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Master

A subjective load monitoring profile: A case study on an elite woman`s football team

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ABBREVIATIONS

RPE	Ratings of perceived exertion
sRPE	Sessional ratings of perceived exertion
SD	Standard deviation
au	Arbitrary unit
Hz	Hertz
GPS	Global positioning system
P1	In-season part one
P2	In-season part two
POMS	Profile of mood states
h	Hours
FFRC	Female football research center

ABSTRACT

PURPOSE: The purpose of this study is to present a subjective load monitoring profile from two consecutive seasons from one Norwegian elite women's football team.

METHODS: One elite women's football team (n=26) playing in the highest level in Norway was monitored for two consecutive seasons (2020 and 2021). Both seasons was divided in pre-season, in season part one (P1) and in-season part two (P2). Borg`s rating of perceived exertion (RPE) scaled 1-10 and duration of training was answered after each training/match. By multiplying RPE and duration, sessional rating of perceived exertion (sRPE) was used as a metric for training load. Wellness metrics answered before training/match based on Hooper Index to present training response and other stressors (fatigue, soreness, stress, sleep quality and mood) scaled 1-5. Sleep duration (h) and readiness scaled 1-10 was also included.

RESULTS: There was a difference in both seasons in sRPE between pre-season and P1 (ES= 0.27 and 0.25) and P1 and P2 (ES= -0.26 and -0.22). There was a negative correlation in sRPE with readiness ($p \leq 0.05$) during all periods/seasons except pre-season in 2021. With fatigue and soreness ($p \leq 0.05$) during pre-season 2021 and P1 in both seasons.

CONCLUSION: Training load during pre-season show typical patterns of periodization, whereas loads during in-season was more varied and tactically influenced. sRPE show associations with readiness, soreness and fatigue. Whereas a potential dose-response relationship between training load and wellness and within wellness metrics should be further investigated.

KEY WORDS: Elite women's football, periodization, load monitoring, sRPE, wellness

ABSTRACT IN NORWEGIAN

FORMÅL: Formålet med denne studien er å presentere en subjektiv belastningsprofil fra to påfølgende sesonger fra ett Norsk kvinnelig elite fotballag.

METODE: Ett kvinnelig elite fotballag (n=26) som spiller på det høyeste nivået i Norge ble monitorert over to sesonger (2020 og 2021). Sesongene ble delt inn i pre-season, in-season del en (P1) og in-season del to (P2). Borg`s rating of perceived exertion (RPE) skalart fra 1-10 og varighet av trening ble besvart etter hver trening/kamp. Ved å multiplisere RPE og varighet ble sessional rating of perceived exertion (sRPE) brukt som variabel for treningsbelastning. Spørsmål om Wellness ble besvart før trening/kamp basert på Hoope Index for måling av treningsrespons og andre kontekstuelle stressfaktorer (fatigue, soreness, stress, sleep quality og mood) skalert fra 1-5. Sleep duration (t) og readiness to play skalert fra 1-10 ble også inkludert.

RESULTAT: Det var en forskjell i sRPE mellom pre-season og P1 (ES= 0,27 og 0,25) og mellom P1 og P2 (ES= -0,26 og -0,22) i begge sesonger. Det var en negativ korrelasjon mellom sRPE og readiness ($p \leq 0,05$) i alle perioder/sesonger unntatt pre-season i 2021. Og negativ korrelasjon i RPE med fatigue og soreness ($p \leq 0,05$) i pre-season 2021 og P1 i begge sesongene.

KONKLUSJON: Treningsbelastningen fra pre-season fra begge sesonger viser typisk periodiseringsmønster, mens belastninger fra in-season er mer varierte og taktisk påvirket. sRPE viser sammenhenger med readiness, fatigue og soreness. Imidlertid bør en potensiell dose-respons sammenheng mellom treningsbelastning og wellness og mellom wellness variabler bør undersøkes nærmere.

NØKKELORD: Elite kvinne fotball, periodisering, trenings monitorering, sRPE, Wellness

STRUCTURE OF THE THESIS

The following thesis is presented in three parts:

Part 1 presents the theoretical background for the study, a description of the used method, and a discussion of methodology.

Part 2 presents the actual research paper, written in accordance with guidelines for an original investigation by the International Journal of Sports Physiology and Performance. It should be noted that the author decided to present tables and figures directly in the article to make it easier for the reader to read. This is not in accordance with JSPP.

Part 3 Consists of appendices.

Part 1:

THEORETICAL BACKROUNDS AND METHODOLOGY

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1.0 INTRODUCTION

In the global context, football is widely regarded as the most popular sport with the largest number of participants . It is also the most extensively studied sport in the scientific community, with professional football players being the primary focus of research (Kirkendall, 2020). However, there is a significant lack of research on women's football, with only approximately 20% of football research involving female players. Furthermore, only 15% of research is focused on the professional level, mainly concerning injury and injury prevention (Kirkendall & Krustrup, 2022; Okholm Kryger et al., 2022)

According to Nassis et al. (2022) there are significant gaps in knowledge about the physical and psychological aspects of women's football, and most training and conditioning strategies are based on their male counterparts. Nevertheless, advances in technology, such as time-motion analysis, global positioning systems (GPS), and other microtechnologies, have provided valuable information on the demands of match play and training load in football (Akenhead & Nassis, 2016), including match play demands of elite women's football (Vescovi et al., 2021).

Interestingly, match analysis has revealed that female and male players cover similar total distances during competitive games, however male players cover significantly greater high-intensity distances (Bradley et al., 2014). Recent research on metabolic work during matches in elite female players has discovered a decrease of 42% in muscle glycogen after a match, with 80% and 69% of depleted glycogen in type I and type II fibers, respectively (Krustrup et al., 2022). These findings, coupled with the gender similarities and differences in running performance, suggest that aerobic demands may play a greater role in women's football than in men's football.

Despite recent advances in understanding match demands, there is still a lack of information on seasonal training loads in women's football, making it challenging to establish evidence-based training strategies (Costa et al., 2022). While external loads, such as locomotive data referring to distances and thresholds, are the most frequently used monitoring tool in football literature, internal loads, such as subjective ratings of perceived exertion (sRPE), have also been widely used to assess training load in football (Miguel et al., 2021)While measures of player wellness have gained more attention in recent years to monitor the training response (Coyne et al., 2018; Miguel et al., 2021). As sRPE has shown a significant correlation with both internal and external load in football (Impellizerri et al, 2004; Coyne et al, 2018), wellness measures have demonstrated associations with both internal and external loads (Clemente, 2018). However, the dose-response relationship between training load and measures of wellness remains debated, with conflicting evidence (Campbell et al., 2021). It is essential to note that research on subjective monitoring of elite women's football is extremely scarce, particularly over a complete season, hence further research is highly recommended (Costa et al., 2022).

1.2 PURPOSE OF RESEARCH

This study is a descriptive case study, with the purpose of providing a subjective monitoring profile from one elite women's football team with an emphasis on the seasonal patterns. What we want to investigate is as following:

1. Are the seasonal patterns of subjective internal load similar with observations from other studies?
2. Are there any associations between the subjective metrics in different parts of the season?

2.0 THEORETICAL FRAMEWORK

2.1 HISTORY OF WOMEN`S FOOTBALL

In recent years, there has been a significant increase in interest and economic development in women's football, as evidenced by record-breaking attendance and viewership in international tournaments (Okholm Kryger et al., 2022). However, this was not always the case as women were previously prohibited from participating in football due to beliefs that it was physically dangerous for them to engage in such a masculine sport (Goksøyr & Olstad, 2002). For instance, in England, women were banned from playing organized football for fifty years due to such beliefs before finally being allowed to participate in 1971. Subsequently, the Norwegian Football Federation approved women's football in Norway in 1976, following England's example (Goksøyr & Olstad, 2002). In 1991, FIFA arranged the first-ever official World Cup for international women's national teams. Currently, football is the most participated sport by girls worldwide, with significant growth in recent years due to its increasing popularity (FIFA, 2020).

2.1.1 CONTEXTUAL FACTORS TO CONSIDER

When examining the salary differences between male and female football players, it becomes apparent that significant disparities exist (Lie, 2017). Nevertheless, the increased interest in women's football and its greater financial prioritization has led to a rise in professionalism and more opportunities for younger generations (McGreary et al., 2021). As a result, more players are now able to earn a living from playing football, and clubs can offer better facilities, training staff, and medical support (McGreary et al., 2021). However, it is important to note that these conditions are only available to the top teams in the best leagues, and the wage gap still necessitates many players to seek secondary employment. Furthermore, given the relatively short length of a football career, many players pursue higher education while simultaneously playing football (Brandt-Hansen & Ottesen, 2019).

In Norway, the average age of players in the top women's football league is 22.7 years, whereas the average age of male players in the top league is 26.5 years. This low average age is partly due to early dropouts, possibly as a result of lack of motivation and external factors such as financial difficulties, studies, and long-term injuries (Bjerksæter & Lagestad, 2022). Interestingly, a study conducted in Poland found that thirty percent of players who quit football did so due to injuries (Grygorowicz et al., 2019). As football is known to be a sport with high injury rates, a review examining the reasons behind injuries in elite female players concluded that it is a complex issue with various intrinsic and extrinsic factors contributing to injury risks (Alahmad et al., 2020).

2.1.2 SUMMARY

As the status of women's football has changed dramatically, there are still some contextual factors to consider when monitoring female players in contrast to their male counterparts. Differences in physiology and a different day to day life can potentially enhance other stressors and is worth consideration. It could be further hypothesized if these stressors could possibly affect restitution and increase levels of fatigue. As injuries are one of the largest threats in terms of early dropouts, more research on female players is needed to prescribe appropriate training loads to prevent injuries.

2.2 LOAD MONITORING

The aim of training is to achieve an adaptive response, but there is a fine balance between adaptive and maladaptive responses as excessive or inadequate training can lead to poor form, illness, or injuries (Viru & Viru, 2000). Load monitoring is a method used to provide objective and subjective insights into an athlete's training load, allowing coaches and practitioners to gather meaningful information on the implemented training and competition (Halson, 2014). Load monitoring has been used for many years in an attempt to control training load and improve performance (Foster et al., 2017). Initially it started with the use of stopwatches, followed by the conceptualization of interval training and the use of heart monitoring in the late 1930s (Foster et al., 2017). With advancements in technology, load monitoring has evolved to encompass newer and more advanced measuring tools, concepts, and variables (Cardinale & Varley, 2017; Foster et al., 2017).

Load monitoring consists of two measurable units, external and internal load (Halson, 2014). The concept of external and internal load was first introduced in 2003 and has since gained global recognition as a useful conceptualization of load monitoring (Impellizzeri et al., 2019). External load represents the output of training/competition, i.e., the work done, typically presented in distances, accelerations, or metabolic power in team sports (Miguel et al., 2021). For instance, in team sports, global navigation satellite system (GNSS) is often utilized to measure distances, velocities, and accelerations. Whereas in strength and power training, the volume load is calculated using the formula repetitions multiplied by resistance. Other measuring tools such as video analysis, force plates, and inertial sensors can also be used to track velocities in power training (Bourdon et al., 2017).

Internal load in sports refers to the biological response to training, which can be measured through both objective (e.g., heart rate and lactate) and subjective (e.g., perceived exertion and questionnaires) markers (Halson, 2014). These markers not only capture the physical and psychological strain from training and competition, but also other contextual factors such as nutrition, genes, stress, mood, and sleep (Impellizzeri et al., 2019). As such, internal load can be a useful tool for coaches and practitioners to capture individual differences in team sports, reflecting an individual's physical form and non-sporting-related strain (Bourdon et al., 2017; Impellizzeri et al., 2019).

While external load monitoring is more commonly used in sports, it is recommended to combine both internal and external load measurements due to their co-dependence and limitations when used alone (Bourdon et al., 2017). Hence, measuring both types of loads provide a more holistic picture of an athlete's total training load and better understanding of their form. For example, an athlete performing a standardized training regimen and experiencing high internal load measures may indicate a decrease in physical form or other factors such as illness. Whereas the same player doing the exact same training regimen but experiencing lower internal load measures may indicate an increase in physical form (Impellizzeri et al., 2019).

Evidence suggests that load monitoring is a useful tool to enhance performance and potentially prevent and predict injuries when interpreted correctly (Halson, 2014). However, the predictability of injuries is debated as some argue that earlier research is inadequate in terms of quality and data interpretation (Impellizzeri et al., 2020). Nonetheless, the need for further research on this matter is agreed upon. Additionally, the increase in variables provided by new technology can make it challenging for practitioners and coaches to interpret data correctly, possibly leading to inappropriate decision-making (Miguel et al., 2021; Weston, 2018). Given that load monitoring is widely employed in elite football and coaches generally perceive it as a valuable tool, it is important to consider the players' perspective, as the coaches' interpretation and use of monitoring can potentially cause players' distrust if they feel it is unfairly utilized (Weston, 2018). This underscores the significance of appropriately interpreting load monitoring in practice.

2.2.1 EXTERNAL LOAD IN FOOTBALL

According to a recent review by Miguel et al. (2021), measures of external load are the most widely researched method for monitoring in football, and locomotive data the most commonly used method of all.

2.2.1.2 LOCOMOTIVE DATA

The demands of athletic competition determine the terms by which athletes must train to optimize their performance (Bangsbo, 2014; Martínez-Lagunas et al., 2014). To this end, the use of match analysis has become a popular method of evaluating the demands of football played at lower and higher levels (Bradley et al., 2014; Bush et al., 2015; Vescovi et al., 2021). Locomotive data, which includes measurements of distances and velocities, is often utilized in match analysis (Akenhead & Nassis, 2016). The total distance, which represents the summation of all the distances covered during a match or training session, is commonly used as a measure of volume (Akenhead & Nassis, 2016; Rago et al., 2020). Professional female footballers have been reported to cover a total distance ranging from approximately 8,200 to 11,000 meters, while male players range from approximately 10,000 to 13,000 meters (Bradley et al., 2014; Bush et al., 2015). These findings suggest relatively low gender differences in total distance at the professional level. Interestingly, Bradley et al. (2014) observed no significant gender differences in low intensity distances, suggesting that high intensity distances constitute the primary factor in observed gender differences.

High intensity running, which is defined as the distance covered above a given threshold, is commonly categorized as high intensity running (HIR), very high intensity running (VHIR), and sprinting (Akenhead & Nassis, 2016). In their review, Vescovi et al. (2021) presented high intensity running values and sprinting distances for professional women ranging from 395-2834 meters and 119-615 meters, respectively. However, the high range between these results is likely enhanced by the lack of established velocity thresholds, in which complicates the comparing of results between the literature (Vescovi et al., 2021). Furthermore, as

Bradley et al. (2009) noted, contextual factors such as tactics, opponents, and playing position should be considered when interpreting locomotive data such as high intensity running.

Recent research on Norwegian elite women's football and demands of playing position reveals that wide backs and wide midfielders cover significantly greater total distances, high intensity running, and sprinting distances compared to center backs. Additionally, wide midfielders perform significantly longer high intensity running distances than midfielders and forwards (Winther et al., 2022). These findings are similar to those observed in men's football, where wide playing positions dictate higher total distance and high intensity running, while center backs perform lower than all other positions (Bush et al., 2015).

In the context of team performance in football, Bradley et al. (2016) found that higher-ranking teams in the English Premier League did not necessarily run more than lower-ranking teams. This finding was consistent with similar research conducted by Asian-Clemente et al. (2019) in the Spanish first division. However, studies have also shown that players at higher levels of play, including both men and women, tend to report higher values in physical qualities such as sprinting, strength, and jumping ability (Martínez-Lagunas et al., 2014; Slimani & Nikolaidis, 2017). These observations could suggest that technical and tactical skills play a crucial role in achieving success at the highest levels in men`s football. Previous match analysis also indicates that high intensity running varies across different levels of play in both genders (Bangsbo, 2014; Vescovi et al., 2021). However, Bradley et al. (2016) found little to no differences in running performance between the Premier League and the English Championship. It is currently unknown whether there are differences in running performance and team ranking in women's football. However, considering findings on running performance, the similar total distance with men and physical qualities differences in level of play, this could possibly indicate that differences in physical ability is more pronounced in women's football.

While distance and velocity measurements during match play have provided valuable information on the physical demands of football, these measurements have limitations in capturing certain movements that are typical of football, such as changes of direction, accelerations, and decelerations (Akenhead & Nassis, 2016; Little & Williams, 2005). Previous research has shown that international female football players perform an average of

164.3 accelerations and 162.1 decelerations (2 to 3 m/s2) during games (Griffin et al., 2021). However, the lack of established thresholds and categorization makes it difficult to compare these findings across different studies (Vescovi et al., 2021). Despite some attempts to establish standard velocity thresholds for female players, there is still no consensus in the field (Bradley & Vescovi, 2015). Interestingly, Griffin et al. (2021) found that international players completed significantly more very high intensity accelerations (>4 m/s2) compared to domestic players, which is consistent with earlier observations in men's football (Oliva-Lozano et al., 2020). Despite the importance of acceleration and deceleration data in interpreting match and training demands in football, Miguel et al. (2021) noted that such data are relatively underused in football research compared to other locomotor data. Moreover, Vescovi et al. (2021) found that acceleration and deceleration data are even less frequently examined in women's football. Interestingly, in their study Douchet et al. (2021) found acceleration and deceleration to be valid metrics for quantification of training load in elite women`s football.

