ZULFAQAR Journal of
Defence Management, Social Science & Humanities

Journal homepage: https://zulfaqar.upnm.edu.my/ijdmssh/

THE RELIABILITY OF RATING PERCEIVED EXERTION AND THE RELATIONSHIP WITH HEART RATE IN YOUNG SOCCER PLAYERS

Siti Azilah Atan[a,*], Mohammad Fazrul Jafar[b], Mohd Syrinaz Azli[a], Jorrye Jakiwa[a], Mohar Kassim[a]

[a] *Defence Fitness Academy, National Defence University of Malaysia*
[b] *Perak Football Association, Perak Darul Ridzuan*

*Corresponding author: *sitiazilah@upnm.edu.my*

ARTICLE INFO

Article history:
Received
09-04-2020
Received in revised
09-09-2020
Accepted
14-02-2021
Available online
30-06-2021

Keywords:
Soccer, internal load, perceptual scales, exercise intensity, youth

e-ISSN: 2773-529X
Type: Article

ABSTRACT

This study aimed to assess the reliability of the RPE scales and the relationship between RPE and HR in young football players (age 15.6 ± 0.4). Twenty male outfield football players (n = 20, 1.67 ± 0.4 m, 55.3 ± 8.4 kg) from the Sekolah Sukan Bukit Jalil (SSBJ) participated in this study. The Football Simulation Protocol (FSP), a test that replicates the U15 football match-play, was performed on two occasions to determine the test-retest reliability of the RPE. The participants performed 4 x 20-min 'blocks' of exercise separated by 3 min recovery. Within the rest periods between exercise blocks, RPE and HR were administered. No significant differences were observed between trials in the RPE scales ($P > 0.05$). The Pearson Correlation and ICC showed excellent correlations of the RPE (r= .776, ICC= 0.834, $P<0.05$). Further assessment of reliability indicating excellent repeatability evidence for the scales (SEM = ± 0.2, 95% CI = ± 0.4). Moderate correlation was found between RPE and HR (r = .581, $P< 0.05$). In conclusion, the RPE scale is valid and reliable to be used with young football players. The findings also indicate that RPE in monitoring training load can provide important information to athletes, coaches, and sports scientists.

Introduction

Football can be described as a high-intermittent exercise interspersed with periods of active and passive recovery played over a relatively extended duration (Svensson & Drust, 2005). The highly intermittent nature of football during prolonged match play necessitates various energy pathways to fulfil the energy demands with a more significant contribution from aerobic metabolism (Yoav, Machnai & Eliakim, 2009). Indeed, there are relatively good correlations between aerobic power and total distance covered, competitive ranking, quality of play and ability to maintain performance throughout the duration during football match-play (Bangsbo & Lindquist, 1992; Krustrup et al., 2003; Metaxas, Koutlianos, Kouidi & Deligiannis, 2005). Even though the contribution of anaerobic activity relatively is small, about 1 -11% per match (Mohr, Krustrup & Bangsbo, 2003; Reilly & Thomas, 1976) or approximately 150 to 250 brief, intense actions (Osgnach, Poser, Bernardini, Rinaldo & Di Prampero, 2010); high-intensity activities are often crucial for the match outcome, for instance, to win possession of the ball, the scoring of goals or to prevent conceding of goals (Reilly, Bangsbo & Franks, 2000). Therefore, training sessions need to be sport-specific to optimise football performance so athletes can reach the optimal competitive edge.

Today, participation in football amongst young players is booming in Malaysia. Despite the overwhelming popularity, such as being included in the Football Association Malaysia (FAM) F:30 road map for youth football development (FAM Roadmap 2019-2030, 2018), research information is scarce for adolescent players. It is essential to highlight those young athletes possess unique characteristics associated with pubertal development. The most noticeable difference is the widespread biological age and variation in the development stages (Malina, Eisenmann, Cumming, Ribeiro, & Aroso, 2004; Meylan, Cronin, Oliver, & Hughes, 2010). These include lower aerobic and anaerobic capacity, limited glycogen stores, substrate utilisation during prolonged exercise (Atan & Kassim, 2019), and inferior body temperature control (Atan, Jafar, Jakiwa, Azli, & Kassim, 2019). However, adolescents rely almost entirely on aerobic metabolism while exercising (Riddell, 2008) even lower VO2max values ($\geq$ 60 $mL{\cdot}kg^{-1}{\cdot}min^{-1}$) were reported compared to adult players at various levels of competition and playing position (Chamari et al., 2005; Stølen, Chamari, Castagna, & Wisløff, 2005). Consequently, it places more challenges on young players. For that reason, young players' training load should be carefully monitored for early prevention from overtrain, fatigue, and injuries.

