HUMAN MOVEMENT
2015, vol. 16 (1), 33– 35

# THE EFFECTS OF ACOUSTIC DISTURBANCE ON ANAEROBIC ENDURANCE IN FEMALE VOLLEYBALL PLAYERS

doi: 10.1515/humo-2015-0024

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ABSTRACT
**Purpose.**The purpose of the study was to assess anaerobic endurance in volleyball players through repeated vertical jump performance under quiet and noisy conditions. **Methods.** A group of 12 female players aged 19–28 year completed six sets of eight standing vertical jump jumps; jump height and heart rate before and after the protocol were measured in quiet and noisy (fan cheering) conditions. **Results.** Maximum and minimum vertical jump heights were higher and intragroup differences were smaller in noisy than quiet conditions. **Conclusions.** Vertical jump testing, a measure of physical activity typical of volleyball, is suitable for monitoring training effects. The influence of noise typical during volleyball matches had a positive effect on player performance and anaerobic endurance.

**Key words:** vertical jump, anaerobic endurance, volleyball

## Introduction

When compared with other team sports, there is no physical contact between players in volleyball. A volleyball match consists of active and passive phases, where the duration of active play ranges between 2.2–55 s and is separated by 5.5–12 s intervals [1, 2]. The specific movements in volleyball are executed in various plays and include starts from various positions, various steps, advances, sprints up to 10 m, and jumps such as the standing vertical jump and run-up jump. The game structure and tasks of volleyball require players to perform multiple short maximal exertions, the most typical being jumps, with performance determined by lower extremity strength. This can be measured by recording maximum jump height orby performing multiple jumps in succession. As jumping ability has been found to be a critical component of success in volleyball [3–5], training has thus focused on shaping jumping skills and lower body strength. Loaded jumps are often used to develop leg extensor strength, force, and power in order to increase vertical jump height [6–8].

Research has indicated that the number of jumps performed in a game depends on playing position and ranges from 65 to 136 jumps in a five-set match [1]. During game play, the onset of fatigue reduces jumping velocity and power and therefore jump height. While high anaerobic capacity is a determinant of player efficacy in a match, there is no research on the effects of ambient conditions typical in competitive play, in particular motivating factors such as cheering fans.

Therefore, the aim of the study was an assessment of the effects of typical spectator noise during game play on the anaerobic capacity of female volleyball players by measuring repeated maximal standing vertical jump performance.

## Material and methods

A group of 12 female volleyball players from a Polish second league club (AZS AWF UKSW Warszawa) volunteered to participate in the study (mean: age 22.8 ± 3.0 years, body height 177.6 ± 6.8 cm, body mass 72.7 ± 5.7 kg, training experience 4.9 ± 2.0 years).

Standing vertical jump performance was measured in February 2014 during afternoon hours in a sport hall. Participants each performed six sets of eight standing vertical jumps interspersed with 15 s of rest after completing a warm-up. Vertical jump performance was assessed twice, separated by a 7-day interval. The first measurement was conducted in quiet conditions (no disturbing noise), the second was accompanied by noise (30 dB) of recorded cries, trumpets, whistles, drums, etc. by live spectators. The highest and lowest vertical jumps in each set were recorded. Heart rate in beats per minute (bpm) was measured immediately before and after the vertical jump protocol.

A performance index (PI) was calculated as the ratio of mean jump height in each set to the maximum value in that set [9–13]. The differences between means were assessed with Student's *t* test for dependent values. Pearson's correlation coefficients were computed between the maximum jump heights and body height and PI. A significance level of $p \leq 0.05$ was adopted.

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**Results**

The results are presented in Table 1 and Figures 1–4. Both the lowest and highest jumps recorded under noisy conditions were significantly higher than in quiet conditions ($p < 0.001$ and $p < 0.05$, respectively). No condition-related differences in heart rate were observed.

The maximum jump height/body height relationship showed a high coefficient of determination ($r^2 = 0.945$), allowing maximum jump height to be predicted from the regression equation with a prediction error of only ± 2.4 cm.