2.2.2.2 GPS AND ACCELEROMETRY

In the field of football, technology such as multiple camera semi-automatic system, local positioning measurement (LPM), and GPS are frequently utilized for locomotor data collection. Although each system has its own set of advantages and disadvantages, GPS is commonly used due to its reported validity, its time saving and ease of use in football (Buchheit et al., 2014). However, there are reported limitations in sampling frequencies in units with a sampling frequency of 1 or 5Hz when it comes to high intensity running, velocity and change of directions (Scott et al., 2016). GPS units with a higher sampling frequency of 10Hz are considered valid and reliable for collecting locomotor data in football (Buchheit et al., 2014).

However, when analyzing acceleration and deceleration, the GPS quantify the metrics by velocities, meaning GPS only registers an action as high intensity running if it is within a given threshold and time (Akenhead & Nassis, 2016; Little & Williams, 2005). One observed limitation of this is the time interval and smoothing filters used to detect accelerations and decelerations that is different between manufacturers and often not defined (Cardinale & Varley, 2017). This have resulted in observed differences after software updates. Hence, studies using the same thresholds have reported significantly different results (Vescovi et al., 2021).

However, it is important to clarify that by including accelerometry, some of the challenges of using only GPS metrics alone can be avoided. As accelerometers doesn't quantify values by velocity, don't rely on satellite signal alone and can be used indoors (Cardinale & Varley, 2017). Due to the higher energetic demands of acceleration and deceleration it is highly recommended to include in load analysis in football (Douchet et al., 2021; Little & Williams, 2005). This is why the accelerometer derived measures is often used to better interpret the total strain by calculating accelerations, deceleration, change of direction and collisions. One example of this is the calculation of PlayerLoad™ from Catapult, in which is the sum of accelerations in all 3 planes of movements (Cardinale & Varley, 2017).

2.2.2 INTERNAL LOAD IN FOOTBALL

Internal loads in sports have often been analysed trough objective measurements. However, in their study Miguel et al. (2021), reported that subjective measurements such as wellness questionnaires, RPE and sessional ratings of perceived exertion (sRPE) are widely used in football, with sRPE being the most commonly used metric. Although incorporating objective measures along subjective measures is recommended, Saw et al. (2016) suggest that using only subjective measurement for monitoring could still be considered meaningful.

2.2.2.1 PERCEIVED SESSIONAL RATINGS

Subjective metrics are generally considered to be more consistent and sensitive than objective measures, and they are also cost-effective (Bourdon et al., 2017). RPE is a subjective method where athletes rate their perceived exertion during an exercise, which reflects the intensity of the exercise relative to their physical condition (Borg et al., 1987). There are various scales used for RPE, but the most commonly used is the Borg scale, which ranges from 6-20, or the modified version that ranges from 1-10 (Foster et al., 2001; Miguel et al., 2021).

The sRPE was developed by Foster et al. (2001) to simplify the quantification of the general strain from a training session by multiplying the RPE with the duration of the exercise. SRPE is regarded as the most commonly used subjective metric in sports (Bourdon et al., 2017), and earlier studies have shown that it is a valid and reliable indicator of training load, with good relationships with accelerometer-derived metrics and total distance (Coyne et al., 2018). Moreover, Impellizzeri et al. (2004) have found a significant association between sRPE and heart rate-based internal load in football. However, some studies have reported conflicting results on the reliability of the sRPE metric (Scott et al., 2013). Practical limitations, such as player education, language, and the timing of data collection, should be considered, underscoring the importance of explaining the metric to the players (Burgess, 2017).

2.2.2.2 WELLNESS

Questionnaires is commonly used as a measuring tool for the psychophysiological recovery (Saw et al., 2017). One of the most used questionnaires in the milieu is The Hooper Index, developed by Hooper, (1995). The Hooper Index was conceptualized as a aid to help detecting signs before reaching the state of an overtraining syndrome (Hooper & Mackinnon, 1995). The theoretical framework behind the Hooper Index is based on empirical conceptualizations such as the Profile of Mood States (POMS) and self-ratings of well-being (Hooper & Mackinnon, 1995; McNair et al., 1971). For instance, by utilizing the concept of POMS, higher rates of mood disturbances have previously shown associations with overtraining syndrome and fatigue (Morgan et al., 1987). Whereas, self-ratings of fatigue, stress, sleep and soreness previously had been successful in predicting overtraining in swimmers (Hooper et al., 1995).

Hence, the metrics used for the Hooper Index questionnaire is stress, soreness, mood, sleep quality, and fatigue (Hooper & Mackinnon, 1995). The questionnaires are to be answered before training/match, giving information regarding the strain from previous training and non-football-related factors (Halson, 2014). However, other metrics such as sleep duration and readiness to play, also referring to a players wellness, have previously been used in research for analyzing a specific research question or to add more information to the original Hooper Index (Alexandersen et al., 2023; Costa et al., 2022).

From a football point of view, stressors like traveling, bad sleeping hygiene, match arousal and inconsistent schedule can affect sleep quality (Nédélec et al., 2015). For a football player playing at the elite level this can be crucial, as sleep can affect the recovery process leading to higher rates of physical and mental fatigue (Nédélec et al., 2015). It is also observed that stress caused by training stimulus could affect psychophysical parameters after training, which again can cause fatigue as a result of cumulative stress (Saw et al., 2016). This demonstrates the complexity of stress, as it not only is used for measurement of non-sporting psychological stressors, but also the psychophysical strain from training. This could further explain why some studies have found association between stress, fatigue and soreness, as these metrics can potentially reflect physiological and neurological responses of high loads of training stimulus (Hooper & Mackinnon, 1995; van Borselen et al., 1992).

The morning ratings of perceived wellness ability to affect the training intensity have been questioned as the results are conflicting (Gallo et al., 2016; Haddad et al., 2013). In their study (Haddad et al., 2013) found that morning ratings of fatigue, stress, DOMS, and sleep do not contribute to higher ratings of sRPE in the following training session that day. However, they only examined training sessions at submaximal intensity, meaning the possible effect on highest intensity sessions was not investigated. In contrast, Gallo et al. (2016) found morning rating of wellness could provide information about expected intensity out-put during skill-based training sessions. Interestingly, in their study Thorpe et al. (2016) discovered that fatigue, soreness and stress was more sensitive with significant changes in training load, meaning as the ratings of sRPE was much higher on matchday and lowest the day before and after, the ratings of wellness changed accordingly.

This dose-response relationship between training load and fatigue, stress and soreness have been especially investigated as these metrics have showed associations with both internal and external load (Clemente, 2018; Clemente et al., 2017; Fernandes et al., 2021). However, other results are conflicting (Campbell et al., 2021; Scott et al., 2020). These conflicting findings could be a result of the questionnaire not being able to grasp the complexity of football (Saw et al., 2017). For example, fatigue can be perceived very differently between individuals as it can reflect both physiological and psychological aspects. Interestingly, by incorporating both internal and external load measurements research have previously been able to identify different types of fatigue. For instance, muscular fatigue has previously been associated with high ratings of perceived exertion (RPE) and heart rate, whereas mental fatigue has mainly been associated with RPE (Marcora et al., 2008; Marcora et al., 2009). In which could indicate an interdependence relationship between the subjective metrics, meaning muscular fatigue could possibly be the result of high intensity training, whereas mental fatigue could potentially affect ratings of RPE. Hence, combining both internal and external load measurements is highly recommended and can provide valuable insight into an athlete's physical and psychological state. However, the need for more research on this dose-response relationship is clear, especially in elite woman's football as the literature is sparse (Costa et al., 2022).

2.2.3 SUMMARY

It is seemingly need for more research in both external and internal load in women's football, although match demands and external loads is more established there is still factors to consider when interpretating these results. The utilization of the sRPE as a measure of internal intensity load, along with ratings of wellness to evaluate training response, aligns with prior research on external and internal loads in the field. Nonetheless, there are concerns regarding the reliability of these measures, as well as the complex interrelationship between the metrics, and conflicting findings emphasize the need for caution when analysing them.

2.3 PERIODIZATION IN FOOTBALL

To meet the demands in football, players undergo organized and structured training following the general principles of adaptive training. An adaptive training response is a result of changes in the organism due to the nature, intensity and duration of an exercise done over a period of time (Viru & Viru, 2000). As load monitoring is a method used to prescribe training load and adjusting of loads accordingly, periodization is used for planning and organizing the training. The main goal of using periodization is to achieve an adapting training load and a supercompensation towards competition, by dividing the training into different phases and cycles (Bompa & Buzzichelli, 2018). The cycles consist of the macrocycle, representing the bigger seasonal plan divided into the preparatory, seasonal, and transition phase of the year. The mesocycle representing the plan for the month week by week, and the microcycle representing the day-by-day planning for each week (Bompa & Buzzichelli, 2018).

When planning and organizing the larger seasonal plan (the macrocycle) in football, it is according to the natural dividing of pre-season and in-season (Bompa & Buzzichelli, 2018). By following a typical periodization this means the pre-season is characterized as a period to enhance physical ability and fitness towards the start of competitive seasons, according to the match demands and become more robust to prevent injuries (Malone et al., 2015). During the in-season the main aim is to perform for the next match, meaning the previous and the next match is the determining factor when adjusting training load within microcycles (Akenhead & Nassis, 2016). The organizing of training specificity, intensity and duration during the macrocycle and microcycles is very depending on coach philosophy as there are several different approaches (Bompa & Buzzichelli, 2018).

One periodization strategy that has gained popularity in recent years is the tactical periodization, developed by Vitor Frade (Afonso et al., 2020). As this approach not only considers the physical but also includes the tactical, technical, and psychological aspect of performance. Meaning, principles such as horizontal alternation in specificity, conditioned practices, complex progression, performance stabilization and tactical fatigue and tactical concentration are accounted for (Delgado-Bordonau & Mendez-Villanueva, 2012). As this study focuses on the physical aspect and training load, the principle of specificity is the most relevant. The principle of specificity is about how physical components are prioritized horizontally, referring to days and not within a day (vertical). For example, a typical tactical periodization would include a recovery phase after a match, counting towards the next matchday (MD-). Thus, rest day on MD- 6 and recovery on MD- 5. Followed by an acquisition phase including strength on MD- 4, endurance on MD- 3 and speed on MD- 2. MD- 1 is a new recovery phase consisting activation (Delgado-Bordonau & Mendez-Villanueva, 2012).

However, match distribution in a microcycle can be very different week to week (Oliveira et al., 2019). Meaning the training load must be adjusted accordingly for the players to be able to perform the following game (Delgado-Bordonau & Mendez-Villanueva, 2012). It is however, important to mention the lack of empirical evidence of improved performance using tactical periodization (Afonso et al., 2020). However, in a recent study on a Norwegian elite woman's football team Karlsson et al. (2023), reported that, by utilizing tactical periodization during in-season the load distribution was considered successful.

2.3.1 SEASONAL CHANGES IN PHYSIOLOGY

The primary goal of periodization in training is to elicit an adaptive response and achieve supercompensation. Hence, physical testing is commonly used to evaluate the results of training (Mara et al., 2015). In football, due to the varied movements and velocity changes, physical qualities such as endurance, sprint, agility, strength, power, and jumping are considered essential qualities for physical football performance and is important to improve or maintain throughout the season (Karlsson et al., 2023). This considered, physical testing is frequently used during pre-season where the primary focus is on increasing physical fitness. However, by investigating seasonal changes, previous research has investigated the physical changes. Studies on men's football have shown improvements in both speed and power-related qualities during pre-season training, which can also be maintained during the in-season period (Caldwell & Peters, 2009; Fessi et al., 2015). However, there is conflicting evidence on endurance, with some studies reporting improvements during the season while others report a decrease, possibly due to contextual or tactical reasons (Caldwell & Peters, 2009; Fessi et al., 2015).

Research on physical changes during a football season in elite women's football is relatively limited. Mara et al. (2015) observed changes in sprint test performance from pre-season to mid-season, with a decline in 5 m and 25 m sprint and maintained 15 m sprint performance towards the end of the season, similar to observations reported in men's football (Fessi et al., 2015). Conversely, a study on Polish women's national players found no significant changes in sprint ability during the pre-season but did observe an improvement in countermovement jump performance (Stepinski et al., 2020). Additionally, by using the Yo-Yo IR2, Mara et al. (2015) did not find any changes in endurance performance during the in-season period, despite a reduction in training load. However, it should be noted that the Yo-Yo IR2 is not generally recommended for female players as it starts at a higher level compared to the Yo-Yo IR1 (Krustrup et al., 2006).

2.3.2 SEASONAL CHANGES IN TRAINING LOAD

There is limited research on training load patterns during both pre- and in-season. However, previous studies have identified seasonal variations in physical performance between pre- and in-season in football. Lee and Mukherjee (2019) discovered that pre-season had higher total distance, high-intensity running, and subjective rating of sRPE compared to in-season. These findings are also supported by other studies from both elite men`s and women`s football (Algrøy et al., 2011; Clemente et al., 2020; Jeong et al., 2011; Mara et al., 2015). Fessi et al. (2016) also found similar results in subjective ratings, with higher total sRPE and wellness scores in pre-season in contrast to in-season. However, Mara et al. (2015) found no significant correlation between training load and wellness. This is in accordance with Saw et al. (2016). However, as Saw et al. (2016) fount that wellness was not sensitive towards increase in training load during acute and chronic periods, there was however patterns of higher scores of wellness when training load was decreased during acute periods. Interestingly, despite higher overall loads during pre-season Fessi et al. (2016) reported the highest RPE ratings during the in-season (Fessi et al., 2016).

Given that external loads, including sRPE and exercise duration, are reported to be higher during pre-season (Malone et al., 2015), these findings suggest significant differences in training volume between pre-season and in-season. Whereas the observed higher peaks of RPE from Fessi et al. (2016) during the in-season may reflect the coach's desire to maintain physical fitness by incorporating high-intensity sessions and/or the high strain from match play (Romero-Moraleda et al., 2021). Considering the conflicting results in physical performance by the end of the season, such as the YoYo-test, and the differences in training load, further investigation into the relationship between coach philosophy and seasonal physical performance is warranted (Burgess, 2017).

Prior research has shown a decrease in training load before the start of the season (Lee & Mukherjee, 2019; Mara et al., 2015), most likely to decrease levels of fatigue towards match. Interestingly, Mara et al. (2015) discovered a decrease in ratings of fatigue toward end of the season. In which could possibly be caused by a cumulative effect from a long season and many fixtures. During in-season training loads have been observed to be more varied compared to pre-season, potentially due to tactical considerations related to upcoming games and the aim of being prepared for the next match (Akenhead & Nassis, 2016; Lee & Mukherjee, 2019). Lee et al. (2019) found that internal and external loads decreased towards the end of the in-season, which is consistent with observations from women's football (Karlsson et al., 2023; Mara et al., 2015).

However, high intensity running remained steady throughout the in-season according to Lee et al. (2019), and similar patterns were also observed by Clemente et al. (2020). This could reflect a typical periodization by reducing training volume whereas intensity is maintained or increased (Bompa & Buzzichelli, 2018). Ratings of wellness throughout the season were generally stable, with exceptions noted by Mara et al. (2015) for correlations between lower total distance and soreness early in the season, and between soreness and high intensity running towards the end of the season. These findings could suggest that higher ratings of soreness may contribute to decrements in high intensity running by the end of the season. Inconsistent results have been reported regarding ratings of wellness throughout the season, with some studies showing a decrease towards the end of the season and others reporting an increase (Gallo et al., 2017; Gastin et al., 2013; Mara et al., 2015).

Notably, studies have identified positional differences in training loads, perceived fatigue, and muscle soreness in men's football (Clemente et al., 2017; Clemente et al., 2020; Lee & Mukherjee, 2019). These differences mainly involve high intensity activities, with greater accumulation of perceived fatigue and muscle soreness observed in certain positions. However, research on elite women's football has not found any positional differences in training load, despite observing differences in internal and external loads between positions (Fernandes et al., 2021; Romero-Moraleda et al., 2021), suggesting that training loads may not align with positional match demands in elite women`s football, although more research on the matter is warranted. However, it could be possible that different definitions of velocity thresholds in women's football may affect the results between external loads and ratings of wellness in terms of metric sensitivity (Bradley & Vescovi, 2015). Interestingly, when adjusting velocity thresholds based generically on individual peak speed, the wellness measures did not correlate with external loads in elite female players (Scott et al., 2020).

2.3.2.1 WITHIN MICROCYCLES

One important aspect to consider when analyzing training load is the distribution of load within a microcycle, which can vary depending on the number of games included (Clemente et al., 2020). Romero-Moraleda et al. (2021) discovered that internal and external match loads were significantly higher than training loads in elite women's football. It has been reported that internal and external loads are significantly lower on MD-1, MD-2 and the day after match (Malone et al., 2015; Oliveira et al., 2019). This pattern is also reflected in ratings of wellness, with significantly lower ratings on MD-1 and higher ratings the day after the game (Gallo et al., 2017). Interestingly, Fernandes et al. (2022) found the lowest training loads and ratings of wellness on MD-2 in elite women's football. However, ratings of wellness did not vary with high-intensity loads (Fernandes et al., 2022). Meaning, no significant changes in wellness was observed in the days prior or after the game.
Daily variations of internal and external loads have also been observed in previous studies (Oliveira et al., 2019). However, these variations were not always corresponding with each other, meaning there was no clear patterns as well as there were no significant differences in sRPE between microcycles with one, two, or three games (Oliveira et al., 2019). However,

Other studies have reported significant differences in internal and external loads during microcycles with one or more games (Clemente et al., 2017; Clemente et al., 2020). Clemente et al. (2017) found higher ratings of internal load in microcycles with one game, while microcycles with two games resulted in lower training loads but higher rates of soreness and fatigue. This pattern is similar in external load (Clemente et al., 2020; Lee & Mukherjee, 2019), which could suggest that periods with a high match schedule accumulate higher rates of muscle soreness and fatigue due to the high loads during games (Romero-Moraleda et al., 2021).

