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# Multivariate assessment of selected performance indicators in relation to the type and result of a typical set in Men's Elite Volleyball

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**Abstract**

***The aim of this study was to identify volleyball performance indicators that best discriminate between winning and losing teams in a set according to set final score differences. The data were collected from teams' performances (N=350) in all sets played during the 2009 Men's European Volleyball Championship in Turkey. Clusters analysis established three different groups of sets according to set final score difference: 2 points (ambivalent), 3-5 points (safe), >5 points (unbalanced). A 3x2 MANOVA (type of set x type of result) was then performed on 9 performance indicators reflecting % expressions of four basic skills of the game (serve, pass, attack, block). The analysis revealed significant multivariate differences in type of set, in type of results, and in their interaction. A follow-up Discriminant Analysis showed that effectiveness of attack is the most important performance indicator for all types of sets, far more for the ambivalent ones. The discriminant function correctly classified increasing % of cases with increase in score difference. Especially for ambivalent sets 67.3% were correctly classified, letting some space for further improving the critical performance indicators. The results suggest that training of a men's volleyball team should emphasize more to improve offensive abilities.***

**Keywords:** Volleyball, game analysis, set characteristics, performance indicators

## 1. Introduction

Volleyball is being widely analyzed by coaches and experts, particularly through match statistics. Selected set events are quantitatively assessed and proper accurate data are extracted and used for the improvement of certain strategies and training aspects of the game. Relevant analyses focus mainly on the identification of quantitative indicators that are essential to determining performance-specific differences between winning and losing teams (Eom and Schutz, 1992a; Laios *et al.*, 2004; Lobietti *et al.*, 2006). Analysts focus on the score-specific role of performance indicators that are statistically related to the six fundamental technical skills of the game. Three of these skills (serve, attack, block) are offensive and contribute to the scoring process directly, while the other three (pass, set, dig) are defensive and engage to the score indirectly by providing the necessary preconditions to initiate offensive schemes (Nishijima *et al.*, 1987). Maximizing these skills is then of high priority and becomes critical to the team's effectiveness (Palao *et al.*, 2004). Zetou *et al.* (2006, 2007) show that the receiver's ability to make the best pass possible and a "serve-ace" point are the most significant predictors to determine the winner in a game. According to the official rules, the game ends when one of the teams wins three sets (F.I.V.B., 2005) and as a result it is composed of three to five almost independent sets.

Previous data show that winning a set relates directly to some performance indicators even though the score of each set is independent of that in the previous sets (Marcelino *et al*., 2009). The issue is central to trainers and sport analysts, but only three studies present initial results regarding performance indicators, with attack, pass and serve being proposed as the principal predictors of the final outcome in a typical set (Marelic *et al*., 2004; Durkovic *et al*., 2009). Hayrinen *et al*. (2004) used t-tests for independent samples to compare means of the winning and losing teams and concluded that attacking and blocking are the most important skills to win a set in men's elite volleyball. Empirical data usually confirm these results, as, for example, among the large number of sets being completed in a typical volleyball tournament, several of them are definitely characterized by clear differences between the competing teams in terms of performing these technical skills. These sets increase the amount of significance of the performance indicators. Accordingly, given the instantaneous effect of the row score on the continuous interaction between the two opponent teams during each set, an in depth statistical revisit of these three scoring skills (serve, attack, block) plus pass would provide valuable information in maximizing winning potential.

The present study examined the extent to which selected Volleyball performance indicators contribute to immediately winning or losing a point during a set. This was achieved by a simultaneous multi-factorial multivariate design with independent variables (factors) the set final outcome (win or lose) and the set final score difference (ambivalent, safe, unbalanced), and dependent the selected performance indicators. Therefore, the purpose of the present study was to identify skill-related volleyball statistics that best discriminate between winning and losing a set according to set final score differences. Expected results may be of considerable value to coaches and researchers with respect to improving team performance in several contexts and especially in making effective practice and match strategy plans more specific.

