The Coach’s Predicted Training Load in Relation to Football Players’ Internal and External Load

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Abstract: The shift from a conventional approach to a more game-based and tactical approach when coaching football has placed an increased emphasis on the monitoring of training sessions and has consequently influenced, to a considerable extent, the further developments of tools and technology. With the growth of this field of practice, it became apparent that there is a gap in scientific understanding of the relationship between the coach’s predicted and players’ perceived training load. The training load that is predicted and perceived by football coaches and players respectively was compared in twenty-two training sessions with a semi-professional football team participating in the Maltese Premier League during the 2019/20 season. This was done through the session ratings of perceived exertion (Session RPE) and global positioning system (GPS). The participants consisted of twenty-one players and their coaches (coach and physical trainer). Athletes responded to the scale of perceived exertion using the BORG scale (scores from 0 to 10) after the training sessions, while the coaches completed the scale pre-session (predicted load) and post session (estimated load). Apart from that, the players were monitored with a Playertek GPS (10hz) throughout all training sessions. These methods were used to collect both the internal load (Session RPE) and external load (GPS). There was little disagreement between the predicted and estimated training load (coaches) and that perceived by the players as high correlations were established. Findings suggest that the coaches’ predicted and estimated loads strongly correlate with the load as perceived by the football players during an ongoing season between December 2019 and February 2020. A strong correlation also exists between the coaches’ predicted and estimated loads and the GPS load.

Keywords: Training Load, Football, Internal Load, External Load, Global Positioning System

Introduction to Football Coaching Methods

Football training has evolved throughout the years and so has knowledge on athletes’ preparation (Changjing Zhou et al. 2020; Issurin 2010; Kerr Cumbo 2018). Tactical content knowledge has attained great importance as football training started shifting from conventional “coach-centred, skill-focused” (Clemente and Rocha 2013; Gary and Hall 2015: 162) and traditional coaching approaches (Gray and Hall 2015) to game-based approaches (Bunker and Thorpe 1982; Light 2013). This change emphasised the importance of teaching the game (Light and Harvey 2017) rather than working on different fundamentals in isolation. A game-based approach is known to be more athlete-centred and tends to focus on coaching within game situations (Clemente and Rocha 2013; Light 2017; Light and Harvey 2017).

With this perspective to football coaching, Vitór Frade’s Tactical Periodization has gained traction in the last decades as one of the football coaching methodologies that has been
developed with the intention to have football trained/learnt whilst respecting its logical structure. This means that the tactical, technical, physiological, and psychological elements are never trained in isolation but are integrated within a game-based approach (Mendez-Villanueva and Delgado-Bordonau 2012). Tactical periodization is all “about our game” (Oliveira 2014) of football and takes a constructivist approach, allowing learning through the created environment (Kerr Cumbo 2018). It sticks to a fixed weekly pattern, respecting the changes in the training-recovery demands (Amieiro et al. 2006). It can be defined as “the subdivision of the seasonal program into smaller periods and training cycles” (Issurin 2010: 191).

The shift from a conventional, traditional approach to a more game-based tactical approach has made the monitoring of training volume, intensity, and load much harder than ever before.

**Monitoring Training**

The monitoring of the training process in high-level sport is deemed essential for the management of positive (fitness) and negative (fatigue/injury) responses to training (Banister 1991; Bartlett et al. 2016; Impellizerri et al. 2005). The balance between training and recovery needs to be carefully managed to prevent longer-term negative consequences to performance (Bartlett et al. 2016). The key to this is the accurate monitoring of the training stress so that coaches are aware of the possible contribution of training towards the training response (Bartlett et al. 2016). Typically coaches plan training sessions with specific outcomes in mind, including planning of physiological stress, which is essential for optimal training adaptations.

Numerous methods to monitor training have been developed over the years including the use of development in technology, such as heart rate (HR) monitors (Akubat et al. 2012; Malone et al. 2015;) and MEMS devices (Malone et al. 2015). However, one of the most prominent methods employed by researchers and practitioners is the session RPE method (Borg et al. 1987; Herman et al. 2006; Pandolf 1983; Scott 2013).

**The Session Rate of Perceived Exertion**

The Session RPE (Foster et al. 2001) uses a modified Borg CR10 scale (Borg et al. 1987) which requires the collection of each player’s perception with regard to how hard the session was on a scale of 1 to 10. The numbers which are not in a standard BORG scale 1 to 10 rating are used to quantify the level of the session, whether it is easy or difficult. As instructed by Foster et al. (2001), this rating is taken thirty minutes after the session. The RPE indicates the athlete’s internal intensity which is the individual’s physiological response to training. A coach can also look at the internal intensity of a player by analysing the HR and haematological measures (Coutts et al. 2010). Once the player rates the session, the individual internal load of the player can be obtained by multiplying the subjective data (Session RPE) by the duration of the session (Comyns et al. 2013). This method was popularised by the early works of Foster et al. (2001) and Impellizerri et al. (2004), where relationships with objective measures of training load deemed the method valid.