Interestingly, previous research on women's football has found a strong association between acceleration/deceleration and sRPE (Douchet et al., 2021; Karlsson et al., 2023). Karlsson et al. (2023) found that a decrease in total distance and accelerations/decelerations resulted in a decrease in sRPE, which could be associated with the high mechanical strain of accelerations and deceleration. Considering acceleration and deceleration have previously been found as a valid index for training load, associated with rating of wellness on elite women's football (Douchet et al., 2021). Coaches and practitioners should consider focusing on accelerations and decelerations incorporated with ratings of wellness for adjustment of training loads during microcycles.

2.3.3 SUMMARY

Findings on internal and external loads from pre-season and in-season are seemingly consistent with the principles of periodization. However, a complex interplay between internal and external training loads during in-season is also observed, possibly due to the influence of match distribution and coaching decisions. Moreover, ratings of wellness have been found to exhibit diverse patterns throughout the season, which further underscores the need for a nuanced, context-specific approach.

3.0 METHODOLOGY

3.1 PARTICIPANTS

The participant in this study is represented by one elite women`s football team (n=26) playing at the highest ranked league in Norway. Only outfield players were concluded as goalkeepers was excluded (Mara et al., 2015; Oliveira et al., 2019). The team was given the necessary tools for data collection and was given information regarding purpose of the study and practical information regarding tools and computer systems for data collection, players were also given information about the subjective metrics (Hooper & Mackinnon, 1995). The study was approved by the Norwegian Centre for Research Data and written informed consent from the participants was collected according to the principle of the Declaration of Helsinki. During the study, the participating team was encouraged to contact the contact person from the institution in charge if they had any questions or technical problems during the seasons.

3.2 STUDY DESIGN

Through a data processor agreement deal, the University of Tromsø agreed to give this study access to some of their raw data from one of their own projects from the Female Football Research Centre (FFRC). The raw data offered for the use in this study involves collected monitoring measurements from one Norwegian elite woman`s football team over two consecutive seasons (2020 and 2021). This study was conducted as a descriptive case-study investigating the subjective load monitoring patterns of a Norwegian elite woman's football. Subjective measures of sessional ratings and ratings of wellness was collected throughout two consecutive seasons including both pre- and in-season. All competitive matches (44 matches) were included when interpreting training load during in-season from both seasons. However, it is important to mention the contextual differences between the two seasons as the league set-up for the 2020-season was influenced by Covid 19, leading to a longer pre-season than usual and no break during the summer as it normally would.

The data was collected through the wellness and injury monitoring system pmSys, a phone application used by the participants (Hoang, 2015). The original project from FFRC did not intervene in the planning or execution of any training during the two seasons. It is also important to mention that the original project included several teams, not only the team used for this study alone. Meaning, the different time schedules between the teams resulted in the teams was given the opportunity determine them self to put time limits for the players to answer the questionaries, as long as they answered the wellness questionaries before and sessional ratings after training/match. However, the teams were encouraged to facilitate time-limits, but players had the opportunity to answer the questionnaires after a potential time-limit administrated by the team leaders. After the questionaires was answered the answers was directly transferred from pmSys and saved in excel. By the end of the project the excel files was collected and the players identification was anonymised accordingly.

3.2.1 INCLUSION CRITERIA

To be included in the analysis for the specific period referring to pre-season, in-season P1 and in-season P2, the players needed an answering rate exceeding 80% for each subjective metric (e.g. mood) (Oliveira et al., 2019). For analysis of in-season the players had to play for at least 60 min on matchday to be included in the microcycle prior to the game, similar with earlier research (Oliveira et al., 2019).

3.2.2 SESSIONAL MEASUREMENT

For measuring the subjective training/match intensity the concept of RPE (Borg, 1970) was used, but with the modified CR 10 RPE scale suggested by Foster et al. (2001). By which, players were asked to rate the training intensity on a scale from 1-10 after each training session and each match. The players were also asked to add the duration of the exercise in the application. By doing this the intensity quantified by RPE were multiplied with duration for calculation of sRPE as proposed by earlier research (Foster et al., 1996). The sRPE have been proved to be a valid measure of training intensity (Bourdon et al., 2017; Foster et al., 2001; Impellizzeri et al., 2004). Although, the reliability of the measure have been questioned (Scott et al., 2013).

3.2.3 WELLNESS MEASUREMENTS

For this study the Hooper Index conceptualized by Hooper, (1995) was used to measure the daily ratings of wellness. The questionnaires consist of mood, stress, fatigue, soreness and sleep quality. The values are rated by a 1-5 score. By summing the mean values from the team, we used an total wellness value in accordance with earlier research (McLean et al., 2010). Extra values like sleep duration and readiness to play scaled from 1-10 was also included in this study similar with (Alexandersen et al., 2023).

3.2.4 DATA PROSESSING AND ANALYSIS

For this study, the raw data was extracted from a One Drive for Business link from the project owner (UIT) and saved on individual files for each variable. For each file the content was as followed: The answer on the specific metric (e.g., mood) from every player, for every day for the two consecutive seasons. For the sorting of the raw data, every game and international game for the Norwegian national team was marked as the seasons includes international breaks. The files were then divided in pre-season 2020, in-season P1 2020, in-season P2 2020, pre-season 2021, in-season P1 2021 and in-season P2 2021, similar with previous used methods (Clemente et al., 2017; Lee & Mukherjee, 2019; Mara et al., 2015). To make sure the two seasons were as comparable as possible, the pre-season from both seasons was set at 14 weeks. As the P1 and P2 was naturally divided by the summer break during the 2021 season, the influence from Covid 19 during the 2020-season the two periods P1 and P2 was visually divided by distributing as even as possible between the weeks and games. No data from the summer brake was included as most of the data were individual trainings and making the two seasons more comparable.

For some days, typically one or two days after games or at the end of the training week in pre-season there would be blank answers, most likely because it was a day-off. To prevent this affecting the calculation of answering rates, referring to the 80% rate limit. Every player was added a cero, making a more considering answering rate but also giving a more realistic picture of the actual load of the day when presented visually in tables. For some players there would also be ratings of several training sessions per day. By summating all session durations and RPE followed by dividing RPE on frequency of sessions a day, the loads of the different sessions are now calculated as a total load equivalent to "one" session per day. For the analyses of in-season, the microcycles were divided in periods of 7 days with variations in match days. Meaning some microcycles included one match day and other cycles contained two match days, similar with earlier research (Mara et al., 2015).

3.3 STATISTICAL ANALYSIS

Microsoft Excel was used to present the descriptive data in mean (±) and standard deviation (SD). The Statistical Package for Social Science (SPSS) version 28.0.1.1 (14) was used to analyse potential associations between the subjective values during different periods of the two seasons using Pearson`s correlation, after testing distribution of normality. The level of significance was sat at $< 0.05$ (Cohen, 1994). Cohens`d effect size (ES) was used to observe the effect of the subjective values between the two seasons and between the different periods of the season (pre-season, in-season P1 and P2) (Cano-Corres et al., 2012). To determine the magnitude of the effect the following criteria was used; < 0.2 = trivial, 0.2 to 0.6 = small effect, 0.6 to 1.2 = moderate effect, 1.2 to 2.0 = large effect, and > 2 = very large effect (Hopkins et al., 2009).

4.0 DISCUSSION OF METHODOLOGY

4.1 DESIGN

The primary aim of this study is to provide a subjective monitoring profile from the highest level of Norwegian women's football. To achieve this objective, a descriptive case study design was employed, which involves the observation and description of a specific group or individual over a given period (Yin, 1984). However, case study designs have been criticized for their limited ability to generalize findings and the potential for insufficient cases in a single study (Tellis, 1997). However, Yin (1984) argues that the research question and purpose of the study should guide the selection of parameters, and that the information obtained from a case study can be used to inform and encourage future research using different approaches.

This study obtained a substantial quantity of raw data, which required extensive cleaning and organising. The initial step involved verifying the quality of the raw data, which included scrutinizing for possible errors. Subsequently, the raw data was structured in conformity with the research question and methodologies of previous research on seasonal changes and microcycles (Alexandersen et al., 2023; Clemente et al., 2017; Karlsson et al., 2023; Mara et al., 2015; Oliveira et al., 2019).

One of the primary challenges encountered during the organization of the raw data was the limited information available regarding the training sessions and players. This presented a particular issue with players who reported multiple sessions on the same day, potentially leading to discrepancies in the calculation of the sRPE metric. To address this, individual session duration and RPE ratings were summated and then divided by the frequency of sessions, allowing for the calculation of a mean sRPE value for each day. However, further complications arose when players reported vastly differing intensities and durations for certain sessions. For instance, if a player reported two sessions in a day, the first rated RPE a 8 with a duration of 90 minutes and the second rated RPE at 2 with a duration of 15 minutes, using the mean value of RPE would not provide an accurate representation of the actual load for the day. To mitigate this issue, an inclusion criteria was established that excluded sessions that rated RPE at 1or 2 and less than 20 minutes in duration, meaning sessions that rated RPE 9 and 15 min duration was still included as this was a high intensity session. This criterion allowed for a more accurate and reliable representation of the training load for each player.

A further limitation that arose due to the inadequate information available about the training sessions and players was the inclusion of participants for analysis. Consistent with prior research, the inclusion criteria for this study were an answering rate exceeding 80% and a minimum of 60 minutes of playing time on match day (Oliveira et al., 2019). During periods of high match density, players who played for more than 60 minutes on match day were included in the days between the previous match. This criterion could effectively prevent the inclusion of injured or non-starting players and provide a more accurate representation of the training loads by employing a specific group of players for a single microcycle. For instance, the inclusion of a non-starter who was subjected to a different training regimen prior to a game could influence the mean training load of the microcycle. However, for the pre-season period, only the > 80% criteria could be applied, indicating the possibility of including players undergoing rehabilitation or individual sessions in the analysis. Hence, this aspect should be taken into consideration while interpreting the results.

When examining previous research on monitoring and periodization in football, a wide range of results have been observed, particularly in subjective monitoring. It is possible that these divergent findings are caused by differences in the methods and analyses employed across studies. In Impellizzeri et al. (2020), the authors identified several limitations and strengths in monitoring research. Among the limitations, they pointed out that there is still no consensus on what training load variables to use and how to quantify them. Moreover, some monitoring tools have limited validity and reliability, which can affect the accuracy of the data. This is also previously mentioned by Akenhead & Nassis, (2016). A lack of consideration for individual differences in response to training is also evident in literature from team sports monitoring. It is also mentioned that using a single measure, such as sRPE, may not provide a complete picture of training load and that a multi-faceted approach should be considered (Impellizzeri et al., 2020). This is also supported by Hopkins et al. (2009) who highlights the limitations of traditional statistical methods in sport science, which can be inadequate for analysing complex data with multiple sources of variation.

In their study, Akenhead & Nassis (2016) have identified the lack of a consensus on appropriate duration of training load accumulation, which may account for the observed differences in subjective monitoring in football. Akenhead & Nassis suggest that acute periods (<7 days) should be included in the analysis, along with longer periods, given the differences in match distribution. However, many studies analysing seasonal changes, only included microcyles with a fixed design, which means that information on the non-included weeks is not included in the analysis. In contrast, the present study divided every microcycle into a fixed 7-day cycle to include every week of the season and categorized them by how many games per week. It is important to note that with this method, the intensity of the week may be misinterpreted, as the distance between games was not taken into account. For example, one week may have two games with five days between them, while another week may have two games with only two days between them. This limitation should be taken into consideration when interpreting the results of this study.

Considering the conflicting results in terms of the ratings of wellness, in which its purpose is to give a picture of training response and the inverse response from contextual factors (Hooper & Mackinnon, 1995). As the possible influence from methods and analysis have been discussed, it is also worth questioning the questionnaires' ability to fully grasp the scope of physical and psychical strains in team sports. As discussed by Saw et al, (2017) one limitation of wellness questionaries is the lack of specific differation in the metrics, for instance, the metrics stress and fatigue can embrace both physical and psychical strains and be sports related or non-sports related (Clemente, 2018; Nédélec et al., 2015). This inquires a common understanding between the coach and the players. However, this can be challenging when dealing with team sports in contrast to individual sports (Saw et al., 2017).
In accordance with previous research a metric for total wellbeing was quantified by summating the wellness metrics in this study (Gallo et al., 2016; McLean et al., 2010). In accordance with Gallo et al. (2016) the mean scores of the wellness metrics were used. However, Gallo et al. (2016) investigated individual differences, whereas from this study we investigated by the mean team values. As wellbeing measures are ranged only from 1-5, the SD is most likely quite low, in contrast to sRPE in which is highly affected by duration (Saw et al., 2017). Hence, when looking at the SD of total wellness from this study, by quantifying the SD based on mean team values the SD got very low.

The impact of the COVID-19 pandemic on the structure and fixtures is a crucial consideration in this study. Due to the outbreak, several leagues were disrupted, with some competitions experiencing an extended pause, while others were terminated prematurely. As such, there have been changes to the scheduling of matches, with some teams playing more games in a shorter period, while others have had longer breaks between games. These changes may have had significant impacts on the players' physical and mental wellbeing, as well as their performance on the pitch.

4.2 PARTICIPANTS

In this study, the participants (n=26) were highly trained female football players who played in the top league of Norwegian football and were considered professional athletes (Winther et al., 2022). In accordance with previous research on seasonal load monitoring in football, goalkeepers were excluded from the analysis (Malone et al., 2015). To ensure high-quality data, inclusion criteria excluded four players, leaving a total of 22 players. The raw data revealed significant individual differences in the number of sessions per day, suggesting differences in players' everyday routines (Bjerksæter & Lagestad, 2022). This could also further explain the observed differences in SD between sRPE and wellness, as sRPE had much higher SD because of big individual differences. During the project, the team and coaches were responsible for setting the criteria for player reporting, as the project's only requirement was to report session ratings after sessions and wellness ratings before sessions. Coaches were able to decide if players should report individual sessions or not.

Prior to the start of the project, players were instructed on how to rate different values. But the risk of different individual perception of the different scales in the questionnaires can still occur. However, when interpreting subjective measurements, it is recommended to evaluate them on an individual level (Burgess, 2017; Saw et al., 2017). For instance, trainers who know their players well are aware that the baseline for mood will vary between individuals. Other contextual factors such as dehydration, nutrition, and illness should also be considered when interpreting subjective monitoring data. These factors may be difficult to detect in wellness reporting in the morning and may only become apparent during or after the training session, which is worth considering when interpreting subjective monitoring data (Impellizzeri, Marcora, & Coutts, 2019).

4.3 STATISTICAL ANALYSIS

In this study, a large dataset of raw data was sorted using Microsoft Excel, and formulas were applied to find mean and standard deviation (SD) for descriptive data. The data was checked for errors multiple times by the author, but human errors cannot be entirely excluded, especially when handling large datasets. To examine possible associations between sRPE and wellness measures during different periods of the season, Pearson`s correlations was used. It should be noted that this approach did not allow for examination between individuals or within person variations as proposed by Hopkins et al. (2009). The Pearson's correlation test presents two values, the Pearson coefficient that quantifies the strength and direction of the relationship between two variables. The correlation coefficient ranges from -1 to +1, with values closer to -1 or +1 indicating a stronger relationship and values closer to 0 indicating a weaker relationship. While the p-value indicates that the observed correlation is statistically significant, meaning that it is unlikely to have occurred by chance alone. The p-value was predetermined at < 0.05 (Cohen, 1994). Using p-value for investigating possible association within the wellness metrics and/or with other measurements is a commonly used analysis (Saw et al., 2016). However, the heavily use of the p-value in the sport milieu has previously been criticized as it is not a sufficient analysis for causality (Hopkins et al., 2009; Impellizzeri et al., 2020).

Hence, to further assess the differences between the two seasons and the three previously defined periods of the season in this study, Cohen's effect-size (ES) was used (Cano-Corres et al., 2012). ES was determined using predefined criteria < 0.2 = trivial, 0.2 to 0.6 = small effect, 0.6 to 1.2 = moderate effect, 1.2 to 2.0 = large effect, and > 2.0 = very large effect, as suggested by Hopkins, Marshall, Batterham, and Hanin (2009). Effect size was calculated by Cohens`d, a calculation that quantifies the magnitude of difference between the mean values of two groups. By combining the SD of the values, the effect size tells us how much separation there is between the two groups in terms of SD (Cano-Corres et al., 2012). However, it is important to mention the low statistical power in this study as this can potentially lead to a misinterpretation of the effect size. A low statistical power can also increase the risk of type II error and reduce the generalizability (Hopkins et al., 2009).

4.4 STRENGTHS AND LIMITATION OF THIS STUDY

For this study, the duration of two consecutive seasons should be considered a strength. As far as we know, the longest observed analysis of seasonal changes in football from other research is one season (Karlsson et al., 2023; Lee & Mukherjee, 2019; Mara et al., 2015). It is also important to mention the fact that this study is a descriptive case study, the purpose of the study is to investigate patterns from on elite women's football team, and on the premises of this not making any causal conclusions. Hence, the choice of correlation test and effect size was used as both is recommended for detecting patterns, and have been widely used on subjective metrics (Cano-Corres et al., 2012; Saw et al., 2016). However, as the research questions for this study is depending on comparing patterns with previous findings there is a risk of p-hacking, especially when this study does not account for individual differences and within person variability (Impellizzeri et al., 2020). Hence, inclusion of effect size in the analysis can strengthen the analysis, as using a correlation test by its own is not recommended (Hopkins et al., 2009).

