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Analysis of Existing Soccer Conditioning Data

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ANALYSIS OF EXISTING SOCCER CONDITIONING DATA

by

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requirements for the degree

of

MASTER OF SCIENCE

in

Health and Human Movement

Approved:

5/22/2017	5/22/2017
Dennis Dolny Major Professor	Tye Harrison Committee Member

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Abstract

The purpose of this study was to examine the internal and external load of collegiate women's soccer players by examining and comparing both physiological and psychological factors associated with typical pre-season and in-season training sessions and competitions. Focusing on physiological and psychological factors such as Heart Rate, Distance traveled, Sprints and Training load and their influence on soccer performance during both training sessions and competitions. Twenty-Two Division I collegiate women's soccer players wore Polar Team Pro heart rate monitors daily during training and competitions and reported subjective Data on the Fit for 90 database. Over the course of the season HR stayed steady for both training (140 ± 6.16 bpm) and competition (135 ± 3.069 bpm) while a decrease was seen in TL scores during training sessions over the course of the season (Week 1: 697.628 AU, Week 14: 209.285 AU). The same was not seen for competitions, TL scores remained relatively stable over the course of the season (Week 2: 646.071 AU, Week 14: 67.363 AU). Training load scores were determined by the total distance covered on a weekly basis. These findings suggest that the physiological factors collected have a relationship with the psychological factors assessed by the athletes. The data suggests that the use of both physiological and psychological data is important in providing the best opportunity for athlete utilization and performance over the course of a longer season such as soccer.

Key Terms

Heart Rate, Training Load, Rate of Perceived Exertion, Internal Load, External Load.

Introduction

The monitoring of physiological and psychological factors can provide a better understanding into the performance of athletes on the field, in both training and competitive atmospheres. For example, understanding the physiological demands placed on an athlete during a soccer match can allow for adjustments to be made during the training sessions leading up to games to optimize performance outcomes. Having an understanding of this information is not only pertinent to the coaching staff but to the entire support staff as it can give insight into injury rates and strength development over the course of a season.

The examination of internal versus external load and how this information allows athletes to compete at their fullest potential is key throughout research. Many different researchers have delved into the complex nature of both internal and external load and the many different variations that there are in measuring both.

The fully understand the intent of this research, one must understand what is meant by the terms internal and external load. External Load is defined as "Work completed by the athlete, measured independently of his or her internal characteristics." (Halson, 2014). Whereas, Internal Load is defined as "The relative physiological and psychological stress imposed." (Halson, 2014). Throughout the literature there were commonalities between research articles as to how these two aspects are measured. When it comes to External Load, much of the work was done using Global Positioning System (GPS) units or by examining video from recorded matches. Typically, the variables of interest are Speed and Distances covered. With regards to Internal Load; Heart Rate monitors, Arbitrary equations such as Training Impulse (TRIMP) and self-evaluative tools such as the Rating of Perceived Exertion (RPE) are common throughout the literature.

Several studies have examined both Training Load based upon RPE and heart rate and how they relate to the game of soccer. In female soccer players, Krustrup and colleagues used HR monitoring systems that used a chest strap and wrist receiver to collect all data. (Krustrup, 2005) RPE based training load scores have typically been used for steady-state exercise. Impellizzeri and colleagues used an RPE based model to determine training load and compared it to HR responses to exercise. (Impellizzeri, 2004) Due to the nature of soccer activity, it has been suggested that the increased anaerobic contribution may be a cause for increased training load scores. The researchers go on to state; "Previous research suggests that RPE may be a more reliable measure of exercise intensity when both anaerobic and aerobic systems are appreciably activated, such as is the case during intermittent activities like soccer." (Impellizzeri, 2004) As with all research, there are benefits and drawbacks from techniques used. The use of RPE alone may not be a reliable measure but combining it with duration and HR can increase the validity in research. (Halson, 2014) The use of HR alone is based on the relationship between the rate of oxygen consumption and HR during steady state exercise. (Halson, 2014) It should be noted that "HR values measured during a match may lead to an overestimation of oxygen consumption as other factors such as hydration status, hyperthermia and mental stress elevate HR" (Bangsbo, 2006)

External load has been researched in various ways throughout the literature. As mentioned previously, research has used video analysis to determine speed and distances for a large sample size. In a comparison done by Dellal et al., 5938 observations were made across two high level European soccer leagues. In this study specifically, the data collected throughout the competitions was converted into raw data, thus reducing the opportunity for researcher error. (Dellal, 2011) In a similar study done by Bradley et al. "the match analysis software had been

independently validated to verify the capture process and subsequent accuracy of the data." (Bradley, 2009)

While internal and external load differ in their findings, they utilize similar data to reach their end goals. The session based RPE training load score uses duration in minutes, which can be attributed to external load, and RPE which is a measure of internal load.

While there is adequate research in the field of internal load and external load, many previous studies have been conducted on professional athletes in higher level European soccer leagues. This limits the researcher's ability to extrapolate findings to athletes at a lower level of performance, as they would likely not have the same physiological findings.

Providing an in-depth look into the internal and external load of a collegiate women's soccer player can allow for a better understanding of the physiological and psychological demands placed upon athletes throughout competition. Much of previous research on external load has been done using video analysis of previously recorded soccer matches. The present study will look to use GPS tracking built into the Polar Heart Rate monitoring system and compare that with the results of differing research techniques from previous studies. Internal load will be measured similarly to previous research by using the Session based RPE model for TL and then comparing that with HR values collected. As previously mentioned, the present study will use these research methods while examining collegiate age women's soccer players, thus allowing for a comparison across gender, age and skill level. Such information may allow for better optimization and usage of players over the course of a season. Therefore, the purpose of this study was to examine the internal and external load of collegiate women's soccer players by examining and comparing both physiological and psychological factors associated with typical pre-season and in-season training sessions and competitions.

Methods

Subjects:

For the purpose of the present study, the Utah State University Women's Soccer team were used as participants. The team consists of 31 players; due to injuries, red-shirts and coach's decisions to not play during matches throughout the season, as well as the exclusion of goalkeepers due to a decreased activity load during matches and practices the total number of participants included in the study was 22. Participants were required, by coaches, to wear the Polar Team Pro Heart Rate Monitors as well as report daily on Fit for 90.

Due to the nature of the online Fit for 90 Database, only active players have data accessible. This study was completed following the competitive season and therefore only players that were on the roster for the upcoming summer and fall season were accessible. This reduced the number of available participants by 7, as those seven were seniors with no remaining years of eligibility.

Data Collection:

Data was collected daily by all the players on the Utah State University Soccer team. This data collection was mandated by the Utah State University Soccer coaches and was collected prior to the initiation of this research.

Collection took place during on-field training sessions as well as during games and covers both pre-season and in-season activity. The data was collected using a polar chest strap with a heart rate monitor, this is transmitted to an iPad on the field. The monitoring took place during warm-ups, activity and cool-down periods of each training session and match. As for the

subjective data, Fit for 90 is used. Players were instructed to report to the website daily, with preference being that they fill it out in the morning and after each session.

Variables:

Throughout the study there were numerous variables being collected by both the Polar Team Pro and by the subjective measures associated with Fit for 90. For the study, some of the variables have been excluded due to redundancies and lack of a relationship to the sport of soccer. Each of the variables have been listed below.

Fit for 90: Rating of Perceived Exertion (RPE) is a subjective scale from 1-10 that allows athletes to give the exercise session a rating based on how easy or difficult they believed the workload was. Training Load, which is calculated by taking the RPE given by the athlete and multiplying that by the duration in minutes of the training session.

Borg's CR 10 Scale for RPE	
Rating	Descriptor
0	Rest
1	Very, Very Easy
2	Easy
3	Moderate
4	Somewhat Hard
5	Hard
6	
7	Very Hard
8	
9	
10	Maximal

Within Fit for 90 software they calculate a readiness score, which considers fatigue, soreness, stress, mood, sleep quality and sleep time. This score will be looked at as well as their Fatigue and Soreness ratings individually. However, due to the randomness with reporting data, only the training load will be used for statistical analysis.

