Athlete Monitoring in Rugby League: a focus on the conceptualisation, implementation and utilisation of a wellness questionnaire.

by

Mark Elias Quinn

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ABSTRACT

Wellness questionnaires are often used to monitor athletes to gain an understanding of the responses to training and gameplay. This thesis presents original information concerning the conceptualisation, implementation and use of wellness questionnaires with a focus on the sport of rugby league. The overall aim of the thesis was to investigate the use and implementation of a wellness questionnaire with the goal of developing a framework for successful implementation.

Whilst wellness questionnaires appear to be a popular method for evaluating the response to training and readiness to perform, there are limited details on the type of questionnaires used by practitioners. Study 1 investigated the use and implementation of current wellness questionnaires across a range of high-performance sports. The study examined if there is commonality amongst the use of wellness questionnaires with regard to customised designs, scales, items and the levels of implementation achieved. Based on a review of the literature and practical experience of the research team, an online survey was constructed consisting of 23 questions. 122 participants recruited through the network of the research team completed the survey. Analysis of the responses indicated that customised wellness questionnaires were prevalent and used by the majority of respondents (74%) each training day. These questionnaires differed in the types of scale, items and analysis techniques used. With regard to implementation, the majority reported completion rates above 75%. However, issues associated with the questionnaire, team resources, issuing reminders and generating buy-in were evident. In a follow up to the main survey, practitioners identified five key themes needed for successful implementation which were labelled the *Implementation Outcomes.* These outcomes can be used to evaluate the success of the implementation and use of wellness questionnaires.

Following on from study 1 it was necessary to give an in-depth focus on the implementation and use of wellness questionnaires within a rugby league context. Previous research has identified factors associated with the measure and the social environment that influence questionnaire use in a range of different sports (Saw, Main, & Gastin, 2015b). Therefore, study 2 interviewed players and staff (n = 20) within a European Super League team to examine the factors that were relevant within their

context. Reported *Implementation Factors* were identified across the organisation (e.g. team resources), the measure (e.g. mode and accessibility of the wellness questionnaire), inter-personal (e.g. reminders), and individual level (e.g. player buy-in). The factors were consistent with previous research into implementation and several novel higher order factors were identified residing within the organisation (context, process, personalisation and coaching staff). Twenty-three original lower order themes specific to a rugby league environment were identified. *Implementation factors* manifested across data collection, analysis and decision-making. The findings lend support to the use of a social ecological model to identify factors influencing wellness questionnaire use in rugby league.

The customised wellness questionnaires which have been used within rugby league research give limited insight into the questionnaire development and validation. No wellness questionnaire exists that has been thoroughly validated and tested within a rugby league environment. Study 3 subsequently sought to develop and validate a new wellness questionnaire for use in rugby league. This study involved four phases of development to examine face, content and concurrent validity in addition to the reliability of the questionnaire. The construction of the new questionnaire also concerned the appraisal as to the ecological fit of using wellness questionnaires within the host setting. Taking into account the findings of studies 1 and 2, consideration was given to implementation in the construction of the questionnaire. Aligned with current guidelines, assessments were made to determine the purpose of using the wellness questionnaire, if there was buy-in from the stakeholders and if it was feasible to implement. The newly developed 9-item wellness questionnaire was deemed valid, reliable and acceptable to use within rugby league environments. The study comprehensively demonstrates the process of developing and validating a wellness questionnaire above and beyond other previously used and published questionnaires.

Study 4 used the newly developed questionnaire to assess player wellness in conjunction with external and internal load in a European Super League team. There is a lack of normative wellness data, including details on how to monitor, analyse and interpret this data at team and individual levels. Players completed a wellness questionnaire across 68 consecutive days of the rugby league season (Super 8s to Grand Final). Global positioning system data and session rating of perceived exertion was recorded for training and games. Results indicate the new wellness questionnaire is sensitive to detect change and identifies

a high variation in wellness data the day after game-play. This questionnaire is recommended to collect data at matchdays +1, +3, +4, and +6. Results support the findings of previous studies which suggest that it takes at least 4 days post-game to recover to pre-game levels of wellness. Wellness questionnaires should be used in conjunction with training load data and results found that post-game wellness strongly correlated with the number of tackles in rugby league games, $r(6) = 0.80$ $p= 0.17$. Furthermore, when tackles were combined with high speed running metres wellness was significantly predicted post-game, $F(2, 5) = 17.760$, $p = .005$, adj. $R^2 = .83$. Wellness scores showed high inter and intra individual variability. The study provides case study examples analysing team and individual player wellness, suggesting the use of z-scores and visualisations using statistical process control charts and radar plots.