One of the main limitations of this study is the low statistical power, as well as the inclusion criteria limits the number of players involved in analysis of microcycles as it can enhance misinterpreting of the analysis. This problem is also observed in other similar studies and in elite football literature in general (Fernandes et al., 2022; Impellizzeri et al., 2020; Oliveira et al., 2019). However, these inclusion criteria's is essential for increasing quality of analysis. Considering the limitation of little information about the training sessions and players the inclusion criteria have also been important to minimize the risk of including injured or non-starting players in analysis of in-season. However, during pre-season, due to only using the 80% answering rate limit, the inclusion of injured players doing individual trainings may have occurred and is considered a big limitation considering pre-season being compared with other periods.

4.5 ETHICS

A data processor agreement deal proposed by Svein Arne Pettersen and UIT was signed by Matt Spencer on behalf of the University of Agder. By this, a link to the raw data was sent from UIT. All data was already anonymized. The document can be found in appendix1.

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Part 2:

Research paper

Seasonal changes in subjective load monitoring: A case study on an elite women's football team

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ABSTRACT

PURPOSE: The purpose of this study is to present a subjective load monitoring profile from two consecutive seasons from one elite women's football team.

METHODS: One elite women's football team (n=26) playing in the highest level in Norway was monitored for two consecutive seasons (2020 and 2021). Both seasons was divided in pre-season, in season part one (P1) and in-season part two (P2). Borg`s rating of perceived exertion (RPE) scaled 1-10 and duration of training was answered after each training/match. By multiplying RPE and duration, sessional rating of perceived exertion (sRPE) was used as a metric for training load. Wellness metrics answered before training/match based on Hooper Index to present training response and other stressors (fatigue, soreness, stress, sleep quality and mood) scaled 1-5. Sleep duration (h) and readiness scaled 1-10 was also included.

RESULTS: There was a difference in both seasons in sRPE between pre-season and P1 (ES= 0.27 and 0.25) and P1 and P2 (ES= -0.26 and -0.22). There was a negative correlation in sRPE with readiness ($p \leq 0.05$) during all periods/seasons except pre-season in 2021. With fatigue and soreness ($p \leq 0.05$) during pre-season 2021 and P1 in both seasons.

CONCLUSION: Training load during pre-season show typical pattern of periodization, whereas loads during in-season was more varied and tactically influenced. sRPE show association with readiness, soreness and fatigue. Whereas a potential dose-response relationship between training load and wellness and within wellness metrics should be further investigated.

KEY WORDS: Elite women's football, periodization, load monitoring, sRPE, wellness

INTRODUCTION

Football is considered the most popular and studied sport in the world. However, research on women's football equals only ~20% of the total literature in football, with only ~15% corresponding of elite female players [1]. Nonetheless, the popularity and economy in woman's football have changed dramatically, referring to the record-breaking attendance and viewership in international tournaments [2]. This considered, the lack of knowledge about the training load and periodization in elite women's football is evident [3].

Load monitoring have given coaches and practitioners the ability to monitor internal and external loads of the individual athlete to better prescribe an appropriate training load [4]. External load refers to the work output, which in football is often presented in distances and velocities [4]. Whereas, internal load is the psychophysiological response to the external load [4]. By using global navigation satellite systems (GNSS) to collect external loads, practitioners has previously collected meaningful information about the match demands in elite women's football. However, other less expensive methods are also considered as valid measurements of training load. Such as sessional ratings of perceived exertion (sRPE) and wellness questionnaires [3].

sRPE is a measurement of the internal load, meaning a subjective rating of the training intensity, in which has previously shown meaningful correlations with external loads and heart-based internal loads in football [5-7]. Whereas ratings of wellness are a measurement of the training response, captured by the metrics fatigue, soreness, stress, sleep and mood in which previously have showed qualities as a measurement for detecting overtraining [8]. However, the dose-response relationship between training load and ratings of wellness in football show conflicting results in the literature [9,10]. As of seasonal changes involves, others studies have reported significant differences in external and internal load between pre-season and in-season, with higher loads in pre-season [11,12]. Whereas loads during different periods during in-season is less predictable with the numbers of games in the week seemingly being a determining factor for training load [13,14].

METHODS

SUBJECTS

One Elite women`s football team playing at the highest level in Norway participated in this study (n= 26). Goalkeepers were excluded from this study. To be included in the analysis the participants needed an answering rate for each subjective metric at > 80% for the specific period of the season. To be included in analysis from in-season and the specific microcycle, the players also had to play for the minimum of 60 min on matchday. The inclusion criteria is in accordance with previous research [14]. After inclusion criteria a total of 22 players was included in the analysis.

DESIGN

This study was conducted as a case-study investigating the subjective load patterns of a Norwegian elite woman's football team. Through a data processor agreement deal (see appendix1), the University of Tromsø agreed to give this study access to some of their raw data from the Female Football Research Centre (FFRC). The project was approved by the Norwegian Centre for Research Data and written informed consent from the participants was collected according to the principle of the Declaration of Helsinki. Subjective measures of sessional ratings and wellness was collected throughout two consecutive seasons, in 2020 and 2021. For the purpose of this study, data was collected from both pre-season and in-season. It is however important to mention the contextual differences in the two seasons as Covid 19 influenced the league set-up for the 2020-season, leading to a longer pre-season than usual and no break during the summer as it normally would.

METHODOLOGY

The data was collected through the wellness and injury monitoring system pmSys, a phone application used by the participants [15]. Every player was asked to give sessional ratings after every training session and match, preferably right after. They were also asked to answer wellness questionnaires in the morning before every training session and match. Prior to the project the participants were given instructions on how to use the applications and the meaning of the different variables.

Sessional ratings of perceived exertion (RPE) was used as measurement for training/match intensity [16]. But with the modified CR 10 RPE scale suggested by [17]. By which, players were asked to rate the training intensity on a scale from 1-10 after each training/match. In addition, duration of exercise was also asked for calculation of sessional rating of perceived exertion (sRPE), conceptualized by [18]. The questionnaires used before every training/match was based on the Hooper Index conceptualized by [8].

The questionnaires are used as a measurement for wellness and consist of mood, stress, fatigue, soreness and sleep quality. The values are rated by a 1-5 score. By summing the values, we used an overall wellness value in accordance with earlier research [19]. Other metrics like readiness to play scaled 1-10 was also included in the analysis of this study. Sleep duration was also included and presented in the descriptive figures in appendices, however this metric was not included in the statistical analysis due to sleep quality being the most presented metric for sleep [20].

STATISTICAL ANALYSIS

Microsoft Excel was used to present the descriptive data in mean (±) and standard deviation (SD). SPSS version 28.0.1.1 was used to analyse the potential correlation between the subjective values in the different periods using Pearson`s correlation, after testing distribution of normality. The level of significance was sat at < 0.05. Cohens`d effect size (ES) was used to observe the effect of the subjective values between the two seasons and between the different periods of the season (pre-season, in-season P1 and P2). To determine the magnitude of the effect the following criteria was used; < 0.2 = trivial, 0.2 to 0.6 = small effect, 0.6 to 1.2 = moderate effect, 1.2 to 2.0 = large effect, and > 2 = very large effect [21].

RESULTS

Effect between seasons: For the pre-season period, it was observed differences between the 2020-season and 2021-season in wellness (15.6 au and 16.0 au, ES= - 4.00), readiness (45.7 au and 48.0 au, ES= -0.24), and mood (23.3 au and 24.6 au, ES= -0.31). For the in-season P1 it was observed a difference in wellness (15.9 au and 16.0, ES= -0.99) and soreness between seasons (19.3 au and 20.4 au, ES= -0.22). For the in-season P2 it was observed difference between seasons in wellness (15.8 au and 16.3 au, ES= -5.0), soreness (19.4 au and 20.6 au, ES= -0.23) and stress (22.0 au and 23.4 au, ES= -0.32).

Effect between periods: Between pre-season and in-season P1 in 2020 it was observed differences in sRPE (3219 au and 2856 au, ES=0.27), wellness (15.6 au and 15.9 au, ES= -3.0), readiness (45.7 au and 49.7 au, ES= 0.47), and mood (23.3 au and 24.1au, ES= -0.21). While pre-season from the 2021 season observed differences in sRPE (3135.6 au and 2831.6 au, ES= 0.25) and soreness (19.3 au and 20.4 au, ES= -0.21). Between pre-season and in-season P2 in 2020 it was observed a difference in wellness (15.6 au and 15.8 au, ES= -2.0) and readiness (45.7 au and 48.1 au ES= -0.27). While for the 2021 season it was observed a difference in wellness (16.0 au and 16.3 au, ES= -3.0), soreness (19.3 au and 20.6 au, ES= -0.24), and fatigue (21.0 au and 22.2 au, ES= -0.27). Between in-season P1 and P2 in the 2020 season it was observed a difference in sRPE (2856.5 au and 3179.8 au, ES= -0.26), wellness (15.9 au and 15.8 au, ES= 0.99) and stress (23.3 au and 22.0 au, ES= 0.32). For the 2021-season, a difference in sRPE (2831.6 au and 3102.9 au, ES= -0.22), wellness (16.0 au and 16.3 au, ES= -3.0) and sleep quality (22.4 au and 23.6 au, ES= -0.23).

Table 1. Differences in subjective measurements between two seasons and different periods of the seasons.

		sRPE	Wellness	Readiness	Sleep	Soreness	Mood	Fatigue	Stress
Pre	**2020**	a* 3219.1 ± 1478.9	a**** 15.6 ± 0.1	a* 45.7 ± 8.2	23.0 ± 4.7	18.7 ± 4.2	a* 23.3 ± 3.7	21.3 ± 3.4	22.8 ± 4.2
	2021	a* 3135.6 ± 1242.0	s**** 16.0 ± 0.1	s* 48.0 ± 10.2	22.9 ± 4.9	a* 19.3 ± 5.0	s* 24.6 ± 4.6	21.0 ± 4.0	22.6 ± 4.7
P1	**2020**	c* 2856.5 ± 1121.1	s** c** 15.9 ± 0.1	49.7 ± 8.7	23.2 ± 4.3	s* 19.3 ± 4.7	24.1 ± 3.9	21.7 ± 3.6	c* 23.3 ± 3.9
	2021	c* 2831.6 ± 1146.0	c**** 16.0 ± 0.1	47.8± 11.3	c* 22.4 ± 5.2	20.4 ± 5.1	24.6 ± 4.4	21.5 ± 4.4	23.0 ± 4.8
P2	**2020**	3179.8 ± 1296.6	s**** b**** 15.8 ± 0.1	b*48.1 ± 9.0	23.3 ± 5.3	s* 19.4 ± 4.7	24.1 ± 4.4	21.5 ± 3.6	s** 22.0 ± 4.1
	2021	3102.9 ± 1232.4	b**** 16.3 ± 0.1	46.1 ±12.2	23.6 ± 5.1	b* 20.6 ± 5.6	24.0 ± 4.6	b* 22.2 ± 4.7	23.4 ± 4.6

Mean values = summation of the weekly load; ± = standard deviation; sRPE = sessional rating of perceived exertion; wellness = summation of daily mean ratings from each variable (sleep quality, soreness, mood, fatigue and stress); sleep quality, soreness, mood, fatigue and stress = summation of mean daily ratings scaled 1-5 from one week; readiness= summation of mean daily ratings scaled 1-10; * = small effect; ** = moderate effect; ****= very large effect size; a= pre-season and in-season P1; b= pre-season and in-season P2; c= in-season P1 and in-season P2; s= between 2020 and 2021.

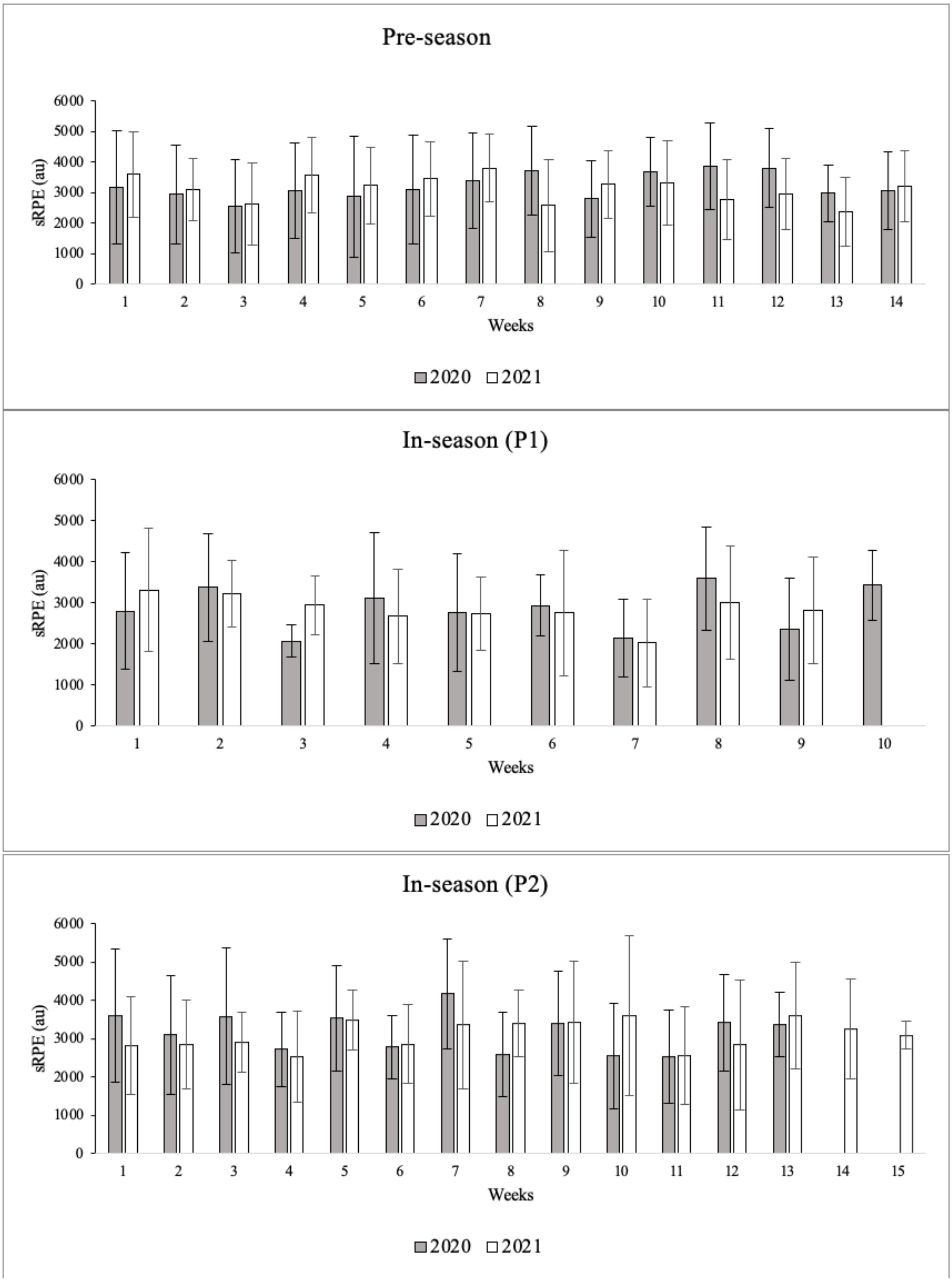

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Fig. 1. Descriptive comparison of weekly score of sRPE between two seasons divided in three periods. Data are presented as a summation of the teams daily mean score and standard deviation from one week. AU= arbitrary unit, sRPE= session rating of perceived exertion (RPE*duration), P1= first part of in-season, P2= second part of in-season.

