RATING OF PERCEIVED EXERTION IN PROFESSIONAL VOLLEYBALL: A SYSTEMATIC REVIEW

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Abstract:*The rating of perceived exertion (RPE) is a non-invasive, cost effective, and time efficient strategy to measure training loads. However, data can be collected without following specific procedures and across a range of methods (e.g., different RPE scales and/or different operational questions). Consequently, practitioners working in professional volleyball can use this information in various ways with different assessment standards between them. Therefore, the purpose of the current review was to systematically and critically evaluate the use of RPE-based methods in professional volleyball athletes. Electronic searches were conducted in four The main findings indicate that, to minimize the effect of the last exercise of the session, the athlete should be presented with the RPE question 10 to 30 minutes after the session is finished .*

Key words *workload, team sports, athletes, monitoring*

Fatigue is a normal and desired part of the training process, and its severity can be observed as a continuum (Halson and Jeukendrup, 2004). When the proper balance between training stress and recovery is ensured, athletes experience acute fatigue in response to training sessions and recover within hours or days (Radojewski et al., 2018). However, if intense training continues without an adequate recovery period, athletes may enter a state of overreaching (Halson and Jeukendrup, 2004). When athletes experience a temporary reduction in performance levels as a result of training, they enter a state of functional overreaching (Meeusen et al., 2013). If training continues and unplanned fatigue persists, athletes may experience non-functional overreaching that can last for several weeks. The last phase of the fatigue continuum is called overtraining syndrome, which is characterized by decreases in performance levels that are usually accompanied by psychological disturbances that can remain for long periods (Meeusen et al., 2013). To prevent these maladaptations associated with excessive training loads, it is recommended that practitioners monitor training loads to ensure adequate recovery. In addition to these negative performance implications, excessive training loads increase the risk of injury and illness in highperformance athletes (Gabbett, 2010). These heightened risks demonstrate the importance of monitoring how athletes respond to training and competition, showing that the key for a good exercise prescription is an adequate understanding of the effect promoted by training loads on the human body (Busso, 2003). Monitoring athletes' training loads is better understood through sub-dividing loads into two types: internal and external (Halson, 2014). The internal training load (ITL) refers to the physiological stress that a training session induces in the athlete (Impellizzeri et al., 2005). The rating of perceived exertion (RPE) has become the most common method of monitoring the ITL as it is a non-invasive, cost effective, and time efficient strategy to measure training loads (Halson, 2014). The RPE method was originally developed by Borg (Borg, 1970), and Foster et al. (1995) created a simple technique to quantify the ITL using a modification of this scale. This technique is known as the session RPE (sRPE) and is derived by multiplying the overall RPE obtained at the end of a training session (or a match), using the Borg Category-Ratio 10 scale (BORG-CR10) by the total duration (in minutes) of the training session, to provide a modified training impulse (TRIMP) score. Developing an understanding of the ITL response to specific mesocycles and the transition between mesocycles could inform future training prescription. However, RPE data can be collected without following specific procedures and across a range of methods (e.g., different RPE scales and/or different questions). For instance, in order to prevent that sRPE scores are overly influenced by how athletes felt at the end of the training session, the question should not be presented immediately after the session is finished (Foster et al., 1995). Consequently, practitioners working in professional volleyball can use this information in various ways with different scales and questions to assess this information. Therefore, a review of the literature specifically examining the available evidence and present suggestions to effectively monitor athletes with the RPE in professional volleyball would be of interest. Such a review can ensure that coaches would use quality information to prescribe training in applied settings. Thus, the purpose of the current review was to systematically and critically evaluate the use of RPE-based methods in professional volleyball. Methods Literature Search Strategy Articles were systematically identified via four electronic databases (PubMed, SPORTDiscus, Scopus, and Web of Science) using the search strategy presented in Table S1 of the Supplementary File. The search string for each variable (the rating of perceived exertion and volleyball) was used independently, after which both were combined in the complete search strategy. The search was restricted to original peerreviewed studies published in English, Spanish, or Portuguese with literature reviews and conference proceedings excluded. The search was developed to consider research articles published online or in print from the database inception until July 2022, when the search was conducted. Selection Criteria The process for screening articles followed the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) guidelines (Moher et al., 2015). The study protocol was registered in INPLASY (INPLASY202280034). Articles considered for inclusion in the review were those examining professional volleyball athletes and reporting RPE outcomes within, at least, one phase of the season (i.e., off-season, preseason, or competitive period). The samples of participants consisted of volleyball athletes who were part of a professional team. Therefore, collegiate and young volleyball athletes were excluded from the present systematic review. Including experimental studies that implemented an intervention