ISSN 1750-9823 (print)
International Journal of Sports Science and Engineering
Vol. 07 (2013) No. 01, pp. 021-025

Evaluation of Volleyball Statistics with Multidimensional Scaling Analysis

Gürol Zırhlıoğlu [+]

Yuzuncu Yil University, Education Faculty, Van, Turkey

(*Received July 27, 2012, accepted September 9, 2012*)

Abstract. The purpose of this study was to investigate the playing characteristics of team performance in Turkey Women's Voleyball. So, it was used some statistical values of team performance. These statistical values are break point, serve error, ace, reception error, reception excellent, attack error, attack block, attack points and block points. 149 female matches of the Turkish AROMA Voleyball League were analyzed. The data was obtained from web site of the Turkish Voleyball Federation. Ace, reception excellent and attack points are variables which are positive in the first dimension and negative in the second dimension play role in determining the performance of teams.

Keywords: multidimentional scaling, AROMA women's volleyball league, performance analysis

1. Introduction

In today's volleyball, the most important way to success is taking offense and defense as a whole and developing technical and tactical strategies in this context. In 1999, after changing the rules of volleyball game, volleyball has experienced a complete change in technical and tactical sense. Particularly, significant changes have occurred in game's offensive stage. In high-level volleyball, matches usually conclude with results such as 3-2 or 3-1. Match result depend on different volleyball skills performed by teams and players. Evaluations made during or after games usually focus on serve rate, return strokes, touches on the block and attacking strokes. Teams and players' performance evaluations are made on these factors [1-2-3].

In volleyball, offensive skills are expressed as serve, attack and passing while defensive skills are expressed as block, return and defense. A volleyball team can get points in four different ways. These are serves, block, attack, and the points gained from the errors of the opposing team. Three different elements are factors that help to score. These factors are return, passing and defensive skills [2]. Eom and Schutz, in a study done in 1992, they stated that the most important factors determining the success of teams were block and spike among the eight skills selected for volleyball [4].

Multidimensional Scaling (MDS) is a statistical analysis method with many multivariate, in which relationships between objects are unknown, that helps to reveal the relationships between objects by using distance between them. MDS first emerged in the fields of psychophysics and psychometric, later, it has begun to be used commonly in medicine, social sciences, educational sciences and other areas [5-6]. By MDS, which does not require any assumption of probability distribution related to data, it is possible to reduce relations between objects or individuals to more explainable and understandable dimension [7-8-9-10].

Measurement of the data used in MDS and determination of scale type in gauging are very important. If data is measured at classifier and sorter level, non-metric scaling method is used developed by Shepard and Kruskal. If it is measured at spaced or proportional measurement level, metric scaling method is used which is created by Richardson and developed by Torgerson. In metric scaling method, distance values are benefited for determining the position of a given observation, in non-metric scaling method, values of distance between observations are used [9-11].

In this study, match results data and match performance of 11 women's volleyball teams competing in 2010-2011 season were evaluated using multidimensional scaling analysis. Through the match statistics

[+] Corresponding author. Tel: +90-554-3006570.
E-Mail address: gurol@yyu.edu.tr

which located in the Turkish Volleyball Federation internet site, the performances of teams examined with less dimension by using MDS. Some of the arguments used in this study were determined to have negative and positive effects on performances of teams.

2. Method

In this study, match performances of 11 women's volleyball team competing in the 2010-2011 season were tried to be evaluated by using data from the match results taken from Turkish Volleyball Federation's official web site. For this purpose, statistics for the variables used were such as break point, serve error, ace, reception error, reception excellent, attack error, attack block, attack points, block points.

MDS was used to obtain a graphical representation of n points in one dimensional or r dimensional space by distance values obtained from a data set consisting of n units or object. This method does not require assumption for distribution of data [6].

Distance between i^{th} and j^{th} units in data set are displayed as p_{ij}, MDS provides representation of these distances in a geometric space such as Euclidean space. In an m-dimensional Euclidean space, he distance between i^{th} and j^{th} points is achieved by equation.

$$d_{ij}(x) = \left(\sum_{s=1}^{p} \left(x_{is} - x_{js} \right)^2 \right)^{1/2} \quad (1)$$

Where x_i, specifies the position (cooridinate) of point i on dimention s. The function that supplies transformation of coordinates in distance function and observed distances to theoretical distances is estimated by an equation named as STRESS which was presented by Kruskal [12]. This equation can be shown as;

$$S = \sqrt{\frac{\sum_{ij} \left(\delta_{ij} - d_{ij} \right)^2}{\sum_{ij} d_{ij}^2}} \quad (2)$$

Being equal of STRESS value to 0 indicates perfect harmony, being equal to 1 indicates a complete mismatch. The value of 0.05 means good fit while 0.20 shows a weak fit [6-9-12-13].

