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THE RELATION AMONG THE SETTER POSITION SETTER HEIGHT AND GAME RESULT IN ELITE WOMEN VOLLEYBALL

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OBJECTIVE. The setter has an important role in the game result in terms of not only the playing position but also the physical characteristics. In this study, the relationship between the variable of win-lost points of the team as the setter in 6 different positions, setter height, and starting position of the setter and the variable of game result is examined.
METHODS. The study is carried out with the data obtained from the records of match analysis concerning 164 plays and 82 matches of 8 teams which were entitled to play in the playoffs from 12 teams of Turkish Women Volleyball League 1.
RESULTS. In accordance with the obtained findings, a statistically significant difference between the setter height and the game result is obtained. In addition, there is a significant difference between the win-lost points of team and front or back position of the setter. The same relationship for medium and tall setters is not so significant statistically. Nevertheless, it is observed that the difference between the points which team win or lose when the setter is back player and the points which team win or lose when the setter is front player is statistically significant. A significant relationship between the setters' starting position and the game result is obtained at the level of 0.10. Besides, a significant relationship is observed between the total average win-lost points when the setter is front and back player at the level of 0.10. It is also detected that the average win-lost points when the setter is a back player is greater than the average win-lost points when the setter is a front player.
CONCLUSIONS. These findings show that considering the setter's starting position together with the setter's height will have a significant effect on the play while creating new tactics.
KEYWORDS: Volleyball, setter position, setter height, game result.

INTRODUCTION

It is certain that team performance shall be improved by scientific supports in the sport volleyball which is watched and played by millions of people in more than 200 countries in the world. Within this scope, detection of the determinative factors of team performance is so important not only in providing exercise effectiveness but also in developing game strategies and building up team compositions.

Today in volleyball in which the competition is so strong, teams collect detailed statistics concerning matches by game analyzing programs and build up new tactical plans for games based on these data. Teams set their offence and defence strategies by considering their players' physical properties. (H.G. Eom and R.W. Schuts, 1992a; H.G. Eom and R.W. Schuts, 1992b).

The setter is a promoter and has an important role in the team structure (K.S. Lenberg, 2004; L. Sawula, 1998). The setter has an important effect on the game result due to physical properties, technical-tactical features and also the position played (A. Selinger, 1986; P. Over, 1992). In accordance with the game rules, the players shall turn clockwise according to the starting position and the setter shall play in six different positions on the play area (L. Alexandros and K. Panagiotis, 2010). The starting position also determines whether the setter in the front or back position. Any studies examining the effects of setter position and setter height on the game result and the effect of setter position on win-lost points cannot be found in the literature concerning volleyball.

RESEARCH METHODS AND PROCEDURES

RESEARCH SAMPLE AND DATA

This study was made by using the game data of the season 2008-2009 of Turkish Women Volleyball League 1. 164 observation data of 82 matches of 8 teams which were entitled to play in the playoffs among 12 teams are used, as each observation refers to play of one team in one match. These 164 observations are consisted of 108 league, 40 playoff, 12 Turkish Cup and 4 Champions Cup games. The total observation number in the analysis is 328. The reason is that, the position variable is located for two times on the data sheet as back and front positions.

17 setters had played in the league of 2008-2009 in total. Data concerning the variables of starting positions of the setters, win-lost points of the team in each position of the setter and game result were collected from the reports of game analysis. Setters' heights are collected from the official web site of the Turkish Volleyball Federation (Team Info, 2008). For the games in which more than one setter had played, the average height of the setters is calculated. The heights of the setters are categorized in three different classes. Setters between 170 and 179 cm are short setters (SS), setters between 180 and 185 cm are

medium setters (MS) and setters between 186 and 190 cm are tall setters (TS).

STATISTICAL ANALYSIS

5 variables in total are used in the study: Game result, win-lost point difference for each setter position, setter as a front or back player, starting position of setter, setter height.

The validities of the below hypothesis are tested:

a) There is a significant relationship between setter height and game result.

b) There is a significant relationship between starting position of setter and game result.

c) There is a significant difference between setter as a front or back player and difference in win-lost point in terms of heights.

d) Differences in win-lost points differ significantly with the setter position.

