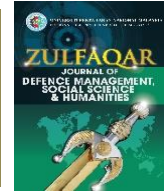




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### THE RELIABILITY OF RATING PERCEIVED EXERTION AND THE RELATIONSHIP WITH HEART RATE IN YOUNG SOCCER PLAYERS

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#### ABSTRACT

The aim of this study were to assess the reliability of the RPE scales and the relationship between RPE and HR in young football players (age  $15.6 \pm 0.4$ ). Twenty male outfield football players ( $n = 20$ ,  $1.67 \pm 0.4$  m,  $55.3 \pm 8.4$  kg) from the Sekolah Sukan Bukit Jalil (SSBJ) volunteered to participate in this study. The Football Simulation Protocol (FSP), a test that replicates the U15 football match-play was performed on two occasions to determine 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 was 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 assesment of realibility indicating excellent repeatability evidence for the scales ( $SEM = \pm 0.2$ ,  $95\% CI = \pm 0.4$ ). Moderate correlation was found between RPE and HR ( $r = .581$ ,  $P < 0.05$ ). In conclusion, the RPE scales is valid and reliable to be use with young football players. The findings also indicates that inclusion of RPE in monitoring training load can provide important information to athletes, coaches and sports scientist.

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#### 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 the use of various energy pathways to fulfil the energy demands with greater contribution from aerobic metabolism (Yoav, Machnai & Eliakim, 2009). Indeed, there is 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; Krstrup et al., 2003; Metaxas, Koutlianos, Kouidi & Deligiannis, 2005). Eventhough contribution of anaerobic activity relatively is small, about 1 -11% per match (Mohr, Krstrup & 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, to optimise football performance, training session need to be sport-specific so athletes may reach optimal competitive edge.

Today, participation in football amongst young players is booming in Malaysia. Despite the overwhelming popularity such as been included in the Football Association Malaysia (FAM) F:30 road map for youth football development (*FAM Roadmap 2019-2030*, 2018), research information available for adolescent players is scarce. It is important to highlight that young athletes possess unique characteristics associated with pubertal development. The most prominent difference is the wide spread of 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 utilization during prolonged exercise (Atan & Kassim, 2019) and inferior control of body temperature (Atan, Jafar, Jakiwa, Azli, & Kassim, 2019). Yet, adolescents rely almost entirely on aerobic metabolism while exercising (Riddell, 2008) even lower  $\text{VO}_2\text{max}$  values ( $\geq 60 \text{ mL}\cdot\text{kg}^{-1}\cdot\text{min}^{-1}$ ) 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, training load of young players should be carefully monitor for early prevention from overtrain, fatigue and injuries.

Internal Training Load (ITL) indicates how the body reacts physiologically to the workload of a certain exercise (Halsen, 2014). There are many variables that 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 common for quantifying training load in football ((Achten & Jeukendrup, 2003; Trewin, Meylan, Varley, & Cronin, 2018). The HR measurements provide a satisfactory estimation of the aerobic capacity during a football match. It appears that working below 85% of  $\text{HR}_{\text{max}}$  indicates the utilisation of energy from the aerobic energy system (Bangsbo, Mohr, & Krstrup, 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  $\text{VO}_2\text{max}$  and energy expenditure (Capranica, Tessitore, Guidetti, & Figura, 2010; Castellano & Casamichana, 2010; Rudolf & Václav, 2009). Meanwhile, GPS provides valuable pool of data such as HR, distance covered, time spent in activities, number of 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 local sports team. In this regards, researchers have proposed an alternative method that are 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 point in time; the lowest ratings indicate exercising at easy to moderate state and highest rating indicate hard to the maximal point of the exercise (Eston, 2012). Indeed, findings shown the relationship of 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  $\%\text{HR}_{\text{max}}$  alone to estimate the  $\%\text{VO}_2\text{max}$  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  $\pm$  SD age:  $17.6 \pm 0.7$  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 Malaysia youth football team. In particular, monitoring training load at this stage is important as players have become a serious competitors and some has started playing at the elite levels. The main purpose of monitoring training load is to ensure players is adapting to the training intensity, observing improvements in training program, minimizing the risk of fatigue and illness/ injury (Halsen, 2014). Given the limitations associated with assessing ITL in young players, the aims of the present study were 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