3. Results

Descriptive statistics for the data used in this study is depicted in Table 1.

Table 1: Descriptive statistics of selected variables

Variables	n	Min	Max	Means	StdDev
PBP (Break points)	12	187	386	275.92	66.17
SERR (Serve error)	12	70	120	88.67	14.71
SPTS (Ace)	12	43	89	66.33	15.14
RERR (Reception error)	12	46	101	80.08	16.82
REXC (Reception excellent)	12	50	95	64.25	13.84
AERR (Attack error)	12	83	123	103.75	14.09
ABLO (Attack block)	12	60	128	102.67	19.24
APTS (Attack points)	12	376	535	438.42	52.49
BK (Block points)	12	64	131	103.67	20.56

According to the results of multidimensional scaling analysis, STRESS statistic used for determining the correspondence between the estimated distances and configuration distance has been found as 0.01341 for r=2 dimension. This value indicates a good fit and indicating that obtained results adequately reflect data set.

Difference matrix obtained for the variables is given in Table 2. This table reveals the similarity and dissimilarity among variables.

Accordingly, the variables that have values close to 0 are perceived as similar; those with over 1 can be perceived as dissimilar. Therfore, variables most closely resembles each other are ace points (SPTS) and reception excellent (REXC) with the value of matrix of 0090. The least similar variables are REXC and attack points (APTS) variables with the value of matrix of 4.445. Also an another point to mention in Table is that attack points variable have 4 and higher values indicating considerably different position from other variables. Coordinate values of volleyball teams determined by variables and based on two-dimensional

geometric representation are given in Table3.

Table2: Matrix of difference of selected variables.

Variables	PBP	SERR	SPTS	RERR	REXC	AERR	ABLO	APTS	BK
PBP	0								
SERR	2.179	0							
SPTS	2.435	0.329	0						
RERR	2.273	0.269	0.377	0					
REXC	2.464	0.345	0.090	0.370	0				
AERR	2.006	0.313	0.573	0.274	0.581	0			
ABLO	2.021	0.346	0.607	0.290	0.618	0.108	0		
APTS	2.030	4.136	4.424	4.204	4.445	3.925	3.928	0	
BK	1.993	0.302	0.472	0.387	0.508	0.315	0.351	3.974	0

Table 3: Coordinate values by variables.

Variables	First dimention	Second dimention
PBP (Break points)	1.4620	0.3245
SERR (Serve error)	-0.6894	-0.0034
SPTS (Ace)	-0.9714	0.1465
RERR (Reception error)	-0.7607	-0.1648
REXC (Reception excellent)	-0.9947	0.1104
AERR (Attack error)	-0.4833	-0.1737
ABLO (Attack block)	-0.4847	-0.2253
APTS (Attack points)	3.4432	-0.1386
BK (Block points)	-0.5209	0.1177