## 2. Method

The data were collected from 350 teams' performances in 175 sets played during the 2009 Men's European Volleyball Championship (Turkey). Each team's performance was classified according to set result (win, loss) and set type (ambivalent, safe, unbalanced). Set type categorization was statistically accomplished through k-means clustering (Norusis, 2006) and produced three clusters with the best possible distinction according to set final score difference: a) 2 points (ambivalent sets), b) 3-5 points (safe sets), c) over 5 points (unbalanced sets).

Set statistics were collected by a team of experts working for the European Volleyball Confederation and included percentages (%) of the following nine (9) performance indicators (abbreviations): 1) Serve Errors (SRVErr%), 2) Serve Points (SRVPts%), 3) Pass Errors (PASSErr%), 4) Pass Perfect (PASSPrf%), 5) Pass Excellent (PASSExc%), 6) Attack Errors (ATTErr%), 7) Attacks stuffed by block (ATTBlo%), 8) Attack points (ATTPts%), 9) Block points per set points (BLK/SETp%). Reliability of the data collection and entry was checked by an independent observer on the basis of repeated recordings from a random sample of 35 sets. The produced intraclass correlation coefficients (ICC) proved to be at highly acceptable levels (>0.90). MANOVA was used to simultaneously compare all nine performance indicators (dependent variables) between the three types of sets and between the two set results. As a follow-up to MANOVA a stepwise Discriminant Analysis (DA) was preformed for the purpose of identifying the statistical importance (contribution) of each performance indicator to the separation of the three types of sets and of the two types of results. In particular it was planned to identify for every type of set: a) which performance indicators are best predictors of set final result, b) the discriminant function (equation) that best separates the three group means, and c) the accuracy of the equation that best discriminates between types of results for every type of set. Each discriminant function was interpreted by examination of the structure coefficients (SC) using the criterion og SC∃|.30| (Tabachnick & Fidell, 2006). Validation of the discriminant models was conducted using "leave one out" classification, similar to jack - knifing (Norusis, 2006), with each case being classified by applying the classification function on all the data except the particular case. The statistical analysis was performed using SPSS13 and significances were tested at the $\alpha$=0.05 probability level.

There were no missing values, extreme scores, or outliers in the data set, and the basic statistical assumptions were tested and met. In particular, there was no multicollinearity between the dependent variables, as the simple correlations were all <|0.50|), tolerance values were >.65, and Variance Inflation Factor values were <1.76. The variance-covariance matrices across groups were homogeneous (Box's M= 226.2, p<.132), while the Bartlett Test of Sphericity verified the presence of significant correlations among the nine dependent variables to proceed with the multivariate analysis (approx. $\chi^2$ =1439.6, p<.001).

## 3. Results

The type of set classification produced by the cluster analysis on the total sample resulted in 55 ambivalent (31.5%), 64 safe (36.5%), and 56 unbalanced (32%) sets. As expected, the classification of performances by the type of result was 50% for win and 50% for loss. The descriptive statistics of the nine performance indicators are presented in Table 1. The values of these variables are percentages (%) of the properties they reflect and in that respect the relative variability (SD/Mean) present in this set of data is within acceptable levels for using these variables in multivariate analysis, as it varies from a maximum of about 98% for variable SRVPts% to a minimum of about 19 % for variable ATTPts%. In addition, based on the statistics presented in table 1.2, the nine dependent variables appear not to be affected even by moderate collinearity, as tolerances were high and variance inflation factor values low: for example, .665 & 1.253 for variable ATTPts% to .985 & 1.015 for variable SRVPts%. Therefore all dependent variables were appropriate for multivariate analysis, as they possessed (a) moderate to low variability, which is partially indicative of low measurement error, and (b) very low collinearity, which leads to unstable parameter estimates and inflated standard errors (Pedhazur, 1997, p. 295, 298).

