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Match load affects perceived wellness significantly in elite women's football during a competitive season

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Abstract

Introduction: Women's football has developed rapidly in Europe over the last decades, and the number of women playing football in Europe continues rising. Despite rising numbers and interest in women's football, scientific research is still lacking. With players competing 50-80 per season, sufficient recovery and understanding women footballer's internal response to match load is important to ensure optimal recovery and training strategies. Thus, the purpose of this study was to examine how perceived wellness changes from matchday (MD) to matchday+1 (MD+1) and matchday+2 (MD+2), and whether internal match load and perceived wellness are correlated.

Methods: 38 Norwegian elite women football players (23.31y ± 5.17) participated in this study. Prior to the study, all players signed a letter of consent. PMSys reporting system was used to monitor session rating of perceived exertion (sRPE) on MD, and perceived wellness on MD, MD+1, and MD+2. Perceived wellness and sRPE were collected during the entire 2020 season.

Results: 4/5 perceived wellness subsets changed significantly from MD to MD+1 and MD+2. Fatigue, delayed onset muscular soreness (DOMS), sleep duration (SD) and sleep quality (SQ) decreased between 10 and 23% from MD to MD+1 and increased from MD+1 to MD+2 between 4-13%. All changes were found to be statistically significant ($p<.001$), expect for DOMS from MD+1 to MD+2 ($p=.065$). Furthermore, no significant changes were found in perceived stress between days ($p=.441$). Lastly, trivial to small negative and positive correlations were found between sRPE on MD and perceived wellness on MD+1 and MD+2. However, all correlations were statistically non-significant ($p>.05$), except for sRPE and fatigue on MD+1.

Conclusion: Norwegian elite women footballers experienced significant changes post-match in all perceived wellness variables, except for stress. No significant relationship between sRPE on MD and perceived wellness on MD+1 and MD+2 was established, except for between sRPE and fatigue on MD+1.

Abbreviations

SD	Sleep duration
SQ	Sleep quality
DOMS	Delayed onset muscular soreness
MD	Matchday
MD+1	First day post-match
MD+2	Second day post-match
AU	Arbitrary unit
FIFA	Fédération Internationale de Football Association
NIH	National Institute of General Medical Sciences
N	Number
PSG	Polysomnography
NRMSE	Normalized root-mean-square error
UEFA	Union of European Football Associations
RPE	Rating of perceived exertion
HI	Hooper Index
sRPE	Session rating of perceived exertion
SCN	Suprachiasmatic nucleus
GAS	General adaptation syndrome
HR	Heart rate
MCAR	Missing completely at random
MVI	Missing value imputation
ICC	Intraclass correlation
CV	Coefficient of variation
DTmean	Daily team mean

Foreword

There are many people who have been very helpful during the process of this paper, from choosing a topic of interest to doing statistics and drawing conclusions. First and foremost, Svein Arne Pettersen my supervisor, thanks for sharing your knowledge, giving me feedback, and helping me through this strenuous and exciting process.
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List of Tables and Figures

1 Introduction

Women's football is developing rapidly, and the number of female players in Europe is rising to over 1.27 million (UEFA, 2019). Former Fédération Internationale de Football Association (FIFA) president Joseph S. Blatter stated "*The future of football is feminine*" in 2010. Blatter's statement reflects the rising popularity of women's football around the world. In addition it highlights FIFA's objective to support the growth of women's football. (FIFA, 2018, p. 287) The increasing number of registered women players, and competitions, has given women footballers the chance to train and compete under more professional circumstances (Martínez-Lagunas, Niessen, & Hartmann, 2014). Despite the rising interest in women's football, scientific research in this area is still limited compared with the male counterpart (Kirkendall & Krustrup, 2021; Martínez-Lagunas et al., 2014). The majority of studies including women footballers have focused on injury prevention, anthropometric relationships and test performances, and physical demands and fatigue development in matches in a smaller degree (Larsen et al., 2021).

Professional football players play between 50-80 games per season (Mohr et al., 2016), therefore monitoring physical match demands has become an essential part of understanding athletes' individual response to external load, a tool of periodization, tapering, as well as controlling the risk of overuse injury, illness, and overload. The combination of an appropriate amount of load and rest is regarded important for better performance, and fewer injuries (Jaspers et al., 2018). Physical match demands has been a hot topic in elite female footballers, and has been examined in several scientific studies (Andersson, Randers, Heiner-Møller, Krustrup, & Mohr, 2010; Bradley, Dellal, Mohr, Castellano, & Wilkie, 2014; Datson et al., 2017; Kjæreng Winther et al., 2021; Larsen et al., 2021; Panduro et al., 2021). However, it is important to notice that external load trigger different individual responses (i.e. physiological and psychological) (Bourdon et al., 2017). Simply monitoring external load (i.e., physical match performance) may not be sufficient, as practioners are missing out on valuable information about individual responses to match demands and readiness for competition. Therefore, implementing methods to monitor player's internal response is recommended. (Ruddy et al., 2020)

Quantifying internal match and training load in women's football is considered as critical, as it allows better planning, periodization, assessment and workload control (McLaren, Smith, Spears, & Weston, 2017). Being able to plan elite women footballers' physical preparation has become an essential part of periodization due to increased match demands (Krustrup, Mohr, Ellingsgaard, & Bangsbo, 2005). Therefore, physical training should be prescribed individually, as it can optimize performance. Unfortunately, in team sports like football training sessions are often conducted groupwise, which reduces the possibility of individualized training (Impellizzeri, Rampinini, & Marcora, 2005). Studies have suggested to develop a simple system such as internal load measuring for coaches, which can increase their ability to monitor and modify personal training load, and thereby overcome limitations associated with team-training (Foster et al., 2001; Impellizzeri, Marcora, & Coutts, 2019). The use of rating of perceived exertion (RPE) has created a lot of attention over the last decade, as well as showing to be a valuable tool of measurement for internal load (Gaudino et al., 2015).

Post-match recovery status of footballers has been investigated in recent studies (Rabbani, Clemente, Kargarfard, & Chamari, 2019; Thorpe et al., 2015; 2016). When tracking post-match recovery, a tool that is sensitive to post-match fatigue is required (Thorpe et al., 2016). Hooper-Index (HI) has shown to be a cost-efficient, non-invasive and easy-to-use tool, that allows practioners to track players recovery and wellness (Hooper & Mackinnon, 1995). HI is a promising tool for monitoring recovery and fatigue in professional footballers (Rabbani et al., 2019), and has been used widely, in several studies, providing further detailed information about players fatigue, sleep quality, muscle soreness, and stress (Clemente et al., 2017; Fernandes et al., 2021b; 2021a; Thorpe et al., 2015; 2016).

1.1 Research questions

The purpose of this study is to provide further scientific information regarding the influence of match play on wellness from which practioners might benefit. Therefore, this study has formulated the following research questions:

1. How does the perceived wellness in Norwegian elite women footballers change from matchday to two days post-match?
2. How does subjective internal load (sRPE) on matchday affect players perceived wellness on the following two days post-match?

2 Theory

2.1 Monitoring load

Monitoring of load is a well-implemented practice in team sports, as it gives coaches a better understanding of training intervention's effect on players (Impellizzeri et al., 2019). Consistent monitoring with a given method of measurement allows practioners to track the intensity of each player. For coaches to cope with players training process, implementing strategies that monitor training intensity, should be complemented by monitoring of wellness or readiness (Gabbett et al., 2017). This approach, also known as athlete monitoring, gives an understanding of how mechanisms related to stimulus and recovery provide information about training periodization. In addition, monitoring wellness provides further information to coaches on individual responses in stressful situations. (Weaving, Beggs, Dalton-Barron, Jones, & Abt, 2019) According to Oliveira et al. (2019) we can expect seasonal variations in training intensity, due to variations of the competitive schedule. Monitoring intensity can be divided into two main dimensions: internal and external. Internal and external load are closely related, since the internal response is a result of the external demands imposed by training- or match demands. (Fernandes et al., 2021b) A holistic approach to physical demands of match-play is required to ensure accurate assessment and understanding of how both internal and external load might be favorable.

External load refers to players instant physical response to demands of quality, quantity, and organization of the exercise (Impellizzeri et al., 2019). Microelectromechanical systems such as global positioning systems (GPS), or optical systems are commonly used to analyze physical responses in team sports, as they provide accelerometry-based, distance-based, and combined variables (Miguel, Oliveira, Loureiro, García-Rubio, & Ibáñez, 2021). These devices have been used widely in other sports than football, such as women's rugby (Clarke, Anson, & Pyne, 2015). While external load is the acute response to demands of practice or competition, internal load is the physio- or psychological response to the external load (Bourdon et al., 2017; McLaren et al., 2018). Given the relationship between internal and external load, one could argue that exposure to similar external load, can result in significantly different internal load between two players. Hence wise, it is reasonable to predict different internal responses for a group of players, following a week of training and competition. Individual responses to match load are hypothesised to be moderately influenced by other factors such as age, playing/training history, fitness levels, nutrition, health and, environment (Bourdon et al., 2017; Impellizzeri et al., 2019; Nedelec et al., 2014; Windt & Gabbett, 2017).

2.1.1 Internal load monitoring

Monitoring players individual response is a crucial process of athlete monitoring. Bourdon et al. (2017) present blood lactate, oxygen consumption, heart rate, and rating of perceived exertion (RPE) as commonly used monitoring tools for individual psychophysiological responses. RPE is an easy instrument to apply, as well as it provides a reliable, sensitive, and valid approach to qualify and quantify internal load, only using a simple questionnaire (Fanchini et al., 2017; F. M. Impellizzeri, Rampinini, Coutts, Sassi, & Marcora, 2004). Foster et al. (2001) introduced the session-RPE (sRPE), where the final RPE score is multiplied with the duration (in minutes) of training/competition. When reporting the RPE score, Borgs CR10 scale is used, where 0 indicates rest and 10 maximal exertion (McLean, Coutts, Kelly, McGuigan, & Cormack, 2010). RPE represents the athlete's own perception of effort, which might include both physiological and psychological dimensions of the effort.

Recommendations for the use of sRPE is to record 30min post-exercise, to ensure that high- or low intensity in the final stages of exercise don't impact the perception of intensity for the entire session (Alexiou & Coutts, 2008; Impellizzeri, Rampinini, Coutts, Sassi, & Marcora, 2004). Nevertheless, some studies have recorded sRPE 15-20min post exercise (Gaudino et al., 2015), or prior to completion of a session (Little & Williams, 2007). sRPE has been used commonly to quantify the internal load of footballers on matchday (Alexiou & Coutts, 2008; Fernandes et al., 2021a; Gaudino et al., 2015; Impellizzeri et al., 2004; Rabbani, Baseri, Reisi, Clemente, & Kargarfard, 2018). Foster et al. (2001) argued that sRPE is the best representation of perceived effort to monitor internal load. By recording sRPE over a longer period, plateau and strain in athletes can be calculated, and potentially provide a clear picture of likelihood of negative outcomes. Daily and weekly measuring of sRPE can provide coaches a graphical view on the periodization plan experienced by players (Foster et al., 2001).

Fernandes et al. (2021a) investigated the relationship between perceived wellness and internal load, by measuring sRPE. The respective study included sixteen elite women football players from a Portuguese team participating in the Portuguese BPI League. An average sRPE of 465.71 ± 223.90 was found on matchday (Ruddy et al.). It is important to notice that these results are based on an average on-field time during matches of 63.00min ± 24.69 (Fernandes et al., 2021a). Given that players played on average 2/3 of a full match, these results should be interpreted with great caution. Furthermore, Fernandes et al. (2021a) reported an average RPE of 7.04AU ± 1.55. Rabbani et al. (2018) measured sRPE in eight collegiate soccer players following full 90min matches. Results showed an average sRPE score of 569.38 ± 192.77 post-match. RPE-scores were not presented.

2.2 Athlete Wellness

In football, two teams of 11 players each compete against each other on a rectangle shaped (60-68m x 100-110m) pitch for 90min. Players on the pitch are playing in different positions, which are often divided in to four categories: goalkeeper, defenders, midfielders, and attackers. During an official match a team can substitute up to 5 of the players starting the game, the rest must play the full match. 5 substitutes are a consequence of the COVID-19 pandemic, normally 3 substitutes are allowed. The game of football is an open loop unpredictable sport, which demands agility, strength, endurance, speed and jumping of players. Even though a full match lasts 90min plus injury time Datson et al. (2017) showed that the average "ball in play time" is 62.0% ± 7.7. Professional football players are exposed to high competition loads, especially in recent years. The high physical load is due to a match fixture with increased frequency of domestic competitions, and higher level of competition due to increased player preparation strategies (Bradley et al., 2009). The muscular damage due to high load following competition and training, can affect athlete's performance negatively from minutes up to several days post exposure of high load (Barnett, 2006). In elite-sport, the line between success and failure is very fine. Analyzing these parameters related to fatigue, such as external load can help to make the right adjustments for each players conditioning (Heidari et al., 2019). Wellness questionnaires such as the Hooper questionnaire (Hooper & Mackinnon, 1995), has in recent years emerged as a cost-efficient, reliable, and easy-to-use method for controlling load (Heidari et al., 2019). In football, with squads of 20-25 players, it's not feasible to talk to each player daily regarding sleeping hours (SD), mood, sleeping quality (SQ), stress, soreness (DOMS), or fatigue. Therefore, wellness questionnaires are considered the second most important monitoring tool, following measures of workload (McCall, Dupont, & Ekstrand, 2016), as they allow practioners to obtain valuable information in a fast and easy-to-process way (Barça Innovation Hub, 2019).