The findings of this thesis lend support to the use of wellness questionnaires in rugby league and high-performance sport, providing they are appropriately developed, validated and implemented. The final written chapter presents a conceptual model named the *Successful Implementation Framework* which aims to guide practitioner implementation of wellness questionnaires. The framework brings together aspects established in this thesis including the *Implementation Considerations* (study 3), *Implementation Areas* (study 2), *Implementation Factors* (study 2), *Implementation Outcomes* (study 1) and recommendations for use (study 4).

CONTENTS

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LIST OF FIGURES

LIST OF TABLES

LIST OF APPENDICES

LIST OF PUBLICATIONS AND PRESENTATIONS

Accepted Manuscripts

Quinn, M., Sinclair, J., & Atkins, S. (2015). Differences in the high speed match-play characteristics of rugby league players before, during and after a period of transmeridian transition. International Journal of Performance Analysis in Sport, 15, 1065-1076.

Manuscripts Currently in Preparation

Quinn, M., Collins, D., Edmundson, C., & Hurst, H. (2019). How do high-performance sports teams use wellness questionnaires?

Conference Presentations

Quinn, M., Atkins, S., & Bentley, I. (2013). GPS in Rugby League at the BASES Parallel Symposium. Preston.

Quinn, M. (2017). Understanding how human conditioning and coaching performance data is combined to optimise player output within a game scenario. The Rugby Innovation Summit. London.

Quinn, M. (2017). The data driven approach to improving performance. Sports Data & Fan Engagement Summit. London.

LIST OF OPERATIONAL DEFINITIONS

Athlete Monitoring: The observation, analysis and evaluation of the preparation and/or performance of athletes.

Athlete Self Report Measure (ASRM): ASRM are any records of an athletes perceived physical, psychological, and/or social wellbeing, completed on a regular basis (Saw, Kellmann, Main & Gastin, 2016). This term incorporates measures such as wellness questionnaires, diaries and logs.

Burnout: A cognitive–affective syndrome comprised of emotional and physical exhaustion, a reduced sense of accomplishment, and sport devaluation (Raedeke and Smith, 2001).

Buy-in: A conscious decision to adopt and accept a specific method or monitoring strategy. Primarily used throughout the thesis with regard to the adoption and acceptance of the use of wellness questionnaires.

European Super League (ESL): The elite level professional rugby league competition for teams in the northern hemisphere.

Fatigue: An assessment of the sensations of a player's tiredness and associated decrements in muscular performance and function.

Global Positioning System (GPS) Technology: US satellite-based navigation system that is used together with microtechnology devices to pinpoint the location of athletes in training and gameplay to measure movement. Includes the use of other technologies (e.g. accelerometers, magnetometers) within the devices to measure other aspects of physical activity.

High-Speed: Movement at quick velocities, identified in this study as any movement within rugby league training or games > 5 metres per second.

High-Speed Running (HSR): The total distance (metres) covered at speeds > 5 metres per second. This speed must be maintained for a minimum of 1 second.

Implementation: The way a programme, method or technology is put into practice and delivered to participants.

Muscle Soreness: A self-reported rating of pain or discomfort in the lower or upper body muscles.

Mood: A self-reported rating of a player's state of mind.

Motivation: An assessment on how enthusiastic the player is to perform in training.

Non-Training Stress: A general assessment of stress an athlete is exposed to that is outside the team led physical training regime. For example, personal relationships, logistical issues and major life events.

Nutrition quality: A wellness question to assess the quality of a player's nutrition in the last 24 hours.

Overreaching: An accumulation of training and/or non-training stress resulting in short-term decrement in performance capacity with or without related physiological and psychological signs and symptoms of maladaptation in which restoration of performance capacity may take from several days to several weeks (Meeusen et al., 2013).

Overtraining: An accumulation of training and/or non-training stress resulting in long-term decrement in performance capacity with or without related physiological and psychological signs and symptoms

of maladaptation in which restoration of performance capacity may take several weeks or months (Meeusen et al., 2013).

Preparation: The training process whereby an athlete engages in behaviours to improve their performance, supported by coaches and performance staff.

Performance: Participation in a competitive sporting event or training session with the aim of achieving success through physical, technical, tactical and psychosocial components.

Readiness to train: The extent to which an athlete is at an optimal state of wellness and preparation for the training session or game.

Rating of Perceived Exertion (RPE): A self-reported method used to measure the degree of physical strain during training or gameplay.

Session Rating of Perceived Exertion (sRPE): Quantification of internal load by asking athletes how their training session or game was on a 10-point scale (Foster et al., 1995). This rating is subsequently multiplied by the training session duration.

Stress: An ongoing process that involves individuals transacting with their environments, making appraisals of the situations they find themselves in, and endeavouring to cope with any issues that may arise (Mellalieu, Hanton, and Fletcher, 2006). Stress contains physical, psychological and/or social dimensions and is imposed by stressors.