Internal Training Load (ITL) indicates how the body reacts physiologically to the workload of a particular exercise (Halson, 2014). Many variables can be used to assess ITL, such as heart rate (HR) and perception of effort. At this present, HR monitors and Global Positioning System (GPS) is typical for quantifying training load in football ((Achten & Jeukendrup, 2003; Trewin, Meylan, Varley, & Cronin, 2018). The HR measurements provide a reasonable estimation of the aerobic capacity during a football match. It appears that working below 85% of HR_{max} indicates the utilisation of energy from the aerobic energy system (Bangsbo, Mohr, & Krustrup, 2006). In addition, the advantage of the HR monitor is possible to measure HR continuously throughout the match, training and/or fitness testing session. This allows a variety of functions, including (but not limited to) grading of exercise intensities, indicating the differences in physiological responses either between halves or playing position, preventing overtraining, estimating VO2max and energy expenditure (Capranica, Tessitore, Guidetti, & Figura, 2010; Castellano & Casamichana, 2010; Rudolf & Václav, 2009). Meanwhile, GPS provides a valuable pool of data such as HR, distance covered, time spent in activities, several sprints and changes in velocity at different intensities (Atan, Foskett, & Ali, 2014). Both HR monitors and GPS allows real-time measurement. Nevertheless, such technologies are quite expensive and unavailable in a local sports team. In this regard, researchers have proposed an alternative method that is low cost, easy to implement and non-invasive, the Rating Perceived Exertion (RPE) for rating exercise ITL in young athletes (Johnson & Phipps, 2006).

Previous studies have shown strong relationships between RPE and other measurements of ITL among team sport (Eston, 2012; Malone et al., 2015; Scott, Black, Quinn, & Coutts, 2013) such as heart rate, oxygen uptake and blood lactate (Wong et al., 2011). The scale enables an individual to evaluate how easy or hard an exercise task feels at any time; the lowest ratings indicate exercising at an easy to moderate state, and the highest rating indicates hard to the maximal point of the exercise (Eston, 2012). Indeed, findings showed the relationship between RPE and HR at different exercise intensities. Wong et al. (2011) used RPE together with HR monitoring to estimate the oxygen uptake in elite youth football players. It was found that using a combination of RPE and HR measures was as accurate as using the %HRmax alone to estimate the % VO2max during continuous endurance training. Other findings from Impellizzeri et al., (2004) suggest a significant correlation between HR and RPE during an incremental treadmill run to exhaustion in 19 football players (mean ± SD age:17.6 ± 0.7 y). They suggest that RPE can be considered a good indicator of the global internal load of football training and very useful in monitoring athletes' exercise intensity.

No study has investigated the use of RPE in Malaysian youth football teams. In particular, monitoring training load is essential as players have become serious competitors, and some have started playing at the elite levels. The primary purpose of monitoring training load is to ensure players adapt to the training intensity, observe improvements in the training program, and minimise the risk of fatigue and illness/ injury (Halson, 2014). Given the limitations associated with assessing ITL in young players, the present study aimed to assess the reliability of the RPE scales and investigate the correlation between HR and RPE during football simulation protocol (FSP). It was hypothesised that the RPE measurements could be similar between trials, and there was a significant relationship between RPE and HR during simulation football match-play.

Materials and Methods

Participants

The data was collected on twenty (n = 20) outfield players representing Sekolah Sukan Bukit Jalil (SSBJ) (Height: 1.67 ± 0.4 m, body mass: 55.3 ± 8.4 kg) who volunteered to participate in the study. The participants were competitive in local and international football tournaments. The written consent form was obtained from the participant's parents/guardian after being thoroughly informed of the study's benefits and potential risks as all the participants were under the age of 18 (15.6 ± 0.4 years); the local institutional ethics committee approved the study. All participants attended one preliminary session to familiarise themselves with the protocol procedures and the Borg RPE 6-20 scale (Borg, 1998) along with height and body mass measurements.