Polar Team Pro: The use of the Polar Team Pro allows for a vast array of variables to be measured, for this study we have decided to specifically analyze the variables that we as researchers find most applicable to the sport of soccer. Duration of each training session or match is important in examining the workload of each athlete, this study will look at both HR Avg. in beats per minute (BPM) as well as the percent of their HR max they are operating at on average (% HR Avg.). The amount of time spent in each heart rate zone (50-59%, 60-69%, 70-79%, 80-89%, 90-100%) can allow for a better understanding of how energy is used throughout training and matches. Max Speed, Average Speed, Total Distance in each speed zone (3.00-6.99 km/hr, 7.00-10.99 km/hr, 11.00-14.99 km/hr, 15.00-18.99 km/hr, 19.00+ km/hr) as well as Number of Accelerations per Zone (-50.00 - -3.00 m/s, -2.99 - -2.00 m/s, -1.99 - -1.00 m/s, -0.99

- -0.50 m/s, 0.50-0.99 m/s, 1.00-1.99 m/s, 2.00-2.99 m/s, 3.00-50.00 m/s) show how players move throughout a session.

The large number of variables allows for a better representation of both training and competitions.

Descriptive Stats:

The season was split into pre-season and in-season activity to allow for a comparison between the time periods.

Pre-Season (August 1st – August 12th): The pre-season consisted of approximately two weeks of data, in which every day and each session within those days was used during data analysis. This data was compiled into a weekly average for each athlete, the averages for each variable were used for analysis.

In-Season (August 13th – November 3rd): The "in-season" consists of all non-conference, conference games and the conference tournament games. This lasted approximately 12 weeks. Typically, throughout the season the athletes were given one day off as well as days off for travel. On average, the team trained three days per week with some weeks being as high as five, those totals do not include the two competitions per week on average. Overall, the team either trained or played in matches between five and seven times per week. All training sessions and competitions were used for analysis. Weekly averages for training sessions were compiled, as well as weekly averages for the competitive matches.

All data was used to evaluate the relationship between and among the variables. The goal was to relate the subjective variables gathered via Fit for 90 with the performance and physiological variables that are collected from the Polar Team Pro software.

Data Analysis

All data collected via Fit for 90 and Polar Team Pro was compiled into Microsoft Excel (2016) to allow for descriptive stats to be calculated. To allow for participants to remain anonymous throughout the research, all data was coded by an outside source.

Data was appropriately divided into individual participant and separated into pre-season and in-season weeks as well as Training and Competition data. Averages for each variable were then calculated for each of the above categories. To get a good understanding of the data collected, the raw numbers were kept in individual participant form and compiled into team averages.

Comparisons were made using both the numerical values and by using graphs formed from the weekly averages of both the individuals and the team.

All variables were used to determine relationships among the variables and based upon the researcher's interpretation of said relationships and their opinion on the importance and relatability to the game of soccer, variables were either included or excluded in the statistical analysis portion of the study.

Statistical Analysis

Descriptive statistics were calculated for all variables. Visualizations of data by individuals and by group were displayed to determine appropriate statistical analysis to be performed. Mixed Model Analysis was used to compare relationships among Heart Rate (HR), Training Load (TL), Distance and Sprints as well as any differences between Pre-Season and In-Season, and Training versus Competition. An alpha level of 0.05 was used to determine any significant interactions and main effects between variables. All statistical analysis was performed using IBM SPSS Software (Version 24, IBM Corporation, Armonk, NY). Graphical analysis was done using R-project (Version 3.4.0)

Results

The values for the physiological and psychological variables collected throughout the season are presented in Table 1 below.

Table 1

Physiological and Psychological Values	
Variable	**Mean ± SD**
Heart Rate (bpm)	
- Pre-Season	141 ± 3.909
- In-Season	137 ± 5.489
- Training	140 ± 6.16
- Competition	135 ± 3.069
Training Load	
- Pre-Season	442.39 ± 93.696
- In-Season	531.702 ± 145.349
- Training	443.228 ± 142.07
- Competition	620.036 ± 63.981
Total Distance (m)	
- Pre-Season	3622 ± 980
- In-Season	5364 ± 1834
- Training	3818 ± 524
- Competition	6748 ± 1469
Total Sprints	
- Pre-Season	10 ± 0.32
- In-Season	12 ± 2.42
- Training	11 ± 2.33
- Competition	13 ± 1.8

**All values represent the Team's Weekly Averages*

Effect of Timing of Season on HR and TL:

After calculating the descriptive statistics through Excel (2016), the average HR for both Pre-Season and In-Season Training sessions stayed steady over the course of the season. The same held true when examining the average HR during competitions. *(Figures C1&C2)*

The interaction between Heart Rate (HR) and Pre-Season versus In-Season was not significant (P = 0.130) *(Table B1)* whereas the interaction between Training Load and the part of the season the athletes were in was approaching a significant relationship (P = 0.077) *(Table B2)*.

Effect of Sprints on HR:

Upon study of the average number of sprints performed by the soccer team throughout the season, and comparing it to the average HR for both training sessions and competitions; there was a trend that showed the number of sprints performed is positively correlated with the average HR for the corresponding week. *(Figures C3, C4&C14)*

Statistical comparison showed that there was a strong statistical interaction between the number of sprints performed and the average HR of the athletes. (P = 0.000) *(Table B3)*.

Effect of Session Type (Training vs. Comp.) HR and Distance on TL:

Lastly, the researchers examined the relationship between Training and Competition Heart Rate as well as training and competition total Distances and how these variables affected Training Load scores reported by the athletes. Graphical representation of the data showed that with respects to HR and TL, training session data showed a decrease in TL while the HR stayed relatively constant in comparison. Whereas, the competition TL and HR both stayed relatively constant over the course of the season. *(Figures C5&C6)* The relationship between distance and training load, the total distance covered remained relatively constant over the course of the season for both training sessions and competitions. However, the training load decreased for training sessions towards the end of the season and did not for the competitions. *(Figures C8&C9)*

The relationship between HR and TL displayed a statistically significant interaction, however it depends on whether the data was collected during a training session or a competition.

(P = 0.000) *(Table B4)* Total Distances' relationship with training load was also dependent on situation (training versus competition), and was statistically significant. (P = 0.001) *(Table B5)* Upon statistical analysis, TL was shown to depend on the week of the season (P = 0.000) *(Tables B4&B5)*

Discussion

The present study examined numerous variables and their relationship to athletic performance in Division I Women's Soccer. Jeong and colleagues examined professional Korean soccer players over the course of the pre-season and in-season. The results of that study were as follows; average pre-season HR was 124 bpm and average in-season HR was 112 bpm. (Jeong, 2011) In comparison, the average HR for pre-season was 141 bpm and 137 bpm in-season for the present study. The study showed that there was not a relationship when examining heart rate during periods of pre-season versus in-season sessions (P = 0.130).

The weekly RPE-based training load scores summated to 4343 arbitrary units (AU) over 6 sessions during the pre-season, giving a daily average of 723.8 AU. In-season, training session, training load totals were 1073 AU over 5 days giving a daily average of 214.6 AU. (Jeong, 2011) Data collected in the present study showed a weekly pre-season TL average of 442.39 AU and an in-season, training session TL average of 443.228 AU. The relationship between TL and portion of the season ("pre" versus "in"), was approaching significance but due to a large amount of variability there is not a statistical significance. (P = 0.077). The lack of an interaction between the timing of the season and heart rate may be attributed to the fact that as a Division I athlete, it is expected that they come into the season with decent levels of physical fitness and one would not expect to see large declines in heart rate associated with exercise, thus indicating increased physical capabilities, as the season progresses. The stronger interaction between timing of the

season and training load scores may be attributed to the fact that it is a psychological score whereas heart rate is purely physiological. As a season progresses athletes become more physically fit as well as perceive workloads as easier efforts. Because of this reason the perception of how hard they are working during training and competitions can be altered depending on the week of the season.

