Game-Related Performance Factors in four European Men’s Professional Volleyball Championships

by
Javier Peña1, Martí Casals1,2,3

The present study was designed to assess the relevance of game-related performance factors as outcome predictors in high-level volleyball. To carry out the analysis, the official box scores of 399 matches played by 47 different teams in four different European male professional volleyball leagues (Italy, Poland, Germany and Turkey) during the 2013-14 regular season were analyzed. A logistic mixed model was performed to determine the effects of different variables in matches’ outcomes. According to the multivariate analysis the following factors were significantly associated with winning matches: the number of scorers (OR = 1.32; CI: 1.09 – 1.59), service errors (OR = 0.91; CI: 0.87 – 0.95), service points (OR = 1.25; CI: 1.15 – 1.36), reception errors (OR = 0.79; CI: 0.74 – 0.84), the percentage of positive receptions (OR = 1.02; CI: 1.00 – 1.04) and blocked balls (OR = 1.17; CI: 1.11 – 1.26). Team category 2 (OR = 0.39; CI: 0.24 – 0.63) and team category 3 (OR = 0.15; CI: 0.09 – 0.25) were significantly associated with losing matches. These findings can contribute to a better understanding of performance indicators in professional volleyball, helping coaches and decision makers to better determine the importance of particular game factors.

Key words: performance analysis, volleyball, logistic mixed models, official box scores, team sports.

Introduction

Today, understanding performance is a major issue within the field of performance analysis. Contemporary performance analysis studies play an important role in advancing scientific understanding, providing coaches with a more ecological knowledge and analyzing the game from a more complex point of view (Drust, 2010).

Performance factors and their relation with games’ outcomes have been objects of research in volleyball since the 1990s. Early examples of research into performance factors include the study of Eom and Schutz (1992) analyzing matches from the third Federation of International Volleyball Cup men’s competition. In recent years, an increasing number of performance analysis studies focused on volleyball has been observed, aiming at finding correlations between different elements of the game and an increased chance of winning matches (Campos et al., 2014; Kountouris et al., 2015; Monteiro et al., 2009; Rodríguez-Ruiz et al., 2011; Silva et al., 2014). Similarly, some of them tried to predict the outcome of a game using some key variables and tailored mathematical and statistical formulas (Marcelino et al., 2011; Miskin et al., 2010; Peña et al., 2013). Zetou et al. (2006, 2007) assessed the effectiveness of different skills grouped in tactical complexes with interesting findings for each of them. According to their research, the most determinant factor to score points playing in Complex I (attack phase) was a direct point from the first attack after reception, while during Complex II (counterattack phase)
the best predictors were direct points coming from a service (aces) and direct points coming from attack actions. However, no categories of blocking or defense seemed relevant to predicting the final outcomes of matches. Palao et al. (2004) in an earlier study reported that blocking was the most important skill for high-ranked male and female teams in the 2000 Olympic Games, observing a significant reduction in block errors and better reception, attack, block and defense effectiveness in teams with a higher final ranking. Patsiaouras et al. (2011) supported this view, stating that blocking was a significant factor in game outcomes of the 2006 men’s World Championship. Additionally, their findings revealed that reception errors and service points were of similar significance to blocking for winning or losing a match. Rodríguez-Ruiz et al. (2011) in an analysis of the 2009 men’s European Championship, observed that the attack was the highest point-scoring game action, but in even matches (with sets ending in more than 25 points or tie break sets), the points scored by blocking became crucial for obtaining a positive final outcome. More recent studies carrying out volleyball game-analysis revealed interesting new facts deserving to be brought to light. Peña et al. (2013) in a research study analyzing 125 matches of the Spanish men’s volleyball professional championship observed that the category of the team, the number of points obtained in Complex II, the number of reception errors and the number of blocked attacks by the opponent were significant statistical predictors of winning or losing the match. Similarly, Silva et al. (2014) studying 24 games from the men’s 2010 World Championship found that service points, reception errors and blocking errors were the variables with a higher discriminatory power to predict the outcome of the match, while service points were the variable with a stronger association with match success. Campos et al. (2014) in an interesting study comparing the outcomes of Brazilian and Italian women’s volleyball leagues, reported that in these professional leagues a home advantage effect was observed, and that the performance indicator most highly correlated with winning was the attack. A longitudinal study by Kountouris et al. (2015) comparing the effectiveness of the five volleyball major skills (service, reception, attack, block and dig) during the last four editions of the Olympic Games, reported interesting differences between male and female teams. The authors’ analyses showed that service faults, successful attacks and faulty blocks prevailed in the game of men when compared with women.