Several studies in recent years, have used the Hooper questionnaire to evaluate football players perceived wellness (Bellinger, Ferguson, Newans, & Minahan, 2020; Charlot, Zongo, Leicht, Hue, & Galy, 2016; Clemente, Bredt, Praça, Duarte, & Mendes, 2020; Clemente et al., 2017;

Lathelan, Gastin, Newstead, & Caroline, 2019; Malone et al., 2018; Thorpe et al., 2015). Many versions of the Hooper questionnaire have emerged in recent years, with studies using the original 7-point Likert scale (Clemente et al., 2020; Clemente et al., 2017; Malone et al., 2018), while others used a 5-point (Doeven, Brink, Huijgen, de Jong, & Lemmink, 2019; Lathelan et al., 2019; Thambawita et al., 2020; Thorpe et al., 2015), or a 10-point Likert scale (Bellinger et al., 2020). The questionnaire consists of five subsets (delayed onset muscle soreness, sleep quality, stress, mood, and fatigue), where players rate each category from 1 (very, very low) to 7 (very, very high) (Hooper & Mackinnon, 1995).

2.3 Athlete's sleep

Sleep is defined as a complex reversible behavioral state where an individual is relatively disengaged and unresponsively from their environment (Doherty, Madigan, Warrington, & Ellis, 2019). For athletes' recovery, sleep is an essential process as it has physiological and psychological restoratives effects. In addition, sleep plays an extremely important role for several biological functions, and sleep deprivations can affect athletes' performance in short-, medium-, and long term. To understand athletes' readiness and responses to training, and make appropriate planning possible, monitoring sleep is a crucial method of doing so. Coaches want to keep players injury free and healthy. By monitoring sleep, the risk of injury, illness and nonfunctional overreaching reduces. Furthermore, it gives practioners the opportunity to better manage individual fatigue, and prescribe training content, or even implement post-match recovery strategies. (Costa, Figueiredo, Nakamura, & Brito, 2022). The interest in understanding athletes' sleep has been growing in recent years (Roberts, Teo, & Warmington, 2019b).

2.3.1 Importance of sleep

The process of sleep is critical to both cognitive and physiological function (Beersma & Gordijn, 2007; Besedovsky, Lange, & Born, 2012; Chennaoui, Arnal, Drogou, Sauvet, & Gomez-Merino, 2016; Costa et al., 2022; Reilly & Waterhouse, 2009). During sleep, i.e. the level of anabolic metabolism is increased (Chennaoui et al., 2016), and the body's immune responses are strengthened (Besedovsky et al., 2012). Furthermore, studies have shown that sleep is important to regulate key molecular mechanisms such as transcriptional regulatory proteins (Abel, Havekes, Saletin, & Walker, 2013), along with sleeps integral role in metabolic homeostasis (Xie et al., 2013). Athletes ability to cope with psychological and physiological stressors is essential for athletic performances (Bishop, 2008), and is affected by several factors such as experience, fitness, motivation, and natural fluctuations of behavioral and physiological processes during a period of 24 hours (i.e. hormone regulation, body temperature, sleep-wake cycle) (Drust, Waterhouse, Atkinson, Edwards, & Reilly, 2005).

The above-mentioned natural changes in behavioral and physiological processes are known as "*circadian rhythms*" (NIH, 2021). The circadian rhythms are controlled by the suprachiasmatic nucleus (SCN) within the hypothalamus (Beersma & Gordijn, 2007). SCN is regarded as the central pacemaker and controls most of the circadian rhythms (Hastings, Maywood, & Brancaccio, 2018). According to Beersma and Gordijn (2007) it is beyond doubt that the circadian pacemaker is controlling the timing of sleep. However, if the SCN is unable to maintain control over these patterns at all times, due to humans high sensitivity to alterations to their natural environments (Beersma & Gordijn, 2007), mostly through the light-dark cycle (Czeisler et al., 1986), the timing of sleep might be disturbed. With athletes being under a strict competition and training schedule during the competitive phase of the season, a lot of disruptions to their natural environments occur i.e., travel, night matches or training sessions. Hence wise a normal sleep-wake cycle and endogenous circadian rhythms can be desynchronized (Beersma & Gordijn, 2007). Such disruptions in sleeping pattern can lead to increased homeostatic pressure, cause a delay in sleep onset, affect emotional regulation, core temperature and circulation levels of melatonin (Lack & Wright, 2007). Research has shown that there is a potential for sleep loss and neurocognitive and physiological performances to be compromised, following periods with a lot of disruptions to the circadian rhythms (Banks & Dinges, 2007; Durmer & Dinges, 2005; Halson, 2008; Samuels, 2008). In contrast to non-athletes, athletes are often exposed to conditions that can interfere with sleep duration and quality, such as jet-lag, night training/matches, unfamiliar sleeping environments, and underlying fatigue (Robey et al., 2014). Costa et al. (2022) argue that it seems important for athletes to learn to manage their sleeping and waking time. Because of the influence on the circadian rhythms, as alternations in the biological might effect sleep duration and quality, but mainly sports performance (Fallon, 2007).

2.3.2 How much sleep is sufficient?

The appropriate amount of sleep for female elite athletes is 8.3 hours to feel completely rested (Sargent, Lastella, Halson, & Roach, 2021). However, Sargent et al. (2021) found that 71% of elite athletes do not obtain the appropriate amount of sleep. A systematic review by Nedelec, Aloulou, Duforez, Meyer, and Dupont (2018) looked at the variability of sleep among elite athletes from different sports. 12 of the studies included, had male elite footballers. In contrast none of the studies included female athletes. This highlights the need of scientific research on women elite footballers. Sleep duration (h:mins) was highly variable from 6:36 ± 0:45 (Carriço et al., 2018) to 8:51 ± 0:06 (Richmond et al., 2007). When it comes to the duration of sleep, one study has shown differences between male and female (Roberts et al., 2021). The respective study compared sleeping patterns between male elite football players (AFL) (n=36) and semiprofessional women footballers (AFWL) (n=34). Players sleep was examined during a preseason phase. Results showed that AFWL slept 7.1h on average, compared to the AFL with 7.9h on average per night ($p < 0.001$) (Roberts et al., 2021). Although sleeping >8h is associated with greater performance in endurance sports (Roberts, Teo, Aisbett, & Warmington, 2019a), 88% of AFWL slept <8h on average per night (Roberts et al., 2021). Thomas, Jones, Whitworth-Turner, and Louis (2021) examined the sleeping pattern of elite female footballers (n=18). Results were similar, athletes (n=18) slept 7.6h ± 0.71 on average per night. The respective study examined SD among core (n=10) and fringe players (n=8) post night matches too. Core players slept less post night matches compared to fringe players, 6.9h ± 1.16 and 7.8h ± 0.73 respectively (Thomas et al., 2021).

2.3.3 Sleep quality

Sleep quality is a well-recognized predictor of physical and mental health, wellness, and overall vitality. The term *"sleep quality"* is widely used by researchers, yet it is lacking a clear definition (Ohayon et al., 2017). Ohayon et al. (2017) argue that sleep continuity measurements such as sleep latencies, awakenings, wake after sleep onset, and sleep efficiency can be regarded as good SQ indicators. These indicators are objective sleep measures, which can be determined by polysomnography (PSG) or actigraphy (Ohayon et al., 2017). PSG is considered to be the gold standard for measuring sleep as it provides superior information about structure and depth of sleep (Keenan & Hirshkowitz, 2011). However, PSG is expensive, and impractical when the aim is to collect data with multiple participants over consecutive nights (Sargent, Lastella, Halson, & Roach, 2016). Actigraphy (Roberts et al., 2021), EEG-system (Tuomilehto et al., 2017), and sleep logs (Fullagar et al., 2016) have been used in recent studies to determine sleep continuity measurements in professional footballers. Furthermore, subjective wellness questionnaires such as the Hooper questionnaire evaluate athletes perceived SQ (Hooper & Mackinnon, 1995), and has been used in studies (Doeven et al., 2019; Lathelan et al., 2019).

Doeven et al. (2019) and Lathelan et al. (2019) used a 5-point Likert scale in their studies, where players rated their perceived SQ from 1 (insomnia) to 5 (very restful). Lathelan et al. (2019) included 562 elite male junior players. Players reported an average SQ of 3.77AU ± 0.74. There were significant differences in SQ between 1 day post-match and 6 days post-match/1 day prior to the next match (p=.001), 3.76AU ± 0.85 and 3.84AU ± 0.82 respectively (Lathelan et al., 2019). Doeven et al. (2019) reported higher SQ the night prior to the match, compared with the night post-match too. However, the circumstances during the observations were extremely different, and might give a false impression. Clemente et al., (2017) showed a positional difference in SQ, in a study that included 35 Portuguese male elite footballers. CM and CD reported the lowest SQ during the season, 2.55AU ± 1.32 and 2.82AU ± 0.99 respectively. Goalkeepers (GK) and FB reported the highest quality of sleep, 3.48AU ± 0.86 and 3.26AU ± 1.13 respectively. It is important to mention that Clemente et al. (2017) used the 7-point scale, while Lathelan et al., (2019) and Doeven et al., (2019) used a 5-point scale. Lathelan et al., (2019) and Clemente et al., (2017) show relatively similar results, given that they used different Likert scales. Lastly, Fernandes et al. (2021a) showed an increase in SQ from MD to matchday+2 (MD+2), indicating that players slept better post-match.

2.4 Stress and fatigue

2.4.1 Stress

The word stress is widely used in science, and many definitions have been proposed. Dr Gillian Butler argues that there are at least three ways of defining stress; (1) a stimulus-based definition, (2) a response-based definition and, (3) stress as a dynamic process (Butler, 1993). The first definition suggests that stress is a result of external pressure. Furthermore, Butler (1993) argues that internal collapse is inevitable when the external pressure exceeds a person's ability to cope with it. The focus of the stimulus-based definition is on external sources of stress and summarizes well its cumulative nature (Butler, 1993). You could argue that there is a connection between Butler's first definition, and Hooper's term of *"stress"*, where player's rate their perceived stress level from 1 to 5, indicating highly stressed and very relaxed respectively (see Figure 3). Mellalieu, Neil, Hanton, and Fletcher (2009) identified five performance related stress sources (i.e., preparation, injury, expectations, self-presentation, and rivalry) and found a total of 173 potential performance related stressors. They identified five organizational stress sources (i.e., factors intrinsic to the sport, roles in the sport organization, sport relationships and interpersonal demands, athletic career and performance development issues, and organizational structure and climate of the sport) with 110 potential stressors. Given the number of potential stressors which may lead to stress levels rising above athlete's ability to cope with, monitoring athlete's perceived stress levels might be useful.

The relationship between stress and performance was portrayed by Nixon P. in 1979. The graph in Figure *1*is called "*The Stress Response Curve*" and shows how stress can affect performance. As levels of stress increase till a certain point, levels of performance increase too. Near the point "*fatigue*" the "*comfort zone*" appears. In that area we find ourselves in a range of stress levels where we can manage and facilitate good performance levels. Once stress levels increase above that point of fatigue, it is perceived as overwhelming or excessive, and performance levels start to decline. If stress levels increase above the point of fatigue, it is called overwhelming stress which may lead to exhaustion, ill-health or breakdown. (Bali, 2015)

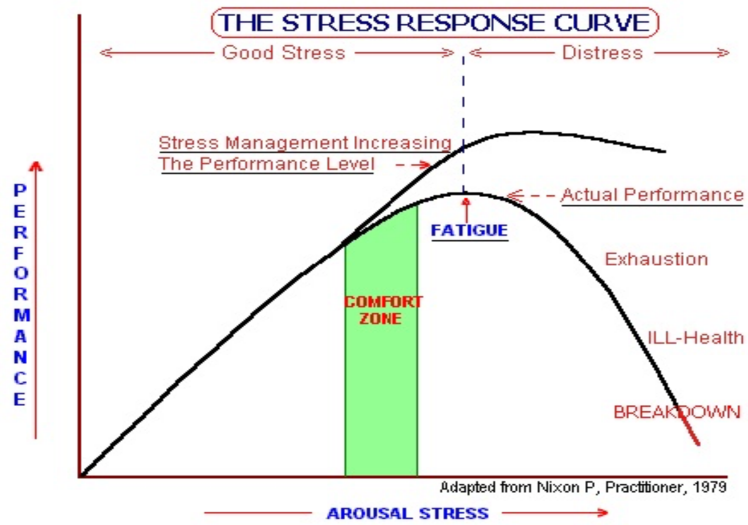

Figure 1| The Stress Response Curve (adapted from Nixon P 1979)

Given the effect high perceived stress can have on performance (see Figure *1*), monitoring players stress levels is reasonable. Lathelan et al. (2019) monitored perceived stress levels in junior elite footballers and found no difference between perceived stress matchday+1 (MD+1) and matchday-1. Players reported an average perceived stress of 1.77AU on both days. Clemente et al. (2020) monitored perceived stress in elite basketball over a whole season. Results show higher daily perceived stress in the earlier stages of the season, compared with later stages, respectively 2.00AU & 2.25AU and 1.42AU & 1.40AU. Unfortunately, there is a limited amount of research on perceived stress in elite women footballers, with only one study having investigated it for now (Fernandes et al., 2021a). Results from the respective study showed that players experienced most stress on MD. However, differences in stress were non-significant between all days, except for MD+3 and MD+5.

2.4.2 Fatigue

The second definition presented by Butler (1993) is based on stress as a response to noxious and aversive stimuli. Measuring stress in terms of physiological responses to stimuli was emphasized by Hans Selye, as early as 1956 (Selye, 1956). He observed what he called the general adaptation syndrome (GAS). GAS is a three stages physiological response to stress, (1) body is alerted and responds with alarm reaction, (2) autonomic activity is triggered and body responses to stress, (3) if stress continues beyond capacity, system gets damaged and may collapse (Selye, 1956). Again, one could argue that there is a connection between the definition and one of the subsets of the Hooper questionnaire. The subset fatigue, where players rate their perceived fatigue on a continuum from 1, always tired to 5, very fresh (see Figure *3*). Fatigue can be defined in many ways, as it is a complex and multifaceted phenom.