Table 1. Descriptive statistics (M±SD) for the performance indicators (N=350).

| Type of set | Ambivalent | | | Safe | | | Unbalanced | | |
|---|---|---|---|---|---|---|---|---|---|
| Type of result | Loss | Win | Total | Loss | Win | Total | Loss | Win | Total |
| 1. SRVErr% | 16.5±6.8 | 14.0±6.3 | 15.2±6.6 | 18.0±9.0 | 16.0±7.2 | 17.0±8.2 | 18.0±8.5 | 13.3±6.6 | 15.5±8.0 |
| 2. SRVPts% | 4.5±3.9 | 4.6±4.9 | 4.5±4.4 | 3.8±3.7 | 5.7±5.3 | 4.7±4.6 | 2.0±3.1 | 6.7±4.2 | 4.3±4.4 |
| 3. PASSErr% | 6.4±6.6 | 6.2±5.4 | 6.3±6.0 | 9.0±7.4 | 5.7±5.2 | 7.3±6.6 | 8.6±6.9 | 5.3±5.5 | 7.0±6.4 |
| 4. PASSPrf% | 21.0±13.0 | 20.4±12.3 | 20.7±12.3 | 19.4±11.1 | 21.8±14.7 | 20.6±13.0 | 18.9±11.1 | 21.1±12.5 | 20.0±11.8 |
| 5. PASSExc% | 44.5±13.5 | 44.8±15.4 | 44.8±14.4 | 41.0±15.6 | 45.0±15.4 | 43.0±15.6 | 42.6±14.3 | 47.0±19.5 | 44.7±17.2 |
| 6. ATTErr% | 7.2±4.9 | 7.5±5.0 | 7.3±5.0 | 8.9±5.1 | 5.6±4.7 | 7.8±5.5 | 10.3±5.5 | 5.3±4.4 | 7.8±5.5 |
| 7. ATTBlo% | 10.7±5.4 | 9.1±5.4 | 9.9±5.4 | 11.8±5.4 | 7.4±5.1 | 9.6±5.7 | 14.9±6.4 | 6.0±4.5 | 10.5±7.1 |
| 8. ATTPts% | 49.2±8.1 | 54.2±8.7 | 51.7±8.7 | 45.4±9.6 | 51.2±8.4 | 48.3±9.4 | 37.5±8.5 | 56.4±9.1 | 47.0±13.0 |
| 9. BLK/SETP% | 10.7±6.7 | 12.2±5.8 | 11.5±6.4 | 10.0±7.4 | 13.1±5.6 | 11.5±6.8 | 9.3±7.0 | 15.2±6.2 | 12.5±7.2 |
| N | 55 | 55 | 110 | 64 | 64 | 128 | 56 | 56 | 112 |

Table 2. Collinearity diagnostics and Correlations among the performance indicators (N=350).

| | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | Tol. | VIF |
|---|---|---|---|---|---|---|---|---|---|---|
| 1. SRVErr% | 1 | | | | | | | | .961 | 1.041 |
| 2. SRVPts% | -.007 | 1 | | | | | | | .985 | 1.015 |
| 3. PASSErr% | .133 | -.080 | 1 | | | | | | .787 | 1.270 |
| 4. PASSPos% | -.115 | -.006 | -.122 | 1 | | | | | .649 | 1.542 |
| 5. PASSExc% | -.002 | .063 | -.300 | -.500 | 1 | | | | .590 | 1.695 |
| 6. ATTErr% | .007 | .046 | .044 | -.015 | -.097 | 1 | | | .828 | 1.208 |
| 7. ATTBlo% | .090 | -.079 | .182 | -.086 | -.094 | -.033 | 1 | | .700 | 1.429 |
| 8. ATTPts% | -.042 | .038 | -.090 | .041 | .151 | -.311 | -.443 | 1 | .655 | 1.526 |
| 9. BLK/SETP% | -.102 | .015 | -.049 | .053 | -.067 | -.100 | -.158 | -.078 | .902 | 1.109 |

Two tailed critical r value for df= 348 & α=0.05 is 0.1055.
Tol.: tolerance = $1-R_i^2$ , with $R_i^2$ = % variance in common with the other variables.
VIF = $1 / (1-R_i^2)$ = variance inflation factor.