The aim of our study was to identify game-related performance factors of four high-level European male volleyball professional leagues, to determine which of them were more relevant, setting some new variables and applying this knowledge to the practical field.

Material and Methods

The study sample consisted of 399 matches played by 47 teams during the 2013-14 regular season in four different European male professional volleyball leagues: Italy (n = 130), Poland (n = 90), Germany (n = 100) and Turkey (n = 80). All the data were retrieved from the official box scores published on the official websites of each professional league. The official box scores provided information on the game statistics analyzing teams’ collective behavior. These game-related statistics are of general use among volleyball coaches, managers and other decision makers, and had been used in the past in several studies (Silva et al., 2014; Campos et al., 2014).

No informed consent was necessary as the used information is public and available on the different leagues official websites.

Measures

The following variables were analyzed: (a) result of the game using a binary variable (1, won match; 0, lost match), (b) a home/away court factor, (c) the team category according to the final ranking of the teams at the end of the regular season (category 1 for the teams ranked 1–4, category 2 for the teams ranked 5–8, and category 3 for the teams ranked 9–12), (d) the number of scorers (considering a scorer a player with a total contribution of at least 10 points), (e) points obtained in Complex II, (f) service errors, (g) service direct points, (h) the number of reception errors, (i) the number of positive receptions, (j) the percentage of positive receptions, (k) the percentage of perfect receptions, (l) the percentage of positive receptions, (m) attack errors, (n) blocked attacks, (o) attack points, and (p) block performances of both teams.

Most of the above-mentioned variables
are well known by volleyball researchers and practitioners despite being of different nature (binary, modifiable by training and uncontrollable); however, in the present study we tried to understand variations in team performances using the game-by-game context of four elite European volleyball leagues. In addition, we introduced a new variable i.e. the number of scorers, considering a player highlighted in scoring when his overall contribution to the team was equal or greater than 10 points.

**Statistical analysis**

A descriptive study was carried out on qualitative and quantitative variables to characterize the study population by frequency distribution for qualitative variables as well as by a central tendency and precision measurement for quantitative variables.

To study the factors considered as predictors of winning matches we used a logistic mixed model assuming a binomial error distribution and the logit link function. The logistic mixed model is also known in the literature as a generalized linear mixed model (GLMM), a hierarchical generalized linear model (HGLMs) and a multilevel generalized linear model (MGLMs) depending on the field (Christensen et al., 2014; Garson et al., 2012; Lee et al., 2006).

On the basis of the works of Bolker (2009), Thiele (2012) and Casals (2014), a list of relevant information and basic characteristics of the logistic mixed model was reported. The model expression for team i in its jth games is the following: logit \( (\pi_{ij}) = \log(\pi_{ij}/1- \pi_{ij}) = X_{ij} \beta + u_i \) where \( \pi_{ij} \) is the probability of winning a match and \( X \) includes all independent variables of interest. The vector \( \beta \) contains the fixed effects, whereas \( u_i \) is the random effect corresponding to team i. The random effects are assumed to be independent and normally distributed: \( u_i \sim N(0, \sigma_u^2) \), where \( \sigma_u^2 \) is the variance of random effect. The model accounted for repeated measures and the fact that the values of \( X \) could change from one game to the next.

As suggested by Crawley (2007), model simplification was performed by backward selection of variables from the full model, and models were compared using the likelihood ratio test (LRT) until a minimal adequate model was obtained. Model selection was based on the Akaike Information Criterion (AIC). To estimate the model parameters we used the Gauss-Hermite quadrature (GHQ) with 10 points (Bolker, 2009). The statistical significance of the fixed effects associated with the covariates included in the model was assessed using the Wald test. We checked the correlation and the main possible interactions among the covariates in the final model. Possible over-dispersion in the model was studied using a Pearson’s dispersion parameter, applying values above 1.5 as the criterion for over-dispersion (Bolker, 2009). Finally, in order to assess the predictive or discriminatory ability of the model we performed the area under the curve (AUC) (Lopez-Raton et al., 2014).