In a football context, fatigue is defined as a decline in the capacity to sustain muscular work that is manifested as a reduction in work rate towards the end of the game (Reilly, Drust, & Clarke, 2008). An appropriate amount of exposure to physical stress results in fatigue, which leads to adaption of various bodily systems (Smith, 2003), which is equivalent to stage 1 of GAS. If fatigue levels rise beyond player's ability to cope with, and recovery is not adequate, performance might be effected negatively (Hamlin, Wilkes, Elliot, Lizamore, & Kathiravel, 2019). One could argue that the negative effect on performance could be equivalent to stage 2 of GAS. Managing fatigue is important to reduce athlete's susceptibility to nonfunctional over-reaching, injury, and illness (Nimmo & Ekblom, 2007). If injury, illness, or over-reaching occurs following a period high of physical stress, and inadequate recovery, stage 3 of GAS is reached. Therefore, monitoring player's perceived general fatigue using the Hooper questionnaire might be a useful tool to ensure better performances and lower risk of injury, illness, and overload.

Some studies have used the 5-point Likert scale presented in Figure *3* to monitor player's perceived fatigue (Crouch, Jiroutek, Snarr, & Bunn, 2021; Doeven et al., 2019; Lathelan et al., 2019). However, the majority of studies have used the 7-point Likert scale (Clemente et al., 2020; Malone et al., 2018; D. Scott, Norris, & Lovell, 2020; Thorpe et al., 2015; Thorpe et al., 2016). Lathelan et al. (2019) reported highest perceived fatigue the day after competition compared to 3- and 6-days post competition, respectively 2.16AU, 2.03AU and 2.01AU. These finding are consistent with Thorpe et al. (2015) findings, who investigated the perceived fatigue of male elite players over a period of 17 days, including two matches. Players reported lower perceived fatigue on the morning of MD, compared with MD+1. Fernandes et al. (2021a) investigated perceived fatigue in elite women footballers and found a significant increase from MD to MD+2.

2.5 Delayed onset muscular soreness

Delayed onset muscular soreness is a familiar experience for both elite and novice athletes. For athletes it often occurs after periods with reduced activity, such as in pre-season. Furthermore, muscular soreness can occur when athletes are introduced to certain types of training, at any point of the year. (Cheung, Hume, & Maxwell, 2003) DOMS is classified as a type 1 muscular strain injury (Gulick & Kimura, 1996), and results in tenderness or stiffness, which rapidly disappears during daily routine activities, to severe debilitating pain with restricted movements (Cheung et al., 2003). DOMS is associated with unfamiliar, high force muscular work and is caused by eccentric actions (Armstrong & Warren, 1993), such as sprinting, jumping etc. (Stauber, 1989). Intensity and duration of exercise are key factors to DOMS (Cheung et al., 2003). Eccentric activity is characterized by an elongation of the muscle during simultaneous contraction. Thus, if the external load exceeds the muscle's ability to resist the load, the muscle is forced to extend and active tension is generated. (Stauber, 1989) Tenderness is concentrated in the distal portion of the muscle (Armstrong & Warren, 1993), and becomes progressively diffuse by 24-48 hours post-exercise (MacIntyre, Reid, & McKenzie, 1995).

Understanding the mechanism behind DOMS seems yet not to be fully understood (Peake, Neubauer, Della Gatta, & Nosaka, 2017). In a literature review by Cheung et al. (2003) a number of theories were presented, trying to explain the pain stimulus associated with DOMS. The authors argued that the general understanding of DOMS amongst researches is that one theory cannot explain the onset of DOMS (Cheung et al., 2003). More recent studies suggest that the primary mechanism behind DOMS is an ultrastructural damage of muscle cells due to unfamiliar sporting activities or eccentric exercises, leading to an inflammatory response, further protein degradation, and apoptosis (Hotfiel et al., 2018). However, Hayashi et al. (2017) performed a study on rats showing that mechanical hyperalgesia (abnormally sensitivity to pain) occurred without any apparent microscopic damage to muscle or signs of inflammation, after eccentric muscle contractions. Yet other studies argue that DOMS is associated with inflammation in the extracellular matrix, instead of myofiber damage and inflammation (Damas, Nosaka, Libardi, Chen, & Ugrinowitsch, 2016).

With the mechanism of DOMS still being uncertain, the impact of DOMS on athletic performances seems to be clearer. Several studies have shown significant reductions in strength and power parameters during DOMS. (Clarkson & Ebbeling, 1988; Donnelly, Maughan, & Whiting, 1990; Hasson et al., 1993; Paddon-Jones & Quigley, 1997). These reductions are most notable in eccentric muscle actions. However, concentric, and isometric strength losses have been reported too (Clarkson & Ebbeling, 1988; Hasson et al., 1993; Paddon-Jones & Quigley, 1997). Ebbeling and Clarkson (1989) showed that it might take between 8-10 days to recover the reduction of strength following eccentric activities. Meanwhile, isometric, and concentric strength losses can be recovered within 4 days.

Several studies have used the perceived wellness questionnaire as a tool to monitor athletes perceived muscular soreness (Bellinger et al., 2020; Charlot et al., 2016; Clemente et al., 2020; Clemente et al., 2017; Doeven et al., 2019; Fernandes et al., 2021a; Lathelan et al., 2019; Thorpe et al., 2015). Lathelan et al. (2019) measured players perceived DOMS on MD+1 and 6-days post-match/1 day prior to the next match. Results showed a significantly decrease in DOMS from MD+1 to 1-day prior to the next match, 2.34AU ±1.00 and 2.04AU ±0.93 respectively. These findings are consistent with other studies. Thorpe et al. (2016) included 29 male Premier League footballer, and reported a DOMS score of 5.1AU ± 0.8 on prematch day. DOMS scores sunk to 3.6AU ± 0.6 and 4.3AU ± 0.7 on MD+1 and MD+2, respectively. DOMS on MD+1 and MD+2 was significant different from prematch day. Fernandes et al. (2021a) investigated DOMS on MD-5, MD-4 and MD-2 in 16 women elite footballers. Results showed a non-significant difference ($p>.05$) between MD and MD-5 (equals MD+2), respectively 3.01AU ± 0.51 and 2.88AU ± 0.82. Interestingly, players reported the highest DOMS scores on MD-4 (equals MD+3) with 3.09AU ± 0.66 on average. Meanwhile, the lowest score was reported on MD-2 (equals MD+5), which might be due to training requesting higher intensities of aerobic resistance training as mentioned by the authors (Fernandes et al., 2021a).

2.6 Relationship between sRPE and perceived wellness

Monitoring internal load has been used extensively in team sports such as football. In comparison to RPE and heart rate (HR), other physiological measures of status are less known and less investigated. Charlot et al. (2016) described the use of the Hooper Index as a reliable method to monitor athletes perceived wellness. The Hooper Index has been used in several studies. However, only a few studies have investigated the relationship between sRPE and the Hooper index (Charlot et al., 2016; Clemente et al., 2017; Haddad et al., 2013; Moalla et al., 2016). Perceived exertion is a perception of the feeling of exertion which is a result of feeling physical stress, effort, and fatigue post training or match. When integrating the RPE method various information, including the many signals from peripheral muscles and joints working, as well as from the central cardiovascular and cardiorespiratory functions, and the central nerve system are obtained (G. Borg, 1982). Research has shown that players experience higher perceived exertion post matches compared with training sessions (Gonçalves et al., 2020). This might be due to the characteristics of a competitive match. Furthermore, a decrease in perceived wellness post-match has been shown in several studies (Fernandes et al., 2021a; D. Scott et al., 2020; Thorpe et al., 2016). Therefore, the possible influence of post-match exertion (sRPE) can be hypothesized to influence post-match perceived wellness.

However, scientific research has not shown if women elite footballers stress, DOMS, SD, SQ and fatigue are influenced by sRPE post-match. Haddad et al. (2013) found no association between sRPE and the Hooper Index. However, the respective study investigated whether the Hooper Index scores are affecting sRPE, and not vice versa. Clemente et al. (2017) who investigated male elite footballers over an entire season divided into 1-match and 2-match micorcycles. The respective study found significant negative small correlation ($p<.05$) between DOMS, SQ, fatigue, stress and sRPE during 2-match microcycles. However, during 1-match microcycles correlations between perceived wellness and sRPE were positive trivial, except for stress, which showed a negative trivial correlation. Interestingly, only the correlation coefficient between stress and sRPE was found to be statistically significant ($p<.01$). These findings were consistent with previous studies that investigated the relationship between sRPE and perceived wellness (Moalla et al., 2016; Thorpe et al., 2015). As these results were obtained during a scientific study including male footballers, one could argue that women might react different. Hence wise this study wants to investigate the relationship between sRPE and perceived wellness in women elite footballers.

3 Methods

3.1 Participants

Two of the top teams (n=34) in the Norwegian women's premier division, *Toppserien*, participated in this study (23.31 ± 5.17y). The players belonged to the following positional categories: goalkeepers (n=5), defenders (n=11), midfielders (n=10) and, attackers (n=8). For the purpose of this study goalkeepers were excluded as the physical characteristics of match play are significantly different, compared with outfield players (Rago et al., 2020). Players were informed about the purpose of the study prior to the start. Furthermore, a letter of consent was signed by each participant (**Appendix I**), before the commencement of the study. The study was approved by the Norwegian Center for Research Data (reference number: 296155).

3.2 Experimental design

This study was conducted as a retrospective cohort study. To investigate changes in subjective wellness ratings post-match, and the relationship between match sRPE, and perceived wellness post-match, perceived wellness ratings for fatigue, DOMS, sleep quality, stress, sleep duration and sRPE were collected over a period of 22 weeks, lasting from 04.07.2020 until 08.12.2020. Originally, the season was planned to start in late March. However, due to the COVID-19 pandemic the start to the season was canceled, and team training was stopped. Team training could resume one month prior to the new start to the season. Pedersen et al. (2021) have shown that the physical qualities were seen to be unaffected by the partial lockdown, in two Norwegian female football teams. During the season both teams played 18 matches each, which gives a total of 36 matches with physical performance data (see Table 1).

Table 1| Number of official matches (N_{match}) for both teams in this study

MONTH	*JULY*	*AUGUST*	*SEPTEMBER*	*OCTOBER*	*NOVEMBER*	*DECEMBER*	*TOTAL N_{MATCH}*
TEAM 1	4	7	3	1	2	1	18
TEAM 2	4	6	3	2	2	1	18
TOTAL N_{MATCH}	8	13	6	3	4	2	36

3.2.1 Internal load (sRPE)

To measure players internal load post-match, players were asked to rank their perceived exertion (RPE) 30min after the match finished. To rank exertion, Borgs CR10 scale was used, as it has been suited to measure intensity during physical activity (Fanchini et al., 2016). Perceived exertion was ranked from 0-10, where 1 indicates *"rest"*, and 10 indicates *"maximal exertion"*. Thereafter, the reported RPE values were multiplied with the duration of the match, resulting in the session-RPE (sRPE). This method of monitoring internal load has been used by several studies (Clemente et al., 2017; Fernandes et al., 2021b; Fernandes et al., 2021a; Fields et al., 2021; Rabbani et al., 2018). PMSys sports logging was used to register RPE values following matches. In this study the PMSys reporting system was used for the reporting of RPE scores, as demonstrated by Thambawita et al. (2020). PMSys sports logging is a smartphone application, which sends scheduled push messages to participants' smartphones, reminding them to report. Push messages are sent to increase the reporting rate.

Modification of the Category Ratio Rating of Perceived Exertion Scale

Rating	Descriptor
0	Rest
1	Very, Very Easy
2	Easy
3	Moderate
4	Somewhat Hard
5	Hard
6	.
7	Very Hard
8	.
9	.
10	Maximal

Figure 2| Modified rating of perceived exertion (RPE) scale

3.2.2 Wellness variables

Players were asked to report their perceived wellness variables and sleep duration on matchday MD, MD+1, and MD+2 on a linear 5-point Likert scale. A qualitive indicator as proposed by McLean et al. (2010) was used to assist players with reporting. Four wellness subsets were included in this study: sleep quality, delayed onset muscular soreness, fatigue and, stress levels. Furthermore, sleep duration was reported, and expressed as the number of hours players slept the night before. Wellness variables were reported every morning over the duration of the whole competitive season. PMSys was used to report wellness variables. When reporting in PMSys, each subset was anchored on a 1 to 5 scale. The fatigue scale asked, "*How fatigued do you feel?*" (1= very tired, 5= very fresh). The sleep quality scale asked, *"How well did you sleep?* (1=Insomnia, 5= Very restful). The muscle soreness scale asked, *"How sore are your muscle?"* (1= very sore, 5= Great). The stress scale asked, *"How stressed are you?"* (1= Highly stressed, 5= Very relaxed). In addition to the four wellness subsets, sleep duration was measures. The sleep duration scale asked, "*How much did you sleep last night?*" (0h to 12h).

Figure 3| Screenshots from PMSys mobile application on wellness subsets and sleep duration

3.3 Inclusion criteria

Players perceived wellness ratings were included if:

1. Players played for the same team during the entire study
2. Players reported wellness at least once

Players sRPE from official was included if:

1. Players played for the same team during the entire study
2. Players played >70min of the match

3.3.1 Missing values

D. Borg, Nguyen, and Tierney (2021) define missing data as values that should have been observed but were not. Missing data when encountering with training load, is a considerable problem for practioners (Windt et al., 2018). Getting players to fully commit to reporting data daily can be difficult, hence, Windt et al. (2018) suggest that missing training load data is a near certainty when collected in applied settings. When using self-report measures, data derived from such reports can be influenced by the fact of missing data (Fox-Wasylyshyn & El-Masri, 2005). For instance, when measuring perceived wellness for every individual in two teams over a longer period, eventually players will forget/fail to report. This results in missing data and an incomplete dataset. Therefore, D. Borg et al. (2021) recommend that researchers in the football field describe the number of missing values in percentage. Missing values should be imputed too, and imputation methods should be explored to ensure appropriate representatives.