Stressor: The environmental demands associated primarily with competitive performance and non-training factors that impose stress on an athlete.

Sleep Quality: The self-rated satisfaction of the sleep experience.

Sleep Quantity: The total amount of hours the player has perceived to have slept.

Social Desirability: An attempt by respondents on a wellness questionnaire to report values in order to project a favourable, socially acceptable image.

Super 8s (S8): The second half of the European Super League Season in which the top 8 teams attempt to reach the grand final and crowned Super League Champions.

Training load: Total training stress imposed on the athlete which can be quantified using external and internal training load methods.

Unexplained Underperformance Syndrome (UUPS): a persistent unexplained performance deficit (recognised and agreed by coach and athlete) despite two weeks of relative rest (Budgett et al., 2000).

Wellness: a balance of physical, mental and social dimensions which allow an individual to cope with sporting demands, life circumstances and achieve an optimal state of being to perform in training and gameplay.

Wellbeing: A state concerned with general satisfaction and contentedness with life as a whole rather than specific to the performance within training and gameplay.

Wellness Questionnaire: A questionnaire that is used to monitor the physical (e.g. muscle soreness), psychological (e.g. mood state) and/or social (e.g. team cohesion) perceptions of athletes to gauge how close they are to achieving their optimal wellness state to perform in training and gameplay.

CHAPTER 1

Introduction

1.1 Background

Rugby league is an intermittent team sport that takes place over two 40 minute halves (Gabbett, 2005). At senior level it involves 13 players per team who compete in a challenging contest to advance with the ball through opposition territory in an attempt to score a try (Gabbett, King & Jenkins, 2008). The two major club competitions are the European Super League (ESL) and the National Rugby League (NRL), located in Australia and New Zealand. The ESL involves up to a maximum of 32 league games in a season with the potential of up to five additional cup games. The NRL involves a maximum of 28 league games with additional competitions such as State of Origin (3 games) and NRL Nines competition. Teams also have the opportunity to compete in the World Club Challenge, a game between the two best club teams in rugby league (winners of ESL and NRL). In 2015 the ESL introduced a new structure whereby after 23 games of the regular season the top eight teams enter into a new group called the 'Super 8'. They continue to play a further 7 league fixtures in an effort to achieve a top 4 finish. If successful they enter a semi-final game in an attempt to reach the Grand Final in which they then compete to become European Super League Champions.

The sport of rugby league is widely acknowledged to be physically demanding (Gabbett, 2005; Gabbett et al., 2008; Johnston, Gabbett, & Jenkins, 2014). The game is characterised by physical collisions, running, sprinting, tackling and wrestling opponents (Gabbett et al., 2008). There are frequent repeat high intensity efforts where three or more maximal acceleration, high speed or contact efforts with less than 21 seconds between each effort occur (Johnston et al., 2014). The research shows (Table 1.1) the typical match-play activity profile to consist of players covering distances between 4000-8000m

at high intensity and low intensity speeds (Austin & Kelly, 2014; Evans et al., 2015; Evans et al., 2018; Gabbett, Jenkins, & Abernethy, 2012; McLellan & Lovell, 2013; Twist et al., 2014; Waldron, Twist, Highton, Worsfold, & Daniels, 2011). The intensity of the distance covered ranges between 83 $m.min^{-1}$ (Evans et al., 2015) to 120 $m.min^{-1}$ (Quinn, Atkins, & Sinclair, 2015). Papers have added context to these demands by identifying the differences between winning and losing teams (Gabbett, 2013), duration of match recovery times (Murray, Gabbett, & Chamari, 2014), activity cycles recognising how long the ball is in play (Gabbett, 2015; Kempton, Sirotic, Cameron, & Coutts, 2013) and the demands across different field positions when attacking or defending (Gabbett, Polley, Dwyer, Kearney, & Corvo, 2014). Research papers have also looked at the intensity of games across small in game periods (Delaney et al., 2015) as well as the tactical and technical differences that impact on a team's success (Gabbett, 2014; Hulin, Gabbett, Kearney, & Corvo, 2015). Explicit comparisons have been made between the NRL and ESL (Twist et al., 2014). Whilst Quinn, Atkins and Sinclair (2015) investigated the differences in match-play demands between the ESL and the World Club Challenge (see appendix A). There is still much to learn about the demands of rugby league and recent papers have advanced understanding on movement in relation to collisions (Johnston et al., 2019; Weaving et al., 2019) and the link to performance characteristics and phases of play (Rennie et al., 2019).