The average number of sprints performed during a competition was 13 (± 1.8), which was substantially lower than the 26 reported for Elite Danish female soccer players. (Krustrup, 2005). The number of sprints taking place during both competitions and practice was strongly correlated with the heart rate observed for individual athletes. While other studies have looked at the relationships between sprinting and soccer performance, many of them were done using video analysis and they examined the timing of sprinting rather than the raw numbers in this study. A potential issue with GPS monitoring is if the software can catch every sprint due to a relay time between receiver and iPad. There are also discrepancies between what constitutes a sprint and each study must determine that beforehand. Mohr, Bangsbo and Krustrup (2003) had participants from both the top international leagues and professional players of a lower standard and through analysis gathered that international players sprinted 58% more than that of lower standard professional players. The researchers gathered data supporting the fact that throughout a game, substitutes sprinted more during the last 15 minutes of a game when compared to players playing the full 90 minutes. (Mohr, 2003) While this previous research gives readers an idea as to fatigue during a game, it may not be able to be extrapolated throughout an entire season of training and competitions. The present study was not looking at fatigue but instead examined how the number of sprints performed during a session would affect the heart rate of each individual. The results of this study showed a positive correlation which was expected by the researchers. As an athlete

increases the number of sprints they naturally increase their heart rate for the given session, therefore the strong statistical significance seen was anticipated.

As with previous physiological variables, there is not a lot of research devoted to changes over the course of an entire season, much of the data seen in previous literature is devoted to in game statistics. A decrease was expected to be seen by the researchers regarding training session TL scores over the course of the season. It is hypothesized that as the season progresses the coaches and support staff typically decrease workload to ensure players perform optimally during competitions. Due to the competitive nature of matches and the importance of late season matches, the linear nature of the competition training load was as expected. Impellizzeri and colleagues (2005) proposed that "in addition to physiological variables, several psychological factors can affect RPE scores." This is a possible explanation as to why there is not a decrease in training load during competitions regardless of at which point the game took place. "There are extraneous variables that come into play that don't during training, such as anxiety to perform well, pressure from coaches, tactical changes, etc." (Wrigley et al, 2012) These are not testable by internal load measurement tools but can play a large role. Wrigley et al. also found a main effect for training load across activity types, meaning the researchers established differences in TL between competitions and training sessions. A study done on elite female Danish soccer players found a competition average heart rate of 167 bpm. (Krustrup, 2005) Average heart rate results for the present study were 32 bpm lower, with an average of 135 bpm. These findings could be affected by the number of sprints performed, total distances covered and the differences in substitution rules between levels of play.

"Evidence suggests that RPE correlates well with heart rate during steady-state exercise and high-intensity interval cycling training, but not as well during short-duration high-intensity

soccer drills." (Halson, 2014) The results of the present study showed that as HR increased during competitions there was a large increase in TL score. While in training sessions, as HR increased there was a slight decrease in TL scores. *(Figure C13)* It was hypothesized by the researchers that during both training sessions and competitions, TL scores would increase with HR, as training load considers how hard one is working and how long they are performing at that level. TL scores may also be affected by perception of effort. While HR doesn't show the full picture of how hard one is working it can provide a snapshot of the intensity of the session.

Athletes in soccer cover large amounts of distance and varying amounts of distance depending on the situation they are in. The average distance covered during a competition for male English Premier League players was 10,714 m. (Bradley, 2009) Similar results were seen when comparing Spanish La Liga players with English Premier League Players, with average total distance ranging from 10,496 m to 11,779 m depending on position. (Dellal, 2011) One of the few studies that examined female soccer players found that elite level soccer players covered an average competition distance of 10,300 m. (Krustrup, 2005) In comparison, the female collegiate players used in the present study had an average distance of 6,748 m during competitions. There are multiple reasons as to why the total distance covered in the present study was lower than that of previous studies. The fitness level of the collegiate athletes in comparison to the professional athletes could lead to a decrease in distance covered, as well as the amount of possible substitutions allowed throughout a game. In professional soccer, you are only allowed three substitutions over the course of a game, whereas in collegiate soccer players are allowed one re-entry in the second half. This rule allows for players to have more time on the sideline, resting, and therefore less time on the field covering distance.

It was hypothesized by the researches, the more distance covered by the athletes would result in a larger training load score. The average total distance covered during competitions was nearly 3000 meters more than the training sessions with the corresponding week. Statistical analysis showed that there was a strong significant interaction between total distance covered and training load scores and that it was dependent on whether data was collected during a training session or during competitions. Descriptive statistics showed that there was a steady decline in training load scores during training sessions whereas the total distance covered maintained a steady average throughout the season. As for competitions, both the training load and total distance covered maintained around the same level over the course of the season. Graphical comparison between total distance and TL scores for each participant over the course of the season showed increases in TL scores for both training sessions and competitions. With a more dramatic rise seen during competitions. *(Figure C12)* When TL scores were compared with weekly distances covered, there was a statistical significance. The researchers theorize that this could be accounted for by the high TL scores during competitions, thus leveling out the lower scores seen during training sessions for the corresponding week of the season.

In conclusion, there are various models in which soccer teams and their support staff can monitor their players. Looking at both internal and external loads can give an individual a better understanding as to the demands placed upon an athlete at any given moment in time. The current study only examined a small sample of the numerous factors that going into the intricate sport of soccer. In the opinion of the researchers, the variables considered for the present study are the most applicable to the game of soccer and the success of athletes. Statistical analysis showed that training load, which was previously defined as RPE times duration, was statistically significant when comparing with the portion of the season, total distance covered on a weekly

basis and HR. This provides a large amount of information for coaches and strength staff members because it shows that the perceived effort given daily matched the workload prescribed by the staff. The most important reasons coaches and other staff members want to monitor their players are as follows; “Injury Prevention (29%), monitoring effectiveness of the training program (27%), maintaining performance (22%) and preventing overtraining (22%)” (Halson, 2014). In practice, the findings of the present study can affect how all aspects of the soccer staff handle athletes daily. Based on the results of the study, monitoring effectiveness of the training program as well as maintaining performance are the most applicable to the variables analyzed. Having access to psychological and physiological aspects of individual athletes and seeing the real-time successes or failures daily allows for a better understanding as to why they are happening. This can in turn alter the amount of training throughout a week, change the lifting and conditioning schedule and give athletic trainers insight to how to optimize the health of their athletes. The low amount of effort required to collect data and the many different uses for the collected data make it very applicable for not only soccer but all sports and may allow for a more competitive atmosphere as well as a possible reduction in overtraining injuries associated with all sports.

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Appendix A

Approval letter from USU IRB

noreply@usu.edu

Thu 4/20/2017 4:09 PM

To:Dennis Dolny <dennis.dolny@usu.edu>;

Institutional Review Board

USU Assurance: FWA#00003308

Request for Determination of Non-human Subjects Research

Approved

FROM:

Melanie Domenech Rodriguez, IRB Chair

Nicole Vouvalis, IRB Administrator

To:	Dennis Dolny
Date:	April 20, 2017
Protocol #:	8508
Title:	Analysis Of Existing Soccer Conditioning Data

Based on the information provided to USU's IRB, it has been determined that this project does not qualify as human subject research as defined in 45 CFR 46.102(d) and (f) and is not subject to oversight by USU's IRB.

4460 Old Main Hill Logan, UT 84322-4460 PH: (435) 797-1821 Fax: (435) 797-3769 WEB: irb.usu.edu EMAIL: irb@usu.edu

Appendix B

Table B1

Type III Test of Fixed Effects				
Source	Numerator df	Denominator df	F	Sig.
Intercept	1	35.477	5960.954	0.000
PI	1	492.932	2.298	0.130
a. Dependent Variable: HR.				