The main results of MANOVA with dependent variables the nine performance indicators and independent the fully crossed factors "type of result" and "type of set" are given in table 3. The linear combination of the nine performance indicators differentiated significantly: (a) the three types of sets (Wilks' Λ = 0.912, F (18, 672) = 1.763, p=0.026, partial $\eta^2$ = 0.045), (b) the two types of results (Wilks's Λ = 0.469, F (9, 336) = 42.2, p< .001, partial $\eta^2$ = 53.1), and (c) their crossed combination (3x2 levels) as reflected by the respective interaction (Wilks' Λ = .659, F (18, 672) = 8.7, p< .001, partial $\eta^2$ = .188). This significant multivariate interaction is indicative of the simultaneous linear effects of both factors on the final set score.

Table 3. Multivariate Tests of Significance

| Effect | Wilks' Lambda Value | F (Hypothesis df, Error df) | Sig. | Partial Eta Squared |
|---|---|---|---|---|
| Type of set | .912 | 1.763 (18, 672) | .026 | .045 |
| Type of Result | .469 | 42.200 (9, 336) | .000 | .531 |
| Set X Result | .659 | 8.665 (18, 672) | .000 | .188 |

Even though univariate results are not necessarily in line with those of the multivariate analyses, for descriptive purposes only, a series of F tests were carried out on each significant main effect of MANOVA and the results are shown in table 4. With respect to the type of result all the variables were highly significant (p< .001) except PASSPrf% and PASSExc% (p=.304 and p=.100, respectively). Almost similar results were found for the univariate F's of the interaction between the two factors, with variables SRVPts%, PASSErr%, ATTErr%, ATTBlo%, ATTPts%, and BLK/SETP% being highly significant (p< .001). An inspection of the mean values (table 1) shows that in all variables representing performance in scoring skills, both in safe and unbalanced sets, there are multivariate differences, showing that the losing teams perform poorly in all skills except pass. On the contrary, for the independent factor "type of set" only ATTPts% was significant (F= 8.698 (2, .067), p< .001) and the particular proportion of explained variance was rather low (partial $\eta^2$ = .048). This finding was further examined by post hoc comparisons using Tukey's HSD (note in table 4), and the results showed a significant difference for that variable between ambivalent and safe sets (p<.05), ambivalent and unbalanced sets (p<.05), but not between safe and unbalanced sets (p>.05).

Table 4. Test of between subjects effects

| Performance | Type of set | | Type of Result | | Set X Result | |
|---|---|---|---|---|---|---|
| Indicators | F | Sig. | F | Sig. | F | Sig. |
| 1. SRVErr% | 1.758 | .167 | 14.155 | .000 | .819 | .442 |
| 2. SRVPts% | .271 | .763 | 23.712 | .000 | 8.132 | .000 |
| 3. PASSErr% | .850 | .429 | 23.925 | .000 | 6.917 | .001 |
| 4. PASSPrf% | .122 | .886 | 1.059 | .304 | .524 | .593 |
| 5. PASSExc% | .471 | .625 | 2.720 | .100 | .629 | .534 |
| 6. ATTErr% | .390 | .677 | 24.958 | .000 | 8.167 | .000 |
| 7. ATTBlo% | .762 | .467 | 72.590 | .000 | 12.394 | .000 |
| 8. ATTPts% | 8.698 | . 000* | 111.050 | .000 | 22.529 | .000 |
| 9. BLK/SETP% | .506 | .603 | 25.501 | .000 | 3.267 | .039 |

* Tukey's test: Ambivalent vs. Safe (p=0.010), Ambivalent vs. Unbalanced (p=0.000), Safe vs. Unbalanced (p=0.429).