In this study, PMSys was used to collect wellness rating, as described in chapter 3.2.2. 1300 of 3315 wellness values were missing (39%). A total of 486 possible sRPE scores could have been obtained. However, due to inclusion criteria 263 were excluded. Out of the 223 which were included, 0 were missing (0%). Bias is likely to occur when missingness is more than 10% (Bennett, 2001). However, Madley-Dowd, Hughes, Tilling, and Heron (2019) demonstrated that unbiased results can be obtained even if proportions of missing data are large. Reasons for missing data in this study were classified as missing completely at random (MCAR) (Rubin, 1976), as data were missing for reasons that are unrelated to any characteristics or responses for the subject, including the value of missing data (Harrell, 2015, p. 45). Using the daily team mean (DTMean) has shown highest accuracy (NRMSE =0.45) for missing value imputation (MVI) when missingness is at 40% (Griffin et al., 2021). Based on the findings of Griffin et al. (2021), the same method of missing values imputation (MVI) was used for wellness values in this study. Missing values were imputed after calculating DTmean separately for each wellness subset, and teamwise.

3.4 Validity and reliability

Validity means the degree of which one can reasonably draw conclusions from the results of a study. Hence, the variable measured must be relevant to the problem under investigation in the respective study (Olsson & Sörensen, 2003). Validity is often divided into internal, and external validity. Internal validity refers to the success in which confounding variables are being controlled, while external validity is the degree in which the results of study are generalizable (Jacobsen, 2005). The terms of external and internal validity in a study are a description of the relationship between the problem under investigation, and whether it corresponds with what is being investigated. Furthermore, the appropriate use of monitoring tool, is important to notice.

Reliability is the degree of compliance between measurements taken with the same measurement tool. A measure has high reliability if it produces similar results under consistent conditions. (Olsson & Sörensen, 2003) If results under same conditions are different, a measurement is said to have low reliability. If the reliability of the measurement in a study is high, and the validity given, a study can produce similar results.

3.4.1 Validity

The validity in this study can be demonstrated in several ways. Firstly, the participants in this study are elite female footballers, who all play at the highest possible level in Norway. In addition, some of the participants are regularly included in the Norwegian women's national team. Secondly, the purpose of the study is to investigate the relationship between internal load and perceived wellness. To investigate the relationship, we used a subjective tool of measurement to determine intensity in matches, as well as the perceived wellness questionnaire. Secondly, the purpose of the study is to investigate the relationship between internal load and perceived wellness. To investigate the relationship, we used a subjective tool of measurement to determine intensity in matches, as well as the perceived wellness questionnaire. CR10 derived sRPE has shown high reliability with objective external load measures such as covered distance, high speed running, and player load, respectively $r= 0.81$, 0.71 and 0.83 ($p<0.05$) (T. Scott, Black, Quinn, & Coutts, 2013). High correlations with objective external performance variables such as distance covered and high-speed running, indicates high validity of the sRPE. These external load variables are measurement of competitive physical performance in matches. Using competitive performance variables, is the most valid measurement of performance itself. In addition results revealed high correlations between sRPE and objective measurements of internal load (Banisters TRIMP and Edwards TRIMP), respectively r=0.83 and 0.83 ($p<0.05$) (T. Scott et al., 2013) .

As per Saw, Kellmann, Main, and Gastin (2017), validity is not a property for athlete self-report measurements such as the wellness questionnaire, instead it is an assessment of whether the data obtained is appropriate, meaningful and useful for the purpose of the study. It is common approach for researchers to develop their own questionnaires to the population of interest (Gastin, Meyer, & Robinson, 2013; Montgomery & Hopkins, 2013). Factors such as player's education, language barriers, and method/timing of collection rise concerns about validity of subjective wellness ratings (Burgess, 2017). Gastin et al. (2013), and Buchheit et al. (2013) have allied validity concerns, by demonstrating sensitivity of subjective wellness ratings to training load changes in male footballers. However, more research is warranted when it comes to the sensitivity of subjective wellness in elite female footballers.

3.4.2 Reliability

Reliability of the wellness questionnaire was investigated by Fitzpatrick, Hicks, Russell, and Hayes (2019) in youth footballers. Intraclass correlations (ICC) were calculated for fatigue, sleep quality, muscle soreness, and stress. ICCs for the subjective measures ranged from -0.01 to 0.78, indicating no correlation to very large correlations (W. Hopkins, 2000). With only one subset showing acceptable reliability levels ($r > 0.7$) (Saw et al., 2017), Fitzpatrick et al. (2019) argued that test-retest reliability is poor, and that caution must be taken when assessing changes subjective wellness as an indicator. High test-retest levels indicate stability for the tool of measurement. However, such stability for a self-report measurement is desirable over the short term. When using self-report over a longer term stability is undesirable, as the purpose will be to detect anticipated changes (Saw et al., 2017). Little research has been conducted on reliability of the wellness questionnaire. Therefore, more research is warranted.

Considering reliability, sRPE is widely used in football research with several studies using it to monitor internal load (Clemente et al., 2017; Fernandes et al., 2021b; Fernandes et al., 2021a). T. Scott et al. (2013) investigated the test-retest reliability of CR10 sRPE during 3 different intensities of intermittent exercise. The percentage coefficient of variation (%CV) and %ICC showed poor reliability over all speed categories (31.9% CV, 0.66 ICC). Furthermore, results showed higher reliability for higher speed trials (Level 3 21.2% CV, 0.66 ICC), compared with lower intensities (Level 1 34.8% CV, 0.55 ICC). These findings are consistent with Wallace, Slattery, Impellizzeri, and Coutts (2014), who found a test-retest reliability of 33.2%CV and 0.596% ICC. Poor reliability indicates low precision of the tool. Saw et al. (2017) argument of long-term stability being undesirable when using self-report is relevant for sRPE as well. When using sRPE during an entire football season, we want to detect potential changes. Hence wise, long-term stability and high test-retest stability is undesirable for the purpose of the study.

3.5 Statistical analyses

Statistical analyses were performed in IBM SPSS Statistics (28.0.0.0, 2021, USA). Results were shown as mean ± standard deviation. Level of statistically significance was set to $p<.005$, allowing a 5% chance of bias. A nonparametric Friedman test was performed on fatigue, DOMS, SQ, and stress to determine whether scores differ before a match, 1st day after, and 2nd day after a match. Following the Friedman test a Wilcoxon signed rank test was performed on variables that show statistically significance. Due to its nominal character a one-way ANOVA was performed on SD to determine potential differences between scores reported on MD, MD+1, and MD+2. If results showed a significant difference between the groups, further analysis was performed. In that case a Tukey post hoc test was executed to examine which groups are statistically significant from one another. Lastly, to determine the relationship between sRPE and wellness subsets on MD+1 and MD+2 a Spearman correlation analysis was performed. Spearman correlations were interpreted using a scale of magnitude compromising of <0.1, trivial; 0.1-0.3, small; 0.3-0.5, moderate; 0.5-0.7, large; 0.7-0.9, very large; and >0.90, nearly perfect (K. Hopkins, Glass, & Hopkins, 1987).

4 Results

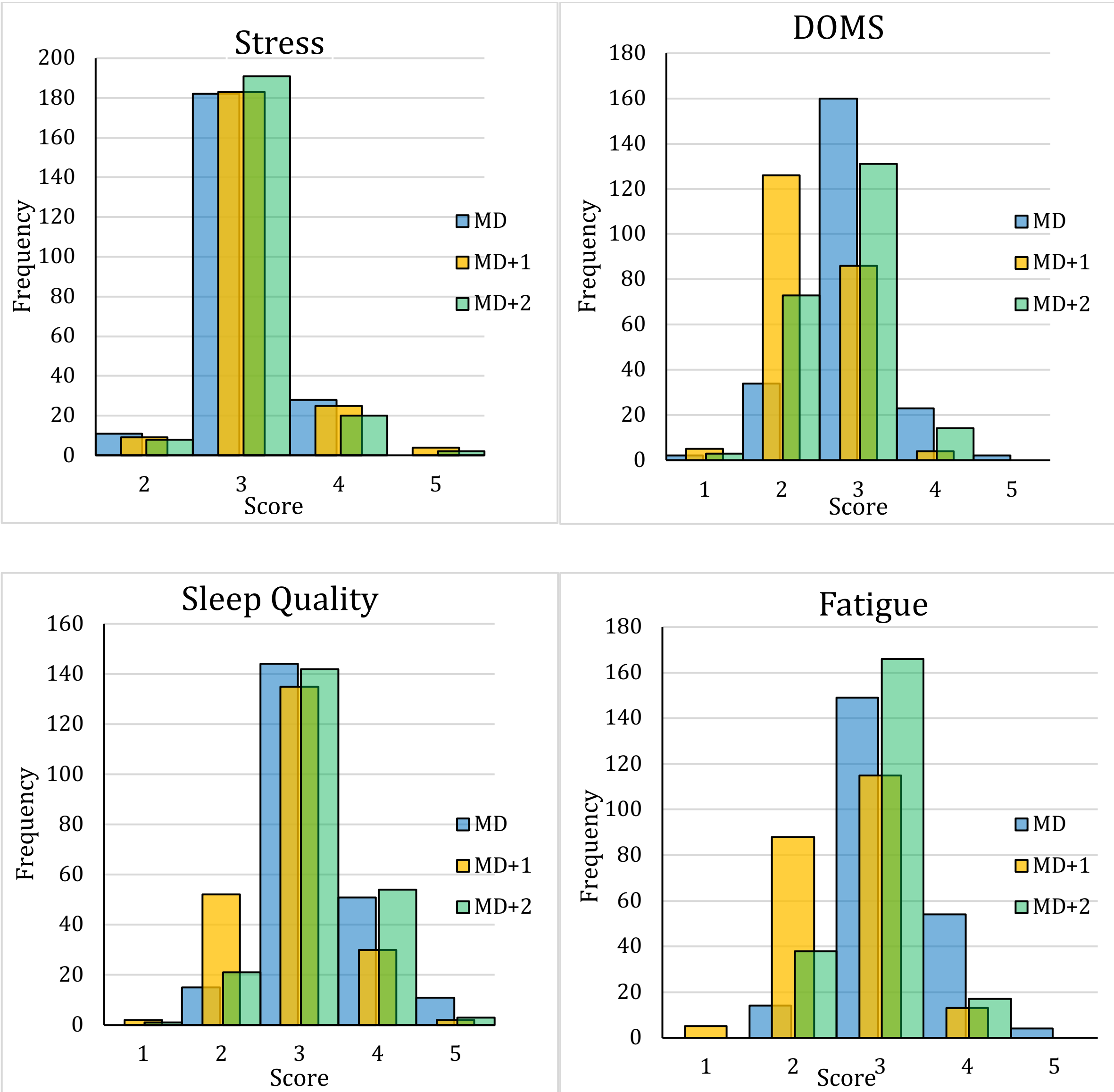

Figure 4| Overlapping histograms showing frequencies of scores for fatigue, stress, sleep quality, and DOMS

Based on visual inspection of the histograms presenting fatigue, SQ, stress and, DOMS the score "3" is dominant, getting >100 votes on all parameters except DOMS MD+1. Firstly, the stress histogram shows relatively normal stress levels among players on all 3 days, with players reporting normal stress levels (3) mostly on MD+2. Interestingly, no players reported to be very relaxed (5) on MD, at the same time more players experienced to be stressed (2) prior to the match, than on days after. No players reported to be highly stressed (1) at any time, neither did any player report to be very relaxed (5) on MD. Secondly, the DOMS histogram is showing that only a few players have reported to feel great (5) on MD, while no players reported 5 on

MD+1 and MD+2. More players experienced to feel good (4) on MD than on MD+1 and MD+2. A normal experience of DOMS (3) was reported the most on MD and MD+2. Interestingly, significantly fewer players reported a normal experience on MD+1 compared with MD and MD+2. However, more players reported to feel increased soreness (2) on MD+1 compared to MD. In addition, twice as many players experienced increased soreness on MD+2 than on MD. Lastly, only a few players reported to feel very sore (1) at any time. However, feeling very sore was reported the most on MD+1, followed by MD+2, and lastly MD. Histogram 3 (bottom left) presents reports from players concerning their SQ. The histogram shows that most players reported normal sleep (3) on all three days. More players experienced to have a very restful (5) night of sleep on MD, compared with the nights following a match (MD+1&+2). A good night of sleep (4) is the second most reported value, with more players reporting a good night of sleep on MD+2 and MD, than on MD+1. As a matter of fact, a night of restless sleep (2) was reported significantly more on MD+1 than on MD. Fewer reports of restless sleep were stated on MD than on MD+2. Lastly, only a very few players reported insomnia (1) at any time (<20), but the histogram shows that insomnia was only reported following matches (MD+1 &+2). The last histogram shows fatigue reported on MD, MD+1, and MD+2. Based on visual inspection, you can tell that the players experienced to feel very fresh (5) on MD only. No players reported 5 on MD+1 or MD+2. The most reports of players feeling fresh were on MD, while the least reports were on MD+1. A normal level of fatigue (3) was the score reported the most by all players. More than 140, 100, and 160 reports were conducted on MD, MD+1, and MD+2 respectively. On MD+1 further players reported to feel more tired than normal (2), compared with MD. Reports of 2 were twice the amount on MD+1 compared to MD, indicating higher fatigue post-match. Lastly, reports of being always tired (1) were limited and reported on MD+1 only.