- Statistical Output for a comparison between Pre-Season and In-Season and its effect on HR.

Table B2

Type III Test of Fixed Effects				
Source	Numerator df	Denominator df	F	Sig.
Intercept	1	26.634	163.155	0.000
PI	1	338.233	3.148	0.077
a. Dependent Variable: TL.				

- Statistical Output for a comparison between Pre-Season and In-Season and its effect on TL.

Table B3

Type III Test of Fixed Effects				
Source	Numerator df	Denominator df	F	Sig.
Intercept	1	26.634	163.155	0.000
SP	128	370.283	2.012	0.000
a. Dependent Variable: HR.				

- Statistical Output for a comparison between Sprints and the effect on HR.

Table B4

Type III Test of Fixed Effects				
Source	Numerator df	Denominator df	F	Sig.
Intercept	1	274.617	2.745	0.099
HR	1	304.856	39.998	0.000
TG	1	306.862	15.794	0.000
Week	13	304.009	2.481	0.003
TG*HR	1	306.952	23.956	0.000
a. Dependent Variable: TL.				

- Statistical Output for a comparison between Training and Competition HR and their effect on TL on a weekly basis.

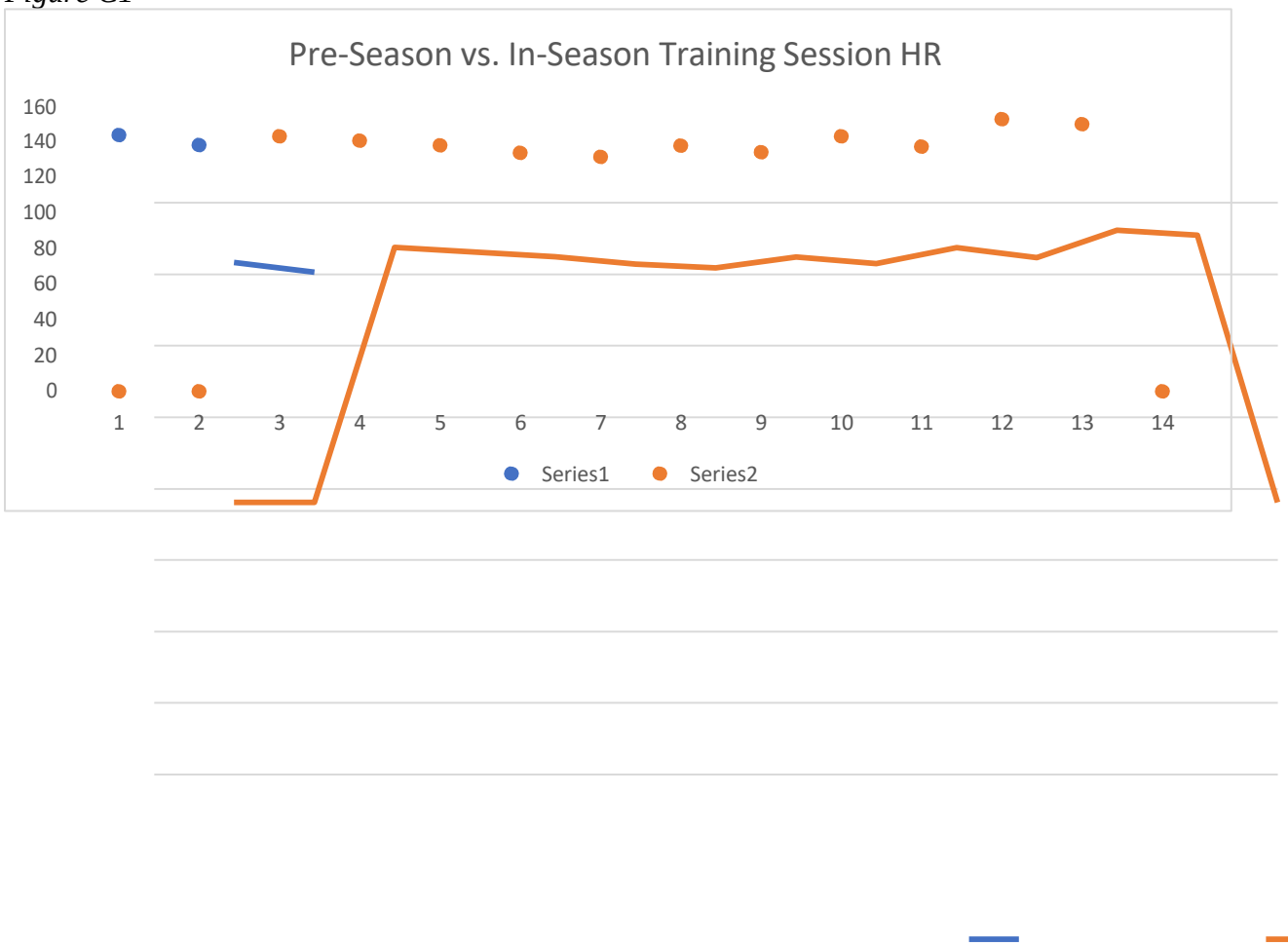
Table B5

Type III Test of Fixed Effects				
Source	Numerator df	Denominator df	F	Sig.
Intercept	1	144.428	42.712	0.000
DIS	1	311.911	6.233	0.013
TG	1	314.317	8.357	0.004
Week	13	303.891	4.03	0.000
TG*DIS	1	313.55	10.397	0.001
a. Dependent Variable: TL				

- Statistical Output for a comparison between Training and Competition Distance and its effect on TL on a weekly basis.

