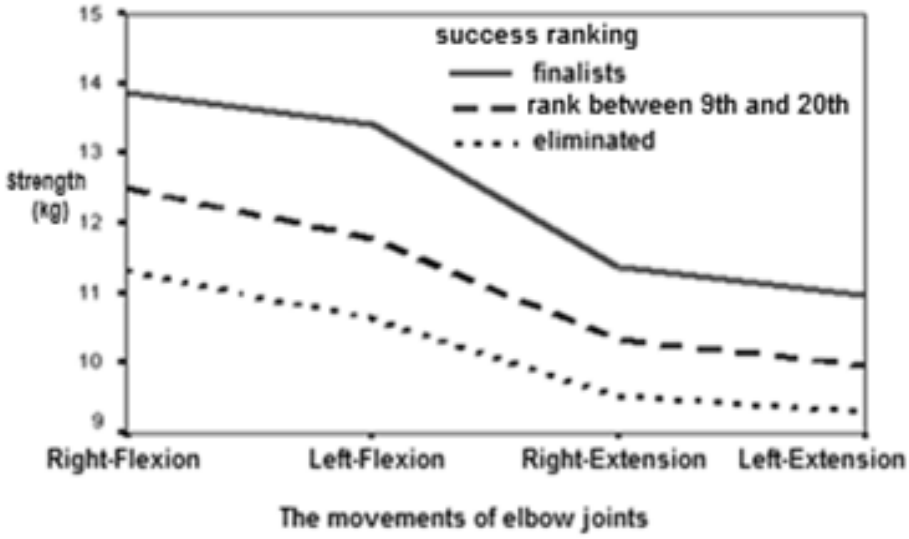

Figure 1. Elbow strength changes depending on success ranking.

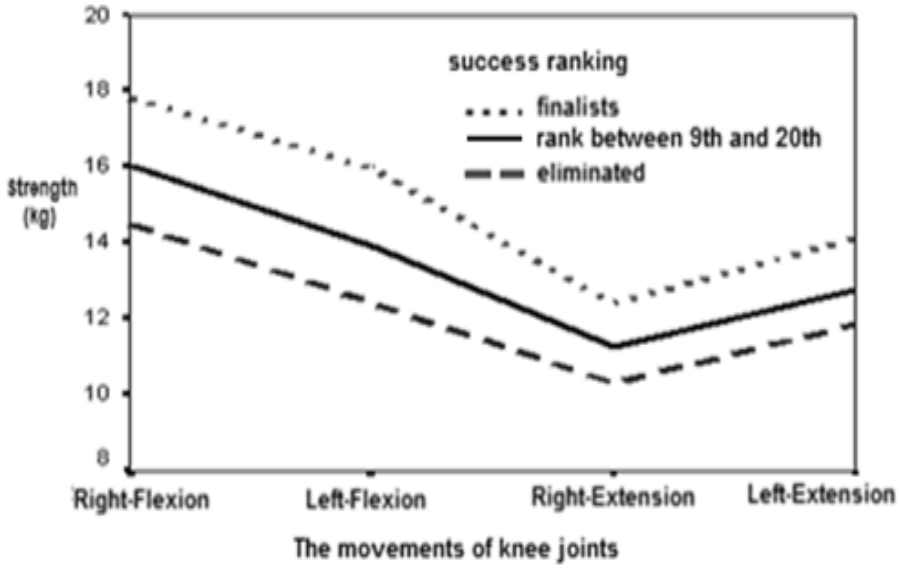

Figure 2. Knee strength changes depending on success ranking.

Table 1. A comparison of physical characteristics and strength scores based on their success ranks.

