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Christine L. Coniglio
East Tennessee State University

Austin Smith
East Tennessee State University

Abdulmalek Bursais
East Tennessee State University

Julia Kirkpatrick
East Tennessee State University

Justin Taylor
East Tennessee State University

See next page for additional authors

TRAINING LOADS OF A DIVISION I CONFERENCE VOLLEYBALL TOURNAMENT

Christine L. Coniglio[1], Austin Smith[1], Abdulmalek Bursais[1], Julia Kirkpatrick[1], Justin Taylor[1], Jeremy Gentles[1]

[1]Center of Excellence of Sport Science and Coach Education, Department of Sport, Exercise, Recreation, and Kinesiology, East Tennessee State University, Johnson City, TN, USA

INTRODUCTION: Volleyball is predominantly an anaerobic sport that requires short repeat bouts of high intensity activity such as jumping, bounding, and quick changes of direction, followed by periods of low intensity activity, such as walking and standing (Gabbet, 2007). Current research using wearable technology has been used for jump quantification and movement assessment for injury prevention (Sanders, 2018), while little work, if any, has been done assessing mechanical training loads in a multigame conference tournament. Additionally, many sports have used microsensors to help quantify training loads, there are very few studies that investigate the demands of women's Division I (DI) volleyball. The purpose of this study was to assess training loads of a division I women's volleyball conference tournament using triaxial accelerometers. This study also examined differences between player specific positions, and single match vs. combined match training loads.

METHODS

***Subjects**:* 10 female volleyball players (19.6±1.1y,76.5±7.5 cm, 69.1±8.6 kg) participated in the study. Athletes were members of a DI NCAA collegiate volleyball team. Subject court position included outside hitter (outside: n=4), middle blocker (middle: n=2), setter (n=2), defensive specialist (DS: n=1), and libero (n=1). Each athlete was assigned a Zephyr^{TM} BioHarness unit (BH; Zephyr Technology Corporation, Annapolis, MD) during preseason training and was familiarized with how to wear and operate the device. Each BH included a Biomodule (version 3) and strap. Athletes were equipped with a BH that was worn during competition. The BH was placed at the level of the xyphoid process and the Biomodule was positioned on the midaxillary line. The Biomodule contains a triaxial accelerometer which samples at 100 Hz. BH data was downloaded to and analyzed with OmniSense^{TM} Analysis (version 4.1.4; Zephyr Technology Corporation, Annapolis, MD). This investigation was approved by the University's Institutional Review Board and all participants completed and signed approved informed consent documentation.

***Match Time**:* A total of three best of five-set matches were played over the course of a three-day period, single elimination tournament. Matches included all sets for each match played, not including pre-game warm-up. All three matches went three sets. Total impulse load (IL) and impulse load by event (walking, running, intense running, jumping/bounding, other) was collected with triaxial accelerometer. Impulse load is a measure of training load and is equal to the sum of areas under the three-axis accelerometry curves for all detected events.

***Accelerometry**:* Bioharness validity and reliability has been demonstrated during a number of different tasks. Very strong relationships have been seen between oxygen uptake and accelerometry (r = 0.97) and step counts (r = 0.99) (Johnstone, 2012a). High intra-device reliability (ICC ≥ 0.99) (Johnstone,2012a) and inter-device reliability (ICC = 0.93) have been reported (Johnstone, 2012c).

Gravitational forces (1 g = 9.81 m/s^2) were recorded to describe acceleration data collected from BH. Total training loads for match play were expressed as Impulse load (IL). Impulse load is the accumulated training load equal to the sum of areas under the 3-axis accelerometry curves and expressed as N*s. Impulse load only includes detected locomotor events (e.g., walking, running, jumping) and impacts. Mean IL were calculated for all 3 conference tournament matches. The formula for IL is displayed below where x = g forces in the medio-lateral ("side-to-side") plane, y = g forces in the anterio-posterior ("forwards and backwards") plane, z = g forces in the vertical ("up and down") plane.

$$Impulse\ Load = \sum_{s=1}^{n} \frac{\sqrt{x_s^2 + y_s^2 + z_s^2}}{9.8067}$$

Statistical Analysis: All data is presented as means, standard deviations using Microsoft Excel (Version 2016, Redmond, WA, USA).

Table 1. Impulse load per match per position

Player	Impulse Load (N·s)
Outside I	13,067 ± 504
Outside II	12,887 ± 448
Outside III	16,623 ± 729
Outside IV	19,475 ± 1,354
Setter I	13,664 ± 523
Setter II	10,651 ± 85
Middle I	12,551 ± 1,371
Middle II	8,360 ± 2,282
Defensive Specialist	6,122 ±1,972
Libero	20,025 ± 938

**All data are represented by means and standard deviations*

RESULTS: The match mean by player 13,365.02±4,448.10 IL. The tournament mean by player was 40,095.07±13,464.32 IL. Table 1 displays means and standard deviations for match for IL for each individual player. Table 2 provides mean match IL by position, mean match IL by position for each event type, percent contribution for event types by position and mean tournament IL.

DISCUSSION: This study presents training loads associated with volleyball tournament play. To the authors' knowledge, this is the first study to quantify the training loads of a collegiate volleyball conference tournament. Impulse Load can used as a measure of total training load (Coniglio 2017). Relative contribution to IL from various locomotor event types differs based upon athlete position. For instance, a larger percentage of a libero's training load consists of running when compared to an outside hitter. However, a larger percentage of training load for an outside hitter consists of jumping and bounding compared to a libero. Additionally, due to higher average playing time, the libero accumulates the highest training loads resulting from longer playing times.