**External Load for an Internal Adaptation (Load)**

External load is defined as the work done by the player, measured independently of their internal characteristics (Wallace et al. 2009). This load is considered by measures of total distance covered, accelerations, or metabolic power (Osgnach et al. 2010). The external load does not determine the actual internal load the player executes during the training session. However, the training outcome is a consequence of this external training load.
together with the physiological stress that is imposed on any individual player (internal load) (Morgans et al. 2014). Irrespective of how it is quantified, coaches prescribe training according to external load to the desired psychophysiological response. It is this response that corresponds to the internal training load (Impellizzeri et al. 2019). There exists a vacuum in research that analyses the relationship between the external load prescribed by the coach/es and that perceived by the athletes (post-session) in a professional senior’s team.

Redkva et al. (2017) got close to this as they examined this relationship between the load perceived by the coach and the actual load (external) perceived by the players. They concluded that despite the different tactical positions and characteristics of the players, there were no statistical relationships in load perception of the coaches and the players. Hence, it was supported that the load as perceived by the coach on his own prescribed session (based on Session RPE) and the load as perceived by the players were in agreement at the end of the sessions. Nonetheless, Redkva et al. (2017) highlighted their limitations of the study, primarily the fact that the researchers could not distinguish between the tactical positions and could not evaluate any physiological variables. Secondly, the researchers only considered the duration of the training sessions and not the session content. Thus, the researchers suggested that future studies should use measures to quantify the internal intensities through HR monitors or external loads with movement analysis or GPS.

Modern coaching teams have numerous influential individuals that decide on training session content. The head coach and fitness coach are two such individuals. To our knowledge, there has not been a study that has compared the perceived intensity of training sessions when more than one member of the coaching team, as well as the players, are taken into consideration. Furthermore, despite studies evaluating the associations in intensity perceived by coaches, studies have not yet explored how this may exhibit itself as overall training load differences in football players. To fill in this gap, and to contribute to such research in the contextual realities of football in Malta, this study will be exploring the correlations in perceived intensity of sessions between head coach, fitness coach, and players.

**Methods**

Owing to the nature of the research objectives, this study adopted a quasi-experimental design with statistical analysis. To study the correlations between several variables (coach predicted/estimated, physical trainer predicted/estimated, player load RPE, player load GPS), this study tested the following hypotheses:

- **H1**: There is a correlation between the training load planned by the coach and the internal and external load obtained by the players.
- **H2**: There is a correlation between the training load planned by the coach and that planned by the physical trainer.
- **H3**: There is a correlation between the training load planned by the coach and the internal and external load obtained by the players from different positions.
- **H4**: The correlations between different load parameters are significantly influenced by the intensity of the training session.
Research Participants

Following ethical approval from the MCAST Board of Ethics, a Football Premier League team in Malta was approached. After official approval from the club, the team’s players and technical staff were approached to participate in this study. Three semi-professional and eighteen professional male football players (excluding goalkeepers), together with the technical staff (full-time head coach, assistant coach, a physical trainer, and a goalkeeper’s coach employed part time) of one Maltese Premier League football team, voluntarily participated in this study. All participating athletes gave written informed consent to be able to participate in the study. The data was gathered during the 2019/2020 season throughout the course of a complete two-month training period, between December and January. All players trained five days a week (evening sessions) and had one game during the weekend. Occasionally, the coach included another morning session particularly for the full-time players. However, the data of these sessions was excluded from this study.

Data Collection Tools

The Session Rate of Perceived Exertion was used as it is a cheap method which has been used and found to be valid and reliable (Borg et al. 1987; Herman et al. 2006; Pandolf 1983; Scott 2013). Apart from that, it does not require any specific equipment.

The global positioning system (GPS) tracks both volume and intensity variables. The volume variables include: distance covered, sprint distance covered (distance covered with speed 6m/s or higher), heart-rate load, player load, power plays (explosive movements such as sprints; every time a player generates over 20w/kg of power in their activity it is counted as a power play), energy (calories used), and impacts (number of collisions the player has been involved). Intensity variables include top speed reached, distance covered/minute, power score (an indication of how much load a player has experienced), work ratio (indicates the amount of time a player is working compared to resting), and player load (total player load during the session/game) (Playertek 2017). The variables used for this study were HR Load and Player Load.

The GPS used, as manufactured by Playertek, is a 10hz integrated with 400 Hz Tri-Axial Accelerometer and 10hz Tri-Axial. The Playertek pod contains a GPS unit and a set of inertial sensors that syndicate to track a player’s movement on the pitch. This system measures: speed, position, impact, force, twisting, and turning (Playertek 2017). The devices were placed in a tight vest which comes packed with the Playertek GPS and is positioned between the players’ scapulae. The GPS was turned on fifteen minutes before the start of the training session, following the instructions given by the producer to optimise the acquisition of satellite signals. Playertek’s GPS player tracking system helps to analyse the player’s physical performance. The GPS calculated the external load of each player during the session. Player Load is calculated in the Playertek system using the established algorithm as explained in a number of academic publications. In the case of the Playertek system, the accelerometer operates at 400hz which is smoothed to 100hz with the Player Load calculated as indicated in equation 1.

\[ \sum_{i=1}^{n} \sqrt{(ax_i - ax_{i-1})^2 + (ay_i - ay_{i-1})^2 + (az_i - az_{i-1})^2} \]

\textbf{Equation 1: PLAYERTEK established algorithm}

Where \(ax_i, ay_i\), and \(az_i\) are the acceleration values in x, y and z directions respectively and \(i = 0, ..., n\) represents the sampled accelerometer points with \(n+1\) points over the time of the
session. This Player Load formula was initially developed at the Australian Institute of Sport as an anticipated metric for measuring effort in a rugby union application and was adapted by Playertek (Playertek 2020). The internal load of the players was also collected through an integrated device inside the Playertek GPS pod.