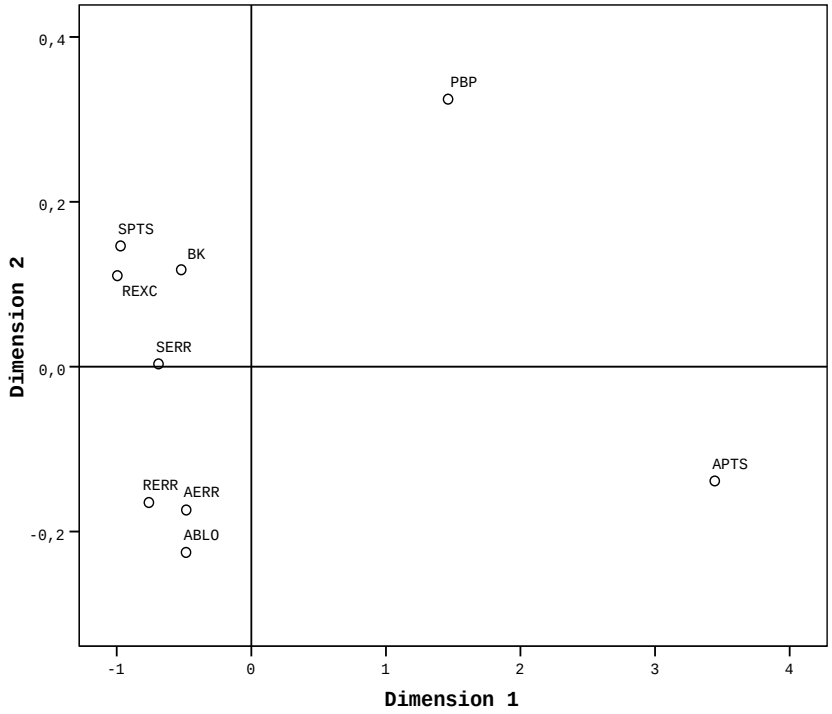

Figure 1. Graphic related to Euclidean distance model

As shown in Table 3, number of *attack points* in point variables has the highest positive value (3.4432). This value is higher than the other performance variables, identified as an important separator. Another important point is that ace variable is that similar to *reception excellent* (-0.9714 and -0.9947) and *attack error* is similar to *attack block* (-0.4833 and -0.4847). In the second dimension, points gained by *break points* variable appears to be the most different variables; difference between the values of all variables seemed to decline. Also, in this dimension, *reception excellent* variable and *block points* variable were identified as being similar to each other (0.1104 and 0.1177). Positions of variables belong to match result statistics of Turkish Volleyball Federation for Aroma Women's League are shown in two-dimensional graph

related to Euclidean distance model in Figure 1.

According to a graphical embodiment in Figure 1, particularly, reception error, numbers of attack error, number of attack block create a group, in the same way, ace, reception excellent and block points constitute another group. Break point and attack points variables are perceived different.

Shepard graph which represents distribution of differences with observed distances of selected variables is given in Figure 2.

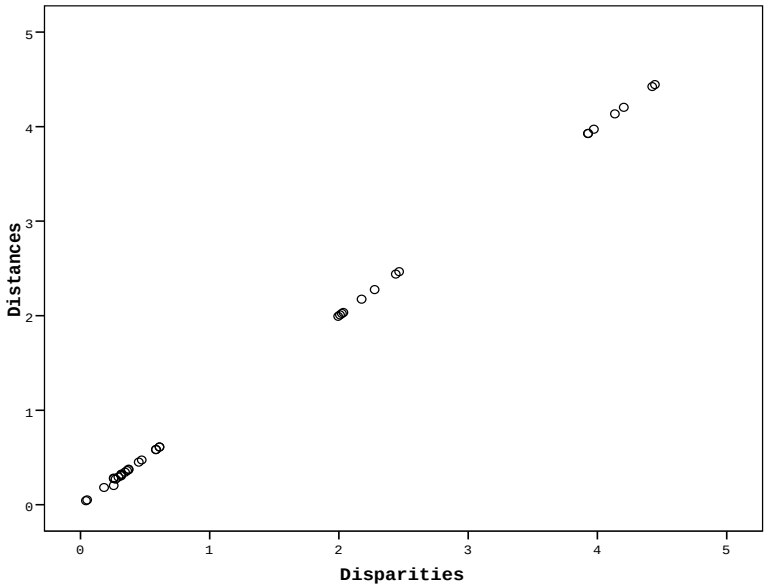

Figure 2. Shepard graphic

Figure 2 is eveident that there is a linear relationship between different distance values, sugessting that estimated distances are compatible with the actual values and appropriate solution can be achieved with linear model.

4. Discussion

Multidimensional scaling analysis, laying down relationships between variables in a lower dimensional space, has a common area of use and it can be performed on the data measured by r ordered, equally spaced, equal proportional scales [11-12-13].

In this study, obtained information as a result of two-dimensional analysis for 11 women's volleyball team adequately reflect the data set used in this study (STRESS statistics = 0.01341), it was determined that model represented data wonderingly in terms of reliability (R^2 = 0.99978). Effectiveness of the block and ace are key distinguishing elements in determining the results of the matches [14].

In determination of ranking points of Aroma Women's League at the end of 2010-2011 season ace, reception excellent and block points variables have similar effects. However, Eom and Schutz (1992) stated that the most important factors determining the success of teams were block and spike among the eight skills selected for volleyball. False attacks and fast break errors are other important factors in determining the match results [15]. In this study, reception error, attack error and attack block variables were found to have similar effect taking place in a different group. However, attack points, break point and serve error variables distinguish from other variables as a separate feature. Negative variables play a negative role on performances of teams to get points. Positive variables have positive effect on performance values.

When coordinate values of the two-dimensional positioning of match results statistics were examined, it was observed that the only variable marked positive is "break points". This argues that ditto variable has an important factor on achievements of teams. Good service is an important factor for scoring point in volleyball. Service can be considered as a team's first offensive action. Therefore, team started the game with an effective service higher chance of scoring point. At the end of season, it was observed that top four teams in Aroma league (Fenerbahçe Acıbadem, Vakifbank Gunes Sigorta, Eczacıbaşı and Galatasaray Medical Park) had higher scores for this variable than average, while Karşıyaka and Dicle University which ranked at bottom had lower points than average. This emphasizes the importance of being able to use efficient

service in volleyball competitions [16].