may have misrepresented the results, thus the review was restricted to crosssectional or longitudinal observational study designs. Studies where player monitoring data were reported only during competitive games or during a portion of a phase of the season (e.g., one week) were excluded as they did not represent the complete workloads experienced by players during a specific period of the annual training plan. Abstracts of all the articles identified in the search were screened independently against the pre-defined selection criteria by two authors (A.R. and D.V.M.). Any disagreements between the two authors regarding article inclusion were further discussed and, if agreement was not reached, a third author (J.R.P.) was consulted to establish consensus. Full-text copies were acquired for all papers that met title and abstract screening criteria. Full-text screening was performed by two reviewers (A.R. and D.V.M.). Again, any discrepancies were discussed until the authors reached an agreement and consulted a third author (J.R.P.) when required. Assessment of Methodological Quality Methodological quality was assessed using a modified version of the Downs and Black (1998) checklist for assessing the methodological quality of healthcare interventions. This checklist had been validated for use with observational study designs (Downs and Black, 1998) and had been previously used to assess methodological quality in systematic reviews assessing crosssectional and longitudinal studies (Fox et al., 2014, 2018). The number of items from the original checklist can be tailored to the scope and needs of the systematic review, with 10–15 items used in previous systematic reviews (Fox et al., 2014, 2018). For this review, 11 items in the checklist were deemed relevant (Table S2 of the Supplementary File). Each item was scored as “1” (yes) or “0” (no/unable to determine), and the scores for each of the 11 items were summed to provide the total quality score. The quality of each included article was rated against the checklist independently by two authors (A.R. and D.V.M.). Any disparity in the outcome of the quality appraisal was discussed, and a third author (J.R.P.) was consulted if a decision could not be reached. Data Extraction and Analysis Data were extracted from each article by the lead author (A.R.). Data not provided or presented non-numerically were identified as “not reported”. The following data, where possible, were extracted from each article: (1) participants' characteristics (sample size, sex, age, body height, and body mass); (2) monitoring period (i.e., seasonal phase(s) and duration); (3) objective measures (e.g., heart rate, time motion analysis); (4) RPE scale methods (e.g., scale, operational question). Results Search Findings and Study Selection The electronic search yielded 442 articles (PubMed = 56, SPORTDiscus = 123, Scopus = 143, Web of Science = 120). A total of 304 duplicate records were removed, and further 114 irrelevant articles were excluded based on the title and the abstract; 24 full-text articles were screened and 10 were removed, leaving 14 articles for inclusion in the review. Reasons for exclusion were analysis only in a part of a period of the season (N = 5), nonprofessional athletes (N = 2), player monitoring limited to competitive games only (N = 2), duplicate data (N = 1), and a conference paper (N = 1). Full results of the search are presented in Figure 1. Methodological Quality The ratings from the quality appraisal for each article are presented in Table S3 of the Supplementary File. Methodological quality scores ranged from 7 to 9 out of 11. In line with previous literature using the Downs and Black checklist (Fox et al., 2014, 2018), no articles were excluded based on methodological quality. Participant Characteristics Characteristics of participants investigated in the included articles are presented in Table 1. Sample sizes ranged from 8 to 16 players. In total, 12 studies monitored only male and two monitored only female athletes. Collection of RPE Data The duration of the selected studies was from six (Horta et al., 2019) to 36 weeks (Clemente et al., 2020; Debien et al., 2018; Mendes et al., 2018). Data were predominantly collected during preparatory and competitive periods (50%) (Andrade et al., 2021; Brandão et al., 2018; Debien et al., 2018; Duarte et al., 2019; Horta et al., 2020; Mendes et al., 2018; Timoteo et al., 2021). Three studies collected RPE-based data during the preparatory period only (21%) (Berriel et al., 2022; Domingos et al., 2022; Horta et al., 2019), and other three during the competitive period only (21%) (Clemente et al., 2020; Lima et al., 2020; Ungureanu et al., 2021). One study reported data during the transition period between clubs and national team camps (7%) (Rabbani et al., 2021). Only two studies complemented RPE-based ITL data with objective measurements such as inertial movement units (Lima et al., 2020) and the heart rate (Ungureanu et al., 2021). A detailed description of RPE data collection procedures is reported in Table 2. All included studies used the BORG-CR10 scale to calculate the sRPE (Table 3). “How was your training session?” was the most used question (29%) (Andrade et al., 2021; Brandão et al., 2018; Domingos et al., 2022; Duarte et al., 2019), followed by “how was your workout?” (21%) (Debien et al., 2018; Horta et al., 2019; Ungureanu et al., 2021). Four studies (29%) did not report the question that was used (Berriel et al., 2022; Mendes et al., 2018; Rabbani et al., 2021; Timoteo et al., 2021). Most studies included the weekly internal training load (wITL) in their results (79%) (Andrade et al., 2021; Berriel et al., 2022; Brandão et al., 2018; Clemente et al., 2020; Debien et al., 2018; Domingos et al., 2022; Duarte et al., 2019; Horta et al., 2019, 2020; Mendes et al., 2018; Timoteo et al., 2021), while few included derived variables such as training monotony (21%) (Clemente et al., 2020; Debien et al., 2018; Timoteo et al., 2021), strain (14%) (Debien et al., 2018; Timoteo et al., 2021), and the acute:chronic workload ratio (ACWR) (21%) (Clemente et al., 2020; Debien et al., 2018; Timoteo et al., 2021).

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