Data Collection Methods

Session RPE together with the GPS were the methods selected to measure both internal and external loads respectively. The Session RPE was used to collect the coach's and physical trainer's predicted intensity before every training session. The actual intensity was also collected from coach, physical trainer, and all players after the session. The Global Positioning System (GPS) was used to obtain actual readings of players' external intensity.

Data Collection Process

Before each training session, the coach and fitness coach rated the Pre-Session RPE (Predicted) in accordance with the periodized plan and classified on a scale of 0 to 10 (Foster et al. 2001). When multiplied by the volume (length of the session), this provided the researcher with the predicted load. After every session, the coaches reviewed the session and gave post-Session RPE of the full session and individually rated the Estimate Player Session RPE according to their own perception. When multiplied by the volume (length of the session), this provided us estimated load. While both the coach and the physical trainer discussed what type of session they aimed to design, they never shared their predicted or estimated loads so that they do not influence each other on the decision taken.

Since the Session RPE is affected by internal and external factors (Lovell et al. 2016), the players were requested to rate their perceived exertion approximately thirty minutes after the end of the session (Herman et al. 2006). This prevents the possibility that the exercise at the end of the session affected the player's final RPE decision (Foster et al. 2001; Impellizzeri et al. 2004). They were instructed not to share their Session RPE with their teammates so as not to influence each other.

The coach and the physical trainer also rated their estimated (post-session) perceived exertion of the players. This information was instantly submitted on Google Forms by both coaches and players which facilitated transfer to MS Excel 16. The total workload for all variables was then calculated by using the formula: Training Load = Intensity x Volume, as used by Coutts et al. (2010). After each session, the GPS Pods were connected to the laptop using Playertek software and the data collected was inputted on their online software. Once the data was uploaded, a report was created by the software itself. When all the necessary data had been gathered, it was transferred to Microsoft Excel.

Methods of Analysis

A descriptive correlational design enabled this research to reveal the relationships between study variables. The GNU PSPP, an open-source programme, was used to run statistical testing and assess the association between variables. Bivariate correlation testing was used to determine the existence of relationships among six different variables: Coach-Predicted, Coach-Estimated, Physical-Trainer-Predicted, Physical-Trainer-Estimated, Player Load (Session RPE), and Player Load GPS. The correlation tests were applied and analysed by separate soccer field positions, namely: Centre-backs, Full-backs, Midfielders, and Attackers. This made it possible to specifically analyse data from a player's position point of view. Finally, correlation testing was applied to identify whether there was a relationship between session difficulty and the coach's and physical trainer's Session-RPE. Before
running the tests, the player load was classified in three levels (easy, moderate, and hard) as suggested by Andrade et al. (2014).

<table>
<thead>
<tr>
<th>Variable</th>
<th>Min.</th>
<th>Max.</th>
<th>Lower 95%CI</th>
<th>Upper 95%CI</th>
<th>Skew.</th>
<th>Kurt.</th>
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<tr>
<td>OO Predicted Load</td>
<td>265.22</td>
<td>110</td>
<td>253.39</td>
<td>277.05</td>
<td>0.33</td>
<td>-1.12</td>
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<tr>
<td>PT Predicted Load</td>
<td>257.82</td>
<td>75</td>
<td>243.07</td>
<td>272.56</td>
<td>0.66</td>
<td>-0.27</td>
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<tr>
<td>Player Load</td>
<td>258.20</td>
<td>55</td>
<td>243.24</td>
<td>273.17</td>
<td>0.85</td>
<td>0.92</td>
</tr>
</tbody>
</table>

**Table 1: Mean, Standard Deviation, Lower and Upper Bounds, Skewness and Kurtosis Scores**

All data was tested for normal distribution, and a 95% interval for the mean was established as can be observed in the Table 1. This means that if we had to collect the data again for a similar group of players, there is a 95% chance that the resulting data will be similar. Furthermore, skewness and kurtosis scores showed that data met the normal distribution assumption.

**Results, Analysis and Discussion**

This section will first present the main results in the form of descriptive analysis, which is followed by a statistical analysis which compares the coach’s and physical trainer’s predicted and estimated loads. The section will then statistically analyse the coach’s and physical trainer’s predicted and estimated loads with the players’ internal and external load. Finally, the section will be exploring the load correlations in view of the intensity of the training sessions.

