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Using the Minimax Accelerometer to Quantify the Demands of Preseason Training in NCAA Volleyball: A Descriptive Case-Study Study

USING THE MINIMAXX ACCELEROMETER TO QUANTIFY THE DEMANDS OF PRESEASON TRAINING IN NCAA VOLLEYBALL: A DESCRIPTIVE CASE STUDY

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INTRODUCTION: The quantification of the physical demands of training and competition is a vital component of implementing a successful periodized training program (Foster et al., 2001). Additionally, quantifying and tracking training loads may provide a means of understanding fatigue (Halson, 2014). In the sport of volleyball, previous research has assessed the physical demands of competition and practice using time-motion analysis (Sheppard et al., 2007; Tillman, Hass, Brunt, & Bennett, 2004), as well as physiological techniques (Viitasalo et al., 1987). Recently, the use of microtechnology such as wearable accelerometers has become a popular method of assessing movement in athletes. Previous research has supported the use of these devices as a means of measuring work-load in team sports (Montgomery, Pyne, & Minahan, 2010). The majority of these investigations focused on field-based sports such as Australian Rules football (Boyd, Ball, & Aughey, 2011, 2013), however the application of this technology has been examined in other sports such as basketball (Montgomery et al., 2010). To the knowledge of the authors, a paucity of studies has used this technology to investigate the demands of indoor volleyball. Therefore, the purpose of the study was to provide a descriptive case-study examining the use of a wearable tri-axial accelerometer to quantify the physical demands of a National Collegiate Athletic Association (NCAA) volleyball preseason training period. A secondary purpose of this investigation was to investigate the relationship between the accelerometer data and perceived or internal estimates of training-load.

METHODS: This descriptive case-study followed a NCAA Division I women's volleyball athlete (age: 21.4y, height: 184.9cm, body mass: 78.9kg, training age: 10.5y), over the course of a two-week preseason training period. During each on-court training session, the athlete was instrumented with a wearable accelerometer unit (MinimaxX S4, Catapult Sports, Soresby, Victoria, Australia) equipped with a tri-axial sensor (Kionix, KXP94) sampling at 100 Hz. During practice, the MinimaxX device was affixed to the posterior upper torso of player using a customized garment developed by the manufacturer. Following each on-court training session, data collected by the sensor were downloaded to a laptop computer and software developed by the manufacture (Catapult Sprint ver. 5.1, Soresby, Victoria, Australia) was then used to crop the raw acceleration data and calculate the following variables: Player load (PL), Jumping events (Jmp), and changes of direction events (COD). The PL metric is a modified vector magnitude developed by the manufacture. It is expressed in arbitrary units and calculated as the square root of the sum of the squared instantaneous rate of change in acceleration in three vectors.

$$Player\ Load = \sqrt{\frac{\left(a_{y1} - a_{y-1}\right)^2 + (a_{x1} - a_{x-1})^2 + (a_{z1} - a_{z-1})^2}{100}}$$

Where, *a* is forward, *x* is sideways, and *z* is vertical acceleration. Both Jump and COD were identified from the raw data using a custom algorithm used by the Sprint 5.1 software. Jumping and COD events were further divided into low-, mid-, and high-range based on criteria set in the software. The specific criteria were as follows; for Jmps low = 0-20 cm, mid = 20-40 cm, high = 40+ cm; for CODs low = 1.5-2.5 m/s, mid = 2.5-3.5 m/s, high = 3.5 + m/s.

In addition to the accelerometer data, a session rating of perceived exertion (sRPE) was obtained from the athlete following each practice session by asking the athlete to rank their level of perceived exertion on a scale ranging from 0-10 (Foster et al., 2001). Based on previously established methods (Foster et al., 2001), sRPE was then multiplied by the time of the session in minutes to form rating of perceived exertion training-load (RPETL). To assess the relationship between variables obtained from the accelerometer and RPETL, a series of Pearson product-moment zero order correlation coefficients were used. All statistical analyses were performed using SPSS 22 (IBM, New York, NY) and statistical significance for all analyses was set at $p \leq 0.05$. Correlation values of 0.0, 0.1, 0.3, 0.5, 0.7, 0.9, and 1.0 were interpreted as trivial, small, moderate, large, very large, nearly perfect, and perfect according to Hopkins (2014). All data collection in this study occurred as part of an ongoing athlete monitoring program. This was study was reviewed and approved by the East Tennessee State University Institutional Review Board.