The significant MANOVA results were further assessed in terms of the relative importance of the nine performance indicators by a series of follow-up Discriminant analysis (tables 5, 6, 7). The test of equality of the two group means for "type of result" (table 5), collapsed "types of sets", was significant for all performance indicators (p<.000), except for PASSPrf% (p=.281) and PASSExc% (p=.090). With the exception of ATTPts% and SRVErr% a clear trend is apparent for ambivalent sets to present no significant differences in terms of winning or losing a set. To the contrary, for safe sets all variables were significant except SRVErr%, PASSPrf% and PASSExc%, while for unbalanced sets this trend was even stronger as only variables PASSPrf% and PASSExc% were not significant (table 5). The eigenvalues, the canonical correlations, the chi-square values, the respective significances as well as the correct classifications of the respective discriminant functions are presented in table 6. The discriminant functions were all statistically significant (p<.005) and a clear trend of progressive change in these statistics between ambivalent, safe, and unbalanced sets is apparent. The "leave one out" test summarized the ability of the model to correctly classify the sets in their respective final outcome. It is then observed from these results that as the score difference gets smaller (unbalanced to safe to ambivalent sets) the discriminatory power of the particular function gets lower and vice-versa. Accordingly, the canonical correlations decrease from .892 to .410 and the corresponding classifications between win or loss of a set reduce from 98% to 67%.

Table 5.Tests of significance (p values) for the equality of group means

| Performance Indicators | Overall D.A. | Ambivalent Sets | Safe sets | Unbalanced Sets |
|---|---|---|---|---|
| 1. SRVErr% | .000 | .044 | .153 | .002 |
| 2. SRVPts% | .000 | .881 | .023 | .000 |
| 3. PASSErr% | .000 | .898 | .005 | .000 |
| 4. PASSPrf% | .281 | .807 | .298 | .305 |
| 5. PASSExc% | .090 | .979 | .152 | .184 |
| 6. ATTErr% | .000 | .756 | .000 | .000 |
| 7. ATTBlo% | .000 | .110 | .000 | .000 |
| 8. ATTPts% | .000 | .002 | .000 | .000 |
| 9. BLK/SETP% | .000 | .231 | .007 | .000 |

D.A.: discriminant analysis.

Table 6. Discriminant analysis statistics for type of result: win vs. defeat in a typical set

| Type of Result | Overall D.A. | Ambivalent Sets | Safe sets | Unbalanced Sets |
|---|---|---|---|---|
| Eigenvalue | .756 | .202 | .746 | 3.879 |
| Canonical Correlation | .656 | .410 | .654 | .892 |
| Wilks' Lambda | .570 | .832 | .573 | .205 |
| Chi-square | 193.39 | 19.031 | 67.689 | 167.220 |
| df | 9 | 9 | 9 | 9 |
| p | .000 | .025 | .000 | .000 |
| Correct Classification | 79.7% | 67.3% | 82.8% | 98.2% |

To assess the relative contribution of each performance indicator in maximizing the multivariate difference between win and loss (type of result) the (discriminant) structure coefficients were examined (table 7). Structure coefficients ∃.|30| (in bold) are meaningful and indicate substantial contribution of the respective independent variables in the separation between the levels of the dependent variable (Pedhazur, 1997, p. 910). Four performance indicators possessed a meaningful structure coefficient (SC) with regards to the multivariate separation between the two groups of "type of result" (SC values in order of size in parenthesis): ATTPts% (.593), ATTBlo% (-.510), BLK/SETP% (.310), ATTErr% (-.308). The negative signs in two of the variables indicate the presence of bipolarity between the positive effect of ATTPts% and BLK/SETP% and the negative effect of ATTBlo% and ATTErr%. The squared SC values indicated that 35%, 26%, 9.6%, and 9.5%, respectively, of the variance in these four variables is accounted for by the discriminant function. Their combination leads to the substantive interpretation that the main difference between the two groups of sets (won, lost) reflects mainly the status of attack.