**Descriptive Analysis: Coach’s and Physical Trainer’s Predicted and Estimated Load**

**Coach’s and Physical Trainer’s Predicted Load**

Figure 1 presents the coach and physical trainer predicted loads (pre session) together with the players’ average perceived load (post session). This initial analysis made it possible to first analyse how the coach and physical trainer compare in their predicted loads for every individual session. It also allows a comparison of their predicted load with the players’ average perceived load per session.

The coach-predicted load and the physical-trainer-predicted load (pre-session) matched on 50% of the occasions (11 sessions). Throughout all the 22 observed training sessions, the physical trainer consistently predicted higher training loads than the coach. The coach’s and the physical trainer’s predicted load matched with the players’ average perceived load (post-session) only once (4.55%). The coach’s predicted load was closer to the players’ perceived load than that of the physical trainer’s predicted load. With the coach scoring at 54.55% and the physical trainer 45.45% of the sessions. Despite noting different predicted load levels, it is still evident that the coaching staff was consistent in their pre-session predicted loading, as although they only perfectly agreed on 50% of the occasions, they were in total agreement about the variance between one and the next session in terms of increase or decrease in load.
Figure 1: Predicted load vs Player Load

Descriptive Analysis: Coach’s and Physical Trainer’s Estimated Load

When comparing the coach and physical trainer estimated loads (post-session) (Figures 2 and 3), one can notice how, particularly from session 6 to session 11, the relationship between the coach and physical trainer estimated load is weaker than the way their predicted load compares. Nevertheless, in line with the analysis of the predicted load (above), once again the physical trainer consistently quantified higher loads than the coach. However, this shows that both the coach and physical trainer remained constant when they felt that the players pushed more than the predicted pre-session.

Figure 2: The Coach’s estimated load
The coach-estimated load and the physical-trainer-estimated load (post-session) matched on 59.09% of the training sessions. Their estimated load (coach’s and physical trainer’s) both matched only once (4.55%) when compared to the players’ average perceived load.

The coach was once again closest at estimating the player’s load with 55.56% while the physical trainer had a percentage of 45.44%.
From observing the graph in Figure 6 below, the way the physical trainer estimated the load seems more consistent with the data obtained from the actual GPS of the players. However, the descriptive data cannot support this through a quantified result. Hence, this will be statistically tested further along in the study.

It was hard to observe the flow between the three variables. For this reason, we decided to look further into statistical results. Hence this will be statistically tested further on.
A Statistical Analysis of the Coach’s and Physical Trainer’s Predicted and Estimated Load

The data set applied for this study is comprised of six variables, these being Coach-Predicted Load (pre session), Physical-Trainer-Predicted Load (pre-session), Coach-Estimated Load (post session), Physical-Trainer-Estimated Load (post session), Player Load (Internal load) and Player Load GPS (external load).

Coach’s vs. Physical Trainer’s Predicted Load (Pre-Session)

The coach’s predicted load was strongly correlated (0.92) to the physical trainer’s predicted load (Figure 8) and $H_2$ was accepted. The aim of physical preparation within a soccer team is crucial to prepare all players for the demands of competition. Accordingly, a knowledge of these demands is critical for accurate prescription (Gabbett and Whiteley 2017). In fact, Martens (2012) explains that even though sports clubs are investing money in physical trainers who are certified to conduct physical training programmes, coaches must also have the knowledge to conduct these training programs. This is crucial for them to be able to understand the basic sports physiology while learning to understand and evaluate the physical trainer’s work. With strong knowledge of the subject, the coach can assist in planning the programme together with the physical trainer and also implement his coaching philosophy more effectively and efficiently.

As a result, we believe that the background of both the coach and the physical trainer participating in this study led to this strong correlation found. The coach was a UEFA pro licensed coach who has also followed the physical trainer’s courses at the Malta Football Association. The physical trainer was a UEFA B licenced coach who has also undertaken the same physical trainer’s course and was at the time of this study reading for a Bachelor of Science (Hons) in Sports, Exercise and Health. Their professional relationship, the profound level of technical discussions and their programming and planning may have been influential in the outcome of these findings.
Figure 8: Scatter plot Coach predicted Load vs Physical Trainer Predicted Load

Coach’s Vs Physical Trainer’s Estimated Load (Post-Session)

The strong agreement between the coach and the physical trainer continues to be shown by the fact that the coach’s and physical trainer’s estimated Session RPE (post-session) had a strong correlation of 0.91 (Table 2). This shows that the session did not differ much from what both the coach and the trainer were expecting, as also shown in the scatter plot (Figure 9).