Table 1.1 Demands of elite rugby league match-play

Study	Competition & Positional Group	Playing time (min ± SD)	Distance (m ± SD)	Metres/Min (m.min^{-1} ± SD)	Low Speed Activity (m ± SD)	High Speed Activity (m ± SD)
Austin & Kelly (2014)	NRL FWD	-	5964 ± 696	85 ± 4	4655 ± 568	432 ± 117
	NRL BACK	-	7628 ± 744	86 ± 5	5,844 ± 549	749 ± 205
Dempsey, Gibson, Sykes, Pryjmachuk, & Turner (2017)	INT FWD	57.6 ± 17.6	4854 ± 1506	84.6 ± 6		
	INT BACK	85.7 ± 13.3	7255 ± 1206	84.9 ± 8.6		
Evans et al. (2018)	ESL OB 2013	83 ± 4.7	-	86.2 ± 4.2	-	-
	ESL PIV 2013	72.3 ± 9.0	-	94.1 ± 2.7	-	-
	ESL MUF 2013	45.5 ± 2.7	-	93.0 ± 5.3	-	-
	ESL WRF 2013	72.3.4	-	91.9 ± 3.0	-	-
	ESL OB 2014	84.1 ± 6.1	-	91.1 ± 3.4	-	-
	ESL PIV 2014	71.6 ± 6.6	-	98.9 ± 2.9	-	-
	ESL MUF 2014	48.0 ± 7.1	-	100.3 ± 3.9	-	-
	ESL WRF 2014	72.4 ± 15.1	-	95.9 ± 6.3	-	-
Evans et al. (2015)	ESL OB	86.7 ± 3.4	7246 ± 333	83.6 ± 2.8	-	618 ± 132
	ESL PIV	72.8 ± 10.6	6549 ± 853	90.2 ± 3.3	-	453 ± 149
	ESL MUF	47.8 ± 6.6	4318 ± 570	90.8 ± 2.2	-	283 ± 84
	ESL WRF	77.0 ± 9.0	6408 ± 629	83.4 ± 2.4	-	457 ± 108
Gabbett et al. (2012)	NRL HUF	38 ± 10.8	3,569 ± 1,177	94 ± 10	3,334 ± 1,082	235 ± 122
	NRL WRF	58.5 ± 16.7	5,561 ± 1,579	96 ± 13	5,143 ± 1,474	418 ± 154
	NRL ADJ	64.1 ± 23.0	6,411 ± 2,468	101 ± 19	5,974 ± 2,299	436 ± 198
	NRL OB	73.5 ± 14.9	6,819 ± 1,421	93 ± 13	6,235 ± 1,325	583 ± 139
Gabbett (2013)	NRL FOR	50.7 ± 13.1	5,129 ± 1,652	105 ± 21	4,878 ± 1,541	251 ± 157
	NRL ADJ	74.9 ± 14.6	7,834 ± 2,207	99 ± 8	7,513 ± 2,138	320 ± 176
	NRL BACK	77.8 ± 10.1	7,575 ± 850	94 ± 10	7,123 ± 830	452 ± 113

Abbreviations: ESL, European Super League; NRL, National Rugby League; INT, International Rugby League; FWD, forwards; ADJ, adjustables; BACK, backs; OB, outside backs; PIV, Pivot; MUF, Middle Unit Forward.

Table 1.1 continued.

Study	Competition & Positional Group	Playing time (min ± SD)	Distance (m ± SD)	Metres/Min (m.min^{-1} ± SD)	Low Speed Activity (m ± SD)	High Speed Activity (m ± SD)
McLellan, Lovell, & Gass (2011b)	NRL FWD	-	4,982 ± 1,185	-	4,664 ± 1,165	232 ± 60
	NRL BACK	-	5,573 ± 1,128	-	4,879 ± 1,339	440 ± 101
McLellan and Lovell (2013)	NRL FWD	-	8,442 ± 812	98 ± 12	-	-
	NRL BACK	-	8,158 ± 673	101 ±8	-	-
Quinn, Atkins, and Sinclair (2015)*	ESL	58	5642 ± 1427	97	-	231 ± 167
	ESL (WCC)	44	5261 ± 1774	120	-	393 ± 172
	ESL	47	5059 ± 1176	108	-	330 ± 163
Twist et al. (2014)	NRL FWD	56.7 ± 16.4	4,948 ± 1,370	88 ±8	-	-
	NRL ADJ	82.8 ± 8.9	7,973 ± 1,160	96 ±8	-	-
	NRL BACK	85.8 ± 3.9	7,381 ± 518	87 ±6	-	-
	ESL FWD	57.9 ± 15.8	5,733 ± 1,158	102 ± 14	-	-
	ESL ADJ	69.7 ± 23.4	6,766 ± 1,495	104 ± 27	-	-
	ESL BACK	83.9 ± 12.9	7,133 ± 1,204	86 ± 11	-	-
Varley, Gabbet, and Aughey (2014)	NRL	64.9 ± 18.8	6,276 ± 1,950	96 ± 16	5,950 ± 1,845	327 ± 168
Waldron et al. (2011)	ESL FWD	44.2 ± 19.2	4,181 ± 1,829	95 ± 7	1,723 ± 743	513 ± 298
	ESL ADJ	65.2 ± 12.4	6,093 ± 1,232	94 ± 8	2,365 ± 667	907 ± 255
	ESL BACK	77.5 ± 12.3	6,917 ± 1,130	89 ± 4	3,262 ± 505	926 ± 291