All statistical analyses were performed using the statistical package R (The R Foundation for Statistical Computing, Vienna, Austria), version 3.1.1. We used the main package for mixed models called lme4 (Bates et al., 2014). The relationships were determined by the odds ratio (OR) and their 95% confidence intervals (CI). Statistical significance was set at alpha <0.05.

**Results**

Table 1 summarizes all of the variables employed in this study for game-related statistics. Moreover, this table shows the descriptive results for all stratified performance factors in the European leagues studied.

Table 2 shows the logistic mixed model for all European leagues assessed, including all the variables of interest. According to the multivariate analysis, the following variables were significantly associated with winning matches: the number of scorers, a team category, service errors, service points, reception errors, the percentage of positive receptions and blocked balls.

A positive, but non-significant relationship between the court and game outcome in the model was also observed. However, it must be acknowledged that there was weak evidence of the importance of this variable, as the AIC of the model was better than the simpler model without the home court variable. The team-level variance was 0.05. The AUC value of the model showed an appropriate performance (AUC: 0.86; 95%CI: 0.84 – 0.89).
Table 1

| Factor                                | [ALL] N=798 | Italy N=264 | Germany N=195 | Poland N=177 | Turkey N=162 |
|---------------------------------------|-------------|-------------|---------------|--------------|--------------|
| Winning matches                       |             |             |               |              |              |
| No                                    | 397 (49.7%) | 132 (50.0%) | 96 (49.2%)    | 88 (49.7%)   | 81 (50.0%)   |
| Yes                                   | 401 (50.3%) | 132 (50.0%) | 99 (50.8%)    | 89 (50.3%)   | 81 (50.0%)   |
| Court                                 |             |             |               |              |              |
| Away                                  | 397 (49.7%) | 132 (50.0%) | 96 (49.2%)    | 88 (49.7%)   | 81 (50.0%)   |
| Home                                  | 401 (50.3%) | 132 (50.0%) | 99 (50.8%)    | 89 (50.3%)   | 81 (50.0%)   |
| Team Category                         |             |             |               |              |              |
| Team category 1                       | 265 (33.2%) | 88 (33.3%)  | 53 (27.2%)    | 54 (30.5%)   | 70 (43.2%)   |
| Team category 2                       | 278 (34.8%) | 87 (33.0%)  | 70 (35.9%)    | 71 (40.1%)   | 50 (30.9%)   |
| Team category 3                       | 255 (32.0%) | 89 (33.7%)  | 72 (36.9%)    | 52 (29.4%)   | 42 (25.9%)   |
| NScorers                              | 2.61 (1.17) | 2.54 (1.15) | 2.67 (1.24)   | 2.68 (1.20)  | 2.56 (1.09)  |
| NScorers categorical                  |             |             |               |              |              |
| <3 scorers                            | 348 (43.6%) | 124 (47.0%) | 81 (41.5%)    | 73 (41.2%)   | 70 (43.2%)   |
| >=3 scorers                           | 450 (56.4%) | 140 (53.0%) | 114 (58.5%)   | 104 (58.8%)  | 92 (56.8%)   |
| Break points                          |             |             |               |              |              |
| Median (IQR)                          | 23 (16-27)  | 21 (15-26)  | 24 (17-27)    | 23 (17-27)   | 23 (17-27)   |
| Service errors                        |             |             |               |              |              |
| Median (IQR)                          | 14 (11-17)  | 15 (12-17)  | 13 (10-16)    | 13 (11-17.5) | 13.5 (11-16) |
| Service points                        |             |             |               |              |              |
| Median (IQR)                          | 4 (3-6)     | 4 (3-6)     | 4 (3-6)       | 4 (3-6)      | 4 (2-6)      |
| Total reception errors                |             |             |               |              |              |
| Median (IQR)                          | 5 (3-8)     | 6(4-9)      | 4 (2-5)       | 4 (3-6)      | 8 (5-10)     |
| Percentage positive receptions        |             |             |               |              |              |
| Median (IQR)                          | 54 (47-60.25)| 56 (49-61)  | 56 (48-63)    | 48 (41-55)   | 57 (51-62)   |
| Percentage perfect receptions         |             |             |               |              |              |
| Median (IQR)                          | 31 (24-39)  | 30.5 (25-38)| 28 (22-36)    | 27 (20-33)   | 43 (35-47)   |
| Attack errors                         |             |             |               |              |              |
| Median (IQR)                          | 8 (5.75-10) | 7 (5-9)     | 9 (7-12)      | 7 (5-9)      | 8 (6-11)     |
| Opponent Blocks                       |             |             |               |              |              |
| Median (IQR)                          | 10 (7-12)   | 9 (6-11)    | 10 (7-13)     | 11 (8-13)    | 9 (7-12)     |
| Attack points                         |             |             |               |              |              |
| Median (IQR)                          | 45 (37-53.25)| 44 (36-51)  | 46 (37-56)    | 46 (38-52.5) | 47.5 (38-54) |
| Blocked balls                         |             |             |               |              |              |
| Median (IQR)                          | 10 (7-12)   | 9 (6-11)    | 10 (7-13)     | 11 (8-13)    | 9 (7-12)     |