RESULTS: A total of 1,307 jumps and 5,570 total COD were identified over the course of fifteen volleyball practice sessions. The average time of each training session was 122.5 ± 27.7 min. Of the total jumps, 53.5% were high-, 22.9% were mid-, and 23.6% were low-range. Of the total COD, 5.0% were registered as high-, 16.3% as mid-, and 78.7% as low-range. Strong statistically significant ($p \leq 0.05$) relationships were found between RPETL and total CODs (r = 0.625, n = 15, p = 0.013) as well as RPETL and PL (r = 0.610, n = 15, p = 0.016).

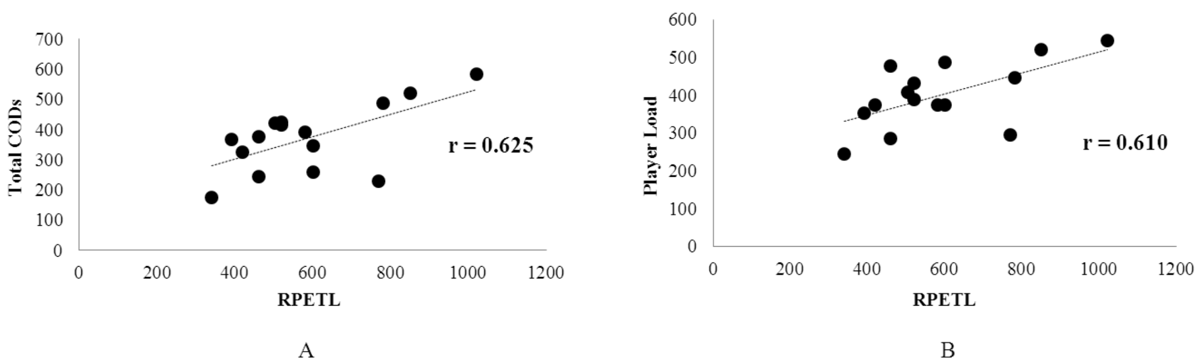

Figure 1. A) The relationship between total COD and RPETL; B) The relationship between PL and RPETL. *Note: RPETL and PL are expressed in arbitrary units.*

DISCUSSION: The primary purpose of this study was to examine the use of a wearable accelerometer to quantify the physical demands of a preseason training period in NCAA women's volleyball. A secondary purpose of this study was to determine the relationship between the data provided by the accelerometer (external) and a perceived or internal estimate of training-load. Over the course of fifteen practice sessions a total of 1,307 Jmp were performed by the athlete, accounting for approximately 87 jumps per training session. When considering the nature of the sport of volleyball, this finding is not surprising. Previous research examining NCAA women's volleyball has found that during a match an average of 45 jumps were performed by all players over two matches, with the maximum number of jumps being 71 (Tillman et al., 2004). Considering repetitive jumping and landing has been implemented as a source of injury in the sport of volleyball (Eerkes, 2012), monitoring the total number of jumps during a training session may be an effective way of assessing the stresses placed on the athletes during training and competition.

Strong statistically significant relationships were found between both RPETL and total CODs as well as RPETL and PL. These findings indicate that 1) the perceived exertion of the athlete was related to the total number of CODs performed during the training session and 2) a relationship exists between PL (an external estimate of training load) and RPETL (a perceived or internal estimate of training load). This information is useful to coaches in that it suggests manipulating the number of CODs in a given drill or training session may be an effective method of varying the training-load experienced by the athlete. Additionally, a simple method of assessing training-load, such as RPETL, seems to provide relatively the same information as the PL metric involving sophisticated instrumentation.

In conclusion, it seems that the MinimaxX accelerometer may be a valuable tool for quantifying the physical demands of training in women's NCAA volleyball. One of the most appeling features of the accelerometer device is its ability to identify and count specific events such as Jmps and CODs. However, the validity of this specific feature is unknown. Although previous research exists supporting the reliability of PL (<2% CV) (Boyd et al., 2011), to the knowledge of the authors there is no published research examining the reliability and validity of the MinimaxX accelerometer in identifying and measuring Jmps and CODs. Future research should seek to validate as well as assess the reliability of these measures.

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