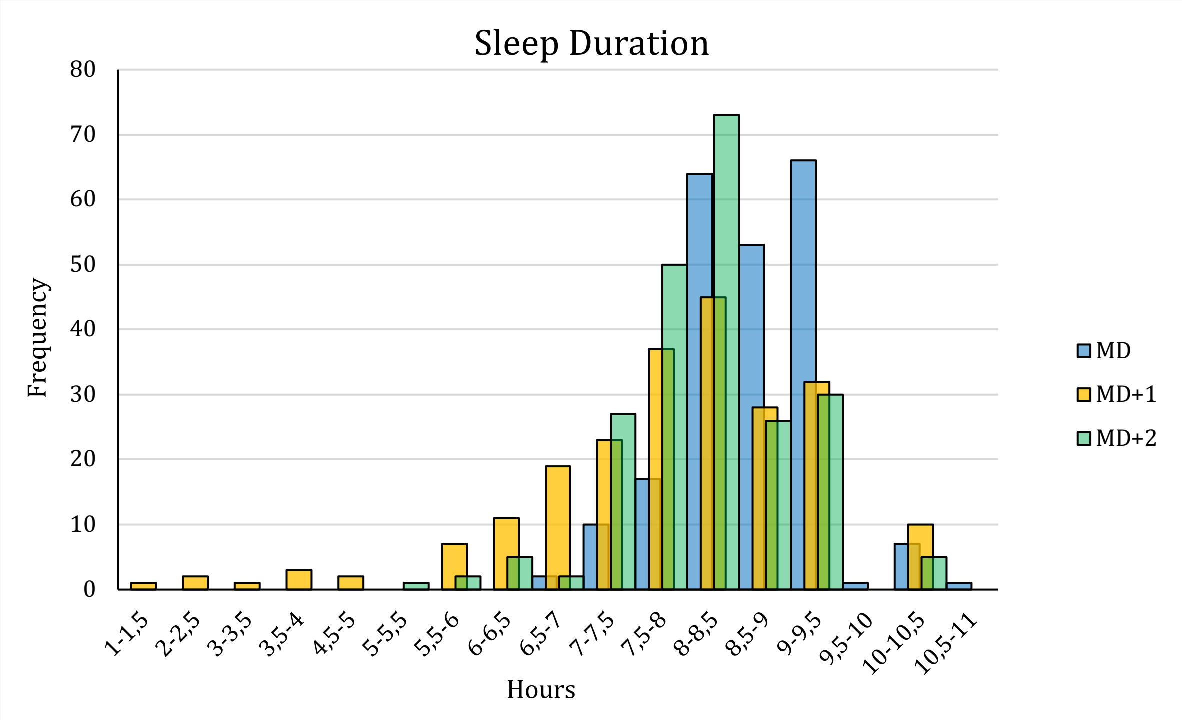

Figure 5| Overlapping histogram for sleep duration

Based on visual inspection of Figure *5* players reported SD ranging from 6,5h up to 11h of sleep the night prior to the game. Majority of reports were on 9-9,5h of sleep on MD, followed by 8-8,5h and 8,5-9h on MD+1 and +2 respectively. No players reported a sleep duration below 6,5h prior to a match during the season. The first night after a match (MD+1) players reported a sleep duration from 1h up to 10,5h of sleep. Interestingly, all reports of SD below 5h were reported on MD+1. SD from 5,5h to 7h were also reported most on MD+1. However, reports on SD from 10-10,5h on MD+1, were higher than on MD and MD+2. Overall, no other day showed a wider range of SD than on MD+1. On MD+2 players reports show SD from 5-10,5h., with the majority reporting 8-8,5h of sleep on MD+2. The fewest reports of sleep were on 5-5,5h of sleep. 8-8,5h of sleep on MD+2 was the highest amount of sleep on any day, with >70 reports.

4.1 Changes in wellness

Table 2| Mean and standard deviation for ratings perceived Wellness on Matchday, Matchday +1, and Matchday +2

	MD	MD +1	MD +2
FATIGUE	3.22 ± 0.58	2.62 ± 0.63	2.90 ± 0.49
SLEEP QUALITY	3.26 ± 0.66	2.90 ± 0.66	3.17 ± 0.62
DOMS	2.95 ± 0.57	2.40 ± 0.57	2.71 ± 0.60
STRESS	3.08 ± 0.41	3.11 ± 0.46	3.07 ± 0.40
SLEEP DURATION (H)	8.48 ± 0.66	7.66 ± 1.39	7.97 ± 0.79

Table 2 presents means ± standard deviation for wellness subsets, and SD on MD, MD+1 and MD+2. Firstly, a mean of 3.22 ± 0.58 in fatigue was reported on MD. From MD to MD+1 fatigue decreased to 2.62 ± 0.63 SD. This equals increased fatigue by 23% from MD to MD+1. From MD+1 to MD+2 an increase in fatigue was reported from 2.62 to 2.90 ± 0.49 (+11%). Players reported an average SQ of 3.26 ± 0.66 on MD, which sunk to 2.90 ± 0.66 on MD+1 (-11%). From MD+1 to MD+2 SQ bettered by 9%, to 3.17 ± 0.62. An average DOMS of 2.95 ± 0.57 was reported on MD. A decline in DOMS scores was found from MD to MD+1, indicating increased DOMS in players. Players reported an average of 2.40 ± 0.57, equaling a decrease by 19% from MD to MD+1. From MD+1 MD+2 DOMS bettered by 13% to 2.71 ± 0.60. Stress was reported to be at 3.08 ± 0.41 on MD, before increasing slightly (<1%) on MD+1. Players reported an average of 3.11 ± 0.46 on MD+1. On MD+2 a mean score of 3.07 ± 0.40 in stress was reported, equaling a decrease by 1%. Lastly, SD was reported to be 8.48h ± 0.66 on MD. Players experienced a decrease of 0.82h (-10%) to 7.66h ± 1.39 on MD+1. Furthermore, 7.97h ± 0.79 of sleep were reported on MD+2, which is an incline by 0.31 (4%) from MD+1.

Table 3| Chi-square and significance levels between MD, MD+1 and MD+2 for fatigue, stress, DOMS & sleep quality

	CHI-SQUARE	*P-VALUE*
FATIGUE	*122.260*	*<.001*
STRESS	*1.635*	*.441*
DOMS	*109.629*	*<.001*
SLEEP QUALITY	*50.834*	*<.001*

A non-parametric Friedman test of differences among repeated measures was conducted. Results are presented in *Table 3*, and show a chi-square value of 122.260 for fatigue, which was statistically significant (p<.001). Differences in stress were statistically non-significant between the different occasion with a chi-square value of 1.635 and p=.441. For DOMS results showed a chi-square value of 109.629 which was statistically significant (p<.001). Lastly, differences between MD, MD+1, and MD+2 in SQ were found to be statistically significant (p<.001), with a chi-square value of 50.834. There exist statistically significant (p<.001) differences between MD, MD+1, and MD+2 for SQ, DOMS, and fatigue.

Table 4| one-way ANOVA between days for sleep duration

SLEEP DURATION (H)		**SUM OF SQUARES**	**DF**	**MEAN SQUARE**	**F**	**SIG.**
	Between groups	75.674	2	37.837	37.571	<.001
	Within groups	664.683	660	1.007		

DF= Degrees of freedom; F= F-ratio; Sig.= Significance level; a= test statistic adjusted for ties

Table 4 presents the results of the one-way ANOVA performed to determine differences in SD between groups. The results show that means of the three different occasions were unequal F *(2,660)* =37.571. Results were statistically significant (p<.001). Therefore, a Tukey post hoc test was performed (see Table 7).

Table 5| Z-score and level of significance for fatigue, DOMS & sleep quality from Wilcoxon signed rank test

		Z	P-value
Fatigue	MD vs. MD+1	-9.25^{b}	<.001
	MD+1 vs. MD+2	-5.98^{c}	<.001
	MD vs. MD+2	-5.78^{b}	<.001
DOMS	MD vs. MD+1	-9.02^{b}	<.001
	MD+1 vs. MD+2	-6.19^{c}	<.001
	MD vs. MD+2	-4.49^{b}	<.001
Sleep Quality	MD vs. MD+1	-6.16^{b}	<.001
	MD+1 vs. MD+2	-5.00^{c}	<.001
	MD vs. MD+2	-1.85	.065

^{b}=based on positive ranks, ^{c}= based on negative ranks

Table 5 shows the results of the Wilcoxon signed rank test, which was used to understand differences between the groups for fatigue, DOMS, and SQ. Results show a significant (p<.001) median increase in fatigue from MD to MD+1, and MD+2, respectively Z= -9.25, and -5.78. Fatigue increased significantly (p<.001) from MD+1 to MD+2 too, Z= -5.98. A statistically significant (p<.001) increase in DOMS was found from MD to MD+1 and MD+2 with Z-scores of respectively -9.02, and -4.49. Results suggest that SQ is increasing from MD to MD+1 (z= -6.16), and from MD+1 to MD+2 (z=-5.00), which was statistically significant (p<.001). From MD to MD+2, results showed a trend towards decrease in SQ (z= -1.85), but this was not statistically significant (p=.065).

Table 6| Mean and sum of ranks from Wilcoxon signed rank test

		N	Mean Rank	Sum of Ranks
FatigueMD-FatigueMD+1	Negative Ranks	122	68.43	8349.00
	Positive Ranks	12	58.00	696.00
	Ties	87		
	Total	221		
FatigueMD+2-FatigueMD+1	Negative Ranks	17	46.24	786.00
	Positive Ranks	76	47.17	3585.00
	Ties	128		
	Total	221		
FatigueMD+2-FatigueMD	Negative Ranks	76	46.09	3503.00
	Positive Ranks	17	48.44	775.00
	Ties	129		
	Total	221		
SleepQualityMD-SleepQualityMD+1	Negative Ranks	82	53.94	4423.00
	Positive Ranks	21	44.43	933.00
	Ties	118		
	Total	221		
SleepQualityMD+2-SleepQualityMD+1	Negative Ranks	17	45.00	765.00
	Positive Ranks	68	42.50	2890.00
	Ties	136		
	Total	221		
DomsMD - DomsMD+1	*Negative Ranks*	*120*	*68.20*	*8184.00*
	Positive Ranks	14	61.50	861.00
	Ties	87		

	Total	221		
DomsMD+2 - DomsMD+1	Negative Ranks	18	45.00	810.00
	Positive Ranks	78	49.31	3846.00
	Ties	125		
	Total	221		
DomsMD+2 - DomsMD	Negative Ranks	67	42.25	2830.00
	Positive Ranks	19	47.92	910.50
	Ties	135		
	Total	221		

Results in Table 6 show that of 221 ratings of fatigue, 122 had a negative rank, meaning that the fatigue was worse on MD+1. 12 ratings showed positive ranks, and therefore a decrease in fatigue from MD to MD+1. Lastly, 87 ratings had ties, indicating no changes in fatigue from MD to MD+1. Fatigue decreased from MD+2 to MD+1 for 76 of 221 rankings, while 17 experienced worse fatigue, and 128 noticed no difference. Lastly, 76 of 221 rankings showed worsened fatigue on MD+2 compared with MD. 16 rankings were positive, indicating higher fatigue on MD than MD+2, while 129 noticed no difference.

82 of 221 ranks showed a negative change in SQ on MD+1 compared with MD. 21 positive ranks were shown, indicating better SQ on MD+1 than on MD. However, 118 ranks ratings showed ties between MD+1 and MD, indicating no changes in SQ. From MD+2 to MD+1 the majority (136/221) showed no change in SQ, meanwhile 68 ranks showed increased SQ on MD+2 compared with MD+1. 17 ranks were reported as ties from MD+2 to MD+1 in SQ, meaning that SQ was similar on MD+1 than MD+2. 120 of 221 ranks in DOMS saw negative changes from MD to MD+1, indicating higher DOMS on MD+1. While 14 positive ranks were reported, which shows worse DOMS on MD than on MD+1. A total of 87 ties were shown, meaning that ratings didn't change. DOMS from MD+2 to MD+1 had 18 positive ranks, meaning that DOMS was worse on MD+1 than MD+2. However, 78 rankings changed positively, indicating higher DOMS on MD+2 than MD+1. 125 ratings didn't experience change, neither negative nor positive. Lastly, rankings from MD+2 to MD in DOMS resulted in 67 negative ranks, 19 positive ranks, and 135 ties. Meaning that 67 ratings experienced more

pronounced DOMS on MD+2 than on MD, 19 experienced reduced DOMS on MD+2 than on MD, meanwhile 135 rating showed no changes in DOMS from MD+2 to MD.

Table 7| Mean difference in sleep duration between MD, MD+1 and MD+2 (Tukey Post hoc test)

DEPENDENT VARIABLE	**(I)DAY**	**(J)DAY**	**MEAN DIFFERENCE (I-J)**	**STD. ERROR**	**SIG.**	**95% CONFIDENCE INTERVAL (ARBITRARY UNITS)**	
						Lower Bound	Upper Bound
SLEEP DURATION (H)	MD	MD+1	-.81*	.0955	<.001	.595	1.043
		MD+2	-.51*	.0955	<.001	.288	.736
	MD+1	MD	.81*	.0955	<.001	-1.043	-.595
		MD+2	.31*	.0955	.004	-.531	-.083
	MD+2	MD	.51*	.0955	<.001	-.736	-.288
		MD+1	-.31*	.0955	.004	.083	.531

**Significant at p<0.05.*

Players SD decreased by -.81 (95%CI, .595 to 1.042) from MD to MD+1, and -.51 (95%CI, .288 to .736) from MD to MD+2. The decrease in SD from MD to MD+1 and +2 was statistically significant (p<.001) SD increased significantly from MD+1 to MD+2 by -.31 (95%CI, -.531 to -.083). The increase in SD from MD+1 to MD+2 was statistically significant (p=.004).

4.2 Correlation between sRPE and wellness on MD+1 & MD+2

Table 8| Correlation coefficients between sRPE and DOMS, sleep quality, sleep duration, stress, and fatigue

	DOMS		**SLEEP QUALITY**		**SLEEP DURATION**		**STRESS**		**FATIGUE**	
	MD+1	MD+2	MD+1	MD+2	MD+1	MD+2	MD+1	MD+2	MD+1	MD+2
SRPE	.010	.129	.107	.045	.094	-.087	-.116	.004	.140*	.072

** Significant at p<0.05*

Results in

Table 8 present Spearman's correlation coefficient between sRPE on MD and DOMS, SQ, SD, stress, and fatigue on MD+1 and MD+2. A statistically significant ($p<.05$) positive small correlation ($r=0.140$) was found between sRPE and fatigue on MD+1. ($p>.05$). Furthermore, the remaining correlations between sRPE and DOMS, SQ, SD, stress and fatigue were found to be trivial to small positive and negative correlations. However, none of them were statistically significant ($p>0.05$).

