The relationship between training load indicators in young male soccer players

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Abstract

Intensity is the most important determinant of the practice. Therefore, the aim of this study was to determine the relationship between training load indicators in young soccer player. In the present study 16 male elite players (15-17 years) (height 168.12±7.1cm, weight 57.42± 7.92 kg, age 15.87 ± 0.8 years) in Tehran and Alborz league. They participated in the study voluntary. Participants were referred to the laboratory twice. In the first session, their height, weight and body composition were measured and finally they got familiar with devices and sports protocol. In the second session, they performed treadmill protocol for Vo2max measurement. All tests were held in time interval of 10-12 at 21±1 oc. According to preliminary studies, it was used ramp protocol on treadmill for Vo2max determination. For each participant, it was used the obtained data of resting status, one-minute average and maximum values of TRIMP, HRR, HR and Vo2max, linear regression between variables for calculation of line slope and constant. According to previous studies, the average and standard deviation of constant and slope were evaluated for each of two methods regarding the baseline (y=x) (slope to 1, constant to 0). The results showed positive significant relationship between %VO2peak with HRmax%, HRR%, RPE%, TRIMP% and RPE% with TRIMP%. Constant value mean and standard deviation values and slope for %VO2peak with %HRmax, % HRR, % RPE , %TRIMP and RPE% with TRIMP% shows a significant difference with base line (p=0.001). Based on the findings of the research and high correlation between all variables and specially RPE among young elite football players which is in consistent with most of the findings of related studies we can use RPE scale for evaluate the intensity of the exercise during practice and match in an easy, simple and inexpensive way needless of specific laboratory equipments and complex methods.

Key words: training impulse, RPE, RAMP Protocol, Vo2, HR

Introduction

Intensity, repetition, duration and the type of the activity are four factors used to describe activity and allowing practice plans (Armstrong, 2006). Intensity is the most important determinant of the practice. Determining the suitable intensity for all groups (healthy and sick) needs special considerations. In general populations there is a minimum activity threshold. If this threshold is observed we can expect the effects related to health and physical fitness to occur. Although activity with the minimum intensity threshold improves Vo2max, but higher intensities have better outcomes like less cardiovascular disease and risks. On the other
hand paying attention to maximum threshold of the activity especially in specific groups is crucial due to increased cardiovascular, respiratory and skeletal system demand. Any disturbance in functions of the above mentioned systems has serious outcomes (Swain and Franklin, 2006). Therefore for achieving an optimum level of health, fitness, improved function, much attention must be paid to determinant indices in sport activities (Armstrong, 2006).

Therefore prescribing sport activities has been developed during decades of physical activity and athletes’ preparation and these have been revised through scientific researches. American college of sport medicine (ACSM) has played a significant part in studying sport physiology and prescribing sport activities. Research findings regarding practice intensity among different individuals differs according to development, type of sport protocol, type of disease and specifically physical fitness (Swain and Leutholtz 1997; Swain and Franklin 2002) To prescribe optimal, secure and effective practice plan theses indices must be evaluated directly and individually in any given age group and both genders. VO2max evaluation is only possible in laboratory, and it costs a lot of time and money and requires expertise. Also increasing VO2max is complicated and with more pressure and results in exhaust in sports like football so the intensity with laboratory tests is almost impossible and costly. Thus alternative validated and reliable methods which are secure cost efficient and in accordance with society must be used.

One of the important issues in research methodology related to measuring protocols. Myers et al., (1991) reported that although hemodynamic responses to ramp and alternative protocols are similar, but there are significant differences between the gas exchange during sub maximum work and VO2max. The VO2 to work ratio in ramp protocols are higher in comparison with alternative protocols due to increasing work. They also suggested that the difference between predicted and evaluated VO2 was the minimum (Myers et al., 1991) Thus, the type of increasing activity protocol can affect the relationship between VO2 and HR, HRR, TRIMP and RPE. Generally the present study aims at answering the following questions about genuine young football players using ramp protocol: Evaluating the relationship between RPE and maximum oxygen intake using heart rate, TRIMP and RPE.

Materials and Methods

Research population and samples
In the present study 16 male players (15-17 years) (height 168.12±7.1cm, weight 57.42± 7.92 kg, age 15.87 ± 0.8 years) with suitable criteria including physical health were chosen after informing elite players in Tehran and Alborz league. They participated in the study voluntarily.

Research Method
Subjects referred to laboratory two times. The first session was for measuring their height, weight and body mass and the sport protocol and equipments were introduced to them. In the second session for measuring VO2max treadmill protocol was conducted. All tests were conducted in 10 to 12 hours intervals in 21 ± 1 °C temperature.