*IQR: interquartile range*
Table 2

| Variables            | Estimate | SE   | OR (95% CI)       | p   |
|----------------------|----------|------|-------------------|-----|
| Intercept            | -1.332   | 0.735| 0.263 (0.062 - 1.115) | 0.070 |
| Home court           | 0.293    | 0.184| 1.341 (0.933 - 1.926) | 0.112 |
| Number of scorers    | 0.278    | 0.096| 1.321 (1.092 - 1.598) | 0.004 |
| Team category 2      | -0.921   | 0.237| 0.397 (0.249 - 0.633) | <0.001 |
| Team category 3      | -1.868   | 0.257| 0.154 (0.093 - 0.255) | <0.001 |
| Service errors       | -0.085   | 0.022| 0.918 (0.878 - 0.959) | <0.001 |
| Service points       | 0.229    | 0.041| 1.257 (1.158 - 1.365) | <0.001 |
| Reception errors     | -0.227   | 0.032| 0.796 (0.746 - 0.849) | <0.001 |
| % Positive receptions| 0.022    | 0.096| 1.022 (1.003 - 1.042) | 0.020 |
| Blocked balls        | 0.165    | 0.029| 1.179 (1.112 - 1.264) | <0.001 |

SE: standard error

Discussion

The number of scorers, the team category, service errors, service points, reception errors, the percentage of positive receptions and blocked balls were found as volleyball performance factors in our study. Coaches and practitioners can use these findings to anticipate a positive or negative game outcome and to study in detail the most relevant factors to improve during practices to achieve a better technical outcome.

Statistical methods commonly used in sport sciences focus on generalized linear models (GLMs) such as counts or proportions (Poisson or logistic regressions). Only a small number of studies consider the correlation structure of repeated measures or recurrent events. Future studies should consider repeated measures and apply the appropriate model. Ignoring the correlation of observations between teams may, for example, lead to underestimation of the standard error. For this reason, sports researchers have started to use statistical models such as logistic mixed models that take into account heterogeneity between teams (Bullock et al., 2009; Casals et al., 2013; Gomez et al., 2014; Sampaio et al., 2010).

To our knowledge, the number of scorers is a variable never used before in research about performance analysis in volleyball. In a sport with the main characteristics of volleyball, it seems quite logical that dividing the total attack load among several players may lead to opponents’ block impairment. Nevertheless, frequently in men’s volleyball we observe a single player bearing this scoring responsibility. From our findings we can understand that sharing the score contribution between 3 or more players is significantly more effective for a positive team performance, increasing the likelihood of winning a match by 1.32 times for each additional player scoring 10 points or more at the end of it.

Belonging to the group of teams ranked from 1 to 4 (category 1) seems to be a significant factor in increasing the probability of winning more matches in all the analyzed leagues, although the teams’ final rankings are a direct product of the number of games won. Besides questions concerning budgets and quality of players in the higher category teams, volleyball is one of the team sports with a lower degree of uncertainty in the game outcomes owing to its structure. This differs from some other sports of the same family with opponent direct
interference. These findings are consistent with those of Peña et al. (2013) who found a similar effect for team categories in the Spanish men's professional volleyball league.

The importance of the service skill in volleyball has been shown in several reports before (Hughes and Daniel, 2003; Patsiaouras et al., 2011; Silva et al., 2014; Zetou et al., 2006). Since the introduction of the rally point system by the F.I.V.B. in 1999, production of Complex-I has balanced the competitive performance of top teams. Thus, the ability of the service to impair directly or indirectly the development of this game phase on the opposing team is clearly related to the final outcome in the competition. The results of our analysis show that the odds of winning a volleyball match increase 1.2 times with every additional service direct point. In contrast, chances of obtaining a positive game outcome decrease by 8.2% for each additional service error. These findings are also consistent with previous research on the matter (Kountouris et al., 2015) showing that error management can be even more important than achieving direct points when using the service skill.