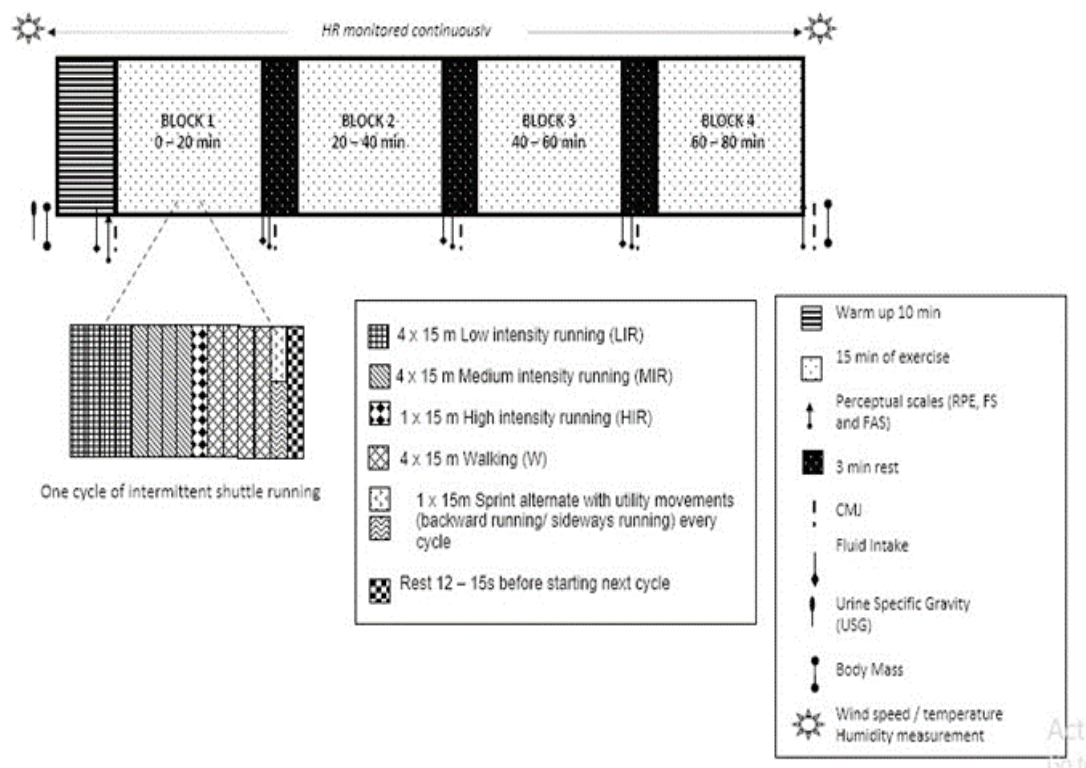
### Participants

The data was collected on twenty ( $n = 20$ ) outfield players representing Sekolah Sukan Bukit Jalil (SSBJ) (Height:  $1.67 \pm 0.4$  m, body mass:  $55.3 \pm 8.4$  kg) volunteered to participate in the study. The participants were competitive in local and international football tournaments. Written consent form was obtained from the participant's parents/guardian after being thoroughly informed the benefits and potential risks of the study as all the participants were under age of 18 ( $15.6 \pm 0.4$  years); the study was approved by the local institutional ethics committee. 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 seen in environmental conditions between trials. The RPE repeatability and correlation of HR and RPE was measured during a Football Simulation Protocol (FSP), a protocol that replicates football match-play. Following familiarisation, the FSP was performed in full on two occasions (separated by 7 days). Participants were asked replicate all activities in Trial 1 and required to repeat the same in Trial 2 to minimise within subject variation, these includes to refrain from strenuous physical activity 24 hours before each trial and record 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 3 min recovery (Figure 1). Within the rest periods between exercise blocks, RPE were 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)**