Experimental Design

Data was collected during the competitive season and took place on outdoor artificial grass pitches with no differences in environmental conditions between trials. The RPE repeatability and correlation of HR and RPE were measured during a Football Simulation Protocol (FSP), a protocol replicating football match-play. Following familiarisation, the FSP was performed in full on two occasions (separated by seven days). Participants were asked to replicate all activities in Trial 1 and required to repeat the same in Trial 2 to minimise within-subject variation; these include refraining from strenuous physical activity 24 hours before each trial and recording dietary intake (24 hours before the first protocol).

After donning the 5 Hz GPS unit (with interpolated 10 Hz output) and heart rate strap (GPSports Systems, Australia), participants performed 10 min of a standardised warm-up, consisting of jogging, striding and dynamic stretching. The FSP performed 4 x 20-min 'blocks' of exercise separated by a 3 min recovery (Figure 1). Within the rest periods between exercise blocks, RPE was administered. The HR was monitored continuously at 5 s intervals (GPSports Systems, Australia).

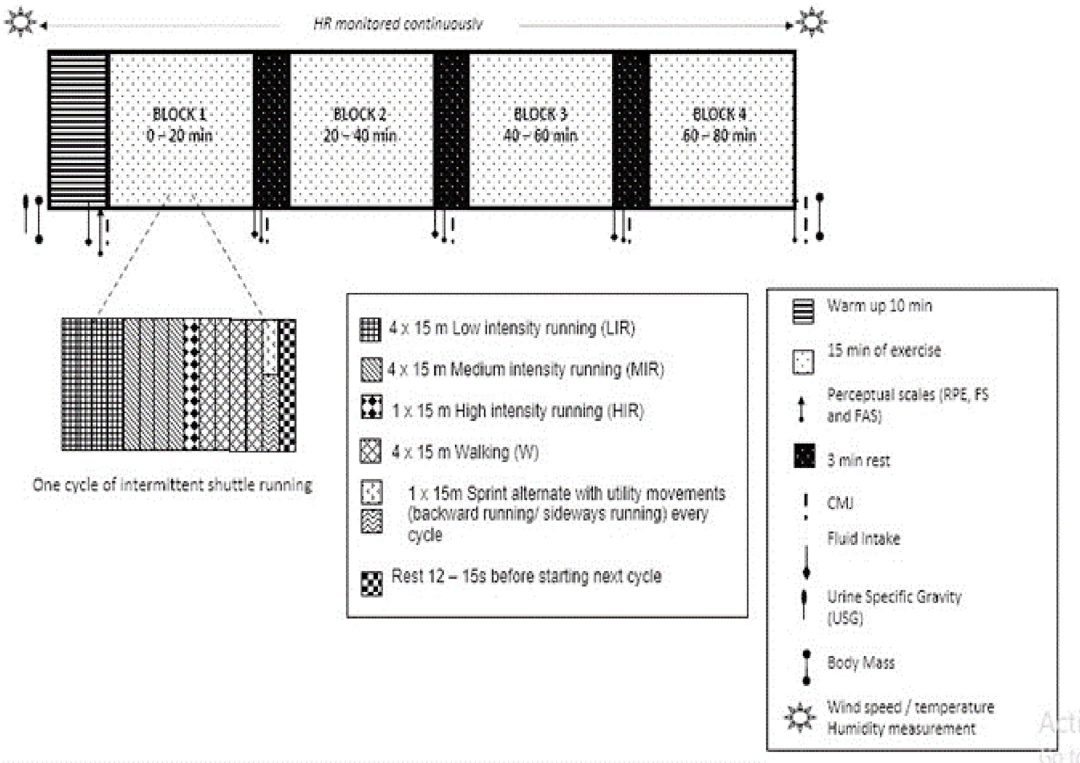

Fig. 1. Schematic representation of the Under 15 football simulation protocol (FSP)