Figure 9: Scatter plot Coach estimated load vs and Physical Trainer estimated load

The Coach’s Predicted Load Vs the Coach’s Estimated Load and the Physical Trainer’s Predicted Load vs Physical Trainer’s Estimated Load

As per Figure 10 it is very evident that both coach and physical trainer had a very strong and positive agreement between their own predicted load (pre-session) and their estimated load (post-session). In fact, the coach-predicted load and -estimated load had a correlation of 0.94 while the physical trainer had a correlation of 0.92 (Table 2). This signifies that both coach and physical trainer felt that the intensity (Session RPE) obtained in their training sessions were very close to what they had planned.
**Figure 10:** Scatter plot Coach Predicted vs Estimated and Physical Trainer Predicted vs Estimated

*The Coach’s and Physical Trainer’s loads Vs Players’ Internal (Session RPE) and External (GPS) Loads.*

All the above data feeds into the main research question, which revolves around the relationship between the load planned by the coach (predicted load) and perceived by the coaching staff (estimated load) in comparison to the player’s internal (player load) and external load (player load GPS). While the hypothesis correlation (Table 2) extrapolates these findings clearly, the upcoming sections will discuss every indicative result. Table 2 shoed that H₃ was accepted because the correlations are statistically significant.

<table>
<thead>
<tr>
<th>Variables</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
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<td>1. CO Predicted Load</td>
<td>-</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2. CO Estimated Load</td>
<td>.94*</td>
<td>-</td>
<td></td>
<td></td>
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<tr>
<td>3. PT Predicted Load</td>
<td>.92*</td>
<td>.94*</td>
<td>-</td>
<td></td>
<td></td>
</tr>
<tr>
<td>4. PT Estimated Load</td>
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<td>.91*</td>
<td>.92*</td>
<td>-</td>
<td></td>
</tr>
<tr>
<td>5. Player Load</td>
<td>.71*</td>
<td>.73*</td>
<td>.76*</td>
<td>.77*</td>
<td>-</td>
</tr>
<tr>
<td>6. Player Load GPS</td>
<td>.54*</td>
<td>.58*</td>
<td>.61*</td>
<td>.57*</td>
<td>.53*</td>
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</tbody>
</table>

\[ n=298, p<.01 \]

**Table 2: Correlations between study variables**

*The Coach’s and Physical Trainer’s Predicted and Estimated Load vs Players’ Internal Load (Session RPE)*

When we examined the players’ internal load (session RPE), the physical trainer was consistently more accurate than the coach, with a strong correlation of 0.76 when predicting the load and a higher correlation of 0.77 when estimating the load. Similarly, the coach had a strong correlation of 0.71 and 0.73 when predicting and estimating the players’ internal load respectively. This shows that the predicted load planned by the coaching staff is generally similar to that perceived by the players. These findings show
that $H_1$ was accepted as it shows that that coaches can use their predictions to create strong periodization plans, which can be scientifically considered as reliable as we can officially conclude that:

**The Coach's and Physical Trainer's Predicted Load vs Players’ External Load (GPS)**

When the coach and physical trainer predicted the session load in terms of player load GPS, the physical trainer was once again more accurate with a strong correlation of 0.61. On the other hand, the coach had a moderately strong correlation of 0.54. When looking at how the players perceived the training load in relation to the GPS load, they had a moderately strong correlation of 0.53.

This demonstrates that the physical trainer and coach predicted the Player Load GPS slightly better than the players themselves. It could be assumed that this result stems from coaches being more knowledgeable than the players when predicting and estimating the training load values. Coaches are the ones that plan the load of the session (predicted load), and then they are the ones who designs the exercises (external input) intended at reaching that predicted load. The GPS reading is a consequence of that predicted load and the plans set to reach that external load. The players on the other hand are only the participants, and as such are perhaps not always as aware as the coach throughout the session. However, one should not underestimate the fact that even the players load obtained a positive correlation to player load GPS.

**The Coach’s and Physical Trainer’s Estimated load (Post-Session) vs Players’ External Load (GPS)**

Estimating the session outcome, the coach had a moderately strong correlation of 0.58, and the physical trainer had a lower yet moderately strong correlation of 0.57. This means that the physical trainer predicted better pre-session, however, the coach estimated the session load slightly better post-session. The physical trainer might have more understanding and experience to periodization and planning (Martens 2012). The fact that the physical trainer was normally more involved during the training session than the coach could have influenced this result, as the physical trainer could have been more concentrated on running the training session, rather than looking at the overall load of the players. On the contrary, the coach spent most of the session time observing the outcome of the session, placing him in a better position to monitor the session throughout and re-align his perceived load to the actual outcome of the session.

Considering this positive correlation between the perceived load and the GPS, one might question the financial cost of investing in equipment such as GPSs, which has to be maintained at a cost from year to year and which ultimately becomes redundant by time, and instead focuses more on the benefits of investing and expanding coaching knowledge.

Although GPS can track precise information (Haddad et al. 2017), Horn (2002) suggests that coaches could positively affect athletes' performance, behaviour, and psychological and emotional wellbeing. Looking into the identified relationships, one can argue that a coach can give more value than a GPS does. A good GPS can quantify several variables but does not consider psychological factors. My thoughts behind this argument would be that a club with a limited budget should instead invest firstly in improving the coach’s knowledge. However, I do not want to minimise the importance of GPS. Clubs who can afford in investing in GPS should do so to use it as a delayed or instant objective verification of the work done by the coaches.
When compared, all load variables (Coach-Predicted and -Estimated, Physical-Trainer-Predicted and -Estimated, Player Load RPE) with the Player Load GPS, were moderately strongly (Coach-Predicted and -Estimated, Physical-Trainer-Estimated, Player Load RPE) and strongly (Physical-Trainer-Predicted) correlated (Table 2). Although the correlation value is not as high compared to the other results, it is still moderate as its >0.50. These results do not jeopardize the level of this correlation, given that the Internal load (Player Load) and External load (Player Load GPS) of the players correlates at 0.53. This is very similar to the relationship identified between the Coach and Physical Trainer correlation to the Player Load GPS. This demonstrates the fact that, despite the lower values being noticed, no inconsistencies or contradictory evidence was highlighted through analysis.