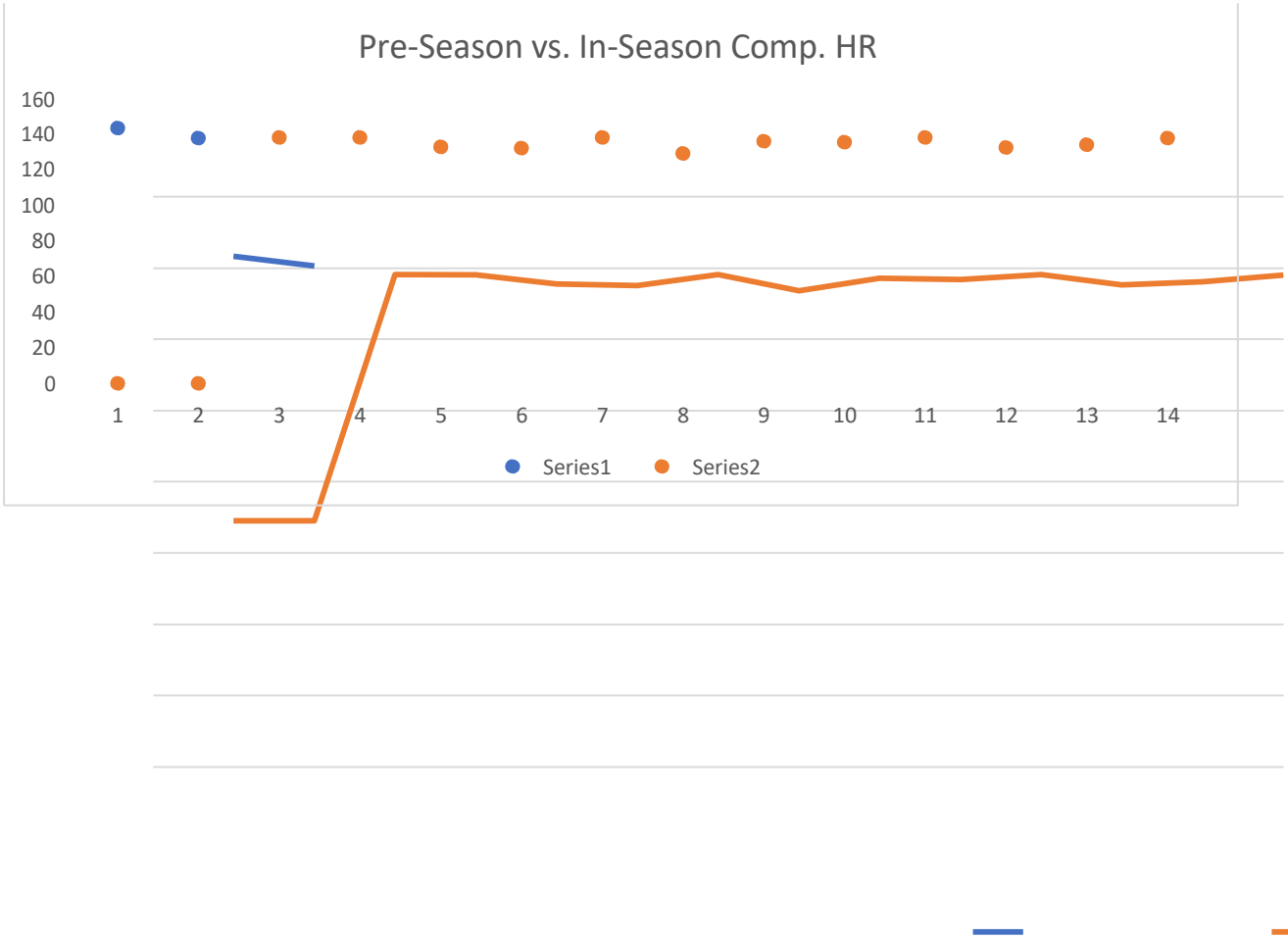
Appendix C

Figure C1



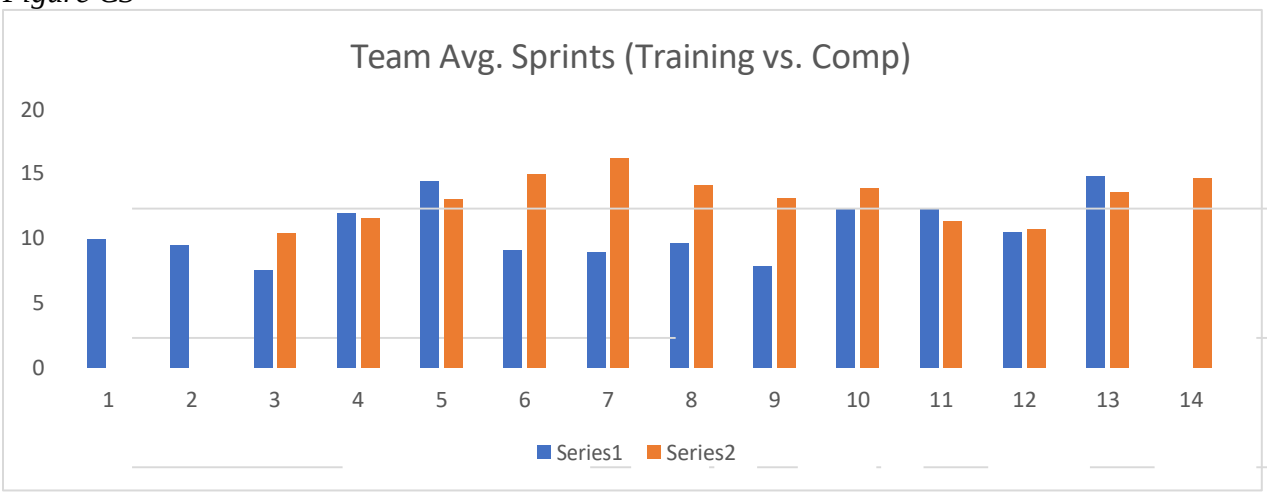
**Series 1: Pre-Season* **Series 2: In-Season*

Figure C2



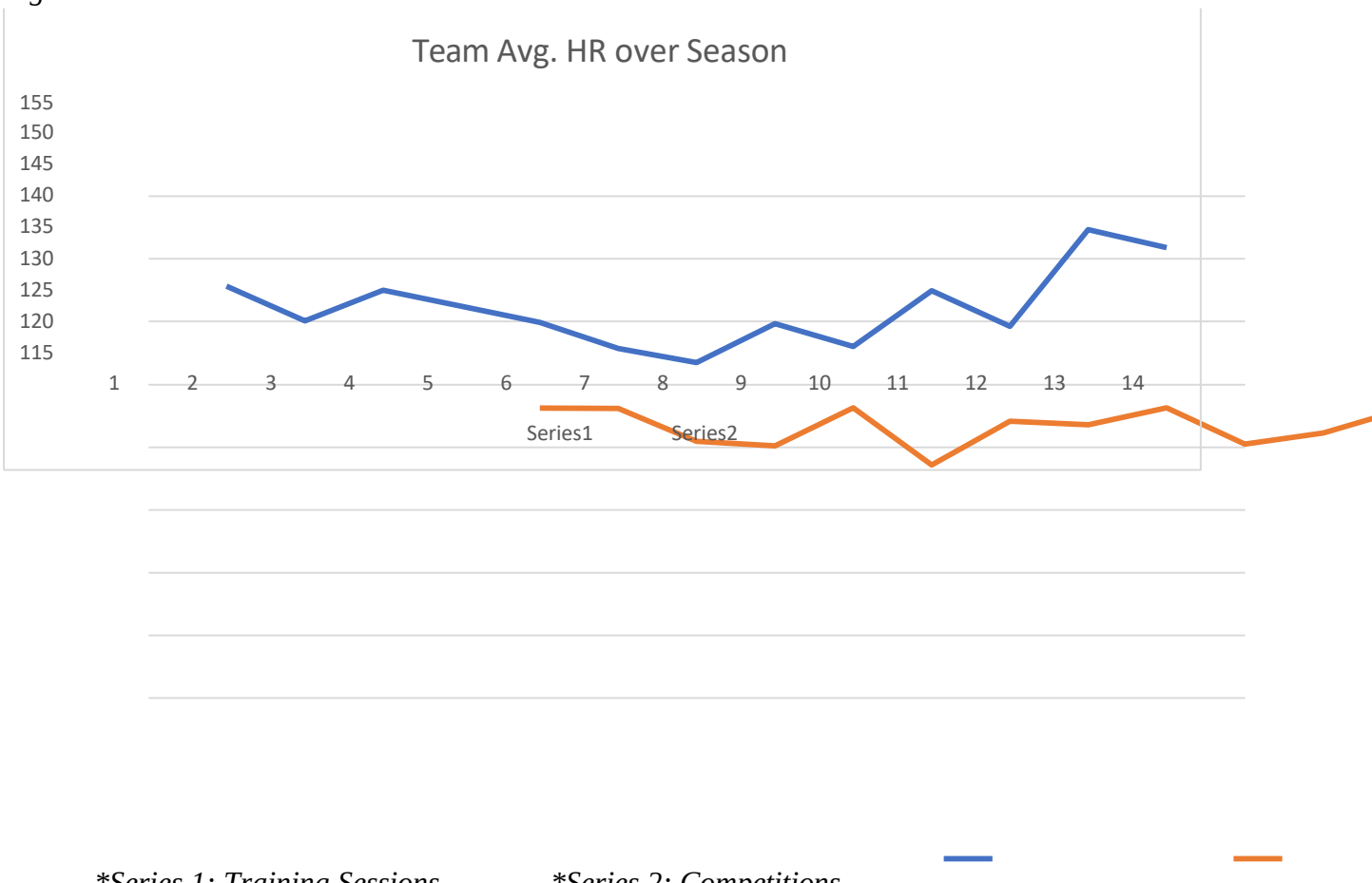
*Series 1: Pre-Season *Series 2: In-Season