Statistical Analysis

All results are reported as means ± standard deviations. Paired sample t-test was used to determine whether there were any differences in physiological and physical measures between trials. Test-retest reliability was assessed using the suggested format outlined by Atkinson & Nevill (1998). Pearson's correlation (r) and Intra-class correlation coefficients (ICC) were used to determine the relative reliability between trials set of scores. In the ICC, the "two-way random" method was used as suggested by Atkinson & Nevill (1998). The standard error of measurement (SEM) with 95% confidence intervals (95% CI) was further used to assess the reliability. The standard method to calculate is SEM = SD ($\sqrt{1\text{-ICC}}$); however, this is only applicable to 68% of the population. To make it applicable for 95% of the population, this formula was used: 95% CI = 1.96 x SEM (Atkinson & Nevill, 1998). The correlation of HR and RPE was measured by using the Pearson correlation (r). All statistical analyses were performed with SPSS software (version 21.0, SPSS Inc, Chicago, IL) with the significance level set at $P \leq 0.05$.

Results

Reliability of the RPE

The means ± standard deviations for RPE during Trial 1 and Trial 2 was 12 ± 1.4 and 11.5 ± 1.5, respectively. No significant differences in the RPE scale between trials ($P > 0.05$). As expected, the RPE scales increase towards the end of the protocol. Using Pearson's ($r = .776$, $P < 0.05$) and ICC (0.834, $P < 0.05$) confirming relative reliability in the RPE when there were high correlations between two trials. Overall, the results in SEM (± 0.2) and 95% CI (± 0.4) indicate excellent repeatability evidence for the scales. A similar trend was observed in HR as the HR increased throughout the exercise in both trials. There was no statistically significant difference ($P > 0.05$) in HR scores from Trial 1 (173 ± 7.28 bpm) to Trial 2 (174.1 ± 8.38 bpm) and no significant differences between time points (measurement at the end of each block) in HR ($P > 0.05$).

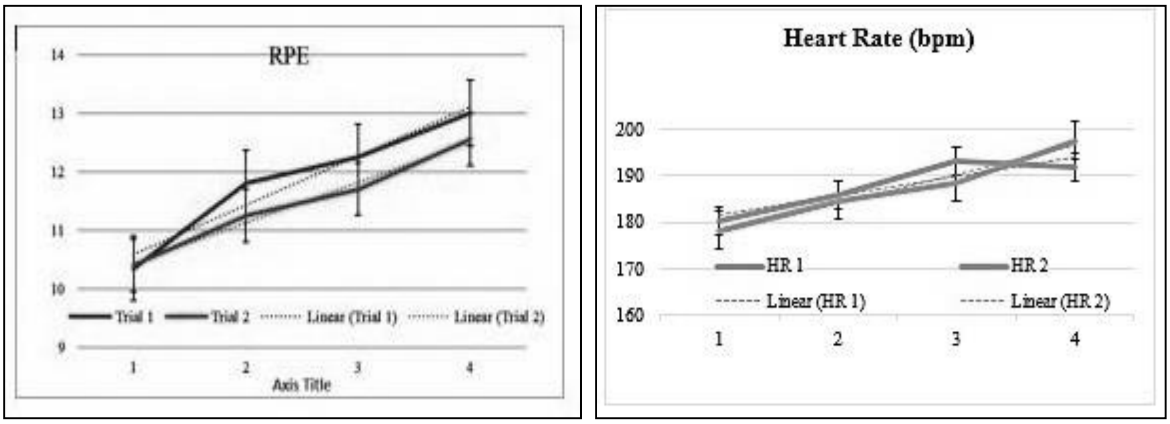

Fig. 2. Mean in the RPE and HR in both trials and at different time points

Correlation Between RPE and HR

The relationship between RPE and HR was investigated using Pearson product-moment correlation coefficient. There was a moderate correlation between the RPE and HR ($r = .581$, $P < 0.05$) in the 80-minute FSP replicating football match-play.