This trend was also clearly apparent in the SC values produced by the discriminant function analysis for each level of the "type of set". Only two variables reflected this composite trend (attack status) in each type of set (ambivalent, safe, unbalanced) as indicated by their meaningful SCs: ATTPts% (0.669, -0.374, -0.550, respectively) and ATTBlo% (-0.345, 0.484, 0.402, respectively). Meaningful importance was also possessed for ambivalent sets by variable SRVErr% (-0.437), for safe sets by variable ATTErr% (0.392), and for unbalanced sets by variable SRVPts% (-0.322).

Table 7. Structure Matrix for type of result: win vs. defeat in a typical set.

| Performance Indicators | Overall D.A. | Ambivalent sets | Safe sets | Unbalanced Sets |
|---|---|---|---|---|
| 1. SRVErr% | -.229 | **-.437** | .148 | .150 |
| 2. SRVPts% | .295 | .032 | -.238 | **-.322** |
| 3. PASSErr% | -.299 | -.027 | .294 | .272 |
| 4. PASSPrf% | .067 | -.052 | -.108 | -.050 |
| 5. PASSExc% | .105 | .006 | -.149 | -.065 |
| 6. ATTErr% | **-.308** | .067 | **.392** | .256 |
| 7. ATTBlo% | **-.510** | **-.345** | **.484** | **.402** |
| 8. ATTPts% | **.593** | **.669** | **-.374** | **-.550** |
| 9. BLK/SETP% | **.310** | .258 | -.285 | -.230 |

## 4. Discussion

Overall, the results of this study indicate that attack as a status composed of particular skills constitutes the principal factor of performance in Volleyball. This is in accordance to previous studies proposing attack as the most important and decisive skill for success in the game (Eom and Schutz, 1992b; Palao *et al*., 2004; Marcelino and Mesquita, 2006; Laios *et al*., 2004; Lobietti *et al*., 2006). Our findings show that as the score difference between the two opponent teams reduces its role becomes increasingly important: the more difficult the set, the more decisive the capacity of either team to apply attack actions. The increasing competence of contemporary teams to score points from attack makes score differences in difficult sets smaller. According to Calhoun *et al*. (2002), it is better for the weaker team to increase the probability of winning a rally when receiving the ball. One way or another, the probability of a team in men's volleyball to win a point when receiving the ball is about 65% (Shimazu *et al.*, 1999; Laios and Kountouris, 2009), and this can be done more effectively by successful attacks. The parallel improvement of both teams in this capability increase the effectiveness of "kill" attack and gives teams easy points to reach the final part of the set (after 20 points). For this reason in ambivalent sets the percentage of points won after attack (ATTPts%) is higher than in the other two types of sets.

The statistical approach followed in this study resulted in maximizing the correctness of identifying the performance indicators that best discriminate between winning and losing a set in Volleyball based on the final score difference. This was achieved by combining results of a 2x3 MANOVA with those of follow-up Discriminant Analysis. Instead of examining each potential performance indicator separately their multivariate combination proved to be statistically successful. Thus the results from safe and unbalanced sets demonstrated that as a general trend the losing teams perform poorly in all indicators of scoring skills (serve, attack, block) except pass. Contrary to our initial hypothesis this skill does not seem to determine the end of the action and the winning of a point. Its impact on the outcome of a typical set was rather small, as indicated by the meaningless respective structure coefficients. This is in agreement with Lobietti *et al.* (2006) but in disagreement with Zetou *et al.* (2007). Apparently it may not be enough for a team to receive well in order to win a set, as the skills which largely determine the result of a set are mostly attack related. This finding is in partial agreement with Marelic *et al.* (2004) who used a quality grade and found clear differences in all four performance skills (attack, pass, serve, block) between the sets won and the sets lost. Perhaps combining quantitative results like those produced in the present study with certain qualitative ones may provide a more comprehensive tool of assessing the skills that best discriminate victory from defeat in a typical volleyball set.