Variables	Ranks	N	Mean±*SD*	Min.-Max.	df	F	Sig.	Schffee summary
Body Height (cm)	1-8 (G1)	71	148.03±9.50	128.00-170.00	2	20.189	.000**	G1>G2,G3; G2>G3
	9-20 (G2)	93	146.63±7.66	130.00-161.00				
	20> (G3)	215	142.28±6.95	126.00-161.00				
	Total	379	144.42±8.03	126.00-170.00				
Body Weight (kg)	1-8 (G1)	71	42.22±12.19	24.00-71.10	2	28.512	.000**	G1>G2,G3; G2>G3
	9-20 (G2)	93	40.31±9.91	26.00-70.80				
	20> (G3)	215	34.57±6.12	24.00-68.80				
	Total	379	37.41±9.14	24.00-71.10				
Body Mass İndex (BMI)	1-8 (G1)	71	18.91±3.65	14.07-28.12	2	19.314	.000**	G1>,G3; G2>G3
	9-20 (G2)	93	18.51±3.14	13.65-27.66				
	20> (G3)	215	16.98±2.01	13.69-29.39				
	Total	379	17.72±2.81	13.65-29.39				
Right Elbow Flexion (kg)	1-8 (G1)	71	13.89±3.80	6.00-23.80	2	20.791	.000**	G1>G2,G3; G2>G3
	9-20 (G2)	93	12.51±2.79	1.60-20.70				
	20> (G3)	215	11.35±2.71	1.20-19.60				
	Total	379	12.11±3.11	1.20-23.80				
Left Elbow Flexion (kg)	1-8 (G1)	71	13.44±3.87	7.30-22.70	2	29.944	.000**	G1>G2,G3; G2>G3
	9-20 (G2)	93	11.80±2.69	5.80-20.30				
	20> (G3)	215	10.63±2.19	6.00-17.20				
	Total	379	11.44±2.90	5.80-22.70				
Right Elbow Extension (kg)	1-8 (G1)	71	11.38±3.15	5.00-26.80	2	18.475	.000**	G1>G2,G3; G2>G3
	9-20 (G2)	93	10.33±2.01	5.00-16.20				
	20> (G3)	215	9.53±2.04	2.60-16.50				
	Total	379	10.07±2.39	2.60-26.80				
Left Elbow Extension (kg)	1-8 (G1)	71	10.99±2.55	6.40-20.30	2	19.720	.000**	G1>G2,G3; G2>G3
	9-20 (G2)	93	9.97±1.98	5.20-16.30				
	20> (G3)	215	9.30±1.77	4.10-13.60				
	Total	379	9.78±2.08	4.10-20.30				
Right Knee Flexion (kg)	1-8 (G1)	71	17.84±4.94	7.80-28.08	2	19.654	.000**	G1>G2,G3; G2>G3
	9-20 (G2)	93	16.05±3.70	2.08-26.91				
	20> (G3)	215	14.50±3.80	1.56-25.48				
	Total	379	15.50±4.21	1.56-28.08				
Left Knee Flexion (kg)	1-8 (G1)	71	15.98±4.81	8.40-27.78	2	29.767	.000**	G1>G2,G3; G2>G3
	9-20 (G2)	93	13.93±3.42	6.67-23.35				
	20> (G3)	215	12.44±2.82	6.90-21.33				
	Total	379	13.47±3.67	6.67-27.78				
Right Knee Extension (kg)	1-8 (G1)	71	12.41±3.58	5.00-29.48	2	18.580	.000**	G1>G2,G3; G2>G3
	9-20 (G2)	93	11.29±2.20	5.15-17.82				
	20> (G3)	215	10.32±2.34	2.78-18.29				
	Total	379	10.95±2.70	2.78-29.48				
Left Knee Extension (kg)	1-8 (G1)	71	14.12±3.45	8.03-26.39	2	19.261	.000**	G1>G2,G3; G2>G3
	9-20 (G2)	93	12.80±2.68	6.76-21.19				
	20> (G3)	215	11.85±2.44	4.06-17.68				
	Total	379	12.51±2.84	4.06-26.39				
R-L Difference in Elbow Flexion (kg)	1-8 (G1)	71	0.45±1.91	-5.20-4.60	2	.602	.548	N.D.
	9-20 (G2)	93	0.71±1.79	-7.20-4.60				
	20> (G3)	215	0.72±1.82	-10.80-6.30				
	Total	379	0.67±1.83	-10.80-6.30				
R-L Difference in Elbow Extension (kg)	1-8 (G1)	71	0.40±1.64	-3.20-6.50	2	.383	.682	N.D.
	9-20 (G2)	93	0.36±1.75	-3.90-5.70				
	20> (G3)	215	0.22±1.69	-4.10-5.00				
	Total	379	0.29±1.70	-4.10-6.502				
R-L Difference in Knee Flexion (kg)	1-8 (G1)	71	1.86±2.34	-4.11-6.69	2	.246	.782	N.D.
	9-20 (G2)	93	2.12±2.25	-8.04-7.23				
	20> (G3)	215	2.06±2.48	-12.24-8.99				
	Total	379	2.04±2.40	-12.24-8.99				
R-L Difference in Knee Extension (kg)	1-8 (G1)	71	-1.71±2.04	-7.32-5.51	2	.225	.798	N.D.
	9-20 (G2)	93	-1.50±2.20	-6.93-3.82				
	20> (G3)	215	-1.54±2.11	-6.50-5.32				
	Total	379	-1.56±2.11	-7.32-5.51				