Along the same lines, the management of reception is also paramount in volleyball, as the ability of the players to reduce direct errors has been revealed in our research as a relevant performance factor. These results match those observed in previous studies (Peña et al., 2013; Silva et al., 2014) and show that reducing errors in this skill can be of outmost importance as it has a direct negative impact on the number of points obtained in Complex II skills by the opposing team. This study also demonstrated that improving the team percentage of positive receptions can unbalance the final outcome. Although some research had stated otherwise (Peña et al., 2013), our findings display increased odds of winning a match when increasing this value. Increasing the number of positive receptions by 1% will give a team 1.02 more odds of winning when compared to a team with 1% fewer positive receptions. On the question of blocked balls, this research found that the team's capacity to neutralize the opponents' attacks with the first line of defense can be linked to obtaining a victory, with several studies agreeing with our findings (Palao et al., 2004; Rodriguez-Ruiz et al., 2011). It seems that when matches become tied, the ability to block comes to be decisive in obtaining the victory in volleyball. In contrast to previous findings (Campos et al., 2015; Eom and Schutz, 1992; Rodriguez-Ruiz et al., 2011; Zetou et al., 2006, 2007), no evidence of any of the attack categories becoming a performance predictor was found in our analyses. In today's volleyball, with an increased frequency of high attacks, the importance of this technical skill seems to be decreasing, matching the competitive opportunities of teams with lower attack potential.

Previous studies evaluating the home-court advantage effect provided inconsistent results on whether playing in a specific venue might be an asset for volleyball teams. Some of them have observed no effects in some leagues (Peña et al., 2013), while others found this factor important exclusively during the initial set of the match (Marcelino et al., 2009). Contrary to expectations, our study found increased odds of winning for the teams playing at home (1.34 times).

**Conclusions**

The main goal of the current study was to determine which performance factors influenced most the outcome of high-level volleyball games. Logistic mixed models appear to be a powerful statistical approach to identify key performance indicators in volleyball. We can conclude that the number of team scorers, the team category, the number of service errors, service points, reception errors, blocked balls, the percentage of positive receptions and the venue are game-related performance factors. Several of these variables can be clearly modified and improved by training, thus, coaches should reconsider their importance in the game and the amount of practice necessary to improve the technical, tactical and physical fitness aspects of each of them. To diversify the number of team main scorers, improving error management and making the right managerial and organizational decisions seems crucial in order to improve performance at the top level, with some skills and factors showing more predictive power than others. At present, winning a volleyball game is becoming increasingly complex and factors at different levels can affect positively and negatively the final outcome.
Acknowledgements

No part of this study has been previously published, nor being under consideration for publication elsewhere. No funding was received in support of this work. The authors declare that they have no conflict of interest relevant to the content of this manuscript and would like to thank Mr. Jorge Rodriguez-Guerra and Mr. Daniel Moreno-Galcerán for their valuable assistance in the data collection process.

References

Bates D, Maechler M, Bolker B, Walker S. Fitting Linear Mixed-Effects Models using lme4. R Journal of Statistical Software, 2015

Bolker B, Brooks M, Clark C, Geange S, Poulsen J, Stevens M, White JSS. Generalized linear mixed models: a practical guide for ecology and evolution. Trends Ecol Ecol, 2009; 24(9): 127-35

Bullock N, Hopkins W. Methods for tracking athletes’ competitive performance in skeleton. J Sports Sci, 2009; 27(9): 937-40

Casals M, Martinez J. Modelling player performance in basketball through mixed models. International Journal of Performance Analysis in Sport, 2013; 13: 64-82

Casals M, Girabent-Farres M, Carrasco J. Methodological quality and reporting of generalized linear mixed models in clinical medicine (2000-2012): a systematic review. PLOS One, 2014; 9(11)

Campos FAD, Stanganelli LCR, Campos LCB, Pasquarelli BN, Gómez MA. Performance indicators analysis at Brazilian and Italian women’s volleyball leagues according to game location, game outcome, and set number. Percept Motor Skills, 2014; 118(2): 347-361