There is a positive correlation between attack effectiveness and scoring points. Effective attack is one of the important factors that determine the performance of teams [16]. In addition, Palao *et al*. [17] stated that reception and effective spikes and blocks are factors that increase success

5. Conclusion

Ace, reception excellent and attack points are variables which are positive in the first dimension and negative in the second dimension play role in determining the performance of teams. Fenerbahce Acibadem Eczacıbasi, Vakifbank Gunes Sigorta, and Galatasaray Medical Park teams, who finishes the league in first four spot, was seen to have higher performances for these values. For both dimensions, variables marked negative such as serve error, reception error, attack error, attack block are variables that have negative impact on the success of teams. Teams finished the league in first four ranks has lower value of these variables. In conclusion it was figured out that using efficient service, block skills and errors made on the offensive were important factors in determining performance. Thus, with practices in these fields will increase technical and tactical capacity of teams.

6. References

[1] Korkmaz, F. and Gültekin, O. Yılı Avrupa Kupa Galipleri Kupası Bayanlar Voleybol Final Karşılaşmalarının Analizi. *Voleybol Bilim ve Teknoloji Dergisi*. 2000, **2**: 25-31.

[2] Häyrinen, M., Hoivala, T. and Blomqvist, M. Differences Between Winning and Losing Teams in Men's European Top-Level Volleyball, In: Performance Analysis of Sport VI. *Cardiff: UWIC*. 2004, pp. 194-199.

[3] Zadražnik, M., Marelić, N. and Rešetar, T. Differences in Rotations Between the Winning and Lossing Teams at the Youth European Volleyball Championships for Girls. *Acta Universitatis Palackianae Olomucensis, Gymnica*. 2009, **39**(4): 33-40.

[4] Eom, H.J. and Schutz, R.W. Statistical Analyses of Volleyball Team Performance. *Research Querterly for Exercise and Sport*. 1992, **63**(1): 11-18.

[5] Hair, J.F., Andersen, R.E., Tatham, R.L. and Black, W.C. *Multivariate Data Analysis*. Prentice Hall, New Jersey. 1998.

[6] Özdamar, K. *Paket Programlar ile İstatistiksel Veri Analizi 2 (Çok Değişkenli Analizler)*. 7th edn. Kaan Kitapevi, Eskişehir. 2010.

[7] Oğuzlar, A. (1995), Çok Boyutlu Ölçekleme ve Kümeleme Analizi Arasındaki İlişkiler. *Uludağ Üniversitesi İ.İ.B.F. Dergisi*, 18(2).

[8] Yiğit, E. *Çok Boyutlu Ölçekleme Yöntemlerinin İncelenmesi ve Bir Uygulama*. Master Thesis, Ondokuz Mayıs University. 2007.

[9] Kalaycı, Ş. *SPSS Uygulamalı Çok Değişkenli İstatistik Teknikleri*. 4th edn., Asil Yayın Dağıtım Ltd. Şti., Ankara. 2009.

[10] Bülbül, S. and Köse, A. Türkiye'de Bölgelerarası İç Göç Hareketlerinin Çok Boyutlu Ölçekleme Yöntemi ile İncelenmesi. *Istanbul University Journal of the School of Business Administration*. 2010, **39**(1): 75-94.

[11] Sağırlı, D., Ediz, B., Cangür, Ş., Ercan, İ. and Kan, İ. Türkiye ve Avrupa Birliği'ne Üye Ülkelerin Sağlık Düzeyi Ölçütlerinin Çok Boyutlu Ölçekleme Analizi ile İncelenmesi. *İnönü Üniversitesi Tıp Fakültesi Dergisi*. 2006, **13**(2): 81-85.

[12] Steyvers, M. *Multidimensional Scaling In: Encyclopedia of Cognotive Science*. Macmillan Reference Ltd. 2002.

[13] Groenen, P.J.F. and Velden, M. *Multidimensional Scaling*. Econometric Institute Report, EI. 2004, (15).

[14] Eleni, Z., Tsigilis, N., Moustakidis, A. and Andromachi, K. Playing Characteristics of Men's Olympic Volleyball Teams in Complex II. *International Journal of Performance Analysis in Sport*. 2006, **1**: 172-177.

[15] Patsiaouras, A., Charitonidis, K., Moustakidis, A. and Kokaridas, D. Comparison of Technical Skills Effectiveness of Men's National Volleyball. *International Journal of Performance Analysis in Sport*. 2009, **9**(1): 1-7(7).

[16] Tsivika, M. and Papadopoulou, S.D. Evaluation of the Technical and Tactical Offensive Elements of the Men's European Volleyball Championship. *Physical Training*. 2008, 2.

[17] Palao, J.M., Santos, J.A. and Ureña, A.Y. Effect of Team Level on Skill Performance in Volleyball. *International Journal of Performance Analysis in Sport*. 2004, **44**(2): 50-60.