*p<0.05, **p<0.01, R-L=Right and Left, N.D.=No Difference.

In this study 2.4% of the subjects were strong left handers, 7.92% were weak left handers, 1.85% were ambidextrous, 52.51% were weak right handers and 35.36% were strong right handers. As dichotomous groups, 12.1% of subjects were left handers and 87.9% right handers.

The results of the study showed that right knee flexion strength of right handers was significantly higher than left handers while left handers had a smaller strength differences between right and left side in elbow extension and knee flexion (Table 2).

Table 2. A comparison of physical characteristics and strength scores with respect to hand dominance.

Variables	Hand Preferences	N	Mean±*SD*	Min.-Max.	t	df	Sig.
Body Height (cm)	Left Handed	46	143.26±9.40	128.00-170.00	-1.048	377	.295
	Right Handed	333	144.59±7.83	126.00-164.00			
	Total	379	144.42±8.03	126.00-170.00			
Body Weight (kg)	Left Handed	46	37.45±10.92	24.00-70.00	.027	377	.978
	Right Handed	333	37.41±8.89	24.00-71.10			
	Total	379	37.41±9.14	24.00-71.10			
Body Mass İndex (BMI)	Left Handed	46	17.92±3.25	13.78-26.67	.519	377	.604
	Right Handed	333	17.69±2.75	13.65-29.39			
	Total	379	17.72±2.81	13.65-29.39			
Right Elbow Flexion (kg)	Left Handed	46	11.50±3.74	4.30-23.80	-1.419	377	.157
	Right Handed	333	12.19±3.01	1.20-20.70			
	Total	379	12.11±3.11	1.20-23.80			
Left Elbow Flexion (kg)	Left Handed	46	11.91±3.69	6.60-22.70	1.166	377	.244
	Right Handed	333	11.38±2.77	5.80-22.40			
	Total	379	11.44±2.90	5.80-22.70			
Right Elbow Extension (kg)	Left Handed	46	9.78±2.64	5.10-15.80	-.895	377	.371
	Right Handed	333	10.11±2.35	2.60-26.80			
	Total	379	10.07±2.39	2.60-26.80			
Left Elbow Extension (kg)	Left Handed	46	9.79±2.07	6.10-16.80	.020	377	.984
	Right Handed	333	9.78±2.09	4.10-20.30			
	Total	379	9.78±2.08	4.10-20.30			
Right Knee Flexion (kg)	Left Handed	46	14.26±4.91	5.59-28.08	-2.157	377	.032*
	Right Handed	333	15.68±4.08	1.56-26.91			
	Total	379	15.50±4.21	1.56-28.08			
Left Knee Flexion (kg)	Left Handed	46	13.74±4.25	7.59-26.11	.533	377	.594
	Right Handed	333	13.43±3.59	6.67-27.78			
	Total	379	13.47±3.67	6.67-27.78			
Right Knee Extension (kg)	Left Handed	46	10.38±3.00	5.00-17.38	-1.541	377	.124
	Right Handed	333	11.03±2.65	2.78-29.48			
	Total	379	10.95±2.70	2.78-29.48			
Left Knee Extension (kg)	Left Handed	46	12.15±3.09	6.41-21.84	-.926	377	.355
	Right Handed	333	12.56±2.81	4.06-26.39			
	Total	379	12.51±2.84	4.06-26.39			
R-L Difference in Elbow Flexion (kg)	Left Handed	46	-0.41±1.72	-5.20-3.30	-4.364	377	.000**
	Right Handed	333	0.81±1.79	-10.80-6.30			
	Total	379	0.67±1.83	-10.80-6.30			
R-L Difference in Elbow Extension (kg)	Left Handed	46	-0.01±1.86	-4.10-4.50	-1.285	377	.199
	Right Handed	333	0.33±1.67	-3.90-6.50			
	Total	379	0.29±1.70	-4.10-6.50			
R-L Difference in Knee Flexion (kg)	Left Handed	46	0.52	-4.11-5.62	-4.715	377	.000**
	Right Handed	333	2.25	-12.24-8.99			
	Total	379	2.04	-12.24-8.99			
R-L Difference in Knee Extension(kg)	Left Handed	46	-1.77	-7.32-5.51	-.718	377	.473
	Right Handed	333	-1.53	-6.93-5.32			
	Total	379	-1.56	-7.32-5.51			

