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Predictors Affecting the Ranking in Women Armwrestling Competition

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A B S T R A C T

The purpose of this study was to investigate the predictors contributing to be in the first three places with right dominant arm in women armwrestling. Thirty-one female senior armwrestlers competed in Turkish National Championship voluntarily participated in this study. The data were collected from six different weight classes. Handgrip strength, auditory reaction time, forearm length, and forearm circumference were determined as the predictors. All the measurements were taken after weigh-ins was completed and before the first day of national championship competition. Logistic regression analysis was conducted to predict whether a competitor in women armwrestling would be in the first three places with right arm, to be a winner or non-winner. Relative handgrip strength and forearm length were found significant predictors ($p < .05$). This result suggests that strength can be viewed as the main predictor in right arm ranking for women competitors; however, in order to apply different techniques during the match, forearm length also found to be an effective factor to be a winner. Thus, this anthropometric measurement can be used for the talent identification for women armwrestlers.

Key words: *Handgrip Strength, Auditory Reaction Time, Forearm Length, Forearm Circumference.*

Introduction

Female participation in sports can be seen in both amateur and professional level. This participation especially rose sharply in the twentieth century. This increased participation can be also observed in armwrestling. Armwrestling is accepted to be one of the oldest sports. Researchers stated that armwrestling can be traced all the way back to ancient Egypt. This is based on a painting depicting a type of armwrestling found in an Egyptian tomb dating to about 2000 B.C. It has started to be very popular in the last century because it does not require many equipments and not have many rules. The first rules for armwrestling was set up and the first organized competition carried out almost 60 years ago in California, USA[1]. Nowadays, it is a genuinely international sport and spread out all over the world.

In armwrestling, the competitors are facing one another. They lock their hands with their elbows firmly planted on the flat surface, and each attempts to force the others arm down to the table. Armwrestling involves primary (medial rotation of the upper arm, pronation of the forearm and hand, flexion of the wrist) and secondary (flexion of the arm and forearm) movements, which recruit the participation of some muscles, such as Pectoralis Major (PM), Biceps Brachii (BB), Pronator Teres (PT) and Flexor Carpi Ulnaris (FCU) muscles. In fact, the PM and FCU muscles participate as agonists in the simulated armwrestling whereas the BB and PT muscles seem to perform secondary functions[2]. Besides the muscle strength, armwrestlers also use different techniques like top-roll and hook. In top-rolling, competitor tries to put his or her hand up opponent's palm. The main aim of the hook technique is to force the opponent's hand back and expose his or her wrist by twisting your wrist towards you[3].

In armwrestling competition, the referee starting the match will be deemed head referee of that particular match. Assistant referee will watch for elbow fouls at start of match and assist in assuring a fair start. In a regular match, assistant referee properly aligns the competitors' hands. Then, head referee starts the match with a "Ready...Go!" signal in an unspecified cadence[4].

One may think that arm strength is the main factor for winning an armwrestling match. However, arm wrestling is not only a "strength" sport, but also a sport with technique and speed5. In fact, studies with armwrestling are very limited in the literature. This draws our attention to search for parameters contributing to winning in armwrestling. Therefore, the purpose of this study was to investigate the factors contributing to be in the first three places with right arm in women armwrestling. For this purpose, we have determined some physiological and perceptual predictors that can be thought as factors affecting to be a winner or non-winner. Handgrip strength, forearm circumference, and forearm length were determined as physiological predictors whereas auditory reaction time was determined as a perceptual predictor. Handgrip strength was taken as the first predictor to win the match. Handgrip strength is often used in many sports, since hand dynamometry is simple, not expensive, and a well-established method for assessing the strength of wrist and digits flexor muscles. Some researchers reported high test - retest reliability of handgrip strength in children and adolescent males[6,7].

As the head referee starts the match with a "Go"signal, it is important for a competitor to react very fast5 to this stimulus to force the others arm down to the table. Thus, we took auditory

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reaction time as the second predictor. Some limb measurements, e.g. forearm length, and forearm circumference, are also used for the talent identification[1], thus, we took these two parameters as the third and fourth predictors.