Figure C3



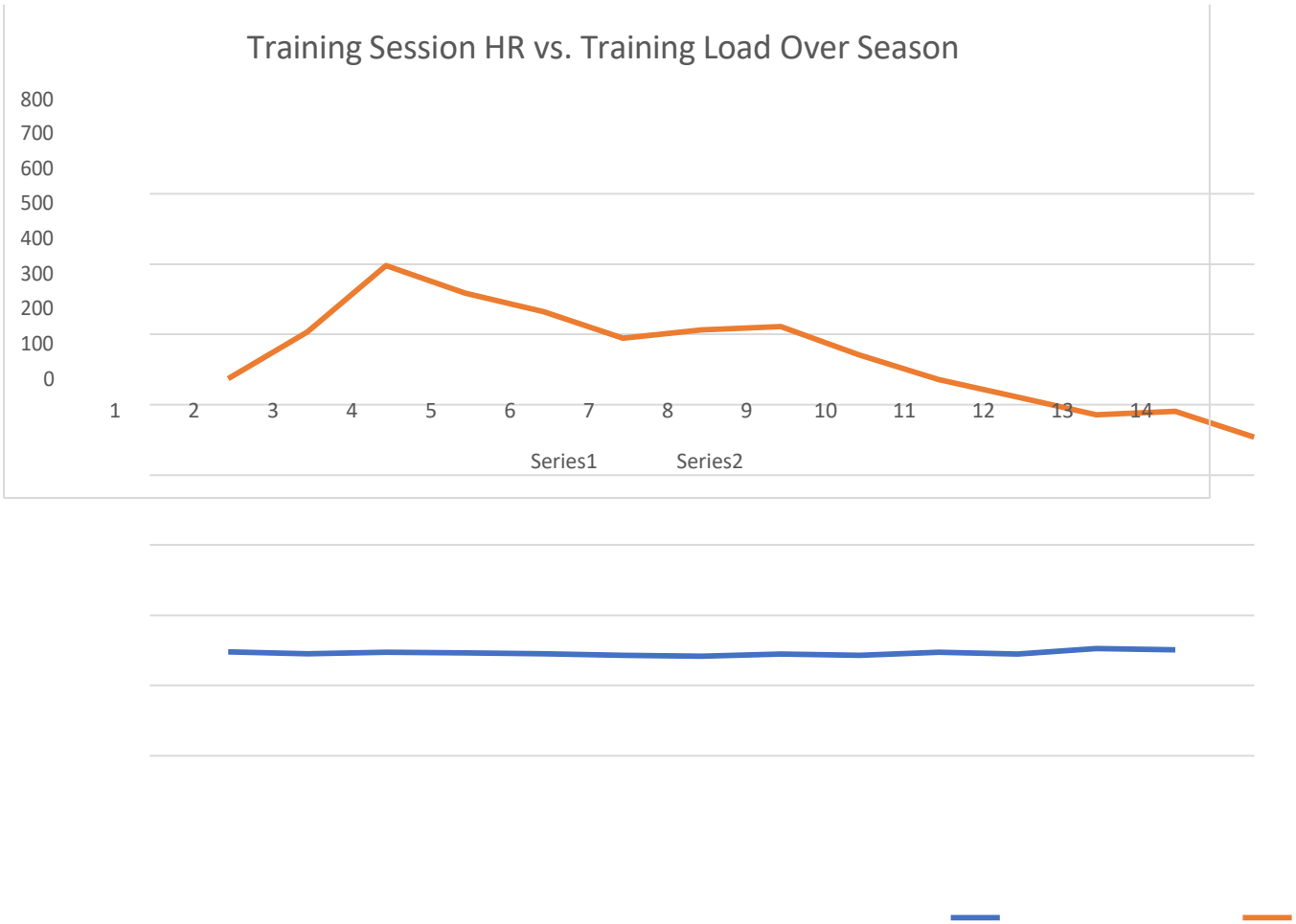
**Series 1: Training Sessions* **Series 2: Competitions*

Figure C4



**Series 1: Training Sessions* **Series 2: Competitions*

Figure C5

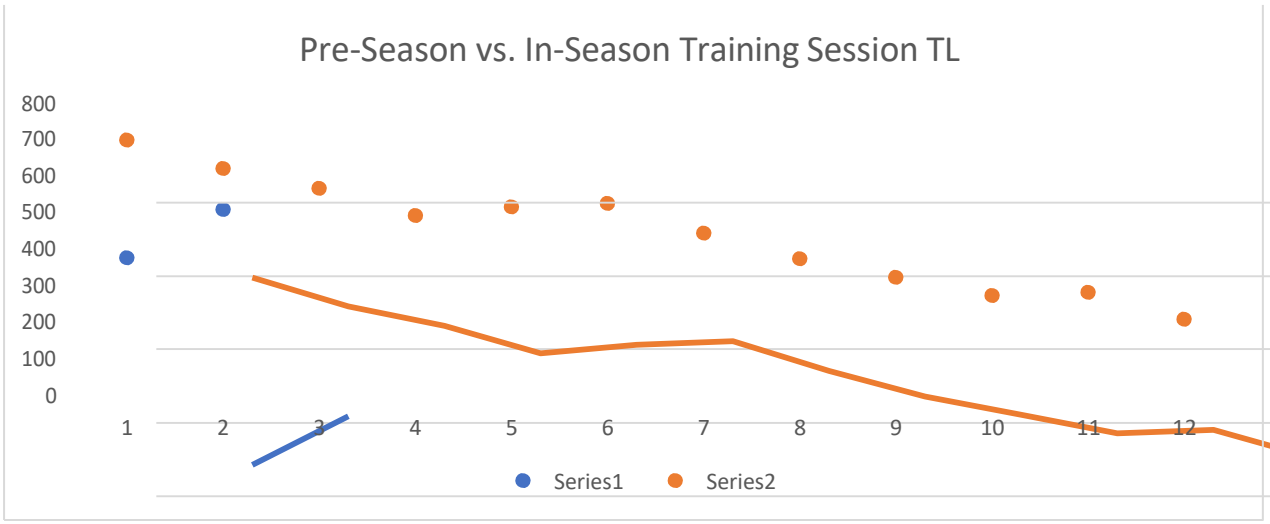


*Series 1: Heart Rate *Series 2: Training Load

Figure C6

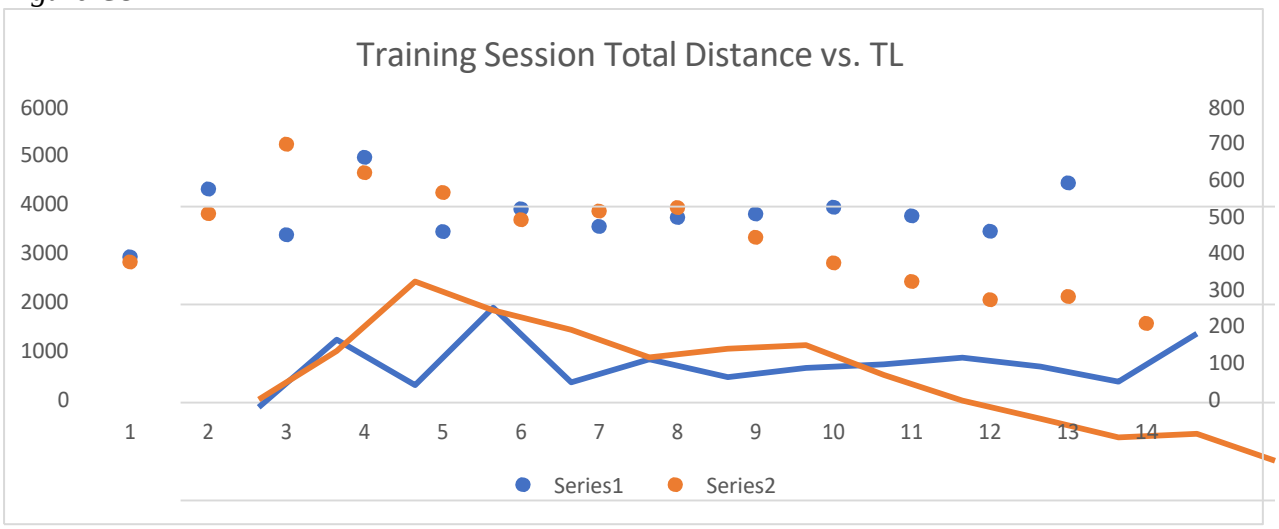
**Series 1: Heart Rate* **Series 2: Training Load*

