THE RELATIONSHIP BETWEEN ACCELEROMETRY DERIVED TRAINING LOADS AND sRPE IN WOMEN'S COLLEGE SOCCER

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INTRODUCTION: A growing market for wearable technology has prompted many companies to develop sensor based systems to monitor athletes. Monitoring of internal and external training loads is commonly used by sport scientists to assess athlete's adaptation, risk of injury, and risk of illness (Hayes & Quinn, 2009). External load is the mechanical work done by the athlete regardless of the physiological demands of an activity and is often measured with accelerometers and GPS during practice and competition, in field or court based sports (Halson, 2014). Unfortunately, the technologies needed to quantify external training loads may be prohibitively expensive or resource intensive for some athletes and teams. Internal load can be described as the physiological and psychological stress experienced by an athlete (Halson, 2014). Session RPE (sRPE), developed by Foster et al. (1998), has been shown to be a reliable and valid measure of internal load (Scott et al., 2013). For instance, sRPE has shown strong relationships with external loads such as time spent in specific running zones, total distance, total distance, and accelerometer based player load in professional soccer (Scott et al., 2013). Zephyr (Zephyr Technology Corporation, Annapolis, MD) provides Impulse Load data, which quantifies external training loads by summing three dimensional accelerations. The validity and reliability of the Zephyr™ BioHarness and related measures have been evaluated by Johnstone et.al., 2012. However, the accuracy of sRPE has been questioned due to the influence of personal perception of physical exertion, including, external factors such as environment, spectators, psychological states, previous experience and memory (Nassis, Hertzog, & Brito, 2017). Therefore, the purpose of this project was to evaluate the correlation between sRPE and Impulse Load (IL), in women's college soccer players, and asses the suitability of sRPE for use in athlete monitoring programs.

METHODS:

***Subjects*:** Twenty-five collegiate DII women's soccer players (age 20.2±1.1 y, height 166.3±5.9 cm, weight 62.0±7.0 kg) participated in this study. This investigation was approved by the Institutional Review Board and all participants completed and signed University approved informed consent.

***Operation of Wearable Device*:** Each athlete was assigned and familiarized with the wear and operation of the Zephyr™ BioHarness (BH; Zephyr Technology Corporation, Annapolis, MD) during preseason training to be worn during practice and competition. Each BH included a strap and Biomodule (version 3) containing a heart rate (HR) sensor and triaxial accelerometer which sample at 250 Hz and 100 Hz, respectively. The BH strap was placed at the level of the xyphoid process and the Biomodule was positioned on the midaxillary line. BH data was downloaded to and analyzed with OmniSense™ Analysis (version 4.1.4; Zephyr Technology Corporation, Annapolis, MD).

***Practice and Match Time*:** Data was collected over an entire regular season (24 practices and 17 games). All BH were powered on by the researchers prior to the start of each practice and game. Match play (MP) included only the time spent playing during the match. The entire match (EM) included data from the start of the warm-up (WU) to the end of the match. Practice (PR) included all data from the start to finish of PR.

***Session RPE*:** Each athlete reported their individual RPE, based on the CR-10 Rating of Perceived Exertion (RPE), after every practice and match according to their perceived difficulty of the session (Borg, Hassman, and Lagerstorm, 1987). Session RPE-EM and sRPE-MP were each calculated by multiplying RPE by the duration of the entire match or match play, respectively(Foster et al., 1998). Session RPE was recorded within 15-20 minutes after the cessation of practices and matches.

***Accelerometry*:** IL was calculated using Formula 1 with acceleration data quantified as gravitational forces (1g = 9.81 m/s^2) from detected locomotor events (e.g., walking, running, jumping) and impacts; x = g forces in the medio-lateral ("side-to-side") direction, y = g forces in the anterio-posterior ("forwards and backwards") direction, z = g forces in the vertical ("up and down") direction.

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

Formula 1.

***Statistics*:** Means and standard deviations were calculated for IL and sRPE resulting from PR, MP and EM. Pearson's product moment correlations were calculated between PR-IL and PR-sRPE, MP-IL and MP-sRPE, as well as EM-IL and EM-sRPE. Critical alpha was set at 0.05. All statistical analyses were performed using SPSS (version 23, IBM, Armonk, New York).

RESULTS: A total of 914 sessions were analyzed (392 MP/EM and 522 PR). Mean IL and sRPE for PR, MP and EM are detailed in Table 1. Pearson product moment correlations revealed a very strong correlation between PR IL and PR sRPE, a very strong relationship between MP IL and sRPE-MP, a weak relationship between sRPE-EM and EM IL (respectively $r = 0.76$, $p < 0.001$; $r = 0.83$, $p < 0.001$; $r=0.37$, $p < 0.001$).

Table 1: Team means for IL and sRPE during PR, EM and MP

	Practice	**Entire Match**	**Match Play**
IL (N*s)	12,414.5 (±4063.9)	27,599.12 (± 10,181.4)	18,008.04 (± 9,670.3)
sRPE	142.90 (±123.6)	788.11 (± 438.1)	247.41 (± 222.6)

DISCUSSION: This study examined two methods of monitoring the training loads of Division II women's soccer matches and practices. Prior to recent technological developments, external load monitoring in field sports was crude (Halson, 2014). Systems that allow external loads to be quantified are now readily available, but can be quite expensive. Coaches may use sRPE as a measure of internal training loads though need to consider the calculation methods which can skew training load estimates. Our findings indicate that sRPE may be a good alternative to IL when calculated including duration of activity, excluding rest, during matches. Typically, sRPE is calculated by multiplying an athlete's reported RPE by the total duration of the activity. When warm-up and total match time was included in sRPE, training loads were weakly related and overestimated internal training load. A stronger relationship was found between IL and sRPE-MP. Athletes may underreport RPE of sessions with frequent and/or long durations of rest or when they are active during a small percentage of the session duration. Training recency may explain part of the observed differences, suggesting that long periods of rest before the end of the game, may reduce reported RPE. Alternatively, athletes may report RPE based upon duration they played despite being instructed to report RPE from the onset of warmup to cessation of the match. This theory is supported by both correlations above, sRPE-MP and IL as well as sRPE-EM and IL. This study evaluated NCAA Division II soccer matches, which allows unlimited substitutions unlike international match play. The results of this study found that sRPE calculated using match play time, rather than entire duration of WU through completion of the match, more closely related to measures of external load. Therefore sRPE-MP may be a suitable measure for monitoring player internal load in D-II soccer.

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