Abbreviations: ESL, European Super League; NRL, National Rugby League; INT, International Rugby League; FWD, forwards; ADJ, adjustables; BACK, backs; OB, outside backs; PIV, Pivot; MUF, Middle Unit Forward. WCC; World Club Challenge. *Attached as Appendix A

As a result of rugby league game-play, significant muscle damage (Twist & Highton, 2013) and muscle soreness follows post-game (McLean, Coutts, Kelly, McGuigan, & Cormack, 2010). Alongside these physical demands there are a number of other stressors and challenges an elite athlete must face throughout the season. In general, players are confronted with physical, psychological, emotional and social strains from gameplay, training and pressures to perform (Drew, Cook, & Finch, 2016; Markser, 2011). In the description that follows, a prototypical example of life as an elite rugby league player in the ESL is documented. The example has been developed from personal experience of working in the industry as a sports scientist alongside insights from applied and academic texts (Heidari, Kölling, Pelka, & Kellmann, 2018; Peacock, 2018). The description is designed to give background and expose the foundation for the use of monitoring strategies with rugby league athletes.

Exemplary description of life as an elite rugby league player
Life as an elite rugby league player (with reference to Heidari, Kölling, Pelka, & Kellmann, 2018; Peacock, 2018)

As a European Super League player your season ideally lasts from late November until the beginning of October, if you are able to endure the pre-season, make the playoffs and proceed to the Grand Final. There are a number of other important competitions along the way including the Challenge Cup and finishing top of the league at the end of the regular season. If you are the reigning national champions there is also the chance to claim the title of the best team in the world in the World Club Challenge. During these eleven months as a rugby league player you are exposed to a stressful and tough schedule involving weekly games, rugby training, weights, physio sessions, team meetings, and off-the-field responsibilities.

In the one month out of season some of the players compete in international competitions and those on their "break" are often completing maintenance programmes in the gym several times a week. It is then straight into the pre-season and the training load is high. Usually teams will train five or six days a week with minimal breaks for rest. You are exhausted most of the time. It is physically relentless and intense but it gives you the base you need for a successful season.

During the season the week is different and the focus is on being mentally and physically ready to perform in the game. There are extremely demanding periods and it is a fast paced career that leaves no room for contemplation of all the experiences you have to deal with. For example, Easter has two games in the space of a weekend often against your local rivals. Then there is the trip to the south of France; up at 3am, flight at 7am, pre-match preparations, game, recovery, post-match commitments, flight home, drive home, into bed at 2am and back to the training ground later that morning for video review and recovery. Next year there is a team in Toronto, Canada! And there is also the World Club Challenge, a great experience when it is in Australia. But it can be stressful flying a round trip to the other side of the world and then straight back into the demands of the regular season.

To make it to the top, and to be winning trophies, you need a large number of skills and personal qualities. Physically life as a rugby player is intense but you also need to cope with mental strains. Family life can take a back seat and you often don't give your social life the attention it deserves. You live your life by saying no to a lot of things; nights out, weddings and other social events. You must be resilient, learn how to deal with failure, know how to improve and have a strong work ethic to do so. You must have a high pain threshold to be able to push yourself through discomfort in training and games. Even sleeping is a challenge. After games at night you are so pumped with adrenalin that you only doze off around 6am for a few hours and feel terrible the next day. The following night you might oversleep from being so tired and get 11 hours, then you find it hard to sleep the next night. By the time you are back to normal it is game day and back to square one.

Rugby league and high-performance sport does not allow you to show any sign of weakness. Making sure you have trained and recovered sufficiently is a delicate juggling act to ensure you are ready to perform in training and games.

The exemplary description above, allied to the earlier academic findings, illustrates that the life of a rugby league player is demanding; an assortment of sport and non-sport specific challenges that can be stressful. Such physical and mental stress may result in an imbalance between stress and recovery (Heidari et al., 2018), contribute to injury, illness or in the long term to an athlete experiencing overtraining syndrome (Meeusen et al., 2013). In an attempt to prevent these negative outcomes, determine adaptations and optimise performance, rugby league teams have increasingly taken scientific approaches in recent years by monitoring their athletes (Twist & Highton, 2013). Substantial human and financial resources are invested in this area (Coutts & Cormack, 2014) as teams use a range of methods in attempt to quantify external training load (e.g. time, distance, speed), internal training load (e.g. Rating of Perceived Exertion, heart rate, lactate), and crucially the response of a player to training and match-play (e.g. wellness questionnaires) (Bourdon et al., 2017).