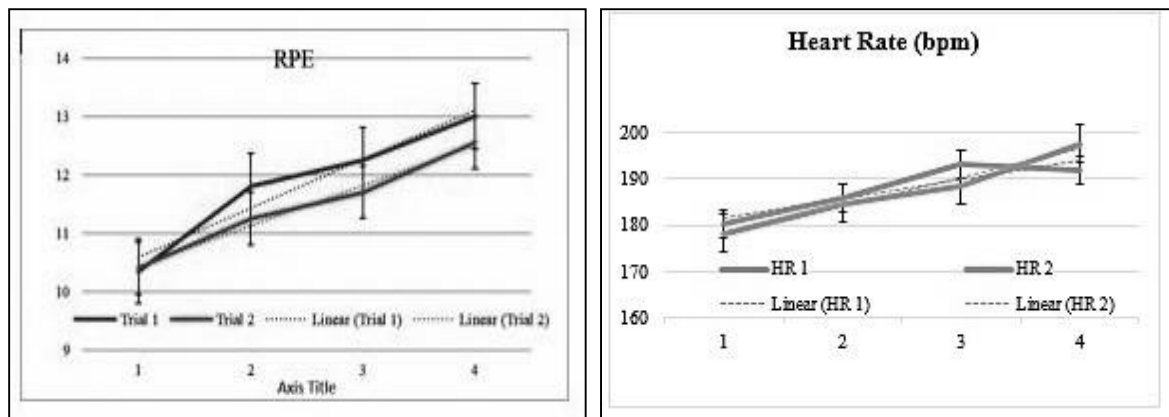
### Statistical Analysis

All results are reported as means  $\pm$  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 common method to calculate is  $SEM = SD (\sqrt{1-ICC})$ , however, this only applicable to 68% of population. To make it applicable for 95% of population this formula was used:  $95\% CI = 1.96 \times SEM$  (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 level of significance set at  $P \leq 0.05$ .

## Results

### Reliability of the RPE

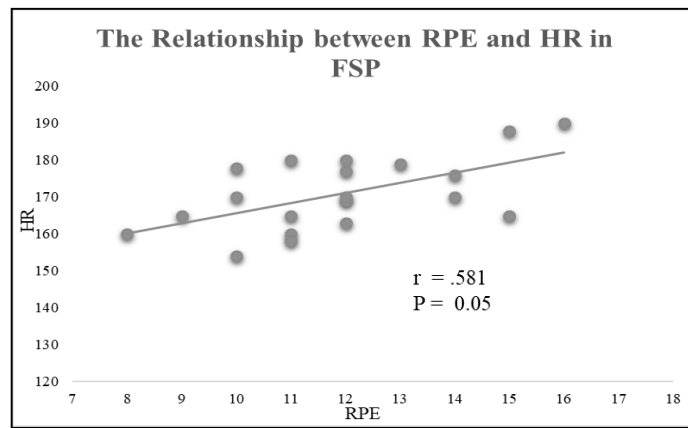
The means  $\pm$  standard deviations for RPE during the Trial 1 and Trial 2 was  $12 \pm 1.4$  and  $11.5 \pm 1.5$  respectively. No significant differences in the RPE scale between trials ( $P > 0.05$ ). As expected, the RPE scales increase towards the end of the protocol. Using Pearson's ( $r = .776$ ,  $P < 0.05$ ) 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 ( $\pm 0.2$ ) and 95% CI ( $\pm 0.4$ ) indicating excellent repeatability evidence for the scales. 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 ( $173 \pm 7.28$  bpm) to Trial 2 ( $174.1 \pm 8.38$  bpm) and no significant differences between time points (measurement at the end of each blocks) 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 that replicates 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 =  $16.5 \pm 0.5$  years, height =  $195.5 \pm 5.8$  cm, body mass =  $90.0 \pm 11.2$  kg). Further assessment of reliability was suggested by Atkinson & Nevill (1988) was SEM and 95% CI. Excellent reliability was measured by small in 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 small value of SEM and 95% CI proved that the RPE scale is repeatable for young players. As expected, the trend shows RPE and HR progressively increase towards the end of the protocols. This suggests the ITL was influenced by the training duration and both RPE and HR provide similar information regarding exercise intensities. To date, this is the first study reported the used of RPE to monitor ITL in Malaysia youth football players. It is important to highlight the needs to educate and familiarise the use of the RPE method with young athletes. This is because 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). A moderate correlation between RPE and HR were found in this study probably influenced by the small sample size. Therefore, it is suggested for future researcher to use a bigger sample size to determine the relationship of 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 on training session or during competitive match. Previous researcher also points out that RPE is a valuable tool to be use with young athletes as it sufficient to provide information on ITL and avoid necessity of expensive tools (Lupo, Tessitore, Gasperi, & Mar, 2017). Thus, the present findings confirm the first and second hypohthesis.

It is common practice of monitoring training load in football (Oliveira et al., 2019). There are few reasons why monitoring ITL is important especially for young athletes. First, to prevent them from overtrain and fatigue (Halsen, 2014). Introducing RPE scale to young athletes may help them to understand and properly prescribe the exercise intensities or training load. This information may be used by coaches 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 adapting, progressing or reach the plateau (Eston, 2012). Second, to lower the risk from injury especially due to overtrain and didn't get enough rest between training session or congested fixture period. 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 =  $19 \pm 1$  years, body mass =

73.0 ± 7.0 kg, height = 181 ± 5 cm). Indeed, this study finding could be valuable reference for coaches/sports scientist to include RPE in training session as monitoring training load is crucial for designing 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 in this study, football simulation test was used to investigate the RPE, future research should therefore concentrate on the investigation of RPE during normal training session.

## Conclusion

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

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