*p<0.05, **p<0.01, R-L=Right and Left.

Although left and right handers had a very similar physical size, left handers had a symmetric strength between right and left side except knee extension while right handers had an asymmetry in all strength variables (Table 3). In addition, significant differences were observed between right and left side regardless of handedness in all strength variables. There was a significant relationship between wrestling performance and strength, and the flexion strength of knee changed depending on the hand dominance. Left handers had only an advantage on right handers only in isometric right knee flexion strength. They had also a symmetric strength between right and left side except knee extension while right handers had an asymmetry in all strength variables.

Table 3. Comparison of strength symmetry between right and left side in each hand preference group in itself.

Variables	Joint	Side	N	M±SD	Difference	Difference%	df	t	Sig.
Left Handed	Elbow Flexion	Right Arm	46	11.50±3.74	-0.41	-3.57	45	-1.617	.113
		Left Arm	46	11.91±3.69					
	Elbow Extension	Right Arm	46	9.78±2.64	-0.01	-0.10	45	-.040	.969
		Left Arm	46	9.79±2.07					
	Knee Flexion	Right Knee	46	14.26±4.91	0.52	3.65	45	1.522	.135
		Left Knee	46	13.74±4.25					
	Knee Extension	Right Knee	46	10.38±3.00	-1.77	-17.05	45	-4.920	.000**
		Left Knee	46	12.15±3.09					
Right Handed	Elbow Flexion	Right Arm	333	12.19±3.01	0.81	6.64	332	8.287	.000**
		Left Arm	333	11.38±2.77					
	Elbow Extension	Right Arm	333	10.11±2.35	0.33	3.26	332	3.624	.000**
		Left Arm	333	9.78±2.09					
	Knee Flexion	Right knee	333	15.68±4.08	2.25	14.35	332	17.557	.000**
		Left Knee	333	13.43±3.59					
	Knee Extension	Right nee	333	11.03±2.65	-1.53	-13.87	332	-13.520	.000**
		Left Knee	333	12.56±2.81					

*p<0.05
**p<0.01

There were changes in all strength parameters based on competition ranks. Left elbow flexion, average elbow flexion and right knee flexion were correlated significantly to hand dominance (Table 5). While there was a significant relationship between wrestling performance and strength; especially left elbow flexion, average elbow flexion and right knee flexion were changed depending on hand dominance.

Table 4. Comparison of strength scores between right and left side in elbow and knee joints regardless of handedness.

		N	M±SD	Difference	% Difference	t	df	Sig.
Elbow Flexion	Right Arm	379	12.11±3.11	0.67	5.53	7.092	378	.000**
	Left Arm	379	11.44±2.90					
Elbow Extension	Right Arm	379	10.07±2.39	0.29	2.88	3.330	378	.001**
	Left Arm	379	9.78±2.08					
Knee Flexion	Right Knee	379	15.50±4.21	2.03	13.10	16.563	378	.000**
	Left Knee	379	13.47±3.67					
Knee Extension	Right Knee	379	10.95±2.70	-1.56	12.47	-14.373	378	.000**
	Left Knee	379	12.51±2.84					

*p<0.05
**p<0.01.