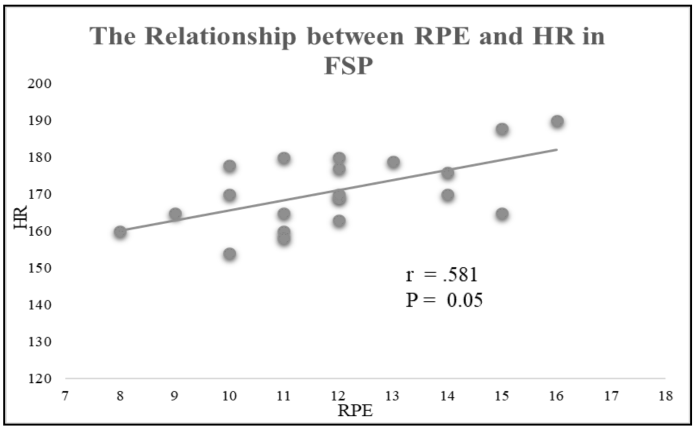

Fig. 3. The relationship between RPE and HR during the FSP (n=20)

Discussion

The primary aims of this study were to assess the reliability of the RPE and the correlation between RPE and HR for use with young football players. The FSP, a test that replicates youth football match play in duration, total distance, time spent in each match running intensities, was used to investigate the repeatability of the RPE and the relationship between HR. The main findings of this study showed that mean values for RPE was similar in both trials. The Pearson's and ICC showed excellent correlations. The findings of the current study are consistent with those of Lupo, Tessitore, Gasperi, & Mar (2017) who found RPE (r = .85, ICC = .74) was reliable when investigating young basketball players during training session (age = 16.5 ± 0.5 years, height = 195.5 ± 5.8 cm, body mass = 90.0 ± 11.2 kg). Further assessment of reliability was suggested by Atkinson & Nevill (1988) was SEM and 95% CI. Excellent reliability was measured by a small magnitude in scores between trials. The SEM indicate how the results could change on retesting with the same test. Meanwhile the 95% CI showed the range of "true" scores. This present finding showed a small value of SEM and 95% CI proved that the RPE scale is repeatable for young players. As expected, the trend shows that RPE and HR progressively increase towards the end of the protocols. This suggests the training duration influenced the ITL, and RPE and HR provide similar exercise intensities. This is the first study that reported the use of RPE to monitor ITL in Malaysian youth football players. It is important to highlight the need to educate and familiarise the use of the RPE method with young athletes. The RPE may be influenced by other physical and psychological stress (Impellizzeri et al., 2004).

The relationship between RPE and HR has been widely investigated (Scherr et al., 2013; Scott, Black, Quinn, & Coutts, 2013), yet limited studies investigating the scale in young athletes (Lupo, Tessitore, Gasperi, & Mar 2017). The small sample size probably influenced a moderate correlation between RPE and HR. Therefore, it is suggested that future researchers use a bigger sample size to determine the relationship between RPE and HR at different exercise intensities. This is in line with study investigating session RPE in six young basketball players during 80-minute training session (Lupo, Tessitore, Gasperi, & Mar 2017). Still, the findings showed the important relationship between RPE and HR in young athletes. Consequently, it is recommended to use RPE as an alternative method to examine young players ITL in a training session or during a competitive match. Previous researchers also point out that RPE is a valuable tool for young athletes as it is sufficient to provide information on ITL and avoid the necessity of expensive tools (Lupo, Tessitore, Gasperi, & Mar 2017). Thus, the present findings confirm the first and second hypotheses.

It is a common practice of monitoring training load in football (Oliveira et al., 2019). There are a few reasons why monitoring ITL is important, especially for young athletes. First, to prevent them from overtraining and fatigue (Halson, 2014). Introducing the RPE scale to young athletes may help them understand and adequately prescribe the exercise intensities or training load. Coaches may use this information to design/modify the training programme accordingly. In addition to this, the RPE scale also may be used to observe meaningful changes from the training programme, such as if the athletes were adapting, progressing or reaching the plateau (Eston, 2012). Second, to lower the risk from injury mainly due to overtraining and not enough rest between training sessions or congested fixture periods. The study by Rampinini et al. (2011) confirms the relationship exists where significant moderate relationships were found between RPE of the match and peripheral fatigue indicators in young athletes (n = 20, age = 19 ± one years, body mass = 73.0 ± 7.0 kg, height = 181 ± 5 cm). Indeed, this study finding could be valuable for coaches/sports scientists to include RPE in training sessions as monitoring training load is crucial for designing an appropriate training programme. Nevertheless, further work needs to be done to establish the RPE use in different age groups, gender, climate, exercise intensity and training duration. In addition, considering that the football simulation test was used to investigate the RPE, future research should concentrate on investigating RPE during regular training sessions.