As both of the variables are categorical in the test of hypothesis a) and b), the significance of the relationship is made by Pearson χ^2 test statistics. For the significance of the difference between the averages of groups in the hypothesis in c) and d), two-sample independent t test and ANOVA are used. In order to decide whether the test concerning the significance of the difference between the groups should be parametric or non-parametric, it is detected whether the sample data has a normal distribution or not. In this sense, Shappiro-Wilk W test statistics is used for normality tests. It is observed that the variables have normal distribution and by this reason parametric t tests and ANOVA are used for the differences in group averages. Prior to the analysis concerning t test and ANOVA, the homogeneity of group variances is detected by F test and thus, t test or ANOVA are carried out in accordance with the result of F test.

PEARSON CHI-SQUARE

This statistic is used to test the hypothesis of no association of columns and rows in tabular data. Note that chi-square is more likely to establish significance to the extent that the relationship is strong, the sample size is large, and/or the number of values of the two associated variables is large. Chi-square is calculated by finding the difference between each observed and theoretical frequency, squaring them, dividing each by the theoretical frequency, and taking the sum of the results as follows $\chi^2 = \sum_{i=1}^{I}\sum_{j=1}^{J}\frac{\left(O_{ij} - E_{ij}\right)}{E_{ij}}$ where $O_{ij} =$ an observed frequency and $E_{ij} =$ an expected (theoretical) frequency, asserted by the null hypothesis.

TWO SAMPLE T TEST

The two-sample *t*-test is used to determine if two population means are equal. The two sample t test for unpaired data is defined as: The hypothesis are defined as $H_0 : \mu_1 = \mu_2 \quad H_1 : \mu_1 \neq \mu_2$ and the test statistics t is calculated as $t = \frac{\bar{X}_1 - \bar{X}_2}{\sqrt{S_1^2 / n_1 + S_2^2 / n_2}}$ where n_1 and n_2 are the sample sizes, $\bar{X}_1$ and $\bar{X}_2$ are the sample means, and S_1^2 and S_2^2 are the sample variances. Reject the null hypothesis that the two means are equal if $t < -t_{\alpha/2,\nu}$ or $t > t_{\alpha/2,\nu}$. If equal variances are assumed, then $\nu = n_1 + n_2 - 2$.

NORMALITY TESTS

The Shappiro-Wilk test calculates a *W* statistic that tests whether a random sample, $x_1, x_2, ..., x_n$ comes from a normal distribution . Small values of *W* are evidence of departure from normality and percentage points for the *W* statistic, obtained via Monte Carlo simulations. The *W* statistic is calculated as $W = \left(\sum_{i=1}^{n} a_i x_{(i)}\right)^2 / \sum_{i=1}^{n}(x_i - \bar{x})^2$, where the $x_{(i)}$ are the ordered sample values and the a_i are constants generated from the means, variances and covariances of the order statistics of a sample of size *n* from a normal distribution. The percentage of W statistics and a_i values are generated by A.V. Pearson and H.O. Hartley (1972).

ONE-WAY ANOVA

The procedure known as the *Analysis of Variance* or *ANOVA* is used to test hypotheses concerning means when we have several populations. ANOVA is a general technique that can be used to test the hypothesis that the means among two or more groups are equal, under the assumption that the sampled populations are normally distributed.

In an analysis of variance the variation in the response measurements is partitioned into components that correspond to different sources of variation. The goal in this procedure is to split the total variation in the data into a portion due to random error and portions due to changes in the values of the independent variable(s).

The total variation (not variance) is comprised the sum of the squares of the differences of each mean $\bar{X}_i$ with the grand mean $\bar{X}_{GM} : SS_{total} = \sum_{j=1}^{p}(\bar{X}_j - \bar{X}_{GM})^2$ where $\bar{X}_{GM} = \sum_{i=1}^{N} x_i$ and the *p* is the number of different groups.

There is the between group variation and the within group variation. The whole idea behind the analysis of variance is to compare the ratio of between group variance to within group variance. If the variance caused by the interaction between the samples is much larger when compared to the variance that appears within each group, then it is because the means aren't the same.

The variation due to the interaction between the samples is denoted SS_b for Sum of Squares Between groups: $SS_b = \sum_{j=1}^{p} n_j (\bar{X}_j - \bar{X}_{GM})^2$, where n_j is the size of j group. The variance due to the interaction between the samples is denoted S_b^2 for Mean Square Between groups: $S_b^2 = \frac{SS_b}{p-1}$

The variation due to differences within individual samples, denoted SS_w for Sum of Squares Within groups: $SS_w = \sum_{j=1}^{p} (n_j - 1) S_j^2$

Each sample is considered independently, no interaction between samples is involved. The degrees of freedom is equal to the sum of the individual degrees of freedom for each sample. Since each sample has degrees of freedom equal to one less than their sample sizes, and there are k samples, the total degrees of freedom is p less than the total sample size: $df = N - p$.