VO2max Protocol on Treadmill
In order to determine VO2max the ramp protocol on Techno Gym Med treadmill (made in Italy) was used and before implementing the protocol the test method and instructions were provided to all subjects and they were asked to continue the practice to exhaustion point. In order to determine the start speed and the level of gradual protocol increase, 6 subjects were tested using cardiovascular preparedness questionnaire and trial and error based on their ability (pilot study). Subjects referred to the laboratory on test day and started with stretching practice to warm up. Then stood on treadmill for 2 minutes to lessen their stress level and then the main protocol were conducted with 1 percent slop. Based on pilot study results, the start speed is 30 percent of the final speed and for gradual increase in every minute the final speed subtracted the start speed and then divided to 10. Subjects did the practice to exhaustion point and the oxygen intake was measured using breathing gas analyzer in all stages. Also the heart rate was recorded. As shown in figure 1 in every one minute of the test the level of their perception about the effort was determined and recorded. In order to ensure achieving Vo2 max in subjects, two of the following conditions should be gained: 1- heart pulses equals to 95% of maximum heart pulse, 2- ratio of respiratory exchange equals to 1.1, 3- diagram of oxygen consumption and heart rate (VO2.HR) reaches to steady state, 4- declaring exhaustion by the subject according to 10 point index of effort perception. In order to ensure achieving VO2 max in subjects, two of the following conditions should be gained: 1- heart pulses equals to 95% of maximum heart pulse, 2- ratio of respiratory exchange equals to 1.1, 3- diagram of oxygen consumption and heart rate (VO2.HR) reaches to steady state, 4- exhaustion state declaration by
The resting status data, the mean of each 30 seconds and the maximum level during the test converted to \% VO$_2$Peak\%. HRmax\%. HRR\%. RPE\%. TRIMP using the following equations:

\[ \%\text{VO}_2\text{Peak} = (\text{Current VO}_2 - \text{VO}_2\text{peak}) \times 100\% \]

\[ \%\text{HRR} = (\text{Current HR} - \text{resting HR}) \times (\text{HRmax} - \text{resting HR}) \times 100\% \]

\[ \%\text{HRmax} = (\text{Current HR} - \text{HRrest}) \times 100\% \]

\[ \text{FEHR} = (\text{Current HR} - \text{HR st}) \times (\text{HRmax} - \text{HRrest}) \]

\[ \text{TRIMP} = T \times \text{FEHR} \]

Figure 1. P-CERT Yelling M (Yelling M, et al. 2002)

Statistical method

In order to categorize and determine indices of distribution, descriptive statistics were used. Data was presented as mean ± standard deviation. After converting data to percentages for each subject, linear regression was calculated for each variable. Constant value mean and standard deviation and slope of all above mentioned methods were calculated and was evaluated regarding previous studies to y-x line using mean comparison test of a society (slope to one and Constant value to zero). Using the Excel 2007 software correspondent percentages with VO$_2$max were calculated and in the following equation the difference between VO$_2$max and HRmax, HRR, RPE, TRIMP were calculated (for other variables the same method was applied):

\[ \text{Percent Error} = (\text{VO}_2\text{max} - x) \times \text{VO}_2\text{max} \times 100 \]

Also, to evaluate the correlation between the variables Pearson correlation test was used.

Results

Anthropometric and physiologic data is presented as mean ± standard deviation in table 1

<table>
<thead>
<tr>
<th>Variable</th>
<th>FFM (kg)</th>
<th>FM (kg)</th>
<th>P.F</th>
<th>BMI (Kg.m$^2$)</th>
<th>VO$_2$max (ml.kg.min)$^{-1}$</th>
<th>HRmax b.min</th>
<th>HRrest b.min</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mean ± SD</td>
<td>49.67±5.64</td>
<td>7.74±3.9</td>
<td>13.02</td>
<td>20.25±2.1</td>
<td>52.62±7.04</td>
<td>201±18</td>
<td>74±8</td>
</tr>
</tbody>
</table>

Correlation test results showed that (table 2) that there is a positive significant relationship between \%VO$_2$peak with (r=0.92, p=0.001) HRR\%, (r=0.97, p=0.001) HRmax\%, (r=0.95, p=0.001) RPE\% and (r=0.95, p=0.001). Constant value mean and standard deviation values and slope for \%VO$_2$Peak with \%HRmax, \% HRR, \%RPE and \%TRIMP shows a significant difference with base line (p=0.001). Table 2 depicts the error in predicting \%VO$_2$peak.
Physiologic benefits of practice, mostly relies on the intensity. Intensity is the most important determinant in improving physical fitness and determining the suitable intensity for all groups (healthy and sick) needs specific considerations.

### The Relationship between VO\(_2\)peak and (HRmax, HRR, TRIMP) HR

The results of correlation test showed that there is a positive significant relationship between VO\(_2\)peak\% with (r=0.984, p=0.001). Constant value and slope mean and standard deviation for VO\(_2\)peak\% and HRmax\% showed a significant difference with base line (p=0.0001). Also the results of correlation test showed that there is a positive and significant relationship between VO\(_2\)peak\% and HRR\% (r=0.985, p=0.001). Fixed and slope mean and standard deviation showed a significant difference for VO\(_2\)peak\% and HRR\% with base line (p=0.0001).