Materials and Methods

Participants

The total number of 31 female senior armwrestlers ($M_{(age)}$ = 27.8 ± 4.41) voluntarily participated in this study. All armwrestlers participated in this study competed in Turkish National Championship. However, we could not reach all participants in the championship. Please note that we have searched the possible predictors for being a winner or non-winner in armwrestling competition for only right ranking. All participants were right handed which was determined using a modified version of the Edinburgh Handedness Inventory. The participants computed in 6 different weight classes (0-50 kg, 55 kg, 60 kg, 65 kg, 70 kg, and 80 kg). The Ethics Committee of Nevşehir University, Turkey approved this study.

Measurements and Procedures

The aim of this study was to investigate the factors contributing to be in the first three places with right arm in women armwrestling. For this purpose, we have determined four predictors; handgrip strength, auditory reaction time, forearm length, and forearm circumference. All the measurements were taken after weigh-ins had been done and before the first day of competition start time. The measurements were taken by two researchers and done in a silent and fresh room so that each participant felt very comfortable. All the measurements for one arm took approximately 5 min. The measurements were started with forearm length and forearm circumference and then continued with auditory reaction time. Finally, the measurement of handgrip strength was applied to the participants.

Forearm length measurement was taken as length of radius, from radiale (proximal point on the lateral side of the head of the radius) to stylion (most distal point on the styloid process of the radius).

Forearm circumference was measured in supination at a point 12 cm distal to the tip of the olecranon in a flexed elbow at 90° and using a flexible tape measure. This was applied closely to the skin, but without causing compression[8].

Simple auditory reaction time was obtained using a multi-choice reaction timer (Lafayette Instruments Company). Participants put their index finger on the key and were instructed to press the key as rapidly as possible when they heard the auditory stimulus.

Handgrip strength measurements were taken with a portable digital hand dynamometer (Jamar, EN - 120604). Each participant performed a standardized warm-up that included one or two preliminary trials for familiarization with the recording procedure and instrumentation. The participants were seated on a chair with the shoulder adducted and neutrally rotated. Whereas the forearm and wrist were set in neutral position, the elbow was flexed at 90° [7,9]. The testing protocol consisted of three maximal isometric contractions for 3 - 5 s, on competed hand. As Ridan et al. (2000) stated the fatigue influence on grip measurement during successive squeezes, a rest period of at least 60 s was provided to the participants between trials[10]. The participants were told to put maximal force on the dynamometer. The result of handgrip strength was provided to the participants after each trial. The maximal strength value (kg) of three trials was used for the analysis. As the participants were from six different weight classes, relative handgrip strength (handgrip strength / body mass) value was used for the statistical analysis.

Statistical Analysis

Data were analyzed using SPSS 18 statistical software. Logistic regression analysis was performed to predict whether a competitor in women armwrestling would be in the first three places with right arm, to be a winner or non-winner. We defined the winners as the competitors who were in the first three places in the armwrestling competition and non-winners as the competitors who were in the fourth or upper places in the armwrestling competition. We also tested collinearity following logistic regression analysis. As SPSS does not have an option for producing collinearity diagnostics in logistic regression, we obtained statistics such as the tolerance and VIF by simply running a linear regression analysis using the same outcome and predictors. The level of significance was set to $p < .05$.

Results

The average and standard deviation of the predictors were provided in Table 1. A logistic regression analysis was conducted for the statistical analysis with relative handgrip strength, auditory reaction time, forearm circumference, and forearm length being as predictors for the analysis.

TABLE 1
PARTICIPANTS' AVERAGE AUDITORY REACTION TIME, RELATIVE HANDGRIP STRENGTH, FOREARM CIRCUMFERENCE, AND FOREARM LENGTH IN RIGHT ARM RANKING

	Winner (n = 18) *M* ± *SD*	Non-winner (n = 13) *M* ± *SD*
Auditory Reaction Time (ms)	139 ± 15.1	148.57 ± 25.7
Relative Handgrip Strength	0.71 ± 0.13	0.60 ± 0.11
Forearm Circumference (cm)	26.81 ± 2.7	25.19 ± 1.78
Forearm Length (cm)	24.92 ± 1.27	23.15 ± 1.34

A test of the full model against a constant only model was statistically significant, indicating that the predictors as a set reliably distinguished between winners and non-winners (chi square = 29.09, $p < .000$ with df = 4). Nagelkerke's R^2 is the most-reported of the R-squared estimates. In our case, it was .82, indicating a high relationship of 82% between the predictors and the prediction. Hosmer and Lemeshow goodness-of-fit statistic was greater than .05, implying that the model's estimates fit the data at an acceptable level[11].