5 Discussion

The purpose of this study was to investigate if and how perceived wellness changes, and if internal match load is related to subjective wellness post-match in Norwegian women elite footballers. We investigated: 1) how players perceived wellness changed from matchday and the following two days, 2) we collected sRPE from official matches to correlate with perceived wellness. The main findings of this study were that match-play in women's elite football significantly affected the wellness of players, especially on MD+1, but also on MD+2 apart from stress which was unaffected. Furthermore, small positive and negative non-significant correlations between sRPE and wellness subsets on MD+1 and MD+2 were found. For this discussion, it is important to mention that an increase on the Likert scale equals a decrease and vice versa in perceived fatigue, SD, stress, and DOMS. In SQ an increase on the Likert scale equals an increase in perceived SQ, and vice versa.

5.1 Sleep quality

Results show that SQ between all days was significantly different from each other, with mean scores ranging from 2.90AU to 3.26AU. Players reported the highest mean SQ the night prior to a match (3.26AU ± 0.66), indicating that the average player had a normal night of sleep (see Figure *3*). The mean of SQ on MD is reflected very well in the histogram in Figure *4*, where 144 of 221 votes were at 3(normal sleep). SQ worsened by -0.32AU from MD to MD+1, equaling a decrease in SQ by 11%. These findings are consistent with findings of Doeven et al. (2019). In comparison with their male counterparts, the decrease in SQ from MD to MD+1 is relatively small. Thorpe et al. (2016) reported a decrease from 5.2AU ± 0.8 to 3.9AU ± 1.2 from MD-1 to MD+1 on a 7-point Likert scale, averaging a decrease by 26%. From MD+1 to MD+2 the present study found a positive change in SQ. The average SQ increased from 2.90AU ± 0.66 on MD+1 to 3.17AU ± 0.62 on MD+2. An increase of 0.27AU equals 9%, which is significantly lower compared with elite male footballers (Thorpe et al., 2016). They showed an increase in SQ from MD+1 to MD+2 by 0.90AU (23%). However, the present study's change in SQ from MD+1 to MD+2 is consistent with Doeven et al. (2019), who reported mean SQ increasing back to baseline value from MD on MD+2. Lastly the present study found slightly negative changes in SQ from MD to MD+2, which is in accordance with Thorpe et al. (2016). While Thorpe et al. (2016) showed a decrease by 7.7%, the present study found a decrease of 2.7% in SQ. In contrast, Fernandes et al. (2021a) showed a positive change in SQ from MD to MD+2. Respectively, an increase from 3.21AU ± 0.61 on MD, to 3.51AU ± 0.77 on MD+2

(MD-5) was found, which is an increase in SQ by 9%. All day-to-day changes in SQ were statistically significant as shown in Table 5.

Results revealed the biggest change in SQ from MD to MD+1, which refers to the first night post-match. Sleep disturbances following competitive matches are common and can impact the recovery process negatively (Nédélec et al., 2013). One could therefore argue, that ensuring a good night of sleep post-match is a first crucial step towards optimal recovery. Firstly, results of this study are in accordance with the findings of a meta-analysis and review article (Roberts et al., 2019b) showing that athletes experience greater sleep the night prior than the night after competition. Results in this study suggest that most players had a normal night of sleep the night prior to competition. However, competition related anxiety the night before a match is a common psychological burden, which has shown to be more prevalent in female versus male athletes prior to competition (Schaal et al., 2011). The statement of women athletes having higher levels of anxiety prior to competition, causing sleep disturbances is not supported by the results of this study, as the majority reported a normal night of sleep. Further studies are warranted to elucidate if there are true sex discrepancies in anxiety levels prior to match leading to sleep disturbances.

Furthermore, the present study found a statistically significant decrease in SQ from MD to MD+1. The decrease in SQ by 11% could be caused by various situations and conditions. Nédélec, Halson, Abaidia, Ahmaidi, and Dupont (2015a) separate between acute and chronic stressors, which potentially can interfere with athlete's sleep. Especially, during night games footballers are exposed to a high amount (~ 2000lux) of bright polychromatic light (Nédélec et al., 2015a), which can interfere with the circadian rhythms and directly influence SQ. However, in this study all games apart from 7, had kick-off before 18.00 o'clock. Therefore, it's reasonable to argue that late kick-offs might not have been the most influential factor on SQ post-match. In comparison with the results of Thorpe et al. (2016), the decrease in SQ from MD to MD+1 is relatively small. A total of 2 matches out of 36 ended in defeat, meaning that both teams in the present study had a good season. With match outcome-related mood being listed as an acute stressor that can affect SQ post-match (Nédélec et al., 2015a), you could argue that it has had a positive effect. This means that the change in SQ potentially has been affected positively by good results, and that SQ could have been worse on MD+1, if the participating teams had lost more matches during the season.

Lastly, the present study revealed small non-significant negative changes in SQ from MD to MD+2 (see *Table 5*). SQ decreased by 2.76% (p=.065). After seeing a significant drop in SQ on MD+1, approximately 48h later SQ values had returned to baseline. These findings are supported by the study of Doeven et al. (2019), who showed similar results after an women's elite rugby tournament. Non-significant changes in SQ from MD to MD+2 could indicate that acute and chronic stressors impacting SQ on MD+1, have less or no impact on MD+2. Another reason for non-statistically significance changes from MD to MD+2 may be an effect of a sample size leading to a statistical type 2 error. Such a consequence cannot be conclusively ruled out.

5.2 Sleep duration

Results on how SD changes from MD to MD+1 and +2 is shown Table 4. The one-way ANOVA revealed statistically significant (p<.001) differences between the days F (2,660) =37.571. Therefore, a post hoc test (Table 7) was performed and revealed negative mean differences in SD between MD and MD+1 (-.82, p<.001), and MD and MD+2 (-.51, p<.001). -.82 in mean difference between MD and MD+1, equals a reduction in sleep of -9.77%. The negative change in SD from MD to MD+2 equals -6,01%. However, a positive change in mean difference between MD+1 and MD+2 (.31, p<.001) was found, indicating that players slept 4.05% longer the second night after a match. Lastly a negative change was found from MD to MD+2, decreasing by 0.51 (-6.01%). These findings are in accordance with the results of Shearer, Jones, Kilduff, and Cook (2015) who investigated SD post-match-play in male elite rugby players. Unfortunately, there is a lack in scientific research investigating SD in women footballer's post-match.

As argued in chapter 2.3.2 female elite athletes need approximately 8.3h of sleep to feel completely rested, but that as much as 71% don't fulfill that recommendation as per Sargent et al. (2021). The women elite players included in this study slept 8.48h ± 0.66 the night prior to a match, with a range of reports from 6.5 up to 11h of sleep. With a total of 128 (58%) reports on MD of players sleeping >8.5h, the author of the present study is critical towards the validity of the findings of Sargent et al. (2021) for elite women's football. The present study shows that 58% of the participants do, and 42% do not fulfill the recommendations. However, it is important to notice that the average SD from all three days seem to be high compared with other studies (Roberts et al., 2021; Thomas et al., 2021). Thomas et al. (2021) reported a mean SD of 7.6h ± 0.71 in elite women footballers, while Roberts et al. (2021) showed an average of

7.1h ± 0.6 in semiprofessional women footballers. The results of this study show higher SD, 0.4h and 0.9h respectively. One could argue that the length of monitoring SD, might play an essential role. The present study monitored SD for an entire season, while the two above-mentioned studies monitored for a shorter period during pre-season, which might explain the differences in mean SD. One could also argue that differences in SD, especially between the elite players in the study by Thomas et al. (2021) and the participants in this study might be due to the different periods of monitoring. Thomas et al. (2021) monitored during pre-season, while this study monitored during the competitive period of the season. Pre-season is associated with significantly greater player training load compared with in-season (Fessi et al., 2016), and could have caused differences in SD between Australian and Norwegian female elite footballers.

The Tukey post hoc test showed a significant negative change in SD from MD to MD+1 by -0.82h, which equaled -9.77%. These findings are consistent with the findings of Thomas et al. (2021), who reported significantly lower SD (-10.51%) on nights of matches compared with training nights. One could argue that their results are relevant for this study as most teams have a light training session the day prior to a match. This means that SD reported on MD is comparable to SD on training nights, and that SD reported on MD+1 is comparable to SD following match nights, as in the study of Thomas et al. (2021).

As SD and SQ are both variables obtained through the process of sleeping, the decrease might have been caused by many of the same conditions and situations such as match-outcome related mood or late kick-offs. Furthermore, napping, congested match schedule, caffeine and/or alcohol consumption, or use of electronical devices have been reported as stressors that can influence players SD (Fullagar et al., 2015; Nédélec et al., 2015a), but were not monitored in the present study. Playing at the top level includes a substantial number of travels both domestic and international. Travelling from and to away games might interfere with player's sleep (Nédélec et al., 2015a). Cumulative sleep loss is a result of travel, which tends to result in cumulative fatigue over a season. However, travel fatigue depends on the distance and frequency of travel, as well as the duration of the competitive season. (Samuels, 2012) With one of the teams in this study having to travel far for all away game during the season, and the other one having to travel far for 50% of the away games one could argue that travel fatigue might have resulted in sleep disturbances post travelling. This means that the decrease in SD from MD to MD+2 might be a result of increased travel fatigue due to travelling to and from away games. However, empirical data on whether short-haul air travel impacts sleep or not, are largely lacking according to Fullagar et al. (2015), and more research is warranted.

After a reduction in mean SD from MD to MD+1, players reported a statistically significant ($p=.004$) increase in SD from MD+1 to MD+2. Results showed that SD increased from 7.66h ± 1.39 to 7.97h ± 0.79, which equals 4.05%. Compared to the results of Shearer et al. (2015), we can see similarities with SD decreasing significantly from MD to MD+1, before increasing from MD+1 to MD+2. However, SD on MD+2 is not recovering back to baseline values from MD. One of the reasons for the increase in SD from MD+1 to MD+2 might be the change in environment around players. On MD+1 player's SD might be influenced by match-related stressors such as, travel, match outcome-related mood, and/or excitement/arousal as a consequence of competition (Nédélec et al., 2015a). On MD+2 these match-related stressors might not be as influential or not influential at all, as it is the second night after a match. This means that arousal, excitement, or mood related to the match have downscaled, and players get to sleep longer and better. Results from SQ in this study can support this, as SQ increased by 23% from MD+1 to MD+2, meaning that match related stressors influenced SQ less.

Based on the results for SQ and SD in this study, the night after a match seems to be the most important to follow up for practioners. Athletes reporting a significant decrease in SQ and SD due to match related stressors, underlines the importance of facilitating a good sleep environment for the individual player (Nédélec et al., 2015a). Implementing sleep hygiene strategies for elite athletes, especially for the night after a match might be beneficial, as there have been promising results in elite footballers (Nédélec et al., 2015b). Given the number of psychological and physiological functions that may be fundamental to the recovery process post-match sleep hygiene strategies should be considered by practioners. However, more research on which sleep hygiene strategies should be implemented, needs to be investigated by future research. The results on SQ and SD from the present study underline the importance of actively working to improve SQ and SD post-match, as it has shown to reduce perceived soreness and fatigue in other sports (Duffield, Murphy, Kellett, & Reid, 2014).

5.3 Fatigue

This study found significant day-to-day changes in fatigue in elite women footballers. Firstly, players reported a mean fatigue score of 3.22AU ± 0.58 on MD. This indicates that players experienced relatively normal levels of fatigue the morning of the match. From MD to MD+1 the mean fatigue score worsened by 18.63%. A mean of 2.62AU ± 0.63 was reported on the first morning post-match. The Wilcoxon signed rank test revealed that the change from MD to MD+1 was statistically significant ($<.001$). The negative change in fatigue is supported by previous studies on male and women footballers (D. Scott et al., 2020; Thorpe et al., 2016). However, this study found that fatigue worsened by 18.63%, which is relatively minor compared with Thorpe et al. (2016) and D. Scott et al. (2020), who reported that fatigue levels increased significantly more, respectively 32% (men) and 42% (women) from MD to MD+1. After a significant change in perceived fatigue on MD+1, players perceived fatigue improved from MD+1 to MD+2. This study found a positive change in means from 2.62AU ± 0.63 on MD+1 to 2.90AU ± 0.49. The positive change of 0.28AU from MD+1 to MD+2 equals 10.69%. Wilcoxon's signed rank test revealed statistically significance for changes from MD+1 to MD+2 ($p<.001$). Compared with the male counterpart in the study of Thorpe et al. (2016), elite women players perceived fatigue in this study seem to recover less. Thorpe et al. (2016) reported mean positive changes in perceived fatigue by 17% from MD+1 to MD+2 in elite male footballers. However, D. Scott et al. (2020) showed improvements from -2.32AU to -1.30AU in perceived fatigue from MD+1 to MD+2, equaling a positive change of 14%. Lastly, this study found a statistically significant change ($p<.001$) in perceived fatigue from MD to MD+2 as well. Results show a decrease from 3.22AU ± 0.58 on MD to 2.90AU ± 0.49 on MD+2. A decrease by 0.32AU equals 9.94%, which is similar to the findings of Thorpe et al. (2016), who showed a decrease from MD to MD+2 by -0.6AU (12%) in male elite footballers. These findings are consistent with studies performed on women elite footballers, who reported a decrease in perceived fatigue from MD to MD+2 (D. Scott et al., 2020). Interestingly, Fernandes et al. (2021a) found that players felt less fatigued on MD+2 than on MD. However, these results were statistically non-significant ($p>.005$). Interestingly there are indications that women may have better fatigue resistance compared with men during endurance events and if the pattern of recovery is not similar between men and women, we should possibly consider separate recovery strategies for women (Tiller et al., 2021).