Whilst a range of monitoring methods exist, it is important to quantify both training load and the response of a player to that load (Coutts & Cormack, 2014). There is a large range of research which has investigated the response to training load in the development of overtraining syndrome. In particular, research highlights the use of multiple strategies which include the use of regular subjective measures such as questionnaires for identifying at risk athletes (Meeusen et al., 2013; Schwellnus et al., 2016).

Subjective measures such as wellness questionnaires are now used frequently in applied practice (Taylor, Chapman, Cronin, Newton, & Gill, 2012) to investigate the responses both on a chronic level, for investigating overtraining, as well as the acute response to

training or match-play and the readiness of an athlete to perform (Haaf et al., 2016). Indeed, subjective measures have recently been shown to have superior sensitivity and consistency over objective measures for monitoring of acute and chronic training loads (Saw, Main, & Gastin, 2016). Furthermore, they have been shown to be effective at identifying subtle changes in rugby league players recovery from match play (McLean et al., 2010).

1.2 Statement of the Problem

The subjective measure that has become popular amongst applied practitioners for monitoring athletes is the wellness questionnaire (Starling & Lambert, 2017; Taylor et al., 2012). In general these questionnaires gather ratings of muscle soreness, fatigue, stress, mood, nutrition, sleep and other metrics on a scale (e.g. 1-10) (McGuigan, 2017). This method is low cost and can be a valid, reliable and sensitive tool to measure how an athlete is coping with the demands of elite sport (Clubb & McGuigan, 2018). There are large benefits of questionnaires being a simple, inexpensive and time efficient monitoring tool that provides valuable information (Hooper & Mackinnon, 1995).

The importance of wellness is perhaps best emphasised by research surrounding the effect of poor wellness on physical measures and performance. Studies across a range of team sports have shown that pre-training wellness values could indicate the exercise output during training sessions (Gallo, Cormack, Gabbett, & Lorenzen, 2017; Govus, Coutts, Duffield, Murray, & Fullagar, 2018; Malone et al., 2018). In particular it is apparent that a reduction in pre-training wellness can correspond to a reduction in player load (Gallo et al., 2017). Furthermore, wellness has been shown to be related to reductions in external

load as determined through GPS, with lower maximal velocities and distances at high speed during training sessions in elite soccer (Malone et al., 2018). In support of these findings an increase in wellness has shown a subsequent increase in player load output as determined through GPS and accelerometers in American football (Govus et al., 2018). Aspects of player wellness are useful to determine levels stress (Hopkins, 1991) and identify risk for injury or illness (Saw, Main, & Gastin, 2016). The relationship between wellness and training load has been highlighted for mood state (Halson et al., 2002; Rietjens et al., 2005), across both acute and chronic loads (Saw, Main, & Gastin, 2016), whilst there is more limited evidence of association with other objective physiological, biochemical and performance measures (Saw, Main, & Gastin, 2016). Importantly, it is the wellness questionnaire which is able to monitor changes in readiness to train, showing promise in its ability to predict outputs and negative consequences such as functional overreaching (Haaf et al., 2016; Wiik et al., 2019).

A benefit of wellness questionnaires is that they are able to assess multiple aspects related to fatigue, recovery and performance which can be easily comprehended by players, coaches and sports science staff. They are particularly useful during intensified periods of training (Saw, Halson, & Mujika, 2018; Saw, Main, & Gastin, 2015c), where players are exposed to many different stressors in addition to match-play that contribute to a player's wellness and performance (e.g. sleep, fatigue, soreness) (Polman & Houlahan, 2004). There are a range of different questionnaires that have been used to monitor the wellness of players including Profile of Mood States (Morgan, Brown, Raglin, O'Connor, & Ellickson, 1987), Daily Analysis of Life Demands for Athletes (Rushall, 1990) and the Recovery Stress Questionnaire (Kellmann, & Kallus 2001). Although such subjective

assessments are sensitive to change in training stress (Twist & Highton, 2013) these are often protracted documents that do not encourage routine compliance.

McLean and colleagues (2010) opted to custom build a questionnaire for use in their study with rugby league players in order to monitor sleep, muscle soreness, fatigue, stress levels and mood on a five-point scale. The questionnaire was brief and thus limited the time burden on athletes to allow for greater implementation on a regular basis. It was shown to be sensitive to change demonstrating an increase in player soreness and poorer overall wellness following each match.