In the Classification table, the columns are the two predicted values of the dependent, while the rows are the two observed (actual) values of the dependent. In a perfect model,

all cases will be on the diagonal and the overall percent correct will be 100%. In this study, 94.4% were correctly classified for the winner group and 92.3% for non-winner group (Table 2). Overall 93.5% (step 1 in Table 2) were correctly predicted. This is a considerable improvement on the 58.1% (step 0 in Table 2) correct classification with the constant model so we know that the model with predictors is a significantly better mode.

TABLE 2
CLASSIFICATION TABLES FOR RIGHT ARM RANKING; STEP 0: BEFORE THE ANALYSIS, STEP 1: AFTER THE ANALYSIS

	Observed		*Predicted*		
			Right Ranking		Percentage Correct
			Winner	Non-winner	
Step 0	Right Arm Ranking	Winner	0	18	100.0
		Non-winner	0	13	0
	Overall Percentage				58.1
Step 1	Right Arm Ranking	Winner	17	1	94.4
		Non-winner	1	12	92.3
	Overall Percentage				93.5

The Wald statistic and associated probabilities provide an index of the significance of each predictor in the equation. The Wald statistic has a chi-square distribution. The simplest way to assess Wald is to take the significance values and if less than .05 reject the null hypothesis as the variable does make a significant contribution. In our case, we note that relative handgrip strength and forearm length contributed significantly to the prediction (p = .03 and p = .04, respectively) but auditory reaction time and forearm circumference did not (p = .19 and p = .62, respectively).

TABLE 3
THE RESULT OF WALD STATISTICS IN LOGISTIC REGRESSION ANALYSIS FOR RIGHT ARM RANKING

	B	*S.E.*	*Wald*	*df*	*Sig.*	*Exp(B)*
Auditory Reaction Time	-.94	.72	1.72	1	.110	.390
Relative Handgrip Strength	-34.13	16.26	4.40	1	.036	.000
Forearm Circumference	-.23	.46	.24	1	.622	.795
Forearm Length	-3.75	1.85	4.06	1	.044*	.24
Constant	132.07	66.17	3.98	1	.046*	2.274

* indicates p-value lower than 0.05

For the assumption of logistic regression, collinearity statistics was also checked with linear regression analysis[11]. The result of the linear regression analysis showed tolerance and VIF values as .92 and 1.32 for auditory reaction time, .87 and 1.72 for relative handgrip strength and forearm circumference, and .94 and 1.12 for forearm length, respectively. For the collinearity statistics, a tolerance values less than .1[12] and a VIF value greater than 10[13] are cause for concern for the parameters of a regression model. In our case, therefore, it is safe to indicate that our logistic regression model is reliable to predict winner or non-winner in an armwrestling competition.

Discussion

Female athletic participation has been increasing in all sports. This increased female participation can be also seen in armwrestling. Armwrestling has become a popular sport in all over the world not only for men but also for women. Even though one may consider arm strength as the main contributing factor for winning, strength is not seen the only factor for winning[5]. Speed and technique are also thought to be effective in this sport. In this study, we tried to find the possible predictors for winning a match in women armwrestling competition. For this purpose, we determined four predictor; relative handgrip strength, forearm circumference, forearm length, and auditory reaction time. Logistic regression analysis displayed that handgrip strength and forearm length were significant predictors for right arm ranking.

In armwrestling, it is very crucial to react fast to the head referee "go" signal to start the match in order to force the others arm down to the table before the opponent attempt. Thus, auditory reaction time plays may play an important role. Interestingly, auditory reaction time was not found a significant predictor although competitors in winner group had faster auditory reaction time (M = 138 ± 15.1 ms) than that of non-winner group (M = 148.57 ± 25.7 ms). It can be still recommended for women armwrestlers to improve this perceptual skill.

Handgrip strength is generally used to measure the maximum isometric strength of the hand and forearm muscles. It is important for any sport in which the hands are used. Strength is also thought to be one of the important factors to win a match in armwrestling[14]. In fact, relative handgrip strength was found to be a significant predictor for being a winner or non-winner in armwrestling competition for right arm ranking in this study. This is not a surprising result as the women competitors aims are to force the others arm down to the table. Thus, being stronger than the opponent can give an advantage to win the match if both competitors have the same auditory reaction time and techniques.