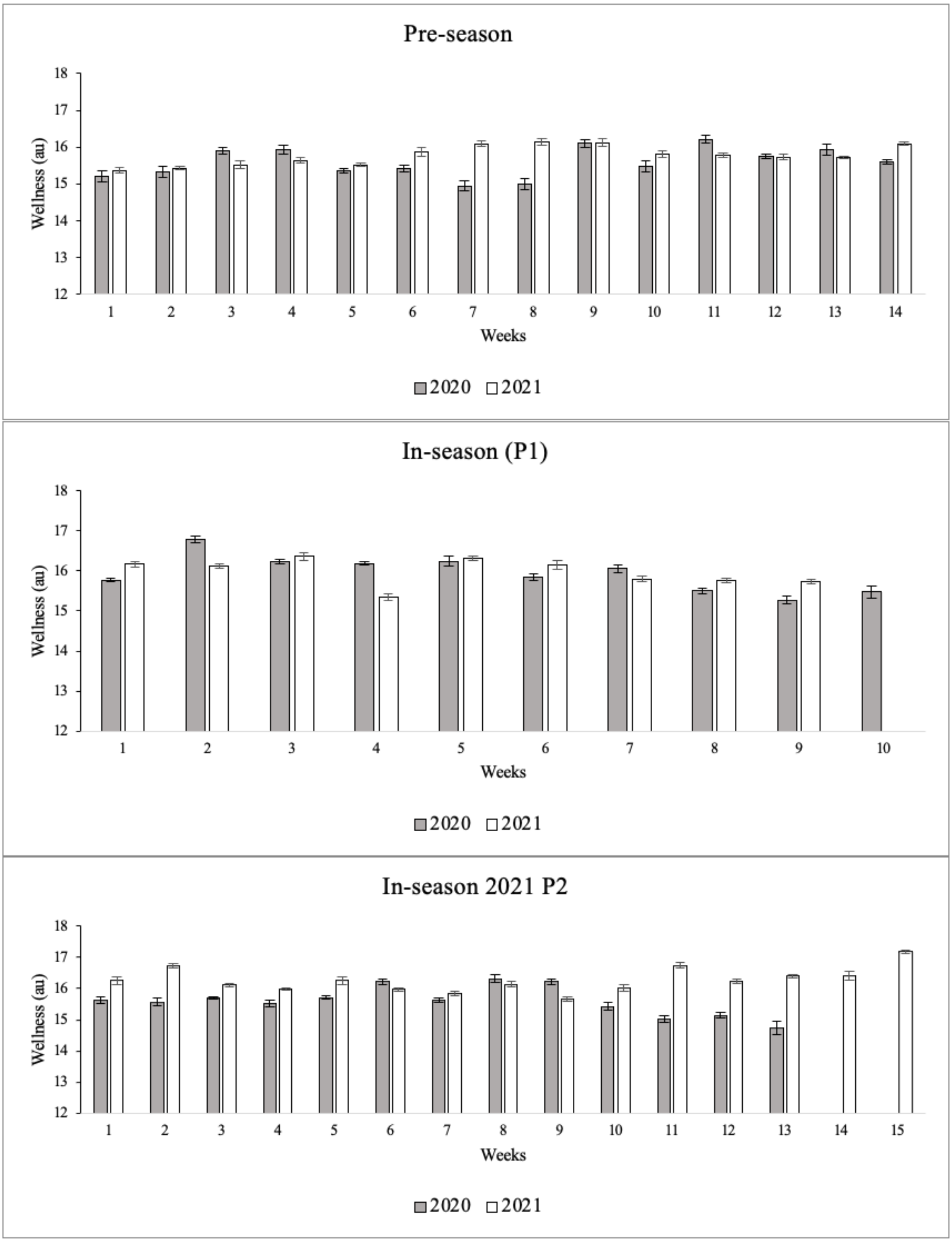

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Fig.2. Descriptive comparison of weekly score of overall wellness between two seasons divided in three periods. Data are presented as a summation of the teams daily mean score and standard deviation from one week. AU= arbitrary unit, Wellness= a summation of stress, fatigue, soreness, sleep quality and mood scores ranging from 1-5, P1= first part of in-season, P2= second part of in-season.

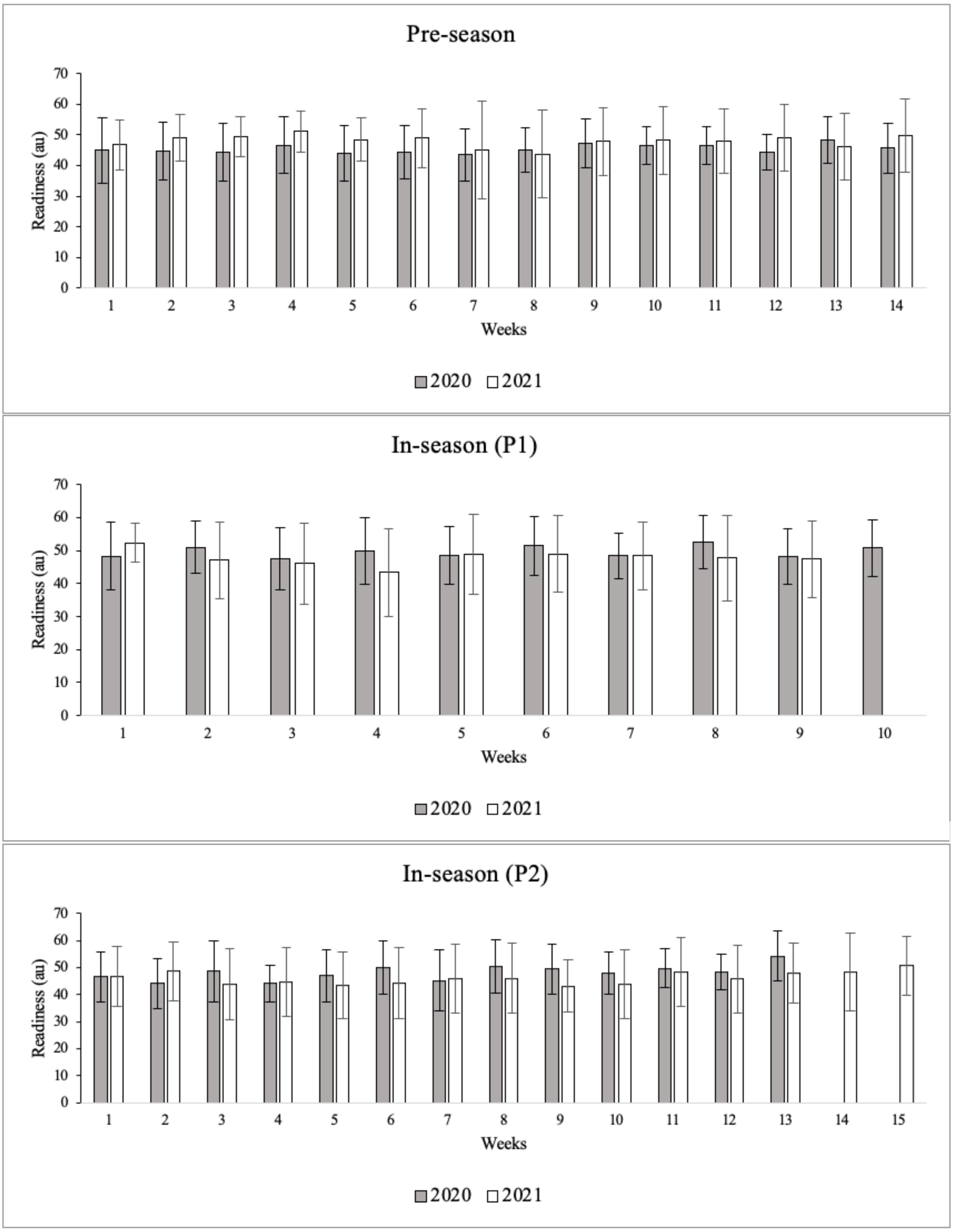

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Fig. 3. Descriptive comparison of weekly score of readiness between two seasons divided in three periods. Data are presented as a summation of the teams daily mean score and standard deviation from one week. AU= arbitrary unit, Readiness= rating of readiness for training scaled 1-10, P1= first part of in-season, P2= second part of in-season.

Correlation test between subjective variables

From the 2020 season: It is observed a negative correlation between sRPE and mood (p≤ 0.05) in pre-season, and a correlation between sRPE and Readiness (p≤ 0.01) from pre- and in-season P1, and in-season P2 (p≤ 0.05). From in-season P1 it was also a correlation between sRPE and fatigue (p≤ 0.05). Wellness is correlated with fatigue, soreness, stress, sleep quality, mood and readiness in all periods (p≤ 0.01) with the exception of a smaller correlation with readiness in pre-season (p≤ 0.05). Readiness is correlated with fatigue and soreness in all periods (p≤ 0.01), readiness also correlates with sleep (p≤ 0.05) and mood (p≤ 0.01) in both periods of the in-season. Fatigue is correlated with soreness, mood and sleep in all periods (p≤ 0.01) with the exception of smaller correlation with soreness and mood in pre-season (p≤ 0.05). Soreness is correlated with stress (p≤ 0.05), sleep and mood (p≤ 0.05) in P1 and with stress and sleep in P2 (p≤ 0.01). It is a correlation between stress and mood (p≤ 0.01). It is a correlation between sleep and mood in pre-season and in-season P2 (p≤ 0.01).

Table 2. Correlation between subjective metrics in different periods of the 2020-season.

2020		sRPE	Wellness	Readiness	Fatigue	Soreness	Stress	Sleep	Mood
Pre	sRPE	1	-0.178	0.417**	0.054	0.025	-0.196	-0.120	-0.206*
	Wellness	-0.178	1	0.244*	0.670**	0.484**	0.657**	0.621**	0.679**
	Readiness	0.417**	0.244*	1	0.310**	0.375	-0.033	0.069	0.058
	Fatigue	-0.054	0.670**	0.310**	1	0.257*	0.196	0.516**	0.231*
	Soreness	0.025	0.484**	0.375**	0.257*	1	0.033	0.022	0.022
	Stress	-0.196	0.657**	-0.033	0.196	0.033	1	0.190	0.495**
	Sleep	-0.120	0.621**	0.069	0.516**	0.022	0.190	1	0.300**
	Mood	-0.206*	0.679**	0.058	0.231*	0.130	0.495**	0.300**	1
P1	sRPE	1	0.212	0.651**	0.304*	0.323**	-0.084	-0.032	0.215
	Wellness	0.212	1	0.507**	0.730**	0.778**	0.576**	0.663**	0.652**
	Readiness	0.651**	0.507**	1	0.700**	0.511**	-0.080	0.244*	0.346**
	Fatigue	0.304*	0.730**	0.700**	1	0.494**	0.214	0.451**	0.328**
	Soreness	0.323**	0.778**	0.511**	0.494**	1	0.256*	0.349**	0.486**
	Stress	-0.084	0.576**	-0.080	0.214	0.256*	1	0.192	0.352**
	Sleep	-0.032	0.663**	0.244*	0.451**	0.349**	0.192	1	0.176
	Mood	0.215	0.652**	0.346**	0.328**	0.486**	0.352**	0.176	1
P2	sRPE	1	-0.069	0.215*	-0.018	-0.109	-0.080	-0.051	0.017
	Wellness	-0.069	1	0.443**	0.737**	0.689**	0.764**	0.758**	0.693**
	Readiness	0.215*	0.443**	1	0.622**	0.318**	0.342**	0.231*	0.314**
	Fatigue	-0.018	0.737**	0.622**	1	0.532**	0.342**	0.447**	0.395**
	Soreness	-0.109	0.689**	0.318**	0.532**	1	0.400**	0.344**	0.196
	Stress	-0.080	0.764**	0.155	0.342**	0.400**	1	0.485**	0.579**
	Sleep	-0.051	0.758**	0.231*	0.447**	0.344**	0.485**	1	0.416**
	Mood	0.017	0.693**	0.314**	0.395**	0.196	0.579**	0.416**	1

Pre= pre-season, P1= in-season part one, P2= in-season part two, the correlation coefficient (between -1 and 1) = show the positive or negative direction and strength of the correlation, *= p-value at <0.05; **= p-value at <0.01.

From the 2021 season: It is observed that sRPE is negative correlated with wellness and soreness ($p \leq 0.05$) and readiness and fatigue ($p \leq 0.01$) in pre-season. sRPE is also negative correlated with readiness, soreness and sleep ($p \leq 0.01$) and fatigue ($p \leq 0.05$) in P1, while in P2 sRPE is negative correlated with mood ($p \leq 0.05$). Wellness is correlated with fatigue, soreness and mood in all periods ($p \leq 0.01$) with the exception of a smaller correlation with fatigue in pre-season and P1 ($p \leq 0.05$) and soreness in P1 ($p \leq 0.05$). During P1 wellness also correlated with stress ($p \leq 0.05$), while during P2 with stress ($p \leq 0.01$) and sleep ($p \leq 0.05$). Readiness correlates with fatigue in all periods ($p \leq 0.01$), and soreness, sleep and mood in P1 and P2 ($p \leq 0.01$) with the exception of a smaller correlation with sleep in P2 ($p \leq 0.05$). In P2 readiness also correlates with stress ($p \leq 0.01$). Fatigue correlates with soreness, stress and mood in all periods ($p \leq 0.01$) with the exception of a smaller correlation with stress in pre-season and P1 ($p \leq 0.05$). Fatigue also correlates with sleep in P1 and P2 ($p \leq 0.01$). Soreness correlates with mood in all periods ($p \leq 0.01$) with the exception of a smaller correlation in P1 ($p \leq 0.05$). Soreness also correlates with stress ($p \leq 0.05$) and sleep ($p \leq 0.01$) in P1 and stress in P2 ($p \leq 0.01$). Stress correlates with sleep and mood in all periods ($p \leq 0.01$) with the exception of a smaller correlation with sleep in P2 ($p \leq 0.05$). Sleep correlates with mood in all periods ($p \leq 0.01$) with the exception of a smaller correlation in P1 ($p \leq 0.05$).

Table 3. Correlation between subjective metrics in different periods of 2021-season.

2021		sRPE	Wellness	Readiness	Fatigue	Soreness	Stress	Sleep	Mood
Pre	sRPE	1	-0.248*	-0.381**	-0.271**	-0.248*	-0.063	0.025	-0.120
	Wellness	-0.248*	1	0.038	0.223*	0.437*	0.159	0.022	0.270**
	Readiness	-0.381**	0.038	1	0.310**	0.070	-0.192	-0.027	-0.126
	Fatigue	-0.271**	0.223*	0.310**	1	0.313**	0.252*	0.190	0.371**
	Soreness	-0.248*	0.437**	0.070	0.313**	1	0.191	-0.080	0.291**
	Stress	-0.063	0.159	-0.192	0.252*	0.191	1	0.377**	0.549**
	Sleep	0.025	0.022	-0.027	0.190	-0.080	0.377**	1	0.349**
	Mood	-0.120	0.270**	-0.126	0.371**	0.291**	0.549**	0.349**	1
P1	sRPE	1	0.198	-0.448**	-0.276*	-0.344**	0.012	-0.361**	-0.091
	Wellness	0.198	1	0.152	0.261*	0.271*	0.293*	0.055	0.342**
	Readiness	-0.448**	0.152	1	0.748**	0.643**	0.040	0.382**	0.346**
	Fatigue	-0.276*	0.261*	0.748**	1	0.639**	0.283*	0.502**	0.419**
	Soreness	-0.344**	0.272*	0.643**	0.639**	1	0.305*	0.371**	0.292*
	Stress	0.012	0.293*	0.040	0.283*	0.305*	1	0.328**	0.518**
	Sleep	-0.361**	0.055	0.382**	0.502**	0.371**	0.328**	1	0.269*
	Mood	-0.091	0.342**	0.346**	0.419**	0.292*	0.518**	0.269*	1
P2	sRPE	1	0.022	-0.120	-0.105	-0.166	-0.111	-0.108	-0.239*
	Wellness	0.022	1	0.455**	0.381**	0.591**	0.571**	0.220*	0.369**
	Readiness	-0.120	0.455**	1	0.649**	0.653**	0.352**	0.209*	0.414**
	Fatigue	-0.105	0.381**	0.649**	1	0.498**	0.297**	0.429**	0.333**
	Soreness	-0.166	0.591**	0.653**	0.498**	1	0.513**	0.140	0.346**
	Stress	-0.111	0.571**	0.352**	0.297**	0.513**	1	0.201*	0.591**
	Sleep	-0.108	0.220*	0.209*	0.429**	0.140	0.201*	1	0.281**
	Mood	-0.239*	0.369**	0.414**	0.333**	0.346**	0.591**	0.281**	1

Pre= pre-season, P1= in-season part one, P2= in-season part two, the correlation coefficient (between -1 and 1) = show the positive or negative direction and strength of the correlation, *= p-value at <0.05; **= p-value at <0.01.

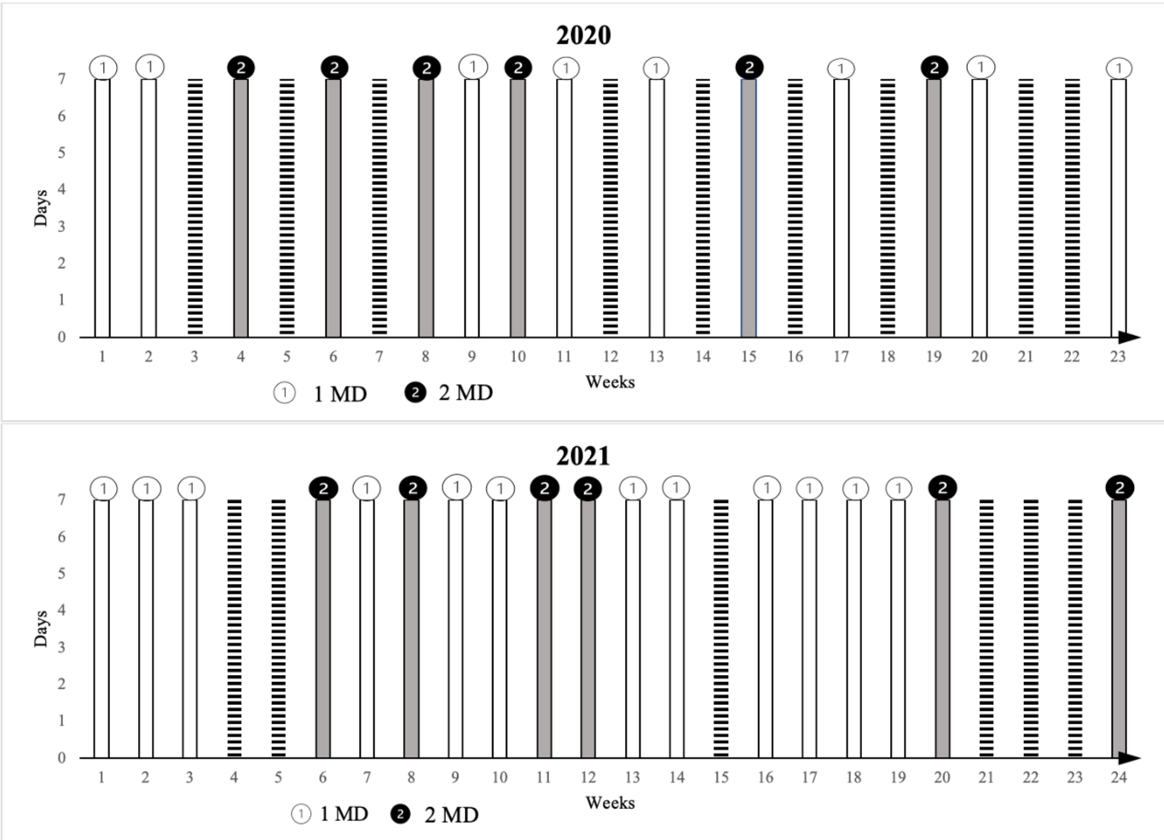

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Fig. 4. Timeline of the weakly game distribution from in-season in 2020 and 2021. 1 MD= one match in the week, 2 MD= two matches in the week, unmarked weeks= no games.