Conclusion

This present study showed that the RPE is reliable and has a significant relationship with the internal training load in young football players. It is suggested to include the RPE in monitoring training load as it is accessible, easy to interpret and administer to increase the effectiveness of the training programme.

Acknowledgement

We want to thank the Sekolah Sukan Bukit Jalil (SSBJ) players for participating in the study.

References

Achten, J., & Jeukendrup, A. E. (2003). Heart rate monitoring: applications and limitations. *Sports Medicine*, *33*(7), pp. 517–538.

Atan, S. A., Jafar, M., Jakiwa, J., Azli, M., & Kassim, M. (2019). The Hydration Status of Malaysia's Young Male Soccer Players during Competitive Season. *Zulfaqar Journal Of Defence Management, Social Science & Humanities*, *2*(2), pp. 1–6.

Atan, S. A., & Kassim, M. (2019). Young football players are not miniature adults; Do young athletes need sports drinks?: A review of literature. *ASM Science Journal*, *12*, pp. 1–12.

Atan, S. A., Foskett, A., & Ali, A. (2014). *Special Populations : Issues and Considerations in Youth Soccer Match Analysis*. *4*(3), pp. 103–114.

Atkinson, G., & Nevill, A. M. (1998). Statistical methods for assessing measurement error (reliability) in variables relevant to sports medicine. *Sports Medicine*, *26*(4), pp. 217–238.

Bangsbo, J., & Lindquist, F. (1992). Comparison of various exercise tests with endurance performance during soccer in professional players. *International Journal of Sports Medicine*, *13*(2), pp. 125–132.

Bangsbo, J., Mohr, M., & Krustrup, P. (2006). Physical and metabolic demands of training and match-play in the elite football player. *Journal of Sports Sciences*, *24*(7), pp. 665–674.

Borg, G. (1998). *Borg's Rating of Perceived Exertion and Pain Scales.* Champaign, IL: Human Kinetics, 1998.

Lupo, C., Tessitore, A., Gasperi, L., & Mar, G. (2017). Session-RPE for quantifying the load of different youth basketball training sessions. *Biology of Sport, 1(34),* pp. 11–17.

Capranica, L., Tessitore, A., Guidetti, L., & Figura, F. (2010). Heart rate and match analysis in pre-pubescent soccer players. *Journal of Sports Sciences*, *19*(6), pp. 379–384.

Castellano, J., & Casamichana, D. (2010). Heart rate and motion analysis by GPS in beach soccer. *Journal of Sports Science and Medicine, 9,* pp. 98–103.

Chamari, K., Moussa-Chamari, I., Boussaïdi, L., Hachana, Y., Kaouech, F., & Wisløff, U. (2005). Appropriate interpretation of aerobic capacity: allometric scaling in adult and young soccer players. *British Journal of Sports Medicine*, *39*(2), pp. 97–101.

Eston, R. (2012). Use of ratings of perceived exertion in sports. *International Journal of Sports Physiology and Performance*, 7, pp. 175–182.

Halson, S. L. (2014). Monitoring Training Load to Understand Fatigue in Athletes. *Sports Medicine*, *44*, pp. 139–147.

Impellizzeri, F.M., Rampinini, E., Coutts, A. J., Sassi, A., & Marcora, S. M.(2004). Use of RPE-Based Training Load in Soccer. *Medicine and Science in Sports and Exercise Science, 36*(6), pp. 1042 - 1047.

Johnson, J. H., & Phipps, L. K. (2006). Preferred method of selecting exercise intensity in adult women. *Journal of Strength and Conditioning Research*, *20*(2), pp. 446–449.

Krustrup, P., Mohr, M., Amstrup, T., Rysgaard, T., Johansen, J., Steensberg, A., & Bangsbo, J. (2003). The yo-yo intermittent recovery test: physiological response, reliability, and validity. *Medicine and Science in Sports and Exercise Science*, *35*(4), pp. 697–705.

Malina, R. M., Eisenmann, J. C., Cumming, S. P., Ribeiro, B., & Aroso, J. (2004). Maturity-associated variation in the growth and functional capacities of youth football (soccer) players 13-15 years. *European Journal of Applied Physiology*, *91*(5–6), pp. 555–562.