The variance due to the differences within individual samples is denoted S_w^2 for Mean Square Within groups. This is the within group variation divided by its degrees of freedom: $S_w^2 = \frac{SS_w}{N-p}$

The F test statistic is calculated by dividing the between group variance by the within group variance: $F = \frac{S_b^2}{S_w^2}$. The degrees of freedom for the numerator is *p-1* and the degrees of freedom for the denominator is the *N-p*.

The decision will be to reject the null hypothesis if the test statistic from the table is greater than the *F* critical value with *p-1* numerator and *N-p* denominator degrees of freedom (E.K. Roger, 2008).

FISHER - HAYTER MULTIPLE COMPARISION TEST

A variety multiple comparisons procedure have been developed to test null hypothesis about contrasts. This test is appropriate for testing all pairwise contrasts among p means. It control the probability of making one or more Type I errors for the collection of tests at or less than α. The Fisher-Hayter approach will be more powerful than the Tukey approach

The Fisher-Hayter multiple comparision test is a two step procedure. The first step consists of using the ANOVA *F* test the omnibus null hypothesis $H_0 : \mu_1 = \mu_2 = ... = \mu_p$ at α level significance. If the F test is not significant, the omnibus null hypothesis is not rejected it is concluded that none of pairwise contrasts differ from 0. In contrast, each of pairwise contrasts is tested using the Fisher-Hayter test statistics.

The Fisher-Hayter test requires three assumptions: Random sampling or random assignment of participants to the treatment levels, the $j = 1, \ldots, p$ populations are normally distributed, and the variances of the $j = 1, \ldots, p$ populations are equal (Hayter, 1986).

The Formula for the test statistics is

$$qFH = \frac{\bar{X}_{.j} - \bar{X}_{.j'}}{\sqrt{\frac{MSWG}{2}\left(\frac{1}{n_j} + \frac{1}{n_{j'}}\right)}}$$

where $\bar{X}_j$ and $\bar{X}_{j'}$ are means of random samples from normal populations, *MSWG* is the denominator of the *F* statistic from an ANOVA, an n_j and $n_{j'}$ are the sizes of the samples used to compute the sample means (A.J. Hayter, 1986; E.K. Roger, 2008).

RESULTS

In this part, statistical analysis results concerning examination hypothesis are given. 17 setters in total had played in the season of 2008-2009 of the Turkish Women Volleyball League 1 where the examination data were collected. Only one of these teams had 3 setters; the other teams had 2 setters. Lengths of these setters are given in Table 1.

Table 1. Lengths of setters (cm)

	T1	T2	T3	T4	T5	T6	T7	T8
S1	181	175	178	174	186	187	183	183
S2	190	173	186	183	173	172	179	178
S3	-	-	-	-	-	-	-	184
Mean	185.5	174	182	178.5	179.5	179.5	181	181.7

T: Team S: Setter

It was detected by Pearson Chi-square statistics whether there is a significant relationship between setter length and game result as both of the parameters are categorical. Statistical test results are given in Table 2.

Table 2. The association between setter height and game result

Setter Height	Game result Lost	Win	Total
Short	56	52	108
Medium	64	46	110
Tall	44	66	110
Total	164	164	328
Pearson $\chi^2(2) = 7.4936$ p = 0.024			

As $p = 0.024 < 0.05$, it is seen that there is a significant relation between setter length and game result.

The results of relation analysis between setter's starting position and game result which is based on Pearson Chi-square are given in Table 3. P1, P6 and P5 refer to back positions and P4, P3 and P2 refers to front positions.

Table 3. Relationship between setter starting position and game result

Setter Starting Position	Game result Lost	Win	Total
P1	76	56	132
P2	20	14	34
P3	10	10	20
P4	2	6	8
P5	24	36	60
P6	32	42	74
Total	164	164	328
Pearson $\chi^2(2) = 9.8405$ p = 0.08			

As $p = 0.08 < 0.10$, then although there is not a significant relation between setter height and game result at the level of 0.05, it can said that the relation exists at the level of 0.10.

In order to decide on the test selection concerning whether there is a difference in win-lost points according to the setter position and under the setter height constraint; Shappiro-Wilk W normality test was carried out for the variable of win-lost point and the results are given in the Table 4.