DISCUSSION

By observing figure 1 from this study, the training intensity for pre-season show a clear pattern of a typical periodization from both seasons, this is reflected in both figure 12 (RPE) and figure 11 (duration) (see appendix 2), with an increase trough the beginning of the pre-season and with a clear drop in the 2-3 weeks before start of in-season. However, the drop is more evident in duration, which could indicate a higher decrease in volume rather than intensity. This pattern is similar with earlier observations from elite men`s and women`s football [7,11,22]. This could also be reflected by the results from analysis (see Table 1), as sRPE showed an effect in sRPE between pre-season and in-season P1 from both seasons (ES= 0.27 and 0.25) however, these are considered as a small effect. The intensity distribution during in-season is much more varied, also in accordance with earlier research [11,23,24]. Interestingly, a small effect size in sRPE was also observed between P1 and P2 from both seasons (ES= -0.26 and -0.22), but no difference was observed between pre-season and P2 in which other studies have reported significant differences in training load between the two period [11,22]. Whereas a difference between P1 and P2 have earlier been observed in women's elite football with a decrease in training load towards the end of season [22,25]. Interestingly, results from Pearson correlation test (see Table 2 and 3) revealed that the most consistent associations between sRPE and fatigue, soreness and readiness was in P1 from both seasons.

As previous findings have showed meaningful differences between pre- and in-season ($p \leq 0.01$) in sleep, stress, fatigue and soreness [12]. The results from this study did not present as strong differences. However, Fessi et al. (2016) did not present in effect size. Interestingly, fatigue and soreness (ES= -0.27 and -0.24) had a small effect between pre-season and P2 in the 2021 season, and readiness (ES= -0.27) in P2 during the 2021 season. Considering the lower mean values in P1 this could possibly indicate a cumulative effect of frequent fixtures. However, the Pearson correlation test revealed no correlation between sRPE with fatigue and soreness in pre-season or P2 in the 2020 season, and no correlation with soreness in P2 during the 2021 season and should be taken to consideration.

Earlier research has previously reported lower training loads and higher ratings of wellness during weeks with two games and higher training loads and lower ratings of wellness in weeks with one game [23]. When comparing figure 1 (sRPE) with figure 4 (Timeline of match distribution), there is no clear pattern as some weeks have higher loads in weeks of one match whereas other weeks it is higher in weeks of two, this is similar with the study from Oliveira et al. (2019), in which found the most significant factor for load adjustment the day before match. However, the load distribution seems to be more in accordance with Clemente et al. (2017) in the 2021-season, especially during P2. Interestingly, during weeks without matches (international brakes) the training load was surprisingly lower or similar to the other microcycles from both seasons. This could be caused by the observed difference in internal and external load in training versus match, as match loads are significantly higher [26], meaning as this study only investigate the total weekly loads, the high loads during match could equalise the possibly lower loads in the other days.

When looking at the different figures from measures of wellness, these are very consistent throughout both seasons in both P1 and P2 and could also reflect the small to none effect in these metrics between the different periods. This has also previously been observed in elite women's football [13]. This considered, the Pearson correlation test did present some negative correlations between sRPE with fatigue and soreness, similar with previous findings [27], however Fernandes et al. (2021) also found a negative correlation with sleep and stress but this was not observed in this study with the exception of sleep ($p \leq 0.01$) in P1 during the 2021 season. Interestingly, readiness was the most consistent correlated metric with sRPE trough all periods in both seasons with the exclusion of P2 in the 2021 season. It is also of interest to mention that fatigue showed correlation with stress, sleep and mood throughout the periods ($p \leq 0.05$) except stress in pre-season and P1 in 2020 and sleep in pre-season 2021.

The total wellness metric shows great correlation with all the wellness metrics but interestingly no correlations with sRPE with the exception of pre-season in the 2021 season. This is most likely due to the impact of mood, sleep and stress who remained stable throughout the seasons (figure 7, 8 and 9 in appendix 2). Hence, the observed very large effect size between the periods in the total wellness metric should be interpreted with great caution as the SD plays a major role in the calculation. This is earlier discussed in the discussion of methodology from the thesis. This highlights the importance of a precise explanation of the calculation of this metric, as many researchers don't include these details. These findings also suggest that using total wellness alone would not be recommended.

LIMITATIONS

Only using sRPE as a metric for training intensity and not include external loads in this study should be considered a big limitation, considering that earlier research have showed that changes in external loads is not always reflected by sRPE and the reliability have been questioned [14,28]. Another limitation of this study is the analysis of the in-season periods, as the data show very varied patterns considering the frequencies of fixtures no clear pattern was found. Therefore, a more thorough statistical analysis including both internal and external loads should be conducted to present a more appropriate presentation of the loads during the different microcycles. The lack of knowledge on the training sessions and the fact that this study only analyse on mean team level, could possibly be of big importance when reading the results [29]. Hence, the readers are warranted to take this into consideration, including the low statistical power.

PRACTICAL IMPLICATIONS

Considering earlier findings and the result from this study there seems to be a difference in training load and strain between pre- and in-season, with higher training load during the pre-season. The pre-season show signs of periodization in accordance with previous findings, whereas the findings from in-season P1 and P2 was more varied. This shows that for longer periods, sRPE can reflect the training load in pre-season and the difference between pre- and in-season, giving coaches meaningful information about longer training periods. Whereas during in-season, the tactical aspect of fixtures dictates a lot of tactical considerations, meaning subjective load monitoring should be interpreted with caution and consideration, as these metrics alone is not enough to make appropriate decisions during acute periods [13]. Considering the central role of the coach`s perception of load monitoring, we would recommend including external loads to better grasp the training load as well as investigating in-depth the coach use of monitoring, especially ratings of wellness as an aid for decision making on a team and/or individual level [29]. However, it is important to reflect on the main purpose of this study, providing knowledge to women's football to enhance the game. Considering the big economical differences in women's football it should be noted that subjective load monitoring is much less expensive and can give valuable information for teams who cannot utilize other measurement [30].

CONCLUSION

Subjective measures for monitoring can give valuable information about the training loads for different periods. Nevertheless, caution is advised when interpreting these measures, especially during acute periods, due to the complex interrelationships among the metrics. Further investigation is required to better understand the relationships between them.

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Part 3:

Appendices

Miriam Byberg
University of Agder

APPENDIX 1: DATA PROCESSOR AGREEMENT DEAL

Databehandleravtale

I henhold til gjeldende norsk personopplysningslovgivning og forordning (EU) 2016/679 av 27. april 2016, Artikkel 28 og 29, jf. Artikkel 32-36, inngås følgende avtale

mellom

UiT Norges arktiske universitet
(behandlingsansvarlig)

og

Universitetet i Agder
(databehandler)

1. Avtalens hensikt

Avtalens hensikt er å regulere rettigheter og plikter i henhold til gjeldende norsk personopplysningslovgivning og forordning (EU) 2016/679 av 27. april 2016 om vern av fysiske personer i forbindelse med behandling av personopplysninger og om fri utveksling av slike opplysninger, samt om oppheving av direktiv 95/46/EF.

Avtalen skal sikre at personopplysninger ikke brukes ulovlig, urettmessig eller at opplysningene behandles på måter som fører til uautorisert tilgang, endring, sletting, skade, tap eller utilgjengelighet.

Avtalen regulerer databehandlers forvaltning av personopplysninger på vegne av den behandlingsansvarlige, herunder innsamling, registrering, sammenstilling, lagring, utlevering eller kombinasjoner av disse, i forbindelse med bruk av/behandling i FFRC-prosjektet (FFRC; Female Football Research Centre).

Ved motstrid skal vilkårene i denne avtalen gå foran databehandlers personvernerklæring eller vilkår i andre avtaler inngått mellom behandlingsansvarlig og databehandler i forbindelse med bruk av/behandling i FFRC-prosjektet.

2. Formålsbegrensning

Formålet med databehandlers forvaltning av personopplysninger på vegne av behandlingsansvarlig er å behandle personopplysninger i forbindelse med delprosjektet «Masteravhandling Miriam Byberg» i FFRC.

Personopplysninger som databehandler forvalter på vegne av behandlingsansvarlig kan ikke brukes til andre formål uten at dette på forhånd er godkjent av behandlingsansvarlig.

Databehandler kan ikke overføre personopplysninger som omfattes av denne avtalen til samarbeidspartnere eller andre tredjeparter uten at dette på forhånd er godkjent av behandlingsansvarlig, jf. punkt 10 i denne avtalen.

3. Instrukser

Databehandler skal følge de skriftlige og dokumenterte instrukser for forvaltning av personopplysninger i FFRC-prosjektet som behandlingsansvarlig har bestemt skal gjelde.

Uni Agder forplikter seg til å overholde alle plikter i henhold til gjeldende norsk personopplysningslovgivning som gjelder ved bruk av FFRC-prosjektet til behandling av personopplysninger.

Databehandler forplikter seg til å varsle behandlingsansvarlig dersom databehandler mottar instrukser fra behandlingsansvarlig som er i strid med bestemmelsene i gjeldende norsk personopplysningslovgivning.

UiT har dog publikasjonsrettighetene til data. Når det spesifikt gjelder data knytta til Miriam Byberg sitt masterprosjekt er det UiA som har prioritet som førsteforfatter, og som på sin side skal sørge for at medforfatterskap og merittering av FFRC-forskere blir ivaretatt.

4. Opplysningstyper og registrerte

Databehandleren forvalter følgende personopplysninger på vegne av behandlingsansvarlig:

- o Personidentifiserende opplysninger om forsøkspersonene i FENDURA-prosjektet (fornavn, etternavn og kontaktinformasjon: telefonnummer og e-post)

Personopplysningene gjelder følgende registrerte:

- Kvinnelige utholdenhetsutøvere innen langrenn og skiskyting som er 18 år eller eldre, og som deltar i FENDURA-prosjektet.

5. De registrertes rettigheter

Databehandler plikter å bistå behandlingsansvarlig ved ivaretakelse av den registrertes rettigheter i henhold til gjeldende norsk personopplysningslovgivning.

Den registrertes rettigheter inkluderer retten til informasjon om hvordan hans eller hennes personopplysninger behandles, retten til å kreve innsyn i egne personopplysninger, retten til å kreve retting eller sletting av egne personopplysninger og retten til å kreve at behandlingen av egne personopplysninger begrenses.

I den grad det er relevant, skal databehandler bistå behandlingsansvarlig med å ivareta de registrertes rett til dataportabilitet og retten til å motsette seg automatiske avgjørelser, inkludert profilering.

Databehandler er erstatningsansvarlig overfor de registrerte dersom feil eller forsømmelser hos databehandler påfører de registrerte økonomiske eller ikke-økonomiske tap som følge av at deres rettigheter eller personvern er krenket.

6. Tilfredsstillende informasjonssikkerhet

Databehandler skal iverksette tilfredsstillende tekniske, fysiske og organisatoriske sikringstiltak for å beskytte personopplysninger som omfattes av denne avtalen mot uautorisert eller ulovlig tilgang, endring, sletting, skade, tap eller utilgjengelighet.

Databehandler skal dokumentere egen sikkerhetsorganisering, retningslinjer og rutiner for sikkerhetsarbeidet, risikovurderinger og etablerte tekniske, fysiske eller organisatoriske sikringstiltak. Dokumentasjonen skal være tilgjengelig for behandlingsansvarlig på forespørsel.

Databehandler skal etablere kontinuitets- og beredskapsplaner for effektiv håndtering av alvorlige sikkerhetshendelser. Dokumentasjonen skal være tilgjengelig for behandlingsansvarlig på forespørsel.

Databehandler skal gi egne ansatte tilstrekkelig informasjon om og opplæring i informasjonssikkerhet slik at sikkerheten til personopplysninger som behandles på vegne av behandlingsansvarlig blir ivaretatt.

7. Taushetsplikt

Kun ansatte hos databehandler som har tjenstlige behov for tilgang til personopplysninger som forvaltes på vegne av behandlingsansvarlig, kan gis slik tilgang. Databehandler plikter å dokumentere retningslinjer og rutiner for tilgangsstyring. Dokumentasjonen skal være tilgjengelig for behandlingsansvarlig på forespørsel.

Ansatte hos databehandler har taushetsplikt om dokumentasjon og personopplysninger som vedkommende får tilgang til i henhold til denne avtalen. Denne bestemmelsen gjelder også etter avtalens opphør. Taushetsplikten omfatter ansatte hos tredjeparter som utfører vedlikehold (eller liknende oppgaver) av systemer, utstyr, nettverk eller bygninger som databehandler anvender for å levere tjenesten.

Norsk lov vil kunne begrense omfanget av taushetsplikten for ansatte hos databehandler og tredjeparter.

8. Tilgang til sikkerhetsdokumentasjon

Databehandler plikter på forespørsel å gi behandlingsansvarlig tilgang til all sikkerhetsdokumentasjon som er nødvendig for at behandlingsansvarlig skal kunne ivareta sine forpliktelser i henhold til gjeldende norsk personopplysningslovgivning.

Databehandler plikter på forespørsel å gi behandlingsansvarlig tilgang til annen relevant dokumentasjon som gjør det mulig for behandlingsansvarlig å vurdere om databehandler overholder vilkårene i denne avtalen.

Behandlingsansvarlig har taushetsplikt for konfidensiell sikkerhetsdokumentasjon som databehandler gjør tilgjengelig for behandlingsansvarlig.

9. Varslingsplikt ved sikkerhetsbrudd

Databehandler skal uten ugrunnet opphold varsle behandlingsansvarlig dersom personopplysninger som forvaltes på vegne av behandlingsansvarlig utsettes for sikkerhetsbrudd.

Varselet til behandlingsansvarlig skal som minimum inneholde informasjon som beskriver sikkerhetsbruddet, hvilke registrerte som er berørt av sikkerhetsbruddet, hvilke personopplysninger som er berørt av sikkerhetsbruddet, hvilke strakstiltak som er iverksatt for å håndtere sikkerhetsbruddet og hvilke forebyggende tiltak som eventuelt er etablert for å unngå liknende hendelser i fremtiden.

Behandlingsansvarlig er ansvarlig for at Datatilsynet blir varslet når dette er påkrevd.

10. Underleverandører

Databehandler plikter å inngå egne avtaler med underleverandører som regulerer underleverandørenes forvaltning av personopplysninger i forbindelse med denne avtalen.

I avtaler mellom databehandler og underleverandører skal underleverandørene pålegges å ivareta alle plikter som databehandleren selv er underlagt i henhold til denne avtalen og lovverket. Databehandler plikter å forelegge avtalene for behandlingsansvarlig på forespørsel.

Databehandler skal kontrollere at underleverandører overholder sine avtalemessige plikter, spesielt at informasjonssikkerheten er tilfredsstillende og at ansatte hos underleverandører er kjent med sine forpliktelser og oppfyller disse.

Databehandler kan ikke engasjere underleverandører uten at dette på forhånd er skriftlig godkjent av behandlingsansvarlig.

Databehandler er erstatningsansvarlig overfor behandlingsansvarlig for økonomiske tap som påføres behandlingsansvarlig og som skyldes ulovlig eller urettmessig behandling av personopplysninger eller mangelfull informasjonssikkerhet hos underleverandører.

11. Overføring til land utenfor EU/EØS

Ingen personopplysninger skal overføres til tredjeland uten at det på forhånd er skriftlig godkjent av behandlingsansvarlig. Dette omfatter også tilgang til personopplysninger lagret innen EU/EØS, fra land utenfor EU/EØS.

12. Sikkerhetsrevisjoner og konsekvensutredninger

Databehandler skal jevnlig gjennomføre sikkerhetsrevisjoner av eget arbeid med sikring av personopplysninger mot uautorisert eller ulovlig tilgang, endring, sletting, skade, tap eller utilgjengelighet.

Sikkerhetsrevisjoner skal omfatte databehandlers sikkerhetsmål og sikkerhetsstrategi, sikkerhetsorganisering, retningslinjer og rutiner for sikkerhetsarbeidet, etablerte tekniske, fysiske og organisatoriske sikringstiltak og arbeidet med informasjonssikkerhet hos underleverandører til denne avtalen. Det skal i tillegg omfatte rutiner for varsling av behandlingsansvarlig ved sikkerhetsbrudd og rutiner for testing av beredskaps- og kontinuitetsplaner.

Databehandler skal dokumentere sikkerhetsrevisjonene. Behandlingsansvarlig skal gis tilgang til revisjonsrapportene på forespørsel.

Dersom en uavhengig tredjepart gjennomfører sikkerhetsrevisjoner hos databehandler, skal behandlingsansvarlig informeres om hvilken revisor som benyttes og få tilgang til oppsummeringer av revisjonsrapportene på forespørsel.