However, despite these previous studies, investigations into the effectiveness of wellness questionnaires in rugby league have not been developed further. This is notwithstanding the fact that many elite sports teams use similar custom-built questionnaires with their athletes in order to make decisions to the training programme based on the information self-reported by players (Saw, Main, & Gastin, 2015a; Taylor et al., 2012). Hooper and Mackinnon (1995) pointed out over 20 years ago a short number of recommendations for monitoring via self-report, and these still form the basis for many questionnaires used in research and applied settings today (Saw, Kellmann, Main, & Gastin, 2016). It is unknown whether such customised subjective measures are valid and accurately reflect changes in athlete wellness (Saw et al., 2015a). Furthermore, apart from the publications of Saw and colleagues (Saw et al., 2016; Saw et al., 2015a; 2015b; 2015c) little research has comprehensively discussed how this data can be collected, analysed, interpreted and used to make decisions despite the wide practical use of these measures. Indeed, questions

remain regarding the usefulness of such a tool during competitive phases of the season in elite level rugby league.

When setting out to develop this thesis, it was noted that very few studies had focussed on the use of contemporary performance data as found in the use of wellness questionnaires. Whilst practitioners were utilising these methods with increasing frequency to inform practice, the effectiveness of the use of this data and the implementation of the methods were unknown. The research practitioner noticed that teams often made customisable changes to wellness questionnaires throughout past seasons and there was no consistency in the methods for collection and analysis of data. Neither was there agreement in the education and promotion of wellness questionnaire use. This thesis consequently set out to add to the knowledge base of how questionnaires are conceptualised, implemented and utilised within high-performance sport. It thus is focussed around applied practice and offers real world applicability to sports scientists, strength & conditioning coaches and other high-performance practitioners.

1.3 Aims and Approach to the Problem

The overarching aim of the thesis was to investigate the use and implementation of a new wellness questionnaire in high-performance sport with the goal of developing a framework for successful implementation specifically within rugby league. A mixed-methods approach was utilised and elements of the research split into three stages:

Stage one: *Qualitative techniques were utilised to understand how to successfully implement the use of a wellness questionnaire.*

- Aim 1 - To investigate how wellness questionnaires are used and implemented in a range of high-performance sports.
- Aim 2 - To investigate the factors that influence implementation of a wellness questionnaire within rugby league.

Stage two: *Quantitative and qualitative methods were used to develop and validate a new wellness questionnaire before assessment of the demands of rugby league and how wellness questionnaires can be used as part of a toolkit of monitoring methods.*

- Aim 3 - To develop and validate a new wellness questionnaire for use within rugby league.
- Aim 4 - To examine applied methods to monitor, analyse and interpret team and individual wellness data in rugby league.

Stage three: *The culmination of the research and synthesis of a conceptual framework for the successful implementation and use of wellness questionnaires.*

- Aim 5 - To develop a conceptual framework for successful implementation and utilisation of a wellness questionnaire in rugby league.

CHAPTER 2

Literature Review

2.1 Preamble

To establish the context for this thesis it is necessary to cover a number of multidisciplinary research areas, in particular within sports science, strength & conditioning, sports psychology, coaching and performance. The aims of this literature review are threefold: (1) To provide an overview of the subject area of athlete monitoring in general and in relation to the context of rugby league. (2) To conceptualise the use of wellness questionnaires by understanding current research, practice and the theoretical underpinnings behind monitoring wellness. (3) To discuss the considerations regarding the implementation of wellness questionnaires and monitoring strategies.

Athlete monitoring has become commonplace in elite sport in recent years and often involves the use of technology and practices to observe, analyse and evaluate the preparation and/or performance of athletes (McGuigan, 2017). There are many different reasons for monitoring players but in general all monitoring is geared around the preparation of athletes in order to achieve consistent and successful performance (Saw et al., 2015c). Wellness questionnaires are one such measure used for monitoring athletes. Sometimes they are referred to as Athlete Self Report Measures within the literature (Saw et al., 2015a), although this term also incorporates diaries and logs as well as questionnaires. Essentially wellness questionnaires in sport are measures in which athletes self-report their subjective physical, psychological, and/or social state of wellness. According to a systematic review of clinical medical literature, wellness refers to a balance of physical, mental and social dimensions which allow an individual to cope with life circumstance and achieve an optimal state of being (Bart et al., 2018). In the context of sport, a wellness questionnaire is used to monitor the physical (e.g. muscle

soreness), psychological (e.g. mood state) and social (e.g. team cohesion) perceptions of athletes to gauge how close they are to achieving their optimal state to perform. It therefore monitors the response to training, game-play and everyday life.