Based on the results the null hypothesis was rejected. This further corroborates our initial findings in that the relationship between the predicted load by the coach, that perceived by the players and the actual load (GPS), were actually aligned.

The results found in this study are consistent with the results of previous studies. In the only study that used training load as the correlated variable before this study was held, Redkva et al. (2017) found a similar correlation of 0.60 between the predicted load of the coaches and that of the players.

Studies from running (Foster et al. 2001) and swimming (Wallace et al. 2009) also found strong correlations between the coaches' and players' perceived intensity (0.75 and 0.84 respectively). Andrade Nogueira et al. (2014) argued that, despite the fact that during a volleyball match each player performs a specific role, there were no statistically significant correlations between the training load as perceived by the same players. On the other hand, in a contrasting fashion, Delattre et al. (2006) found that cyclists tend to overestimate the training load prescribed by the coach. Similarly, when analysing U17 and U19 soccer players, Brink et al. (2014) noted how both age groups perceived training harder than that planned by the coaching staff.

When looking at Brink's et al. (2014) research, one has to consider that the fact that the study was carried out on young athletes may possibly be of great influence on the different results. As the authors concluded, considering their young age, the athletes may assumably lack knowledge on the principles of periodization and awareness to alternate high training loads with sufficient recovery, and this may have an influence on the obtained negative correlation in the said study. Our research, on the other hand, was carried out on older players, most of whom are professionals and hence experienced with such methods of training. In fact, findings found in our study seem to be more constant with most of the studies (Andrade Nogueira et al. 2014; Foster et al. 2001; Redkva et al. 2017; Wallace et al. 2009) in this field of research. Considering the strong correlation found between the coach's and physical trainer's predicted and estimated load to the players' perceived load and the players' external load (GPS), it became compelling to look at other variables that might be influential.

The first variable to be identified and tested was the playing position. We were curious to understand whether this correlation remains strong irrespective of the position of the players. This curiosity was influenced by Andrade et al. (2014) who have done a study in which they have explored the level of agreement between the perceived internal load of volleyball players with the coach's predicted load, and who also studied the perceptions of internal training load between different positions in volleyball. Through a bivariate correlation test we could explore the correlation between the predicted load of the coaches
and the internal and external load of the players according to their positions. This way, we could further strengthen, or perhaps, differentiate according to playing positions. These findings could indicate with which position the coach and physical trainer correlated the most.

The players were split into four groups: Centre-backs (CB), Full-backs (FB), Midfielders (MD) and Attackers (ATT). The centre-backs’ load (internal load) strongly correlated both with the coach’s predicted load (0.77) and the physical trainer’s predicted load (0.83). From analysing all positions, the centre-backs had the highest correlation. The centre-backs’ load was also the one with the highest correlation with the Player Load GPS (Table 3). Based on these findings, one could argue that the centre-backs participating in this study were the oldest hence the most experienced in the team, which as discussed earlier, might be influential to obtain such result.

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</thead>
<tbody>
<tr>
<td>1. CO Predicted Load</td>
<td>-</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2. PT Predicted Load</td>
<td>.92*</td>
<td>-</td>
<td></td>
</tr>
<tr>
<td>3. Player Load CB</td>
<td>.77*</td>
<td>.83*</td>
<td>-</td>
</tr>
<tr>
<td>4. Player Load GPS CB</td>
<td>.57*</td>
<td>.66*</td>
<td>.69*</td>
</tr>
</tbody>
</table>

\(n=68, \ast p<.01\)

**Table 3:** Correlations between Coaches’ predicted loads and CB

The full-backs’ perceived load has correlated strongly with the coach’s predicted load (0.70) and with the physical trainer’s predicted load (0.79). The full-backs’ predicted load has also correlated moderately strong to the player load GPS (0.52) (Table 4).

<table>
<thead>
<tr>
<th>Variables</th>
<th>1</th>
<th>2</th>
<th>3</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. CO Predicted Load</td>
<td>-</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2. PT Predicted Load</td>
<td>.91*</td>
<td>-</td>
<td></td>
</tr>
<tr>
<td>3. Player Load FB</td>
<td>.70*</td>
<td>.79*</td>
<td>-</td>
</tr>
<tr>
<td>4. Player Load GPS FB</td>
<td>.56*</td>
<td>.62*</td>
<td>.52*</td>
</tr>
</tbody>
</table>

\(n=53, p<.01\)

**Table 4:** Correlations between Coaches’ predicted loads and Full-Backs

The midfielders’ load also strongly correlated to the coach’s predicted load (0.72) and to the physical trainer’s predicted load (0.75). Nevertheless, one may notice that the midfielders have the weakest correlation among the four positions. Similarly, they recorded the lowest correlation with the Player Load GPS that of 0.51 (Table 5).