Databehandler skal bistå behandlingsansvarlig dersom behandlingen som omfattes av denne avtale medfører at behandlingsansvarlig har plikt til å utrede personvernkonsekvenser før FFRC-prosjektet tas i bruk/settes i gang, jf. forordning (EU) 2016/679 av 27. april 2016, Artikkel 35 og 36. Databehandler kan bistå behandlingsansvarlig ved iverksetting av personvernfremmende tiltak dersom konsekvensutredningen viser at dette er nødvendig.

13. Tilbakelevering og sletting

Ved opphør av denne avtalen plikter databehandler å tilbakelevere og slette alle personopplysninger som forvaltes på vegne av behandlingsansvarlig i henhold til denne avtalen. Behandlingsansvarlig bestemmer hvordan tilbakelevering av personopplysningene skal skje, herunder hvilket format som skal benyttes.

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14. Mislighold

Ved mislighold av vilkårene i denne avtalen som skyldes feil eller forsømmelser fra databehandlers side, kan behandlingsansvarlig si opp avtalen med øyeblikkelig virkning. Databehandler vil fortsatt være pliktig til å tilbakelevere og slette personopplysninger som forvaltes på vegne av behandlingsansvarlig i henhold til bestemmelsene i punkt 13 ovenfor.

Behandlingsansvarlig kan kreve erstatning for økonomiske tap som feil eller forsømmelser fra databehandlers side, inkludert mislighold av vilkårene i denne avtalen, har påført behandlingsansvarlig, jf. også punkt 5 og 10 ovenfor.

15. Avtalens varighet

Denne avtalen gjelder ut prosjektperioden (31. juli 2024), eller så lenge databehandler forvalter personopplysninger på vegne av behandlingsansvarlig i forbindelse med FFRC-prosjektet.

16. Kontaktpersoner

Kontaktperson hos databehandler for spørsmål knyttet til denne avtalen er: ??.

Kontaktperson hos behandlingsansvarlig for spørsmål knyttet til denne avtalen er: Svein Arne Pettersen

17. Lovvalg og tvisteløsning

Partenes rettigheter og plikter etter denne avtalen bestemmes i sin helhet av norsk rett. Eventuelle tvister som springer ut av denne avtalen skal først søkes løst gjennom forhandlinger.

Dersom partene ikke oppnår enighet gjennom forhandlinger, skal tvisten løses med bindende virkning av Kunnskapsdepartementet. Hver av partene kan forlange at tvisten oversendes departementet.

***

Denne avtale er i 2 – to eksemplarer, hvorav partene har hvert sitt.

Sted og dato

Kristiansand/Tromsø, xx.xx. 202x

På vegne av behandlingsansvarlig	På vegne av databehandler
Svein Arne Pettersen …………………………..	………………………
(underskrift)	(underskrift)

Matt Spencer

Professor
Fakultet for helse- og idrettsvitenskap/Faculty of Health and Sport Science
Institutt for idrettsvitenskap og kroppsøving/ Department of Sport Science and Physical Education,
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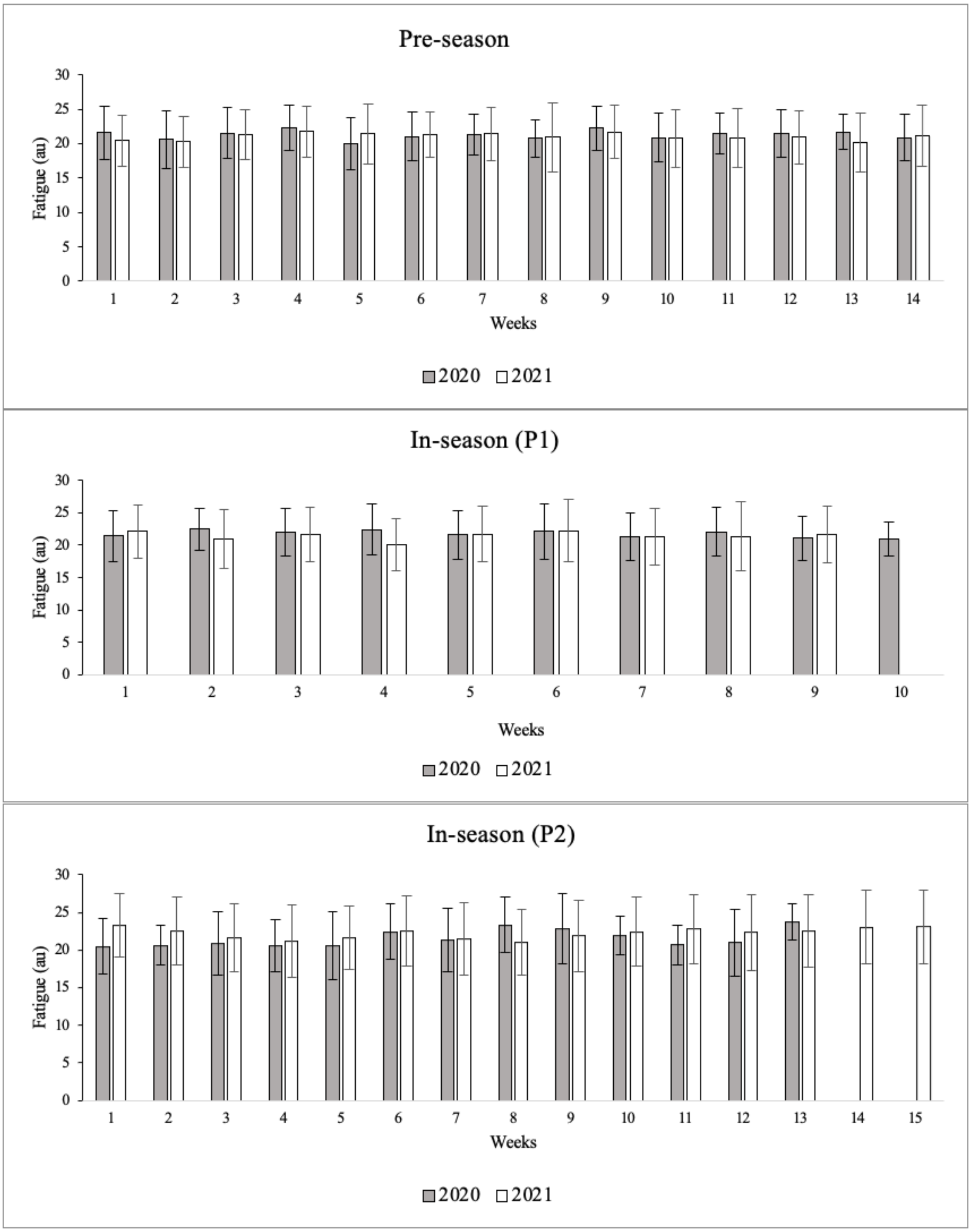
Mob: +47 98404378

APPENDIX 2: Figures



1

Fig. 5. Descriptive comparison of weekly score of fatigue between two seasons divided in three periods. Data are presented as a summation of the teams daily mean score and standard deviation from one week. AU= arbitrary unit, Fatigue= rating of fatigue scaled 1-5, P1= first part of in-season, P2= second part of in-season.

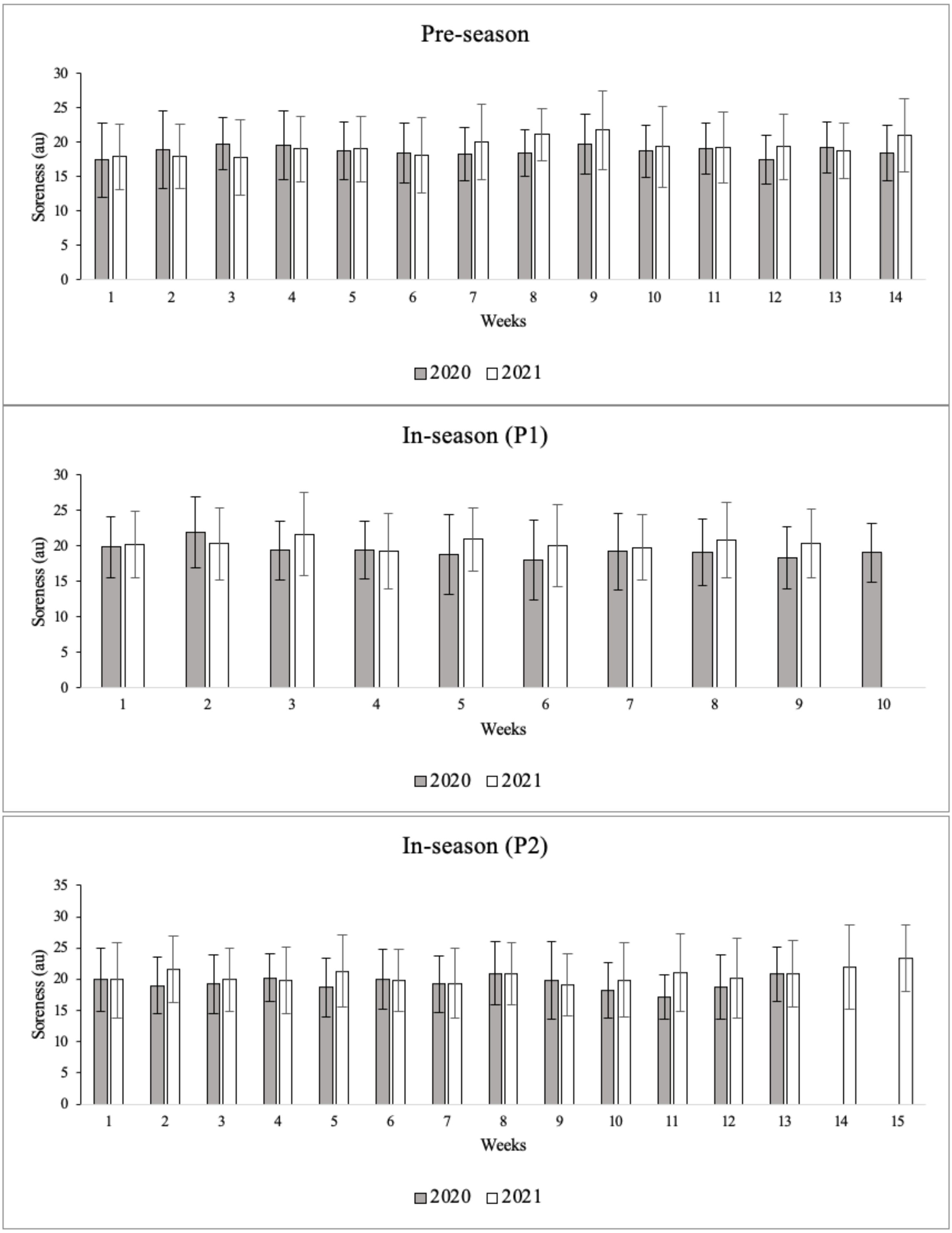


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Fig. 6. Descriptive comparison of weekly score of soreness between two seasons divided in three periods. Data are presented as a summation of the teams daily mean score and standard deviation from one week. AU= arbitrary unit, Soreness= rating of soreness scaled 1-5, P1= first part of in-season, P2= second part of in-season.

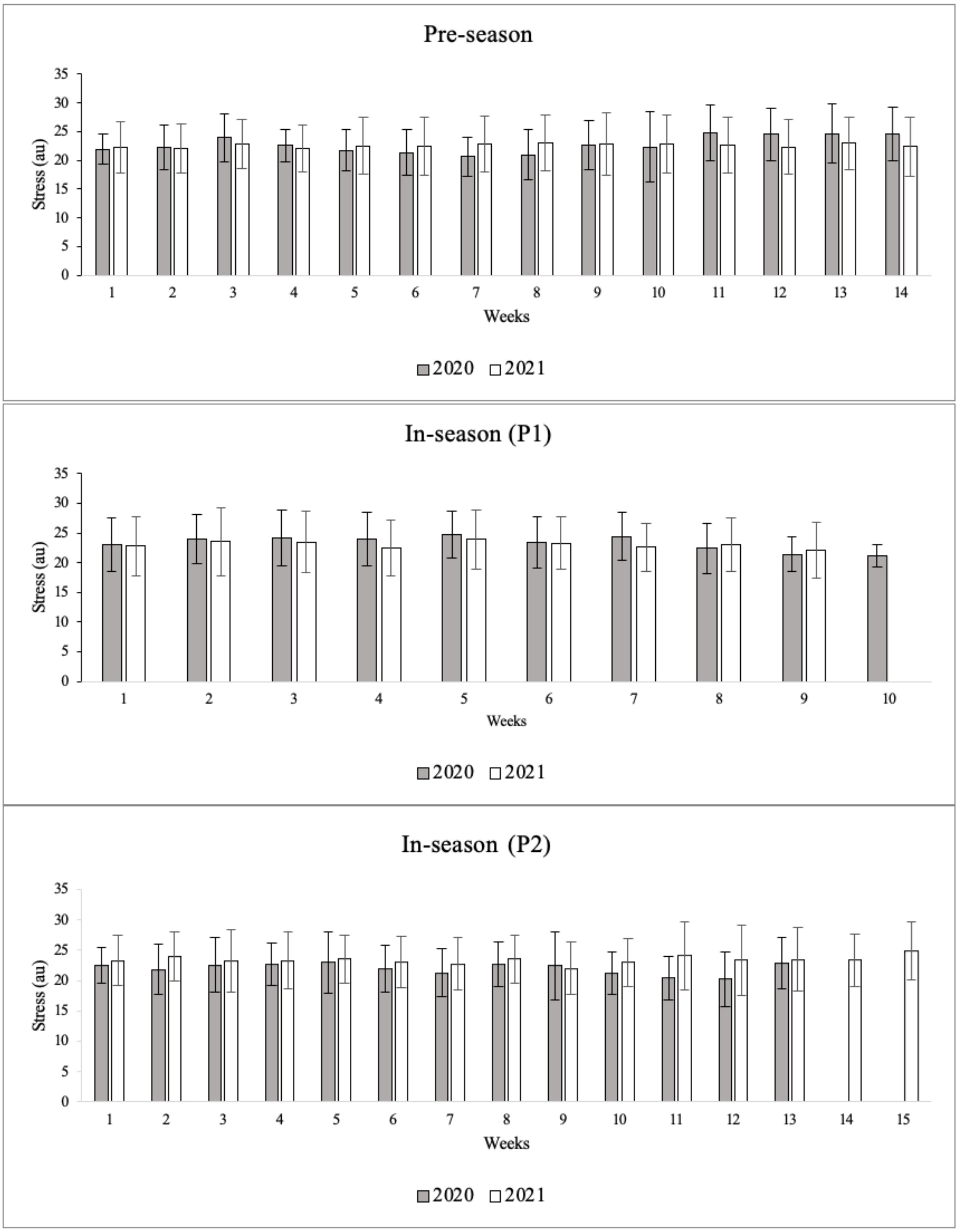

Fig. 7. Descriptive comparison of weekly score of stress between two seasons divided in three periods. Data are presented as a summation of the teams daily mean score and standard deviation from one week. AU= arbitrary unit, Stress= rating of stress scaled 1-5, P1= first part of in-season, P2= second part of in-season.

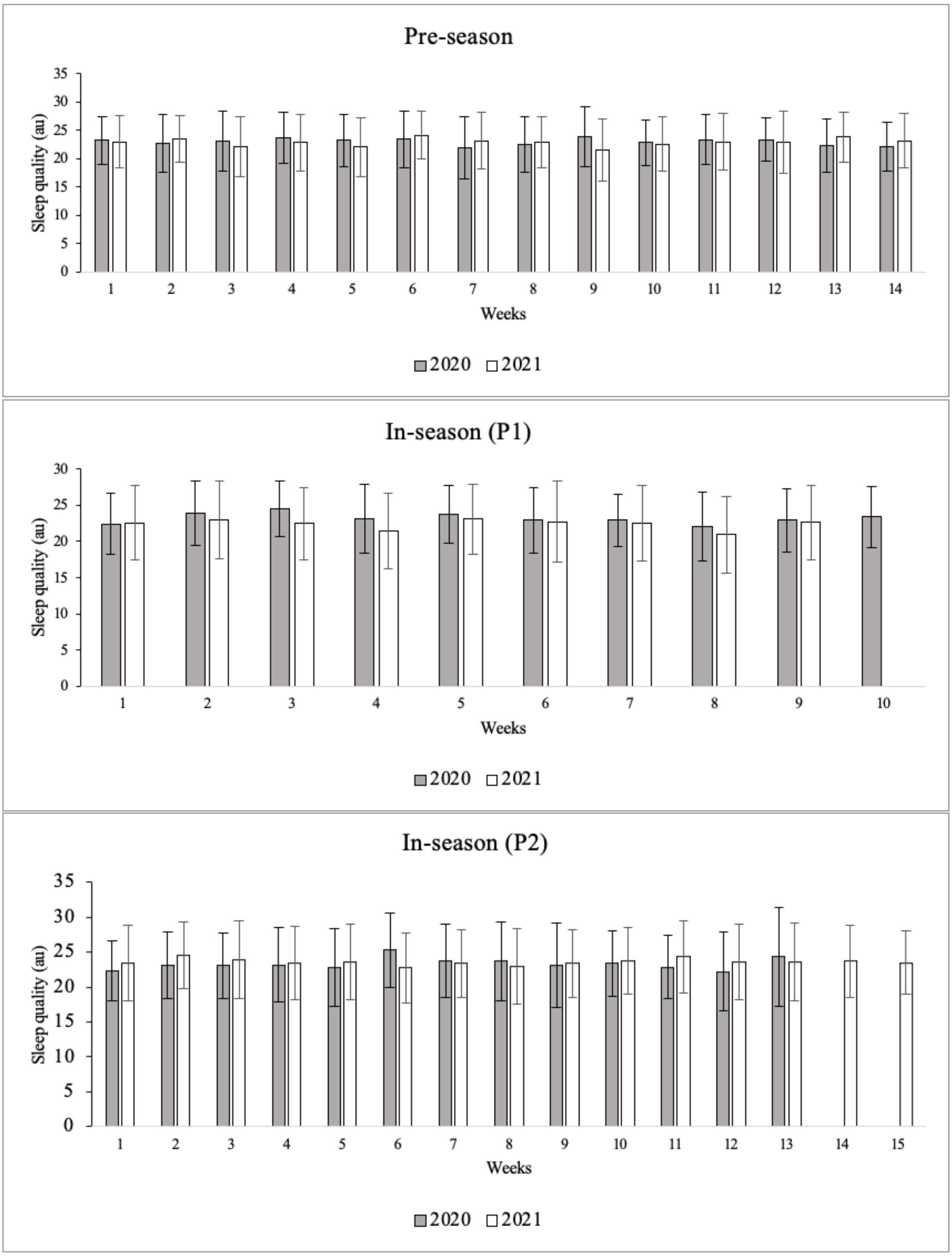

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Fig. 8. Descriptive comparison of weekly score of sleep quality between two seasons divided in three periods. Data are presented as a summation of the teams daily mean score and standard deviation from one week. AU= arbitrary unit, Sleep quality= rating of sleep quality scaled 1-5, P1= first part of in-season, P2= second part of in-season.