Figure C7



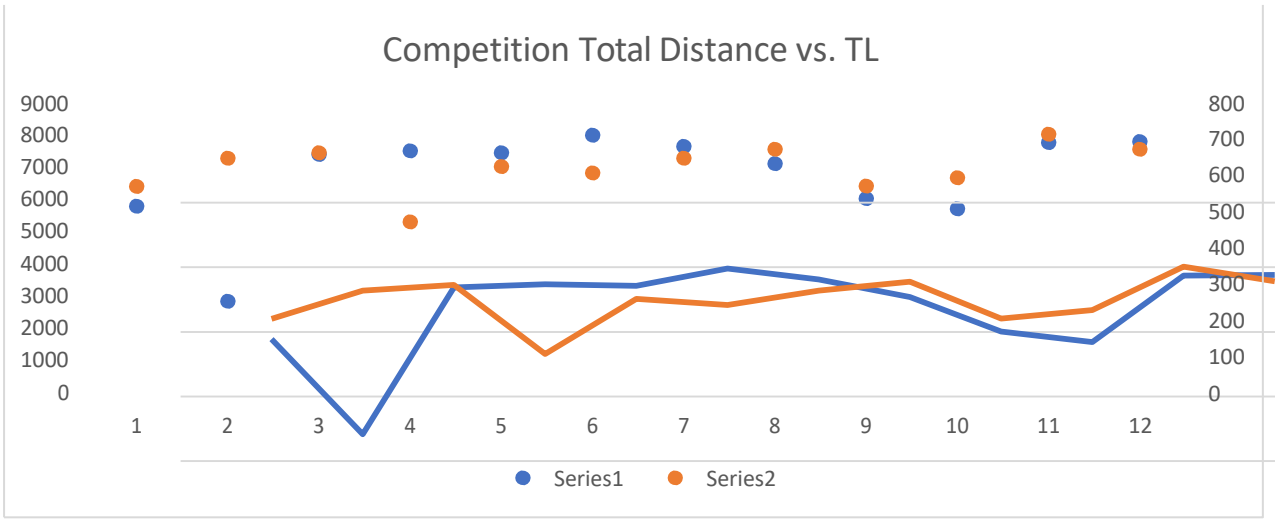
*Series 1: Pre-Season *Series 2: In-Season

Figure C8



**Series 1: Total Distance (Left Axis)* **Series 2: Training Load (Right Axis)*

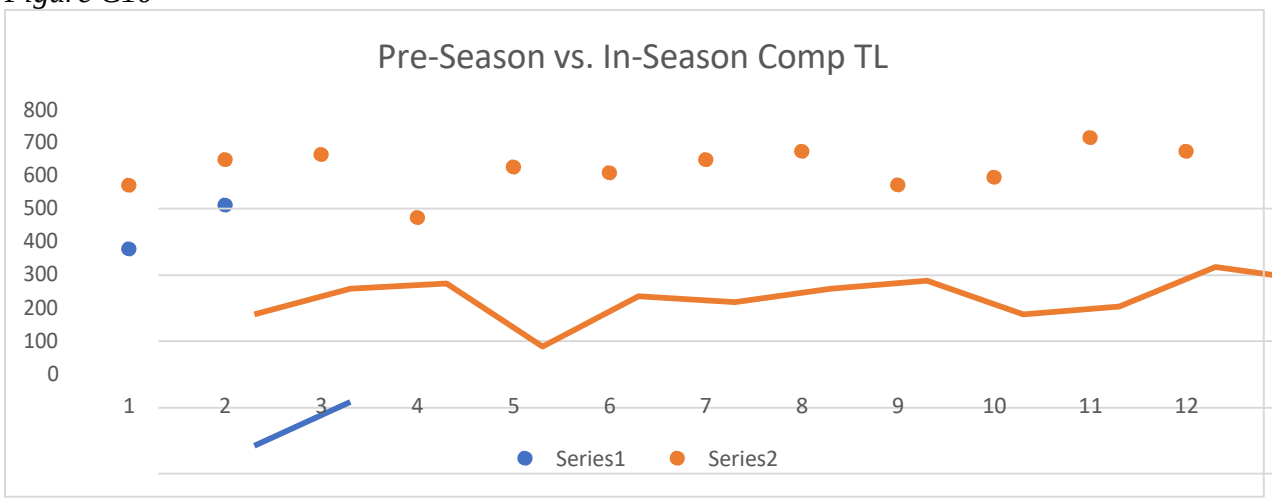
Figure C9



*Series 1: Total Distance (Left Axis)

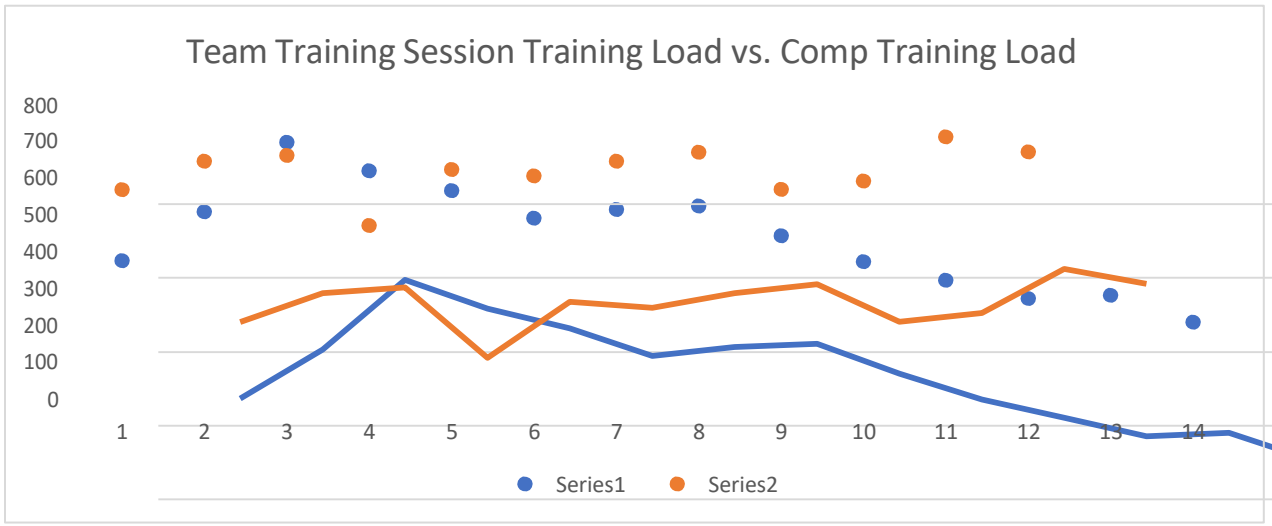
*Series 2: Training Load (Right Axis)

Figure C10



**Series 1: Pre-Season* **Series 2: In-Season*

Figure C11



*Series 1: Training Session

*Series 2: Competitions

Figure C12

Distance and Training Load (Training Session vs Comp)