Crawley M. The R book. Chichester: Wiley; 2007

Drust B. Performance analysis research: Meeting the challenge. Journal of Sports Sciences, 2010; 28(9): 921–922

Eom HJ, Schutz RW. Statistical analyses of volleyball team performance. Research Quarterly for Exercise and Sport, 1992; 63(1): 11-18

Garson GGD. Hierarchical linear modeling: Guide and applications. Los Angeles: Sage Publications; 2012

Gomez MA, Lago-Peñas C, Viaño J, González-García I. Effects of game location, team quality and final outcome on game-related statistics in professional handball close games. Kinesiology, 2014; 46(2): 249-257

Kountouris P, Drikos S, Aggelonidis J, Laios A. Evidence for differences in men’s and women’s volleyball games based on skills effectiveness in four consecutive Olympic tournaments. Comprehensive Psychology, 2015; 4: article 9, ISSN 2165-2228

Lee Y, Nelder JA, Pawitan Y. Generalized linear models with random effects: Unified analysis via H-likelihood. Boca Raton, FL: CRC Press; 2006

Lopez-Raton M, Rodriguez-Alvarez MX, Cadarso-Suárez C, Gude-Sampedro F. Optimal Cutpoints: An R Package for Selecting Optimal Cutpoints in Diagnostic Tests. Journal of Statistical Software, 2014; 61(8): 1-36

Marcelino R, Mesquita I, Palao JM, Sampaio J. Home advantage in high-level volleyball varies according to set number. J Sport Sci Med, 2009; 8(3): 352-356

Miskin MA, Fellingham GW, Florence LW. Skill importance in women’s volleyball. Journal of Quantitative Analysis in Sports, 2010; 6: article 5

Monteiro R, Mesquita I, Marcelino R. Relationship between the set outcome and the dig and attack efficacy in elite male Volleyball game. International Journal of Performance Analysis in Sport, 2009; 9: 294-305

Palao JM, Santos JA, Ureña A. Effect of team level on skill performance in volleyball. International Journal of Performance Analysis in Sport, 2004; 4: 50-60

Patsiouras A, Charitonidis K, Moustakidis A, Kokaridas D. Technical Skills Leading in Winning or Losing
Volleyball Matches During Beijing Olympic Games. *Journal of Physical Education and Sport*, 2011; 11(2): 39-42

Peña J, Rodríguez-Guerra J, Busca B, Serra N. Which skills and factors better predict winning and losing in high-level men’s volleyball? *J Strength Cond Res*, 2013; 27(9): 2487-93

Rodríguez-Ruiz D, Quiroga M, Miralles JA, Sarmiento S, de Saá Y, García-Manso JM. Study of the Technical and Tactical Variables Determining Set Win or Loss in Top-Level European Men’s Volleyball. *International Journal of Performance Analysis in Sport*, 2011; 7(1): 7-7

Sampaio J, Drinkwater E, Leite N. Effects of season period, team quality, and playing time on basketball players’ game-related statistics. *Eur J Sport Sci*, 2010; 10(2): 141-9

Stryhn H, Christensen J. The analysis-Hierarchical models: Past, present and future. *Prev Vet Med*, 2014; 11(3): 304–312

Silva M, Lacerda D, Joao PV. Game-Related Volleyball Skills that Influence Victory. *J Human Kinet*, 2014; 41: 173–179

Thiele J, Markussen B. Potential of GLMM in modelling invasive spread. *CAB Reviews Perspectives in Agriculture Veterinary Science Nutrition and Natural Resources*, 2012; 7(017): 1-12

Zetou E, Tsigilis N, Moustakidis A, Komninakidou A. Playing characteristics of men’s Olympic Volleyball teams in complex II. *International Journal of Performance Analysis in Sport*, 2006; 6(1): 172-177

Zetou E, Moustakidis A, Tsigilis N, Komninakidou A. Does Effectiveness of Skill in Complex I Predict Win in Men’s Olympic Volleyball Games? *International Journal of Performance Analysis in Sport*, 2007; 3: article 3

**Corresponding author:**

**Javier Peña**

Sport Performance Analysis Research Group, University of Vic, Spain.
Sagrada Família, 7, 08500 Vic, Barcelona, Spain.
Phone: +34 938 816 164
Fax: +34 938 891 063
Email: javier.pena@uvic.cat