Considering all six sets of eight vertical jumps, maximum jump height was significantly ($p < 0.05$) higher

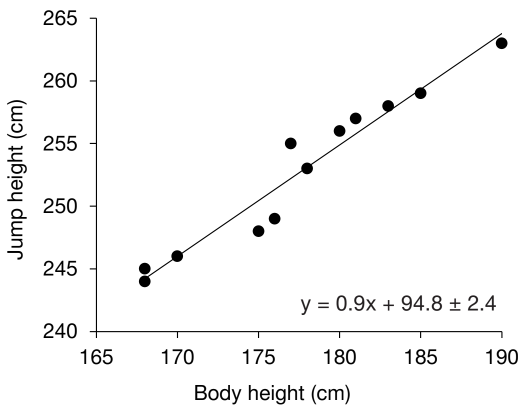


Figure 1. Relationship between maximum jump height and body height

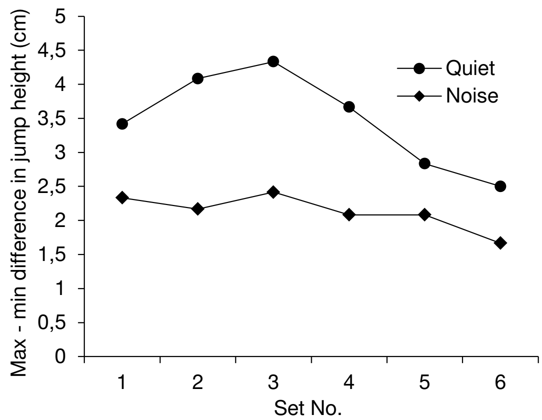


Figure 3. Mean maximum–minimum differences in jump heights

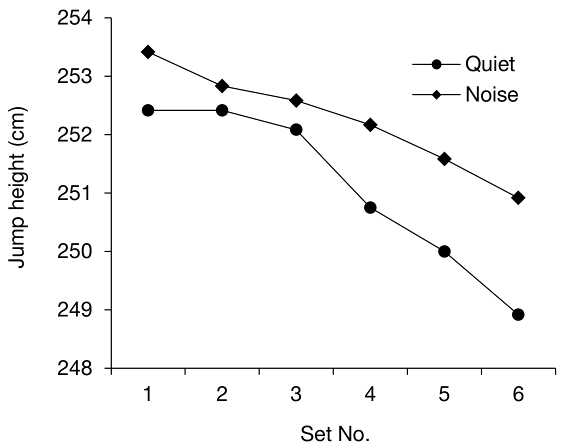


Figure 2. Mean values of maximum jump height

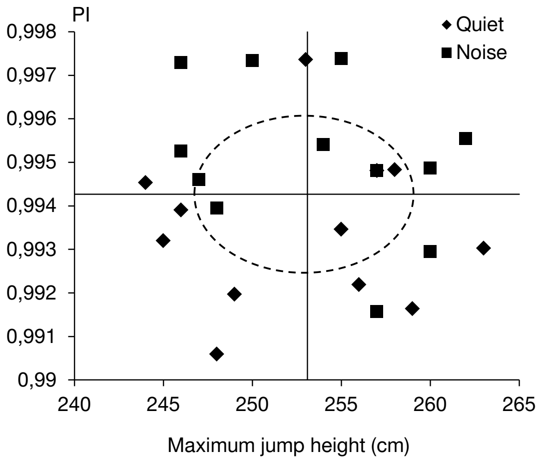


Figure 4. Relationship between maximum jump height and performance index (PI)

Table 1. Mean values (± *SD* and value ranges) of sample characteristics and analysed variables

| Variable | Quiet | Noise |
|---|---|---|
| Age (years) | 22.8 ± 3.0 (19–28) | |
| Body height (cm) | 177.6 ± 6.8 (168–190) | |
| Body mass (kg) | 72.7 ± 5.7 (65–83) | |
| BMI | 23.1 ± 1.5 (21.3–26.0) | |
| Training experience (years) | 4.9 ± 2.0 (3–8) | |
| Maximum jump height (cm) | 252.8 ± 6.2 (263–244) | 253.5 ± 5.9* (246–262) |
| Minimum jump height (cm) | 246.3 ± 6.1 (239–256) | 249.3 ± 5.4*** (242–258) |
| Performance index (PI) | 0.987 ± 0.002 (0.984–0.999) | 0.992 ± 0.003** (0.992–0.994) |
| HR pre-exertion (bpm) | 105.7 ± 5.7 (97–115) | 106.7 ± 6.1 (99–116) |
| HR post-exertion (bpm) | 124.8 ± 6.2 (116–135) | 126.8 ± 7.0 (118–137) |

Significantly different from 'Quiet': * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

in noisy than quiet conditions (Figure 2) and the same was true ($p < 0.001$) for the differences between maximum and minimum jump heights, especially in the first four sets of jumps (Figure 3).

The values of the performance index (PI) recorded in noisy conditions were significantly ($p < 0.01$) higher than in quiet conditions (Table 1). In both instances, the PI values were not significantly correlated with maximum jump height (Figure 4).