Such data might reflect the fact that most of the players in this position were either young or foreigners who might have not fully understood the use of the data collection tools due to a language barrier. According to Ramlan et al. (2018), language barriers and
communication style were found to have a substantial effect on how foreigners perform at their work.

<table>
<thead>
<tr>
<th>Variables</th>
<th>1</th>
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<th>3</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. CO Predicted Load</td>
<td>-</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2. PT Predicted Load</td>
<td>.93*</td>
<td>-</td>
<td></td>
</tr>
<tr>
<td>3. Player Load MD</td>
<td>.72*</td>
<td>.75*</td>
<td>-</td>
</tr>
<tr>
<td>4. Player Load GPS MD</td>
<td>.58*</td>
<td>.62*</td>
<td>.51*</td>
</tr>
</tbody>
</table>

\[ n=108, \ast p<.01 \]

**Table 5: Correlations between Coaches’ predicted loads and MD**

The attackers’ load has strongly correlated to the coach’s predicted load (0.71) and to the physical trainer’s predicted load (0.79). When comparing the attackers’ player load with the Player Load GPS, they had a moderately strong correlation (0.57). The attackers were also experienced players, as almost all of them were over the age of twenty-eight. This is consistent with both the data found for centre-backs in this study and the findings of Brink et al. (2014) in that players with a lack of experience found it relatively harder to predict and estimate load.

<table>
<thead>
<tr>
<th>Variables</th>
<th>1</th>
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<th>3</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. CO Predicted Load</td>
<td>-</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2. PT Predicted Load</td>
<td>.90*</td>
<td>-</td>
<td></td>
</tr>
<tr>
<td>3. Player Load ATT</td>
<td>.71*</td>
<td>.79*</td>
<td>-</td>
</tr>
<tr>
<td>4. Player Load GPS ATT</td>
<td>.47*</td>
<td>.59*</td>
<td>.57*</td>
</tr>
</tbody>
</table>

\[ n=75, \ast p<.01 \]

**Table 6: Correlations between Coaches’ predicted loads and Attackers**

**Exploring Load Correlations in View of the Intensity of the Session**

Influenced by Andrade et al. (2014), it was also interesting to additionally test \( H_4 \) to explore whether the correlation (or lack of it) between the coach’s predicted and estimated load and the players’ internal load and external load is in any way influenced by the level of intensity of the session. To be able to run these tests, sessions were categorised according to the coach’s and physical trainer’s predicted Session RPE (intensity). Following Andrade et al. (2014), the sessions were categorised as easy if they were predicted by the coach to be between RPE 1 and 3, moderate if they were predicted by the coach to be between RPE 4 and 5, and as hard if they were predicted by the coach as RPE 6 and over. The coach’s and physical trainers’ predicted load from each of the section was always tested against both the Player Load (RPE) and the Player Load GPS.
Exploring the Coach’s Predicted Intensities vs Players’ Internal and External Load

During the period that the data collection was collected, the coach only rated sessions as easy and moderate while the physical trainer rated sessions as easy, moderate, and hard.

When predicting easy sessions, the coach had a strong positive correlation with both the Internal Load (0.60) and External load (0.63) of the athletes (Table 8).

<table>
<thead>
<tr>
<th>Variables</th>
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</thead>
<tbody>
<tr>
<td>1. CO Predicted Load</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>2. Player Load</td>
<td>.60*</td>
<td>-</td>
</tr>
<tr>
<td>3. Player Load GPS</td>
<td>.63*</td>
<td>.56*</td>
</tr>
</tbody>
</table>

\( n=154, \ast p<.01 \)

**Table 7:** Correlation between the Coach and Players when the session was perceived as easy

When predicting moderate sessions, the coach had a moderate positive correlation with the internal load (0.56) of the players, and had a weak positive correlation (0.31) with the external load (Table 8).

<table>
<thead>
<tr>
<th>Variables</th>
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</tr>
</thead>
<tbody>
<tr>
<td>1. CO Predicted Load</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>2. Player Load</td>
<td>.56*</td>
<td>-</td>
</tr>
<tr>
<td>3. Player Load GPS</td>
<td>.31*</td>
<td>.30*</td>
</tr>
</tbody>
</table>

\( n=144, \ast p<.01 \)

**Table 8:** Correlation between the Coach and Players when the session was perceived as moderate

On the other hand, when predicting easy sessions, the physical trainer’s predicted load had a moderate positive correlation with the players’ internal load (0.51) and a strong positive correlation (0.79) with the players’ external load (Table 10).