Based on the observations in this study, and the observations of Thorpe et al. (2016), it seems like women footballers report significant lower perceived fatigue on MD+1 compared to their male counterparts. This study's results revealed that fatigue levels increased by 18.63% from MD to MD+1, while Thorpe et al. (2016) reported that fatigue levels increased by 32%. Firstly, one could argue that it could be due to differences in training status or gender-specific fatigue development (Kent-Braun, Ng, Doyle, & Towse, 2002) as some studies have shown that women experience less fatigue than men (Fulco et al., 1999; Hicks & McCartney, 1996). However, these studies have investigated physically active men and women, as well as older people (60-80y) and might not be applicable to elite footballers.

Results in this study suggest that women elite footballers are not fully recovered from post-match fatigue after 48h. As presented in

Table 2, players in this study didn't manage to get back to baseline fatigue values from MD, within the two days post-match. On MD+2 players reported a mean fatigue of 2.90AU ± 0.49, which is -0.32AU from MD baseline values. Interestingly, results show that from MD+1 to MD+2 players physical fatigue decreased by -0.28AU from 2.62AU ± 0.63 to 2.90AU ± 0.49. If recovery from post-match fatigue would follow a linear pattern, we would see an average perceived fatigue score close to MD on MD+3. As this study didn't monitor fatigue on MD+3, it's speculative to draw such conclusions. However, the findings of Fernandes et al. (2021a) support this argument, as their results showed that perceived fatigue scores were back to baseline on MD-4 (equals MD+3). Therefore, it's reasonable to argue that women's elite players need more than 48 hours with efficient recovery post-match, to be fully recovered and able to perform at their best. Future research should investigate the recovery process through monitoring biological markers in women's elite football.

5.4 DOMS

In this study significant changes in DOMS were found on all three days, meaning that elite women footballers experienced changes in muscular soreness post-match, both negative and positive. On MD players reported an average DOMS score of 2.95AU ± 0.57, indicating normal levels of soreness. These findings are consistent with the results of Fernandes et al. (2021a) who reported an average DOMS of 3.01AU ± 0.51 in Portuguese elite women footballers on MD. Furthermore, these findings are consistent with results from studies including male elite footballers (Thorpe et al., 2016). From MD to MD+1 an increase in DOMS by -0.55AU was found. A mean DOMS score of 2.40AU ± 0.57 was reported on the first day post-match. The increase by -0.55AU equals 18.64% from MD to MD+1. In comparison, D. Scott et al. (2020) reported increased DOMS by 39% on MD+1. The male counterpart reported a larger increase in DOMS from MD to MD+1 too, 29.41% respectively (Thorpe et al., 2016). The increase in DOMS from MD to MD+1 in this study was statistically significance ($p<.001$), as revealed by the Wilcoxon signed rank test (see
Table 6). From MD+1 to MD+2 a decrease in DOMS was reported. This study found a mean DOMS of 2.71AU ± 0.60 on MD+2, which is an increase by 0.31AU from MD+1. Given that an increase on the Likert scale equals a decrease in perceived DOMS, players felt less sore compared with MD+1. Less perceived DOMS on MD+2 than on MD+1 has been shown in

elite women footballers in a recent study (D. Scott et al., 2020). Interestingly, women seem to recover slightly less from DOMS on MD+1 to MD+2 than their male counterparts. DOMS decreased by 13% in this study, while Thorpe et al. (2016) reported a 19% decrease. Lastly, this study found a statistically significant ($p<.001$) change in DOMS from MD to MD+2. Players reported to feel more perceived soreness on MD+2, compared with MD. The mean sunk from 2.95AU on MD to 2.71AU ± 0.60 on MD+2, indicating an increase in DOMS by 8%. This is consistent with previous studies investigating DOMS in women elite footballers (Fernandes et al., 2021a; D. Scott et al., 2020), and male elite footballers (Thorpe et al., 2016).

To the author's notice, no study has investigated changes in perceived DOMS from MD to MD+1 in elite women footballers over a competitive season. Observations from this study show that women elite footballers experience a statistically significant ($p<.001$) increase in perceived DOMS from MD to MD+1. The increase is consistent with observations in previous studies in (Thorpe et al., 2016), and is caused by eccentric actions (Armstrong & Warren, 1993) Interestingly, the increase in perceived DOMS in this study is relatively small compared with their male counterpart (Thorpe et al., 2016). Differences in intensity between women's and men's football, might have caused different changes in DOMS from MD to MD+1 between genders. Kjæreng Winther et al. (2021) showed that women elite footballers run between 1054 to 1894m at high intensities ($>4.44m\bullet s^{-1}$) and sprinted between 227 to 530m ($>5.55m\bullet s^{-1}$), depending on their on-field position during competitive matches. Studies have shown that top class male footballers run 2430 ± 140m at high intensities ($>5m\bullet s^{-1}$), and sprint 650 ± 60m ($>8.33m\bullet s^{-1}$) during a full match (Mohr, Krustrup, & Bangsbo, 2003). Given that male footballers seem to run more on higher intensities, less perceived DOMS for women footballers on MD+1 would be reasonable. However, literature available on women's football has shown that physiological demands (percentage of heart rate and VO_{2max}) obtained during match play in women's football, are similar to those in male football (Stølen, Chamari, Castagna, & Wisløff, 2005).

After a significant increase in DOMS from MD to MD+1, results show that players perceived DOMS decreased by 13% from MD+1 to MD+2. The Wilcoxon signed rank test revealed that the decrease is statistically significant ($p<.001$). Compared to the findings of Thorpe et al. (2016), it seems like the participants in this study recovered slightly less from DOMS on MD+1, with Thorpe et al. (2016) reporting a slightly higher decrease in DOMS. One could argue that team recovery interventions post-match such as low intensity cycling, hydrotherapy and foam rolling caused better recovery in the study of Thorpe et al. (2016). Given that increased DOMS is associated with significantly reduced concentric, isometric, and eccentric strength as well as reduced power parameters, quick recovery is desirable (Clarkson & Ebbeling, 1988; Donnelly et al., 1990; Hasson et al., 1993; Paddon-Jones & Quigley, 1997). Implementing recovery strategies such as in the study of Thorpe et al. (2016), might have given better recovery from DOMS from MD+1 to MD+2. Research has shown that 20 min of foam rolling immediately, 24h, and 48h post-exercise effectively reduces DOMS and associated decreases in dynamic performance measures (Pearcey et al., 2015). With professional footballers being exposed to a higher load, due to increased frequency of domestic competition implementing a recovery strategy might have a positive effect on players DOMS. However, one of the teams in this study has implemented recovery strategies such as low intensity cycling and foam rolling, directly after the match and on MD+1. Nevertheless, players are responsible for the implementation of recovery strategies themselves. One could argue that the decrease in DOMS from MD+1 to MD+2 in this study could have been more pronounced, if a structured recovery strategy was mandatory for all players, instead of voluntary. No results of how many of the players implemented recovery strategies in their post-match routine in the present study are available.

Lastly, we observed that players reported higher perceived DOMS on MD+2 compared with MD. These observations were found to be statistically significant ($p<.001$). To the authors notice, only one study has investigated changes in perceived DOMS from to MD to MD+2 in elite women footballers (Fernandes et al., 2021a). Interestingly, this study's data provided a significant ($p<.001$) increase in DOMS from MD to MD+2, while the data of Fernandes et al. (2021a) provided a non-significant ($p>0.05$) increase. The statistically insignificance of the increase in DOMS from MD to MD+2 in the study of Fernandes et al. (2021a) could be due a small sample size ($n=12$) from 12 matches, leading to type II statistical error. This can be regarded as a strength in the present study, with a larger sample size ($n=22$) and data from 36 matches. Finally, research has shown that DOMS is a potential result of poor sleep post competition (Johnston, Gabbett, Jenkins, & Hulin, 2015). With DOMS not being back to baseline value from MD, and players still feeling "*a bit sore*" (2) on MD+2, one could argue that SQ and SD on the two nights post-match have had a negative influence on DOMS. Both SD and SQ on MD+1 and SD on MD+2 were significantly ($p<.001$) lower than on MD, indicating poorer sleep post-match than prior to match. Furthermore, practioners could as prior discussed benefit from implementing sleep hygiene strategies (see chapter 5.2) post-match, as it might result in a better night of sleep, and therefore better recovery of DOMS from MD to MD+2.

5.5 Stress

In this study we found non-significant day-to-day changes in stress in elite women footballers. To the author's notice, only Fernandes et al. (2021a) have investigated stress in women elite footballers previously, and have shown similar results. Players in this study reported an average of 3.08AU ± 0.41 in the morning of MD, indicating "normal stress levels". The mean is well presented by score "3" in the overlapping histogram in Figure *4* with a total of 182 of 221 (82%) votes on MD, followed by score "4" indicating "relaxed" with 28 of 221 (13%) votes. The mean stress score reported by players on MD in this study seem to be consistent with the findings of Fernandes et al. (2021a), who reported an average of 3.01AU ± 0.64 on MD. Compared to male elite junior footballers (Lathelan et al., 2019), players in this study reported to be more relaxed. However, Lathelan et al. (2019) didn't monitor players stress levels on MD, but on MD+6 (MD-1). From MD to MD+1 we saw an increase in mean stress levels by 0.03AU. This study found a mean stress level of 3.11AU ± 0.46AU on MD+1. As shown in Table 3, the Friedmann test revealed non-significant day-to-day changes (Chi-square 1.635, $p=0.441$). Therefore, no further analysis was performed. Score "3" and "4" got most votes on MD+1, with a total 208 of 221 (94%) in total. Players experiencing normal (3) stress levels was reported 183 (83%) times, while relaxed (4) was reported 25 (11%) times. No study has investigated changes in stress levels from MD to MD+1 in elite women football. In the study of Lathelan et al. (2019), no changes in stress levels between MD-1 and MD+1 were shown, with an average of 1.77AU on both days. One could argue that elite women footballers are feeling less stressed on the first day post-competition (MD+1) than elite junior footballers, respectively 3.11AU ± 0.46 and 1.77AU ± 0.91. From MD+1 to MD+2 mean stress score decreased insignificantly from 3.11AU to 3.07AU ± 0.40. 211 of 221 (95%) reports were either normal or relaxed stress levels, with 191 (86%) reports on normal stress levels. Findings from this study on MD+2 are consistent with Fernandes et al. (2021a), who reported an average of 3.56AU ± 0.95 on MD+2. From MD to MD+2 a non-significant change was found in this, with a difference of 0.01AU. A non-significant difference between MD and MD+2 was found in the study of Fernandes et al. (2021a) too. However, their results showed that stress levels decreased from 3.01AU on MD to 3.46AU on MD+2.

Norwegian elite footballers seem to be less stressed compared with other populations e.g., Portuguese women elite footballers. Even though results presented in both studies seem to be similar, the use of different scales in the answer options must be taken into consideration. In this study a 5-point Likert scale was used, while Fernandes et al. (2021a) used a 7-point Likert scale. On a 5-point scale 3 is the median value, while 4 is the median value on the 7-point scale. Thus, reporting 3 on a 5-point Likert scale is nor negative nor positive. As Fernandes et al. (2021a) interpreted scores as “higher is better”, reporting 3 refers to players being slightly more (negative) stressed. Therefore, one could argue that players in this study are experiencing less stress on MD and post-match. In addition, players in the study by Lathelan et al. (2019) reported significantly higher perceived stress, using a 5-point Likert scale. As mentioned in chapter 5.1, results for both participating teams in this study were positive during the monitoring period, with exception of 2 matches. With only two losses over 36 matches, one could argue that it might have played a substantial role in player’s perceived stress. In a study including 11 coaches, 10 identified poor competitive performances as an influential stressor in athletes (Thelwell, Weston, Greenlees, & Hutchings, 2008). With fewer poor performances, one influential stressor is eliminated. On the other hand, players in this study were exposed to other external stressors such as the covid-19 pandemic, with lots of uncertainty related to it. Research showed that there was increased symptoms of post-traumatic stress related to the pandemic period (Şenışık, Denerel, Köyağasıoğlu, & Tunç, 2021). One could argue that covid-19 might have affected players stress levels negatively, and that stress levels could have been lower under normal circumstances. So many more potential stressors might have led to players in this study reporting lower perceived stress compared to others, related to both organizational aspects and performance (Thelwell et al., 2008), or other external stressors such as covid-19. However, the purpose of this study was not to investigate what is affecting players stress levels. Therefore, future research should investigate competition related stress and its effect on different populations.

Lastly, there seems to be a tendency for differences in stress levels in elite footballers to be statistically non-significant. This study reported a significance level of $p=0.441$, when investigating differences between days (see Table 3). Interestingly, studies investigating perceived stress using the Hooper questionnaire in football have reported non-significant changes too (Fernandes et al., 2021a; Lathelan et al., 2019). However, studies involving other sports, such as elite rugby have shown significant impaired stress level following competition (Doeven et al., 2019). One could argue that contextual factors might have played a decisive role during this study, as matches were played without a crowd due to covid-19 regulations. With a crowd comes expectations and atmosphere. Doeven et al. (2019) who investigated a 7-day Rugby tournament prior to the covid-19 pandemic argued that contextual factors such as crowd, atmosphere and sponsors may have played an important role during the tournament, and impacted athletes stress levels. Thus, one could argue that stress levels in women elite footballers might have been higher, especially on MD without covid-19 regulations. However, the direct impact of covid-19 regulations on players stress levels remains to be determined.

5.6 Correlation between sRPE and post-match wellness

To the best of our knowledge this is the first study to investigate the relationship between sRPE and wellness in elite women's football. A Spearman correlation test was performed to investigate the relationship between match internal load on MD (sRPE) and wellness on MD+1 and +2. Results revealed trivial to small correlations between sRPE, and all wellness subsets included in this study. All Correlation coefficients were statistically non-significant, except of fatigue on MD+1 and sRPE ($r=.140$; $p<.05$) The correlation coefficient of fatigue on MD+1 and sRPE was the largest correlation found in this study, while stress on MD+1 was the smallest ($r=.004$). Lastly, results showed two non-significant negative correlations between sRPE and SD on MD+2 ($r=-.087$) and stress on MD+1 ($r=-.116$). Clemente et al. (2017) found similar results showing trivial to small negative correlation between internal load and wellness subsets. When playing one match a week, correlations were found to be trivial positive and negative. Therefore, we can argue that there are similarities between men and women's elite football, when it comes to the relationship between sRPE and wellness. Interestingly, findings of this study were statistically non-significant, while Clemente et al. (2017) reported statistically significant r-values. This might be due to differences in analyzing internal load. This study has used all sRPE values post-match and analyzed through Spearman correlation. Furthermore, different characteristics of the population investigated, or other outside factors might have led to this outcome. However, Clemente et al. (2017) have divided it into a general column, a one match a week column, and a two matches a week column. One could argue that this study analyses are comparable to the general column of Clemente et al. (2017), which were f statistically significant. Nevertheless, potential biases could have occurred and led to non-significant results in this study.