The other dependent variable used in this study predicting to be a winner or non-winner in armwrestling was forearm circumference. Forearm circumference was found to be a predictor of maximum handgrip strength in many studies[8,15,16]. In this study, forearm circumference was not found a significant predictor although forearm circumference value in winner group

(M = 26.81 ± 2.7 cm) was more than that of non-winner group (M = 25.19 ± 1.78 cm).

In some countries, forearm length is used as a criterion to select talented armwrestlers[1]. It was previously stated that forearm length had a positive correlation with the maximum handgrip strength[16]. In this study, we have found forearm length together with relative handgrip strength a significant predictor to be a winner or non-winner. Thus, the result of this study supports Nicolay and Walker (2005) research[16]. Forearm length may be effective to apply different techniques (the top-roll or the hook) during the match as it may give an advantage to put hand over the opponent's palm. Even though we did not aim to search the effect of forearm length on applying techniques, having a longer forearm predicts to win the match for women armwrestlers.

Conclusion

Armwrestling has been increasing its popularity for the last two decades. However, scientific studies about armwrestling are very limited in the literature, especially for women. This study aimed to investigate possible predictors to be a winner or non-winner in women armwrestling competition. Overall, relative handgrip strength and forearm length were found to be significant predictors for right arm ranking. Competitors in this sport mostly perform strength training in their practice regime[14]. Even though auditory reaction time was not found to be a significant predictor, women wrestlers in the winner group had the faster reaction time than the reaction time of the non-winners. Therefore, it is also suggested that women wrestlers should also allocate some time to improve their auditory reaction time. Speedy response in order to set muscles into motion will definitely give an advantage to apply appropriate technique and win the match. Forearm circumference was not found as a significant predictor in this study. Therefore, this anthropometric measurement does not need to be used for the talent identification. In order to apply different techniques during the match, having longer forearm length increases the probability of winning the match. Thus, this anthropometric measurement should be used for the talent identification for women wrestlers. In conclusion, the predictors to be a winner or non-winner in women armwrestling were found to be relative handgrip strength and forearm length. Even though forearm length is genetically determined anthropometric measurement, women armwrestlers can focus on to improve their handgrip strength.

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PREDIKTORI KOJI DOPRINOSE BOLJEM RANGIRANJU KOD TAKMIČENJA U OBARANJU RUKU U ŽENSKOJ KONKURENCIJI

S A Ž E T A K

Cilj ovog istraživanja je bio da se utvrde prediktori koji doprinose da se takmičarke koje koriste desnu ruku nađu među prva tri mjesta na tabeli. Uzorak je sačinjavala 31 odrasla takmičarka u Turskom nacionalnom šampionatu u obaranju ruku dok su sirovi podaci prikupljeni iz šest različitih težinskih kategorija. Snaga stiska ruke, vrijeme reakcije na zvuk, dužina i obim podlaktice su predviđeni da budu prediktori u ovom istraživanju. Testiranje je sprovedeno nakon zvaničnog mjerenja takmičarki, kao i prije prvog zvaničnog takmičarskog dana. Logistička regresivna analiza je primjenjena kako bi se utvrdilo da li će takmičarke u obaranju ruku osvojiti jedno od prva tri mjesta desnom rukom, biti pobjednica ili poražena. Utvrđeno je da su relativna snaga stiska ruke i dužina podlaktice značajni prediktori ($p < .05$). Ovi rezultati ukazuju na to da snaga može biti posmatrana kao glavni prediktor koji doprinosi boljem rangiranju kod takmičenja u obaranju ruku u ženskoj konkurenciji; međutim, u cilju primjene različitih tehnika tokom meča, utvrđeno je da je i dužina podlaktice, takođe značajan faktor za ostvarivanje pobjede. Dakle, primjenjena antropometrijska mjerenja mogu biti korišćena za identifikaciju talenata kod obaranja ruku u ženskoj konkurenciji.

Ključne riječi: Snaga stiska ruke, vrijeme reakcije na zvuk, dužina podlaktice, obim podlaktice.