<table>
<thead>
<tr>
<th>Variables</th>
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<th>2</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. CO Predicted Load</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>2. Player Load</td>
<td>.51*</td>
<td>-</td>
</tr>
<tr>
<td>3. Player Load GPS</td>
<td>.79*</td>
<td>.56*</td>
</tr>
</tbody>
</table>

\( n=156, \ast p<.01 \)

**Table 9:** Correlation between the Physical Trainer and Players when the session was perceived as easy
When predicting moderate sessions, the physical trainer had weak positive correlation when predicting the internal load (0.25) and very weak positive predicting the external load (0.10) (Table 10).

<table>
<thead>
<tr>
<th>Variables</th>
<th>1</th>
<th>2</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. CO Predicted Load</td>
<td>-</td>
<td></td>
</tr>
<tr>
<td>2. Player Load</td>
<td>.25*</td>
<td>-</td>
</tr>
<tr>
<td>3. Player Load GPS</td>
<td>.10</td>
<td>.03</td>
</tr>
</tbody>
</table>

n=115, *p<.01

Table 10: Correlation between the Physical Trainer and Players when the session was perceived as moderate.

When predicting hard sessions, the physical trainer had a very weak negative correlation both with the internal (-infinity .000) and external load of the players (+infinity .000). This could be due to only one session out of twenty-two was found to be hard; thus, the data tested was not enough for a reliable outcome.

<table>
<thead>
<tr>
<th>Variables</th>
<th>1</th>
<th>2</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. CO Predicted Load</td>
<td>-</td>
<td></td>
</tr>
<tr>
<td>2. Player Load</td>
<td>-Infinity*</td>
<td>-</td>
</tr>
<tr>
<td>3. Player Load GPS</td>
<td>+Infinity*</td>
<td>.05</td>
</tr>
</tbody>
</table>

n=115, *p<.01

Table 11: Correlation between the Physical Trainer and Players when the session was perceived as hard.

From these multiple correlation tests that we carried out, we could realise that the highest significance was found when predicting easy sessions. When predicting moderate sessions, it correlated less, and when predicting harder sessions, there was a negative correlation.

This might shed light on the results obtained on the main hypothesis, where a strong positive correlation was noted amongst the variables being analysed. As noted earlier in the study, the analysis was made during December 2019 to February 2020, which is considered as the mid-season. During such a period, the periodized plan tends to be relatively less intense due to many games being played at that time.

**Conclusion**

Every coaching life exists in an ongoing struggle between the planned and the achieved. In simple terms, based on their planning, coaches always aim or hope to achieve an outcome which is very close to their planned sessions (Brink et al. 2014; Redkva et al. 2017). However, through its main hypothesis, that is, “There is a correlation between the training load planned by the coach and the internal and external load obtained by the players”, this study challenges this assumption and looks at this from an objective position. To my knowledge, this study is the first to examine the relationship of the coaches’ predicted load with the internal and external load achieved by the players.
The primary purpose of this study was to analyse the relationship between the coach-predicted load and the athletes’ internal and external load. A set of secondary hypotheses were designed to generate findings aimed at informing the main hypothesis even further.

**Limitations of the Study**

While a full effort was made to control for the limitations of the study, a set of limitations are hereby discussed. When testing the findings against the difficulty of training sessions, there was only one session which was classified as hard. This could limit the findings of this same study. While when discussing periodization in the literature review this study considers tactical periodization, and while it also considers the four corners, through data collection, this research did not take note of the psychological, social, and tactical affects that might have influenced the results. While this does not reduce the validity of this study, future research may also consider these areas when comparing predicted and estimated loads. However, one may also consider the fact that RPE recognise the influence of these factors (Haddad et al. 2017).

**Suggestion for the Research**

The second limitation of the study leads me to suggest future studies to use methods which quantify the internal of the athlete (e.g. HR) besides using the Session RPE, as the idea of this study was in the first place.

In addition, we suggest other researchers to look in more detail when it comes to session difficulty and its correlation with the coach-predicted load. When we ran the bivariate tests there was only one session classified as hard, thus this could influence the final result due to the lack of data collected. It is interesting to note that when it comes to predicting “hard” sessions there will be less correlation between the coaching staff and the players. Hence, a longitudinal study, of perhaps at least one season, might be needed. Another solution would be taking the pre-season as a data collection period, as the pre-season may tend to cover all type of training sessions, these being easy, medium, and hard.

Another assumption I had and which could be further suggested is that experienced players might have a higher correlation when it comes to perceiving the Session RPE with that predicted by the coach. Future research studies can aim at running tests looking at the correlations based on the age of the players and their nationality. Further research should also consider the relationship of predicted and estimated loads as influenced by the tactical, psychological, and social aspects of training, and not only from a physiological point of view.

**Main Findings and Conclusion**

The main findings of this study show a strong relationship between the coach-predicted load and internal and external load achieved by the players during the mid-season training sessions. In fact, it was identified that midfielders had the weakest correlation and the tendency to underestimate their load. Furthermore, the results of this study show that when the coaches predict training sessions, they had their highest correlation when predicating easy sessions. Based on the characteristics of individuals and methodology of this study, we conclude that the predicted load of the coaches and the internal and external load of the players correlated. The findings strengthen the idea of planned periodization, with high emphasis on coaches to control their training load to avoid overtraining and reduce the risk of injuries (Redkva et al. 2017).
References