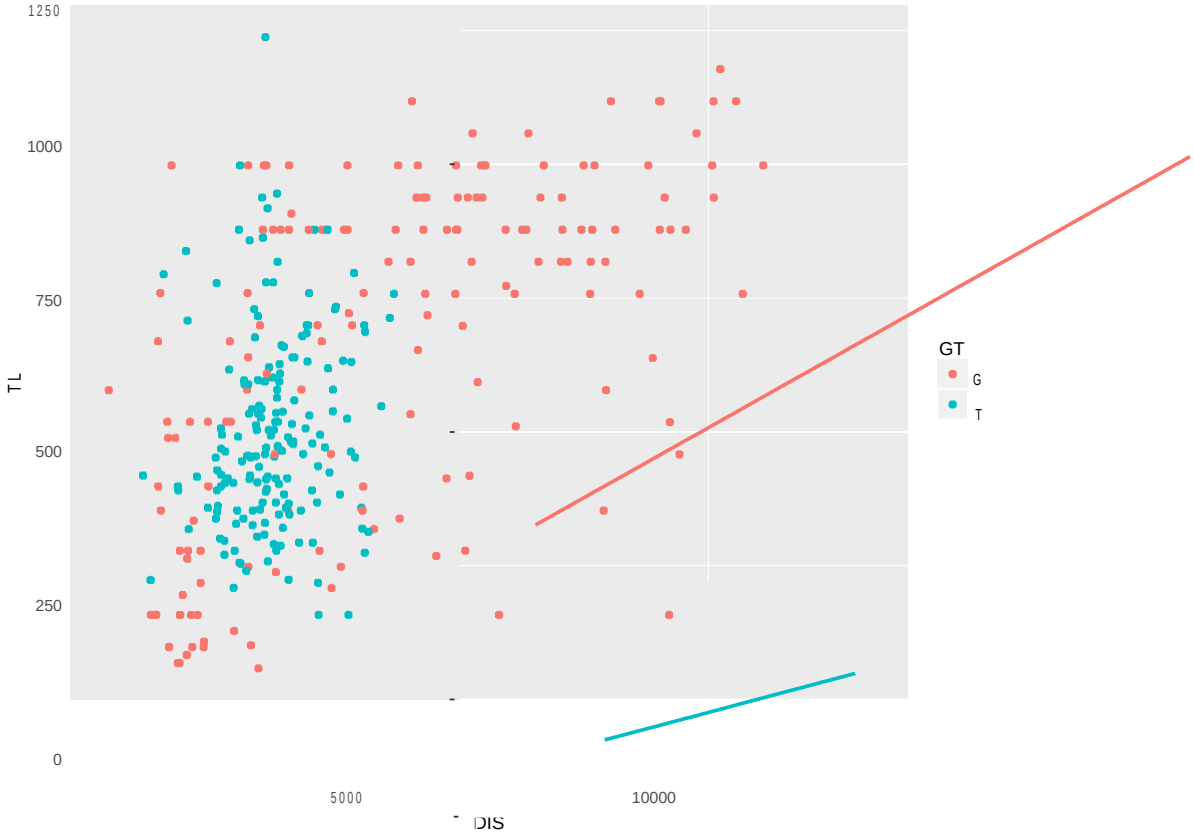


Figure C13

Heart Rate and Training Load (Training Session vs. Comp)

Figure C14

Sprints and Heart Rate (All Sessions: Training and Comp)

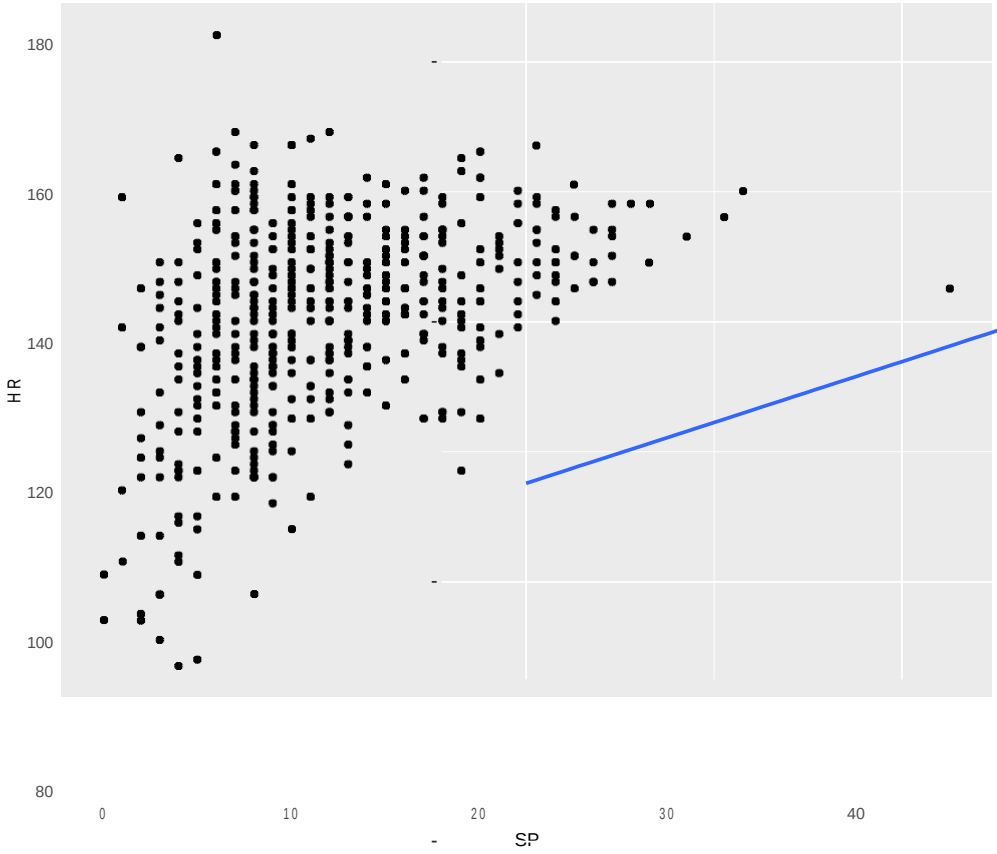
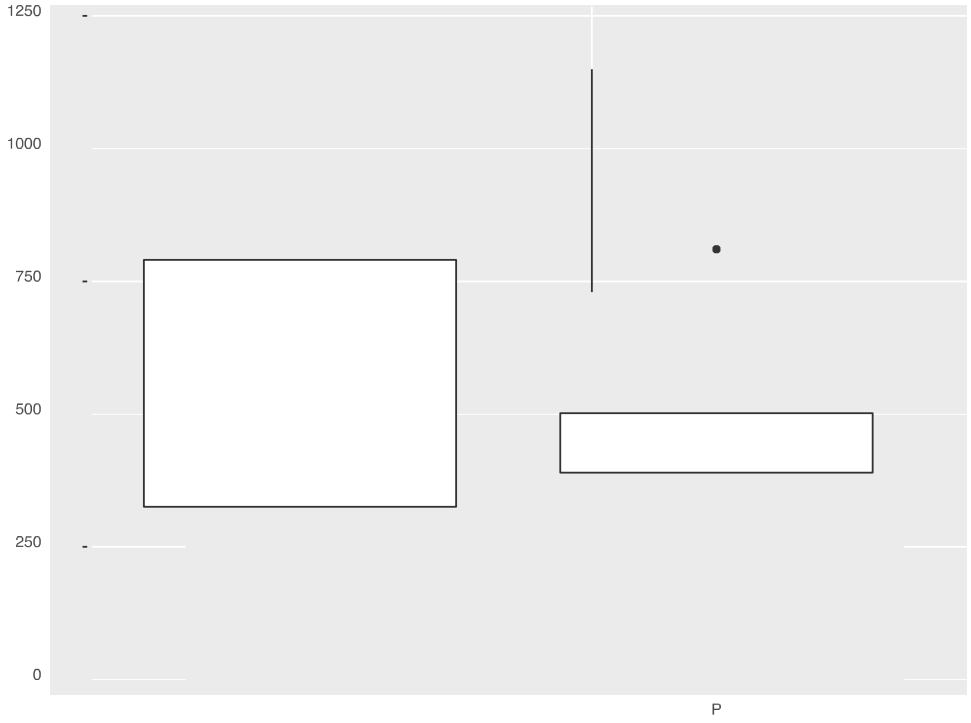


Figure C15

Pre-Season and In-Season Training Load Values

TL


1250
1000
750
500
250
0
P
P