According to Karlis & Ntzoufras (2003) in team sports, in general, the match is characterized by the continuous interaction between the two opponent teams. Consequently, the differentiation of important performance indicators according to the score difference is of particular value. Especially in ambivalent sets in volleyball, the skills that mostly determine the final set score are the effectiveness of attack, the avoidance of the opponent block, and the reduction of serve errors. In these types of sets, attack must be successful by initially securing avoidance of potential direct block point by the opponent team. Spiking and blocking in the game are evaluated by their effectiveness as a result of a constant interaction with the opponent at the net, more than the performance itself. In other words, the effectiveness of a spike or block depends also upon the opponent's reaction. Thus, attackers must improve quick estimation of the opponent block at the time of spiking, while equally important is the cover of the attack with which every team is designed to protect the direct touch of the ball to the ground after a stuffed attack by opponent block. Especially in ambivalent sets, besides the reasonable effectiveness of attack, the percentage of serve errors seems to play an important role. The reduction in the number of serve errors increases the probability of winning the set. Obviously, when the difference in the score is small the game must be played "safely" from serve's position. In this way the serving team transfers to the team which receives not only the ball but also the probability of making an unforced error in their three touches of the ball (pass, set, spike). This implies a more conservative tactic in executing the serves and, as a result, a smaller number (%) of passing errors are observed in the ambivalent sets as opposed to the safe and unbalanced sets, as shown in the present study.

In safe sets the three indicators that define attack (% of attack points, % of attack blocks, % of attack errors) proved to be the only substantial discriminators of win and defeat as indicated by their meaningful structure coefficients (>|.30|).Also in safe sets all scoring skills differentiated winning and losing teams except for serve errors. An inspection of the respective mean values shows in this type of set both teams are prone to a bigger percentage of serve errors than in the other two types of sets. The score differences that are created during the set provide a guarantee to the team leading the score to risk in serve and, consequently, to lose more serves. This simply means that teams that try to reduce the score difference by risking in serve end-up with more serve errors.

In unbalanced sets the results allowed a greater discrimination between win and defeat and this was exclusively based on the % attack points, the % attack blocks, and the % serve errors. As a general trend, winning teams exhibit better performance values than losing teams. However training in elite men's volleyball should mainly focus on attack in two ways. First, by increasing direct effectiveness and avoidance of direct stuffed attack by opponent's block, and second, by reducing direct attacking errors. Especially in ambivalent sets, coaches must have several versions of offensive scenarios to reinforce their potentiality in attack and they must prepare all players, starters or non starters, to be ready to gain a point from this skill.

Regarding accuracy of the discriminant functions, a tendency was revealed for the percentage of correct classification of cases to increase along the increase in the score difference. In a similar approach by Marelic *et al.* (2004) about 83% correct classifications were produced, though based on statistics from only one team. In the present study the discriminant function equation classified correctly about 98% of the unbalanced sets, 83% of the safe sets, and 67% of the ambivalent sets, which are finished with the minimum difference of two points. In a recent analysis Drikos (2009) used data from only one team and found no significant discriminant function for sets with a final score difference of 2-3 points. Thus, the creation of a discriminant equation for ambivalent sets in tournaments as competitive as Men's European Championship points-out the necessity for further research in two directions: (a) to determine the hierarchy of variables which can increase the percentage of correct discriminant classification, and (b) to investigate the relationship between performance and randomness in the variation of the result. If the approximately 30% of the sets that end-up with a final score difference of two points are not won by the team with the best performance in the basic technical skills of the game, then the rules that define the end of the set (score difference of at least two points) should be adapted to correct for this inconsistency.

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