## Discussion

In team sports, athletes who are able perform all necessary game actions at a high level of performance throughout the entirety of a match, i.e. are resistant to fatigue, are highly ranked. This study assessed volleyball players with repeated vertical jump testing and by calculating a performance index. Although this index was not correlated with maximum jump height, both factors may be useful in planning training load and in classifying/selecting players [12, 14]. As plotted in Figure 4, participants who attained the highest jump heights and largest PI values are found in the upper right sector of the scatter plot, whereas less efficient athletes were grouped in the lower left sector. This allows us to determine those athletes that need to concentrate on improving jump height (upper left sector) or who need to focus on increasing anaerobic endurance (lower right sector), or those who show average qualities, as plotted in the centre within one standard deviation of both variables.

The results are indicative of significantly better performance when exposed to match-specific noise. Such an approach allows trainers and coaches to select the best conditions to shape specific skills. It may be assumed that under quiet conditions, athletes concentrated more on the task at hand and this may have increased fatigue. Noise, in turn, may have diverted attention from fatigue induced by the vertical jump protocol. Future research is needed to confirm the above by rating the perceived exertion of athletes.

## Conclusions

A protocol of multiple standing vertical jumps is well suited to monitor training effects when combined with the use of a performance index (PI) similar the one adopted in this study. As match-specific noise significantly improved jumping performance and endurance, such external noise-based disturbances may be useful in the training of volleyball players.

## References

1. Borras X., Balius X., Drobnic F., Galilea P., Vertical jump assessment on volleyball: A follow-up of three seasons of a high-level volleyball team. *J Strength Cond Res*, 2011, 25 (6), 1686–1694, doi: 10.1519/JSC.0b013e3181db9f2e.
2. Gabbett T., Georgieff B., Physiological and anthropometric characteristics of Australian junior national, state, and novice volleyball players. *J Strength Cond Res*, 2007, 21 (3), 902–908.
3. Sheppard J.M., Cronin J.B., Gabbett T.J., McGuigan M.R., Etxebarria N., Newton R.U., Relative importance of strength, power, and anthropometric measures to jump performance of elite volleyball players. *J Strength Cond Res*, 2008, 22 (3), 758–765, doi: 10.1519/JSC.0b013e31816a8440.
4. Sheppard J.M., Gabbett T.J., Taylor K.L., Dorman J., Lebedew A.J., Borgeaud R., Development of a repeated-effort test for elite men's volleyball. *Int J Sports Physiol Perform*, 2007, 2 (3), 292–304.
5. Sheppard J.M., Borgeaud R., Influence of stature on movement speed and repeated efforts in elite volleyball players. *J Aust Strength Cond*, 2008, 16 (3), 12–14.
6. Newton R.U., Kraemer W.J., Hakkinen K., Effects of ballistic training on preseason preparation of elite volleyball players. *Med Sci Sports Exerc*, 1999, 31 (2), 323–330.
7. Newton R.U., Rogers R.A., Volek J.S., Häkkinen K., Kraemer W.J., Four weeks of optimal load ballistic resistance training at the end of season attenuates declining jump performance of women volleyball players. *J Strength Cond Res*, 2006, 20 (4), 955–961.
8. McBride J.M., Triplett-McBride T., Davie A., Newton R.U., The effect of heavy- vs. light-load jump squats on the development of strength, power, and speed. *J Strength Cond Res*, 2002, 16 (1), 75–82.
9. Sienkiewicz-Dianzenza E., Rusin M., Stupnicki R., Anaerobic resistance of soccer players. *Fitness Perform J*, 2009, 8 (3), 199–203, doi: 10.3900/fpj.8.3.199.e.
10. Sienkiewicz-Dianzenza E., Tomaszewski P., Stupnicki R., "Performance index" and application to the assessment of multiple bouts of leg exercise. *Physical Education and Sport* 2005, 49, 52–55.
11. Sienkiewicz-Dianzenza E., Tomaszewski P., Stupnicki R., Iwańska D., Application of the performance index (*PI*) to repeated bouts exercise. In: Starosta W. (ed.), Monografie cykliczne: Scientific fundaments of human movement and sport practice. 2005, 21, 533–534.
12. Stupnicki R., Sienkiewicz-Dianzenza E., "Anaerobic endurance" and its assessment. *J Hum Kinet*, 2004, 2, 109–116.
13. Stupnicki R., Sienkiewicz-Dianzenza E., Assessment of repeated bouts of exercise. International Summer School for Young Researchers, Lecture notes and short communicates, 2005.
14. Stupnicki R., Sienkiewicz-Dianzenza E., Classification of subjects by performance. International Summer School for Young Researchers, Lecture notes and short communications, 2005.

Paper received by the Editor: November 18, 2014
Paper accepted for publication: January 23, 2015

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