The use of accelerometry derived training loads may allow coaching staff to better measure the demands of each position, which may be difficult to quantify otherwise. For instance, from practical experience, coaches may assume outside hitters accumulate higher training loads than other positions due to their visibility on court, scoring responsibilities and explosive actions near the net. However, this research demonstrates that training loads may be high across all or most positions but the relative contribution from locomotor event types will differ depending across positions. Using IL allows for quantification of different event types that can contribute to training loads and possible fatigue during match-play.

Table 2. Mean impulse load by position and event type during match and tournament play

Locomotion	Position	Match IL (N·s)	Percent	Tournament IL (N·s)
Total IL	Outside	15,513 ± 2,940	NA	46,538 ± 9,456
	Setter	12,157 ± 1,684	NA	36472 ± 6,391
	DS	6,122 ± 1,972	NA	18,367 ± 0
	Middle	10,456 ± 2,847	NA	31,367 ± 8,889
	Libero	20,251 ± 938	NA	60,752 ± 0
Walk	Outside	8,006 ± 160	51.6%	24,019 ± 2,126
	Setter	6,050 ± 1,280	49.8%	18,150 ± 4,915
	DS	1,910 ± 545	31.2%	5,731 ± 0
	Middle	6,042 ± 599	57.8%	18,125 ± 1,832
	Libero	9,611 ± 572	47.5%	28,832 ± 0
Run	Outside	3,964 ± 1,164	25.6%	11,892 ± 3,745
	Setter	3,852 ± 698	31.7%	11,557 ± 2,663
	DS	604 ± 224	9.9%	1,813 ± 0
	Middle	2,079 ± 1,077	19.9%	6,238 ± 3,138
	Libero	7,816 ± 223	38.6%	23,448 ± 0
Sprint	Outside	140 ± 44	0.9%	420 ± 133
	Setter	125 ± 81	1.0%	374 ± 207
	DS	26 ± 0	0.4%	26 ± 0
	Middle	106 ± 84	1.0%	317 ± 6
	Libero	235 ± 80	1.2%	705 ± 0
Jumping and Bounding	Outside	702 ± 236	4.5%	2,107 ± 747
	Setter	667 ± 197	5.5%	2,000 ± 603
	DS	34 ± 13	0.6%	101 ± 0
	Middle	593 ± 379	5.7%	1,778 ± 1181
	Libero	797 ± 109	3.9%	2391 ± 0
Other	Outside	2,700 ± 1,887	17.4%	8100 ± 6,227
	Setter	1,464 ± 544	12.0%	4,391 ± 1,997
	DS	3,565 ± 1,224	58.2%	10,696 ± 0
	Middle	1,636 ± 996	15.6%	4,909 ± 2,733
	Libero	1,792 ± 242	8.8%	5,376 ± 0

**Match and tournament impulse load (IL) data are represented by means and standard deviations. Percentages represent relative contributions for event types. IL= Impulse Load, DS= Defensive Specialist.*

REFERENCES

Barnes, J. L., Schilling, B. K., Falvo, M. J., Weiss, L. W., Creasy, A. K., & Fry, A. C. (2007). Relationship of jumping and agility performance in female volleyball athletes. *Journal of Strength and Conditioning Research*, *21*(4), 1192.

Coniglio, C. L., Travis, K., & Gentles, J. A. The relationship between accelerometry and total distance measured with GPS in women's college soccer. *12th Annual Coaches and Sport Science College, Johnson City, TN, December 1-2.*

Gabbett, T., & Georgieff, B. (2007). Physiological and anthropometric characteristics of Australian junior national, state, and novice volleyball players. *Journal of Strength and Conditioning Research*, *21*(3), 90.

Gescheit, D. T., Cormack, S. J., Reid, M., & Duffield, R. (2015). Consecutive days of prolonged tennis match play: performance, physical, and perceptual responses in trained players. *International Journal of Sports Physiology and Performance*, *10*(7), 913-920.

Johnstone, J. A., Ford, P. A., Hughes, G., Watson, T., & Garrett, A. T. (2012). BioHarness™ multivariable monitoring device: part. I: validity. *Journal of sports science & medicine*, *11*(3), 400.

Johnstone, J. A., Ford, P. A., Hughes, G., Watson, T., & Garrett, A. T. (2012). Bioharness™ multivariable monitoring device: part. II: reliability. *Journal of sports science & medicine*, *11*(3), 409.

Johnstone, J. A., Ford, P. A., Hughes, G., Watson, T., Mitchell, A. C., & Garrett, A. T. (2012). Field based reliability and validity of the bioharness™ multivariable monitoring device. *Journal of sports science & medicine*, *11*(4), 643.

Sanders, G. J., Boos, B., Shipley, F., Scheadler, C. M., & Peacock, C. A. (2018). An Accelerometer-Based Training Load Analysis to Assess Volleyball Performance. *Journal of Exercise and Nutrition*, *1*, 1-4.

Sheppard, J. M., Gabbett, T. J., & Stanganelli, L. C. R. (2009). An analysis of playing positions in elite men's volleyball: considerations for competition demands and physiologic characteristics. *The Journal of Strength and Conditioning Research*, *23*(6), 1858-1866.