As table 2 shows, HRmax\% predicts the VO\(_2\)peak\% error percentage in low intensity: -130, medium intensity: -50 to -23.3, hard intensity: -15.7 and very hard intensity: -8.2. Our results are in consistent with the results (Coote, 2009) and diversified from the result (Manzi V, et al., 200). While practicing (playing sports) with increasing heart rate the stroke volume increases and results in more cardiac output. Suring early recovery stage and after the activity is over, cardiac output, stroke volume and heart rate decreases. Oxygen intake is related to both cardiac output and stroke volume. Increasing heart beat translates to more oxygen intake (Edwards, 1993).

1. The correlation test results showed that there is a positive and significant relationship between VO\(_2\)peak\% and TRIMP\% (r=0.984, p=0.001). Constant value and slope mean and standard deviation showed a significant difference for VO\(_2\)peak\% and TRIMP\% with base line (p=0.0001). As table 2 shows TRIMP\% predicts the error percentage VO\(_2\)peak\% for low intensity: 30, medium intensity: 27.3 to 28.3, hard intensity: 28.5 and very hard intensity: 28.2. In the present study, based on TRIMP %the activity with less than 28 percent TREMP\% is light between 24 - 42 are medium, between 43-60 are hard and more than 61 are very hard activities). The results of this study are in consistent with (Lauca et al, 2003; Ascensão et al, 2008). All of the subjects were young elite players which is one of strength of the study. They mostly used sub maximum and
gradual treadmill protocol. We used ramp protocol in this study to precisely calculate VO\(_2\)peak. The VO\(_2\) to work ratio in ramp protocol is higher in comparison with permanent or alternative protocols due to increasing work. Studies showed that aerobic exercises relax resting heart rate that shows the decrease in Sympathetic Nervous System activity or increase in Parasympathetic tone (Edwards, 1993). Although some studies report resting heart rate decrease even in the absence of automatic nervous system changes. Also the decrease in resting heart rate resulting from sport activities can be a result of sinoatrial node adjustments or increasing venous returns after playing sports and a result of decreased heart rate (Edwards, 1993). Considering the findings of this research and other related studies we can conclude that HR is a valid physiologic factor to evaluate the maximum oxygen intake and intensity of the activity in athletes.

The Relationship between VO\(_2\)peak\% and RPE\%

The results of the correlation study showed that there is a positive and significant relationship between VO\(_2\)peak\% and RPE\% (r=\%911, p=\%001). Constant value and slope mean and standard deviation for VO\(_2\)peak\% and RPE\% showed a significant difference with the base line (r=\%0001). In researches that evaluate the relationship between RPE and VO\(_2\) the results are diversified and often specific measures have been used. Using Borg 10 point scale in two performances on treadmill has reported 70 to 75 percent correlation. Using Cart and Load Effort Rating scale (CALER) and Pictorial Children’s Effort Rating Table (PCERT) correlation was reported more than 0.84 to 0.94. Any way the correlation magnitude ranges from 0.32 to 0.94 using Omnibus (OMNII) in running, Walking, cycling, and taking stairs and many other situations (Edwards, 1993; Robertson et al. 2005; Roemmich 2006).

The Relationship between RPE\% and TRIMP\%

The correlation test results showed that there is a positive and significant relationship between RPE\% and TRIMP\% (r=\%974, p=\%0001). Constant value and slope mean and standard deviation for RPE\% and TRIMP\% showed a significant difference with base line (p=\%0001). The results of the present study are in consistent with (Thomas and Goeppinger, 2013). All these studied mentioned that their participants were among elite players. They adopted increasing treadmill protocol, gradual and sub maximum test. Subjects were male and female. Physiologic factors impacting the pressure perception can be stated based on internal or external load. Internal load like are physiologic functions of the body like heart rate, blood lactate, maximum oxygen intake, External load includes the environment affecting body (like temperature, light, noise, potentials, athlete’s capacity, physiologic and mental stress) which result in exhaustion changes. Exhaustion also can be affected by many stimulus, type of contraction (isometric, isotonic, alternative or permanent), duration, amount and intensity of the activity and the type of muscle (Marinov et al. 2008). Because of the high correlation between RPE and HR, RPE is a valid and precise method for monitoring the intensity of the activity needless of expensive and specific equipment’s and it can be very useful and practical for coaches and athletes. For athletes to gain optimum preparedness in practice, knowing the precise intensity based on one of the intensity evaluation indices is crucial. Scientific studies show that practice intensity is the most important factor in continuous and development of respiration and cardiac preparedness (Ostojic et al. 2011) so the above mentioned programs must be according to practice features and a safe and suitable work pressure limit must be set.

Based on the findings of the research and high correlation between all variables and specially RPE among young elite football players which is in consistent with most of the findings of related studies we can use RPE scale to evaluate the intensity of the exercise during practice and match in an easy, simple and inexpensive way needless of specific laboratory equipment’s and complex methods.

Conflict of interest

The authors declare no conflict of interest

References