Table 4. The normality tests for win-lost points by setter position and setter height

Setter height	Setter Position	Obs	W	z	p
Short	Back	54	0.97	0.45	0.32
	Front	54	0.98	-0.55	0.70
Medium	Back	55	0.98	-0.25	0.60
	Front	55	0.98	-0.79	0.78
Tall	Back	55	0.97	0.05	0.47
	Front	55	0.98	-1.44	0.92
No height constraint	Back	164	0.99	-0.58	0.72
	Front	164	0.99	0.50	0.30

As all the probability values $p(Z > z)$ concerning Shappiro-Wilk W statistics are greater than the significance level of 0.05, the null hypothesis of "distribution of the variables is normal" cannot be rejected. Thus, two-sample independent t test can be used for significance test for the difference between the group averages. However, before performing the two-sample independent t test, variance ratio tests by F statistics was carried out concerning the necessity of under which equal or non-equal group variances estimations this test should be performed. The results are given in Table 5.

Table 5. Variance ratio tests

Setter height	Alternative Hypothesis	F	$2*Pr(F<f)$
Short	Ha: ratio≠1	0.765	0.334
Medium	Ha: ratio≠1	1.093	0.744
Tall	Ha: ratio≠1	1.150	0.608
No height contraint	Ha: ratio≠1	1.002	0.986

As $2*\Pr(F < f) > 0.05$, the null hypothesis that the group variances are equal cannot be rejected at the 0.05 significance level. As the hypothesis which declares that the group variances are equal cannot be disclaimed, for the short setters, two-sample t test with equal variances concerning the significance of the difference between the differences in win-lost points observed while the setter plays in a front or back position was performed and the results are given in Table 6.

Table 6. Two sample t test for difference between two groups' win-lost points

Group	Obs	Mean	Std. Err.	Std. Dev.	[95% Conf. Interval]	
Back	164	2.87	0.82	10.54	1.25	4.50
Front	164	1.17	0.82	10.53	-0.44	2.80
Combined	328	2.02	0.58	10.55	0.88	3.17
diff		1.70	1.16		-0.58	3.99

H0 = mean(1) - mean(2) Ha: diff > 0 t = 1.461
p(T > t) = 0.072

It can be said at the level of 0.10 that there is a significant difference between the win-lost points of the team in favour of back position while the setter plays in a front or back position.

Table 7. Two-sample t test for difference between back-front groups' win-lost means, given setter height is short

Group	Obs	Mean	Std. Err.	Std. Dev.	[95% Conf. Int.]	
Back	54	4.42	1.31	9.66	1.78	7.06
Front	54	.296	1.50	11.04	-2.7	3.31
Combined	108	2.36	1.01	10.53	.35	4.37
diff		4.12	1.99		.17	8.08

H0 = mean(1) - mean(2) Ha: diff > 0 t = 2.06 P(T > t) = 0.020

There is a significant difference between the win-lost points while the setter plays in a front or back position for short setters. The average win-lost point while the setter plays in a back position is significantly greater than the average win-lost points while the setter plays in a front position as $p(T > t) = 0.0205 < 0.05$.

Table 8. Two-sample t test for difference between two groups' win-lost points, given setter height is medium

Group	Obs	Mean	Std. Err.	Std. Dev.	[95% Conf. Int.]	
Back	55	.25	10.81	1.45	-2.6	3.17
Front	55	-.07	10.33	1.39	-2.8	2.72
Combined	110	.09	10.52	1.00	-1.8	2.08
diff		.32	2.01		-3.6	4.32

H0 = mean(1) - mean(2) Ha: diff > 0 t = 0.16
p(T > t) = 0.435

There is not a significant difference in win-lost points while a medium height setter play in a front or back position. As $p(T > t) = 0.435 > 0.05$, the average win-lost points when the setter in a back position is not significantly greater than the average win-lost points when the setter in a front position.

Table 9. Two sample t test for difference between two groups' win-lost points, given setter height is tall

Group	Obs	Mean	Std. Err.	Std. Dev.	[95% Conf. Int.]	
Back	55	3.98	1.45	10.79	1.06	6.90
Front	55	3.29	1.35	10.06	0.56	6.01
Combined	110	3.63	0.99	10.39	1.67	5.60
diff		0.69	1.99		-3.2	4.63
H0 = mean(1) - mean(2) Ha: diff > 0 t = 0.347 p(T > t) = 0.364						

There is not a significant difference in win-lost points while a tall setter play in a front or back position. , Although the average win-lost points when the setter in a back position is greater than the average win-lost points when the setter in a front position, as $p(T > t) = 0.435 > 0.05$, the advantage of this difference in favour of back position is not significantly greater.