Furthermore, this analysis revealed higher subjective values of fatigue, SD and SQ on MD+1 than on MD+2. Higher subjective values are expected for DOMS and stress on MD+2. In addition, largest changes in DOMS and fatigue are expected, as the highest correlation coefficients were found, respectively r=.129 and .140. These findings are in line with previous studies (Clemente et al., 2017; Moalla et al., 2016). Expecting higher values of fatigue, SD and SQ on MD+1 would mean increased fatigue, lower SQ and shorter SD. This might be caused by changes in physiological and psychological parameters affecting these 3 subsets on MD+1, due to higher internal load on MD compared with training days (Gonçalves et al., 2020). However, as only the relationship between sRPE and fatigue on MD+1 is statistically significant ($p<.05$), one could argue that correlation coefficients for SD and SQ are biased due to non-statistically significance ($p>.05$) and should be interpreted with great caution. The same argument is applicable for DOMS and stress on MD+2, which are expected to be higher on MD+2 than on MD+1. With results in this study being statistically non-significant ($p>.05$), they must be interpreted with great caution due to potential bias.

Results suggest that there are trivial to small negative and positive correlations between the reliable, valid, and sensitive sRPE method, and wellness subsets. With exception of SD on MD+2 and stress on MD+1, all correlations were found to be positive. This means that if sRPE increases, wellness scores (except for the two above mentioned) should increase on the two days post-match. Both SD on MD+2, and stress on MD+1 decrease if sRPE increases, hence the negative correlation coefficient. Based on these results one could argue that Hoopers wellness subsets on MD+1 and MD+2 (except for fatigue on MD+1) are not sensitive to sRPE and vice versa. This would not be in line with previous research (Clemente et al., 2017). But, with 90% of the results in this study being statistically non-significant, this is a reasonable argument. However, given that previous studies have shown significant small to moderate correlations between sRPE and wellness subsets in elite male footballers (Clemente et al., 2017; Moalla et al., 2016), more research on women's elite footballers is warranted.

5.7 Limitations

The observational study design provides a certain limitation to this study. Mainly, that only observations of changes and associations between variables could be made. Due to the lack of experimental manipulation, little information about possible confounding factors that could have influenced results have been obtained.

Furthermore, there are two limitations regarding the participation of this study. Firstly, the original number of participants have been reduced from 34 to 22 during the time of monitoring. As reported by Kjæreng Winther et al. (2021) and Panduro et al. (2021), there are different positional physical demands to women elite footballers, which might have influenced the results. This is a limitation in this study as the majority of players were defenders, who often have less external load (i.e. total distance, high intensity running) during matches compared with midfielders (Datson et al., 2014). Due to differences in physical demands during matches, dividing into positional categories might have given a more compound picture of changes in wellness post-match. On the other hand, dividing the sample into three or five position-groups would have affected the statistical analysis with increasing possibilities of statistical type II error. With more participants, potential differences between position in post-match wellness could have been provided. Therefore, future research should focus on investigating variables in women's elite football in relation to playing position, as there certainly are positional differences in external load in matches (Kjæreng Winther et al., 2021; Panduro et al., 2021).

Furthermore, two limitations in relation to the use of sRPE need to be pinpointed. Firstly, even though sRPE has shown to be correlated to several external load measurements, other factors such as nutrition and subjective characteristics can interfere with sRPE (Haddad, Stylianides, Djaoui, Dellal, & Chamari, 2017). This can be regarded as a limitation of this study, as sRPE ratings post-match could be influenced by several factors. Secondly, internal load in this study was measured by sRPE and may have constrained the "real" physiological effect of a match. Using measurements of internal load in combination with measurements of external load provides greater insight to training and match stress (Bourdon et al., 2017). This can be regarded as a limitation of this study as no measurements of external load in combination with internal load were made in the present study.

Lastly, the number of missing values in this study can be regarded as a limitation. The amount of missing values in perceived wellness was calculated to be 39%. Bennett (2001) argued that more than 10% missing values is likely to result in bias. Even though Madley-Dowd et al. (2019) found a reliable method to impute missing values (DTmean), which was used in the present study, results could have been different with fewer missing values. Therefore, the large number of missing values in perceived wellness can be regarded as a limitation in this study.

5.8 Future directions

To the authors notice, only a few studies have investigated changes in perceived wellness post-match in elite women's football to this date (Fernandes et al., 2021a; D. Scott et al., 2020). Therefore, more, and larger scaled studies are warranted to get a better understanding of perceived wellness in elite women's football. Furthermore, perceived wellness variables have only been investigated sparsely in elite women's football. Future research should consider experimental trials regarding player's perceived wellness, where potential factors interfering with perceived wellness variables are being manipulated. This would be favorable, as it would provide practitioners with more scientific research on which factors should be considered to ensure optimal recovery and performance in women's elite football. In this study, perceived wellness from the entire season were observed. Future research should investigate changes in wellness during different periods of the seasons. Perceived wellness following weeks with one match and compared to congested fixtures should be investigated as well. With positional differences in physical match demands (Kjæreng Winther et al., 2021), players perceived wellness might change differently in various positions. Hence wise, potential differences in changes should be investigated.

To the best of our knowledge, the present study is the first to investigate the relationship between matchday sRPE and post-match perceived wellness in women's elite football, more research is warranted. Lastly, to get a better picture of total load, future research should monitor internal and external load simultaneously, before correlating them with perceived wellness variables. This would provide practitioners with more detailed information regarding the perception of DOMS and fatigue following match load.

Finally, in chapter 5.7 we discussed that sRPE can be influenced by several factors (Haddad et al., 2017). As the observational design of this study cannot provide detailed information about which and how factors affect sRPE, future research should use an experimental approach to post-match sRPE and investigate factors interfering with it.

6 Conclusion

Fatigue, DOMS, SD and, SQ changed significantly between MD, MD+1 and MD+2 in elite women's football, except for DOMS from MD+1 to MD+2. Perceived fatigue, DOMS, SD and, SQ decreased from MD to MD+1 by 10-23% before increasing from MD+1 to MD+2 by 4-13%. However, elite women footballers showed non-significant changes in perceived stress between MD, MD+1, and MD+2.

Trivial to small positive and negative correlations were found between sRPE on MD and perceived wellness on MD+1 and MD+2. Most correlations were statistically non-significant ($p>.05$). However, the relationship between sRPE on MD and fatigue on MD+1 was found to be statistically significant ($p<.05$), but with small positive correlation ($r=.140$).

To conclude, Norwegian elite women footballers experienced significant changes post-match in all perceived wellness variables, except for stress. No significant relationship between sRPE on MD and perceived wellness on MD+1 and MD+2 was established, except for between sRPE and fatigue on MD+1.

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8 Appendix

Appendix I: Letter of consent

Vil du delta i forskningsprosjektet
"Female Football Centre"

Dette er et spørsmål til deg om å delta i et forskningsprosjekt hvor formålet er å kartlegge fysiske/fysiologiske krav til toppspillere i kvinnefotball samt gjennomføre treningsintervensjoner for å bedre prestasjonsevnen. I dette skrivet gir vi deg informasjon om målene for prosjektet og hva deltakelse vil innebære for deg.

Formål

Hovedmålet er å få fundamental innsikt i hva som påvirker prestasjonsevnen og den generelle helsen hos kvinnelige elitespillere, og kunne tolke funnene slik at norsk, og internasjonal, kvinnefotball kan.

Første del er deskriptiv der spillerne bærer GPS på alle kamper for å få bedre kunnskap om hvilke krav de ulike posisjonene stiller i forhold til fysisk kapasitet.

Deretter vil vi analysere treningene for å se hvordan det trenes i forhold til kampkravene.

Et tredje mål er å gjennomføre kontrollerte treningsstudier der en måler effekt på ulike fysiske egenskaper som er viktige definert av data fra kamp.

Alle vil i tillegg rapportere daglig via en App hvordan de føler seg fysisk og mentalt (antall timer søvn, søvnkvalitet, humør, stressnivå, fatigue, muskelstølhet,"readiness to train" Trenerteamet vil også få tilgang til dine tracking og wellnessdata gjennom en webportal for å kunne optimalisere din trenings og kamphverdag.

Dette er en del av et større tverrfaglig forskningsprosjekt på kvinnelig toppfotball og data fra denne datainnsamlingen kan bli sammenstilt med innsamlet data fra andre forskningsområder i Female Football Centre prosjektet. Disse områdene dreier seg om helse og psykologiske aspekter hos kvinnelige fotballspillere. Ved sammenstilling av data vil du som spiller bli forespurt og få en egen detaljert forespørsel om samtykke. Prosjektet er et doktorgradsprosjekt.

Hvem er ansvarlig for forskningsprosjektet?

UiT, Norges arktiske universitet er ansvarlig for prosjektet. *Simula Research lab er også en samarbeidspartner*

Hvorfor får du spørsmål om å delta?

Du får spørsmål om å delta siden du er registrert som spiller i Toppserien/1. divisjon i fotball for kvinner.

Hva innebærer det for deg å delta?

Alle deltakere vil daglig svare via en App (PMSys) på 7 spørsmål (hvor klar du er til trening på en skala fra 1-10**, antall timer søvn** i timer, **søvnkvalitet** Insomnia, restless sleep, normal, good sleep, exellent sleep, **trøtthet** very tired, more tired than normal, normal, fresh and very fresh, **muskelstølhet** Very sore, abit sore, normal ,good, great, **stressnivå** Highly stressed, somewhat stressed, normal, relaxed, very relaxed, **humør**, Very bad mood, bad mood, normal, good mood, very good mood. I tillegg rapporterer du hvor har du syntes trening kamp var (på en skala fra 1 veldig lett til 10, maksimal) noe som tar ca 15-25 sek. Etter hver trening registeres hvor hard du vurderte økta var på en skala fra 1-10. Spillere fra 4 klubber vil i tillegg bære GPS i alle kamper og i utvalgte treningssykluser.

Det er frivillig å delta

Det er frivillig å delta i prosjektet. Hvis du velger å delta, kan du når som helst trekke samtykke tilbake uten å oppgi noen grunn. Alle opplysninger om deg vil da bli anonymisert. Det vil ikke ha noen negative konsekvenser for deg hvis du ikke vil delta eller senere velger å trekke deg.

Ditt personvern – hvordan vi oppbevarer og bruker dine opplysninger

Vi vil bare bruke opplysningene om deg til formålene vi har fortalt om i dette skrivet. Vi behandler opplysningene konfidensielt og i samsvar med personvernregelverket.

- *Trenerapparatet ditt samt prosjektleder, databehandler ved Simula Research Lab og doktorgradsstudent vil ha tilgang til dine data.*
- *Trackingdata lagres i en sky noe som også gjelder PMSys data (Appen er konstruert slik at ingen andre enn de som er nevnt foran vil kunne få tilgang til dine data)*

- *Ved publikasjon av data vil du være anonymisert og det vil ikke være mulig å spore resultat til ditt navn*

Prosjektet skal etter planen avsluttes *[31.12.2024]. Beskriv hva som skjer med personopplysninger og eventuelle opptak ved prosjektslutt.*

Hva skjer med opplysningene dine når vi avslutter forskningsprosjektet?

Prosjektet skal etter planen avsluttes *[31.12.2024]. Anonymiserte data (kodet) vil bli oppbevart for eventuell senere forskning og kan oppbevares i ubestemt tid.*

Dine rettigheter

Så lenge du kan identifiseres i datamaterialet, har du rett til:

- innsyn i hvilke personopplysninger som er registrert om deg,
- å få rettet personopplysninger om deg,
- få slettet personopplysninger om deg,
- få utlevert en kopi av dine personopplysninger (dataportabilitet), og
- å sende klage til personvernombudet eller Datatilsynet om behandlingen av dine personopplysninger.

Hva gir oss rett til å behandle personopplysninger om deg?

Vi behandler opplysninger om deg basert på ditt samtykke.

På oppdrag fra *UiT, Norges arktiske universitet* har NSD – Norsk senter for forskningsdata AS vurdert at behandlingen av personopplysninger i dette prosjektet er i samsvar med personvernregelverket.

Hvor kan jeg finne ut mer?

Hvis du har spørsmål til studien, eller ønsker å benytte deg av dine rettigheter, ta kontakt med:

- *UiT, Norges arktiske universitet, Svein Arne Pettersen tlf 93229644*
- Vårt personvernombud: *Joakim Bakkevold UiT, Norges arktiske universitet,* personvernombud@uit.no
- NSD – Norsk senter for forskningsdata AS, på epost (personverntjenester@nsd.no) eller telefon: 55 58 21 17.
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Med vennlig hilsen

Svein Arne Pettersen

Prosjektansvarlig *Andreas K. Winther*

(Forsker/veileder) Stipendiat

Samtykkeerklæring

Jeg har mottatt og forstått informasjon om prosjektet *Female Football Centre,* og har fått anledning til å stille spørsmål. Jeg samtykker til:

- ☐ å delta i *tracking av trening og kamp*
- ☐ å delta i *å daglig rapportere* antall timer søvn, søvnkvalitet, humør, stressnivå, fatigue, muskelstølhet,"readiness to train" og RPE *via en App (PMSys)*

Jeg samtykker til at mine opplysninger behandles frem til prosjektet er avsluttet, ca. *[31.12.2024]*

(Signert av prosjektdeltaker, dato)