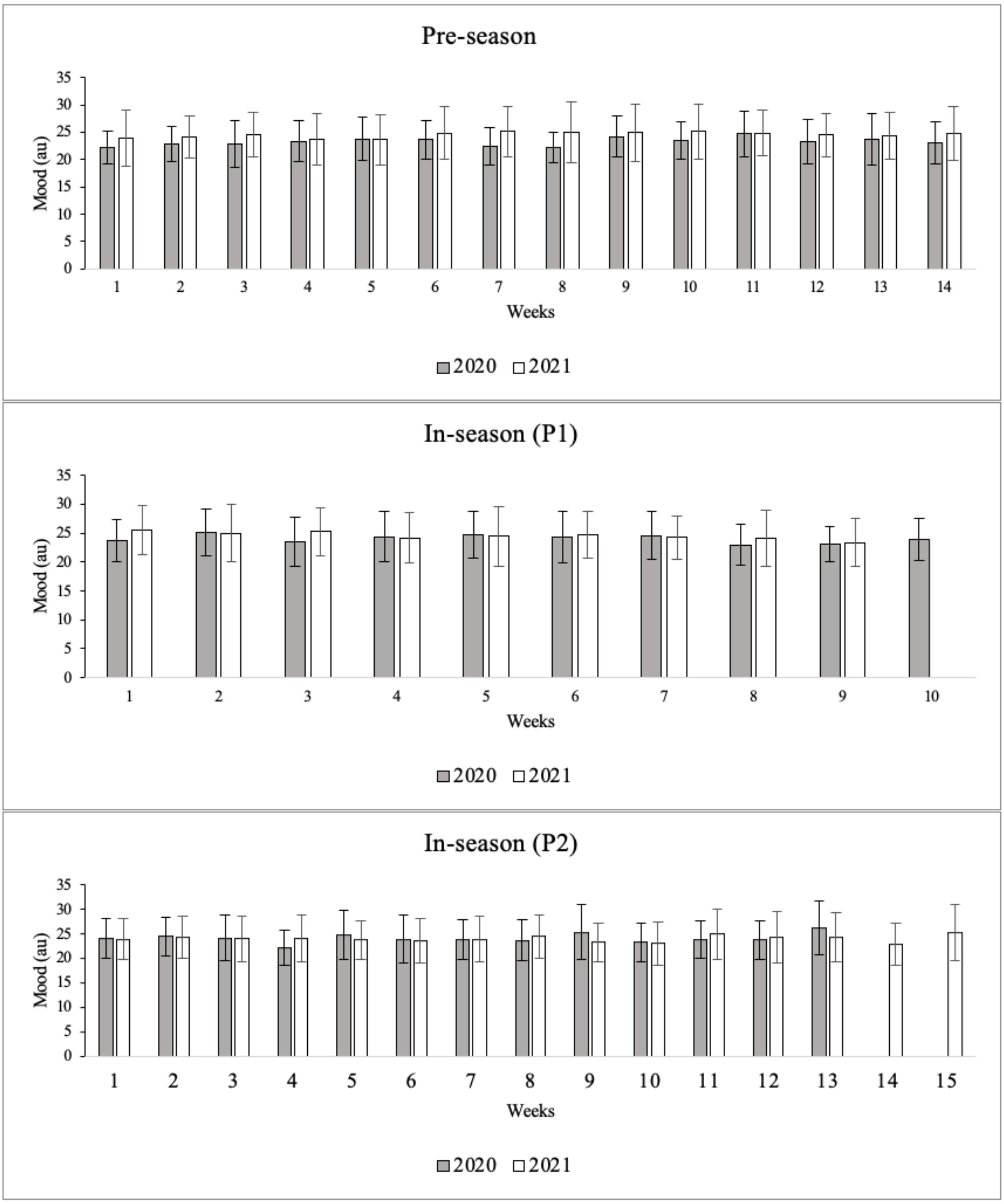

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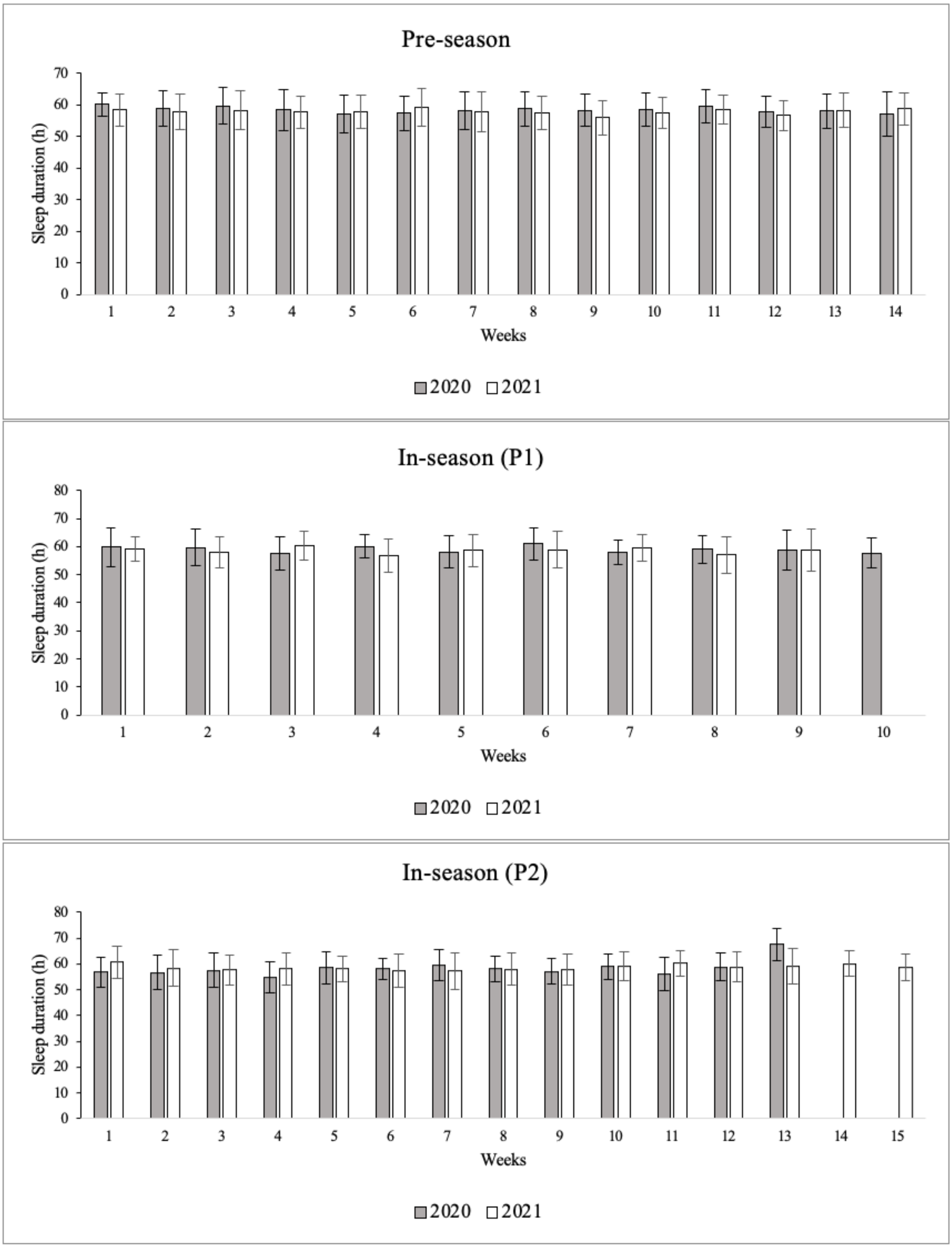
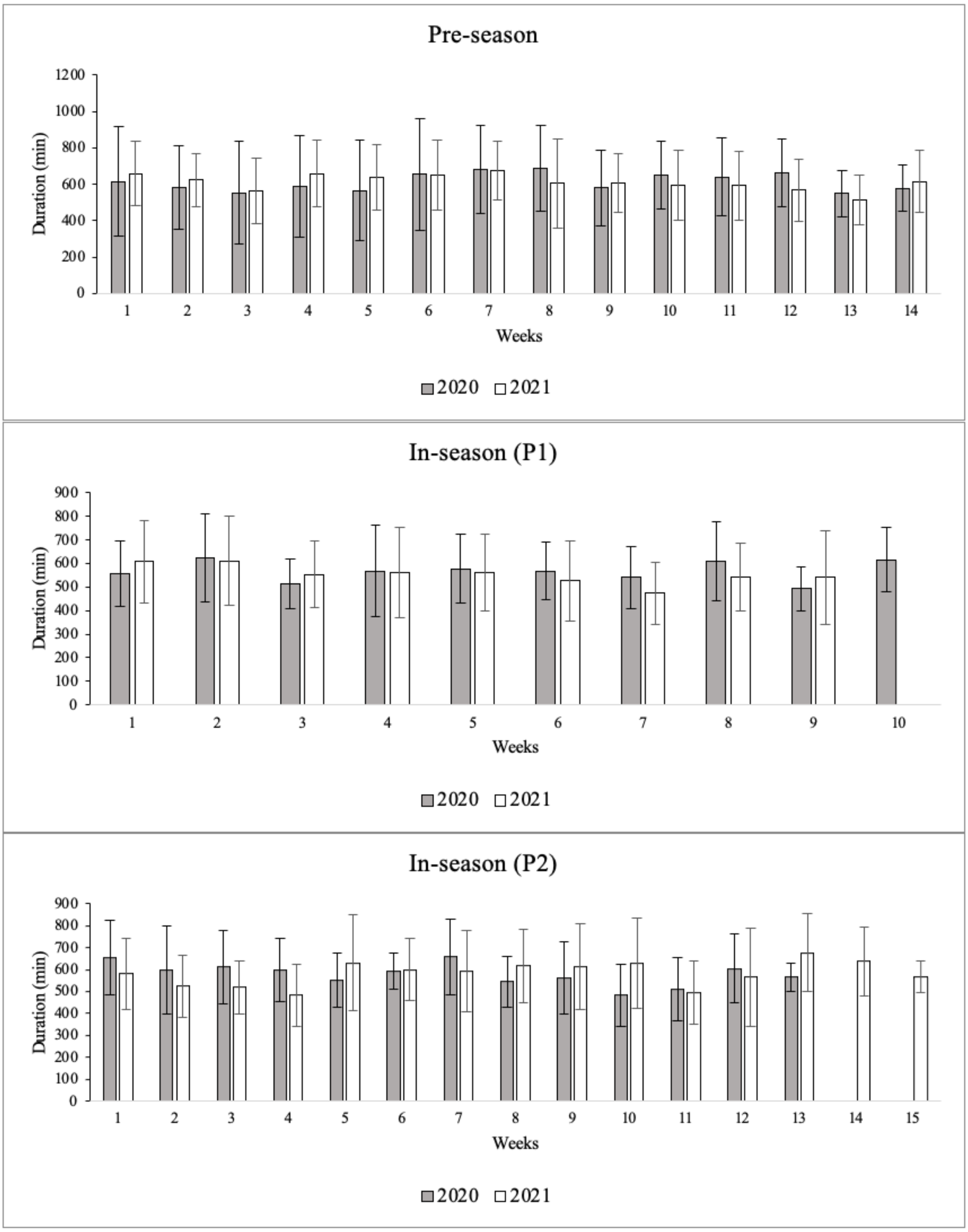
Fig. 9. Descriptive comparison of weekly score of mood between two seasons divided in three periods. Data are presented as a summation of the teams daily mean score and standard deviation from one week. AU= arbitrary unit, mood= rating of mood scaled 1-5, P1= first part of in-season, P2= second part of in-season.



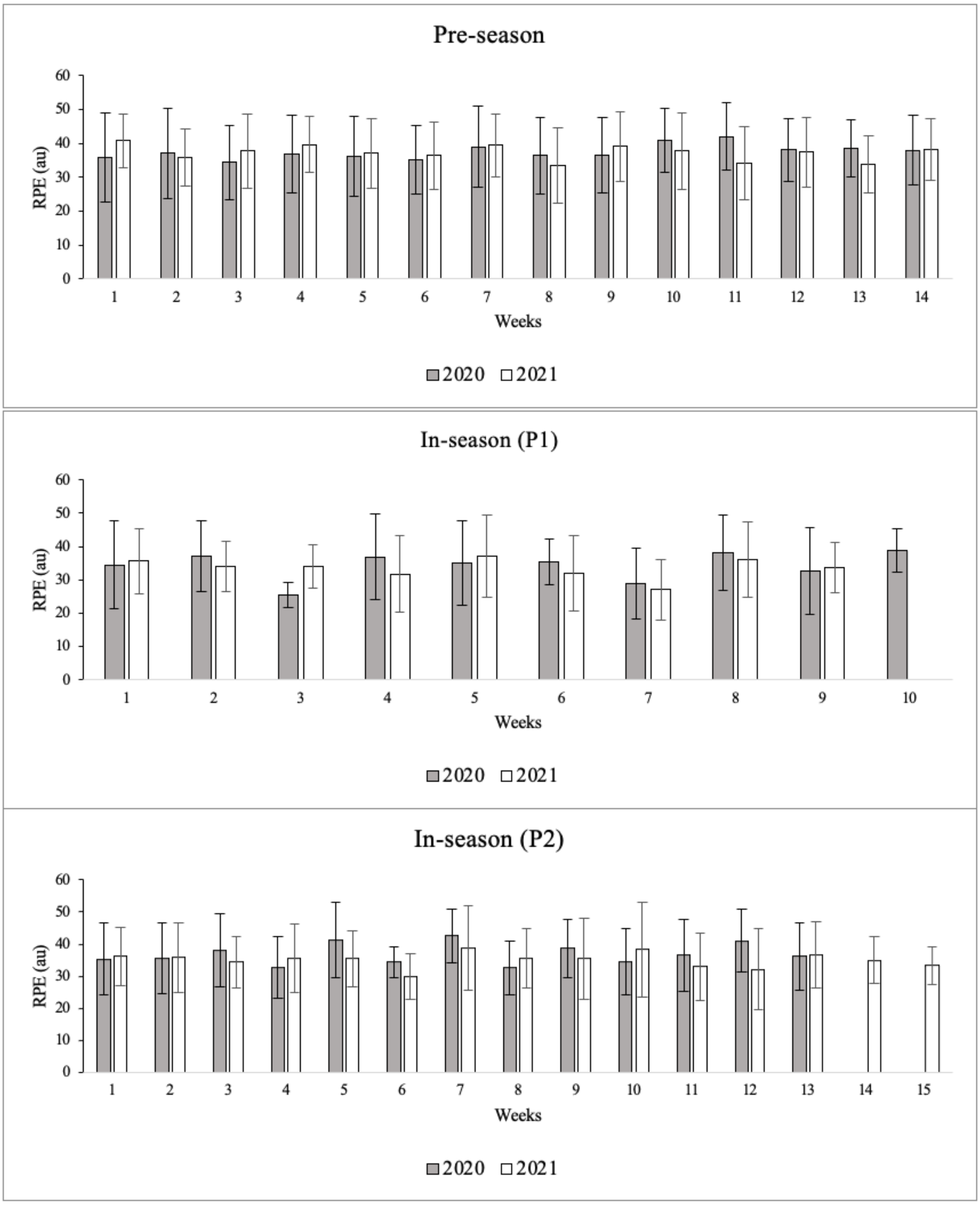
8

Fig. 10. Descriptive comparison of weekly score of sleep duration between two seasons divided in three periods. Data are presented as a summation of the teams daily mean score and standard deviation from one week. AU= arbitrary unit, Sleep duration= how many hours of sleep, h= hours, P1= first part of in-season, P2= second part of in-season.



10

Fig. 11. Descriptive comparison of weekly score of training duration between two seasons divided in three periods. Data are presented as a summation of the teams daily mean score and standard deviation from one week. AU= arbitrary unit, Duration= duration of training in minutes, min= minutes, P1= first part of in-season, P2= second part of in-season.



11

Fig.12. Descriptive comparison of weekly ratings of perceived exertion between two seasons divided in three periods. Data are presented as a summation of the teams daily mean score and standard deviation from one week. AU= arbitrary unit, RPE= rating of perceived exertion, P1= first part of in-season, P2= second part of in-season.