One way ANOVA was used for both positions to determine whether there is a significant difference between the win-lost points according to the setter height when the setter is a back or front position.

The results of the analysis are given in Table 10 and Table 11.

Table 10. ANOVA table for setter length at back position

Source	SS	df	MS	F	p
Between groups	574.93	2	287.46	2.64	0.074
Within groups	17556.6	161	109.04		
Total	18131.5	163	111.23		
Bartlett's test for equal variances: chi2(2) = 0.8551 Prob>chi2 = 0.652					

Fisher-Hayter pairwise comparisons. Studentized range critical value(.1, 2, 322) = 2.33

Group vs group	Group means		Mean diff	FH-test
Short vs medium	4.42	0.25	4.17	2.94*
Short vs Tall	4.42	3.98	0.44	0.31
Medium vs Tall	0.25	3.98	3.72	2.64*
*significant at 0.10 level				

There is a significant difference at the level of 0.08 between the win-lost points according to the height variable when the setter plays in back position. Post hoc analysis was made by Fisher-Hayter test in order to observe between which height there exists a difference; and it seen that at the level of 0.10, the differences between short and medium and medium and tall are significant.

Table 11. ANOVA table for setter length at front position

Source	SS	Df	MS	F	p
Between groups	373.55	2	186.77	1.70	0.18
Within groups	17708.31	161	109.98		
Total					
Bartlett's test for equal variances: chi2(2) = 0.48 Prob>chi2 = 0.78					

Fisher-Hayter pairwise comparisons. Studentized range critical value(.1, 2, 322) = 2.33

Group vs group	Group means		Mean diff	FH-test
Short vs medium	0.29	-0.07	0.36	0.26
Short vs Tall	0.29	3.29	2.99	2.11
Medium vs Tall	-0.07	3.36	3.29	2.38*
*significant at 0.10 level				

When the same analysis made with the setter in front position, F test resulted that there is not a significant difference between the groups. However, as the Prob>F=18 value is relatively small, post hoc analysis was carried out and it is observed that there is a significant difference in win-lost points between the heights of medium and tall at the level of 0.10.

DISCUSSION

It observed that the statistical analysis results significantly support the hypothesis asserted in connection with relations among setter position, setter length, game result and win-lost points.

Although, the setter length was not said to be an important factor in winning the match formerly in volleyball practices, today it is paid attention especially on lengths together with other features to become advantageous in net front (Z. Ran, 1989).

The analysis results given in Table 2 support the rightness of this tendency. The relation between the setter height and winning the game can be expressed especially by tall setters easily.

Although it is commonly preferred to start the game in P1 position in volleyball matches, the tendency to start in P5 and P6 positions are increasing in recent years. The starting position distribution given in Table 3 shows that it is started to game at P1 position mainly; P6 and P5 positions follow the P1 position. Statistical analysis has given results in favour of this tendency. For instance, the number of lost matches when it was started at P1 position is greater than the number of lost matches when it was started at P6 and P5 positions. Thus, the relation between both of the variables have found significant at the level of 0.10.

The results which are given in Table 6 which indicates that there is a significant difference between win-lost points when the setter is at a front or back position at the level of 0.10, also shows that the team is more successful when the setter is at back position. This result is on the same wavelength with the study (J.M. Palao, J.A. Santos, A. Urena, 2004; J.M. Palao, J.A. Santos, A. Urena, 2005). The analysis carried out for the win-lost points when the setter at a front or back position in the detail of lengths (Table 7, 8 and 9), indicated that there is a significant difference between the average win-lost points in favour of back position when only the short setters play at a front or back position.

CONCLUSIONS

A statistically significant relation between setter height and game result, setter's starting position and game result have been detected. As there is a significant difference between the win-lost points of the team when the short setter plays at a front or back position, this difference was not found statistically significant for the medium and tall setters. Besides, it is detected that the number of win-lost points of the team when the setter is a back player is significantly different from the number of win-lost points of the team when the setter is a front player. It is also observed that as there is a significant difference between the average of win-lost points when the setter is a front or back player, the average of win-lost points when the setter is a back player is greater than the average of win-lost points when the setter is a front player.

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