Malone, J. J., Di Michele, R., Morgans, R., Burgess, D., Morton, J. P., & Drust, B. (2015). Seasonal training-load quantification in elite English Premier League soccer players. *International Journal of Sports Physiology and Performance*, *10*(4), pp. 489–497.

Metaxas, T. I., Koutlianos, N.A., Kouidi, E. J., & Deligiannis, A. P. (2005). Comparative study of field and laboratory tests for the evaluation of aerobic capacity in soccer players. *Journal of Strength and Conditioning Research*, *19*(1), pp. 79–84.

Meylan, C., Cronin, J., Oliver, J., & Hughes, M. (2010). Reviews: Talent Identification in Soccer: The Role of Maturity Status on Physical, Physiological and Technical Characteristics. *International Journal of Sports Science and Coaching*, *5*(4), pp. 571–592.

Mohr, M., Krustrup, P., & Bangsbo, J. (2003). Match performance of high-standard soccer players with special reference to development of fatigue. *Journal of Sports Sciences*, *21*(7), pp. 519–528.

Oliveira, R., Brito, J. P., Martins, A., Mendes, B., Marinho, D. A., Ferraz, R., & Marques, M. C. (2019). In-season internal and external training load quantification of an elite European soccer team. *PLoS ONE*, *14*(4).

Osgnach, C., Poser, S., Bernardini, R., Rinaldo, R., & Di Prampero, P. E. (2010). Energy cost and metabolic power in elite soccer: a new match analysis approach. *Journal of Sports Science and Medicine*, *42*(1), pp. 170–178.

Rampinini, E., Bosio, A., Ferraresi, I., Petruolo, A., Morelli, A., & Sassi, A. (2011). Match-Related Fatigue in Soccer Players. *Medicine & Science in Sports & Exercise*, *43*(11), pp. 2161–2170.

Reilly, T., Bangsbo, J., & Franks, A. (2000). Anthropometric and physiological predispositions for elite soccer. *Journal of Sports Sciences*, *18*(9), pp. 669–683.

Reilly, T., & Thomas, V. (1976). A motion analysis of work-rate in different positional roles in professional football match play. *Journal Human Movement Studies*, *2*, pp. 87–97.

Riddell, M. C. (2008). The endocrine response and substrate utilisation during exercise in children and adolescents. *Journal of Applied Physiology*, *105*(2), pp. 725–733.

Rudolf, P., & Václav, B. (2009). Heart rate response and game-related activity of younger school-age boys in different formats of soccer game. *Physical Education and Sport*, 1, pp. 69–74.

Scherr, J., Wolfarth, B., Christle, J. W., Pressler, A., Wagenpfeil, S., & Halle, M. (2013). Associations between Borg's rating of perceived exertion and physiological measures of exercise intensity. *European Journal of Applied Physiology*, *113*(1), pp. 147–155.

Scott, T. J., Black, C. R., Quinn, J., & Coutts, A. J. (2013). Validity and reliability of the session-RPE method for quantifying training in Australian football: acomparison of the CR10 and CR100 scales. *Journal of Strength and Conditioning Research*, *27*(1), pp. 270–276.

Stølen, T., Chamari, K., Castagna, C., & Wisløff, U. (2005). Physiology of Soccer. *Sports Medicine*, *35*(6), pp. 501–536.

Svensson, M., & Drust, B. (2005). Testing soccer players. *Journal of Sports Sciences*, *23*(6), pp. 601–618.

Trewin, J., Meylan, C., Varley, M. C., & Cronin, J. (2018). The match-to-match variation of match-running in elite female soccer. *Journal of Science and Medicine in Sport*, *21*(2).

Wong, D. P., Carling, C., Chaouachi, A., Dellal, A., Castagna, C., Chamari, K., & Behm, D. G. (2011). Estimation of oxygen uptake from heart rate and rating of perceived exertion in young soccer players. *Journal of Strength and Conditioning Research*, *25*(7), pp. 1983–1988.

Yoav, M., Machnai, O., & Eliakim, A. (2009). Relationship among repeated sprint tests, aerobic fitness, and anaerobic fitness in elite adolescent soccer players. *Journal of Strength and Conditioning Research*, *23*(1), pp. 163–169.