Table 5. Correlation coefficients between the variables wrestling competition ranks, hand dominance and strength of elbow and knee joints.

Variables		Rankings	Handedness
Elbow Joint	Right Elbow Flexion Strength (kg)	.000**	.106
	Left Elbow Flexion Strength (kg)	.000**	.117
	Right Elbow Extension Strength (kg)	.000**	.199
	Left Elbow Extension Strength (kg)	.000**	.334
	Average Elbow Flexion Strength (kg)	.000**	.469
	Average Elbow Extension Strength (kg)	.000**	.199
Knee Joint	Right Knee Flexion Strength (kg)	.000**	.017*
	Left Knee Flexion Strength (kg)	.000**	.330
	Right Knee Extension Strength (kg)	.000**	.026*
	Left Knee Extension Strength (kg)	.000**	.070
	Average Knee Flexion Strength (kg)	.000**	.167
	Average Knee Extension Strength (kg)	.000**	.033*

** Significant relationship at the level of 0.01
* Significant relationship at the level of 0.05

Right brain hemisphere dominance in left handers seems to be related to strength performance. This situation brings strength to the forefront and ignores psychological tendency and trainability, and seems to limit the training to be successful wrestlers.

In general, the most obvious difference between left hander and right hander wrestlers is the creativity and spontaneity levels of their movement structures. The right hemisphere of the brain is generally related to spontaneous and automatic reactions. The left hemisphere of the brain is mostly responsible for logical, controlled and conscious acts and thoughts (22). Tactic is defined as the plan of act for special tasks as practiced in training. Spontaneity is doing, practicising and thinking without planning. Spontaneity in wrestling involves unpredictable acts in unexpected moments during competition. Thus, left handers' creativity and spontaneity during wrestling cannot be considered as their tactical advantage. During the game, neither the opponent's position nor the required technical moves of the moment are known. Wrestling requires very complex maneuvers involving attacks and counter attacks. Left-handed wrestlers have shorter reaction times than right-handed wrestlers. Left-handed wrestlers have less strength differences than right-handed wrestlers on both sides. On the other hand, right-handed wrestlers have the advantage of doing well planned moves in the game strategy. Right handers have a talent for executing very sequential moves and maneuvers. As a result, these characteristics of left-handed wrestlers and the fact that they have short reaction times can cause them to have more advantages (12,8). Both groups of wrestlers can be said to have advantages and disadvantages over each other. Although this assessment supports Wood and Aggleton's (26) view that left handers' being a majority in various sport branches is not because of neurological superiority but because of the characteristics of that sport, Ziyagil et al. (27) reported that in two international championships both left-handed men and left-handed women got more medals. It is obvious that new researches are required in this field. In order to equalize muscle strength asymmetry between the right and left side of the arms and legs, the weaker side was trained with increasing of repetitions and/or resistance. Resistance training results in improvement in muscular strength in preadolescents. This improvement in prepubescent children may be more a reflection of improved neuromuscular adaptation, than actual muscle hypertrophy (17). However, the strength training of prepubertal children should be monitored by an experienced coach (9). Asymmetric knee or leg strength development that prevents prepubertal children from reaching their biological potential may not be compensated enough in the following development stages (3).

CONCLUSIONS

Hand dominance and strength variables are significantly related to wrestling competition rankings. While knee strength is significantly related to hand dominance, there is no significant relation between elbow joint strength and hand dominance. Competition rankings correlated significantly all strength variables. Children's training should be based on factors such as age, gender, physical condition level and training past (6) and also their brain's hemisphere dominance. There is a significant relationship between competition ranking and strength and

Wrestling Training Center talent identification shows that selections are based on strength more than wrestling skills. Using wrestling competition as a method in the Wrestling Training Center selections scouting seems not to be a useful method. Basic movement or perceptual motor skills, the child's psychological characteristics and especially his or her interest and love in wrestling, along with trainability in developmental stages should be considered as selection criteria.

Further research is required to assess whether handedness and strength associated with wrestling performance, can differentiate the talented athletes through developmental stages in male and female athletes.

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