2.2 Athlete Monitoring

Monitoring athletes is anything but a new phenomenon. Distances, speeds and time have been measured since competitive sport began. Even the relatively modern concept of wearable technology can be traced back to primitive examples in the 1920's where athletes wore magnets to detect acceleration as they sprinted past coils of copper wire (Hill, 1927). However, the modern-day landscape has seen exponential development of technologies and companies targeting the athlete monitoring market (McGuigan, 2017). Substantial resources are continually invested by sports organisations in monitoring methods such as Global Positioning System devices or wellness questionnaires within internet based athlete monitoring systems (Coutts & Cormack, 2014). Indeed, 91% of respondents in a survey by Taylor and Colleagues (2012) implemented some form of monitoring, whilst in a survey by Akenhead and Nassis (2016) 41 elite football teams from across the world used monitoring practices. This level of monitoring has been parallel to the rise of sports science and strength & conditioning careers in applied environments. It is the role of these practitioners to use these monitoring methods and evidence based practices to inform coaches on player response to training, gameplay, and tailor training accordingly so they are ready to perform.

There are a number of benefits and insights that contemporary monitoring has given sports from a research and practical perspective which are outlined in the review below.

However, these developments have not been without critique and at a recent conference on analytics (Inaugural Seattle Sounders Analytics Conference, 2019), some academics and practitioners stated they were disheartened with the monitoring world of sports science (Robertson & Ward, 2019). In particular that the discipline has become preoccupied with monitoring and practitioners becoming purveyors of gadgetry. In some instances this may be the case, but wellness monitoring can be useful for research and practice. However, for performance data to have this utility one of the initial steps to take before selecting any type of monitoring method is to explore the reasons for doing so and then how this may be achieved.

2.2.1 Establishing the Purpose for Athlete Monitoring

When collecting any type of data it is first important to establish the reason for doing so. Implementation research across health and education stresses the importance of conducting a needs assessment from the outset (Meyers, Durlak, & Wandersman, 2012). Graham (1990) also conveys this paramount importance when handling data by explaining that the initial step is to pose the question. A potential, perhaps common, mistake within sport is to determine the need or solution before identifying any problem (Torres-Ronda & Schelling, 2017). Unless the practitioner knows the initial impetus behind initial data collection it can be very difficult to execute the steps in the data-handling process. It is important to be clear on the reasons for monitoring so that appropriate collection, analysis and interpretation of data can be achieved.

There are many reasons teams and organisations choose to use monitoring practices. Athlete monitoring can help to inform on the individual and collective response to a

training programme, the assessment of fatigue, recovery and minimisation of the risk of non-functional overreaching, injury and illness (Bourdon et al., 2017). Ultimately monitoring has performance at the core, as the practitioner looks to use monitoring to enhance, or ensure, optimal performance and wellness. To be effective any monitoring needs to be able to quantify what the athlete is doing (external and internal workload in training and competition) and give an understanding of how the athlete is coping with elite sport (Borresen & Lambert, 2009; Gabbett et al., 2017). This includes analysing many factors associated with high-performance including non-training factors (e.g. nutrition, hydration, relationships, stress, sleep). Monitoring these aspects provides a platform for decisions to be made regarding adaptation, recovery and performance.

With regards to why a practitioner may monitor wellness, it is likely to be because these measures typically inform on the response to training (Saw et al., 2016) and/or detect player readiness to perform (Haaf et al., 2016). For example, an insight into player muscle soreness provides evidence on the perceptions of how athletes have physically responded to a training session and when they are ready for the next session. In doing so this facilitates information disclosure and communication between team personnel, improving the overall management of athlete preparation (Saw et al., 2015c). Several guidelines have been set out to help the practitioner establish purpose when using self-report measures (Saw et al., 2016). Commitment of the coaching team and other stakeholders is an important initial consideration and practitioners are advised to firstly establish the need for monitoring via conversation. Thus having a well-defined purpose can ultimately help with player buy-in clarifying to them the need for data to be collected (Saw et al., 2015c).

Because of the range of uses of wellness questionnaires it is vital to be clear on how the questionnaire will work alongside other monitoring methods. To that extent Gabbett and colleagues (2017) have recently provided a practical guide around the athlete monitoring process (Figure 2.1). They stress the initial importance of knowing the reason for implementing a monitoring strategy as this will inform on the measures selected. For example, measurement and monitoring of training load will be different in rugby league to baseball. Quantification of external load in rugby league may focus on high speed running whereas for a baseball pitcher may focus on quantifying the number and speed of balls thrown. In this respect external, internal and performance tests should be context specific. The same is true for monitoring the response via the use of wellness questionnaires, as these should reflect the environment they are used in (Saw et al., 2015a). However, the importance of the athlete monitoring cycle lies in how the combination of stages, designed around a purposeful question, results in useable information for the practitioner to make decisions around the training programme. For example, simplistically if a player has “good” wellness and a “low” workload, then the training workload can likely increase (Figure 2.1). Two aspects which are integral to this model are monitoring the internal and external workload. These must be considered before monitoring the response to training and using wellness questionnaires.

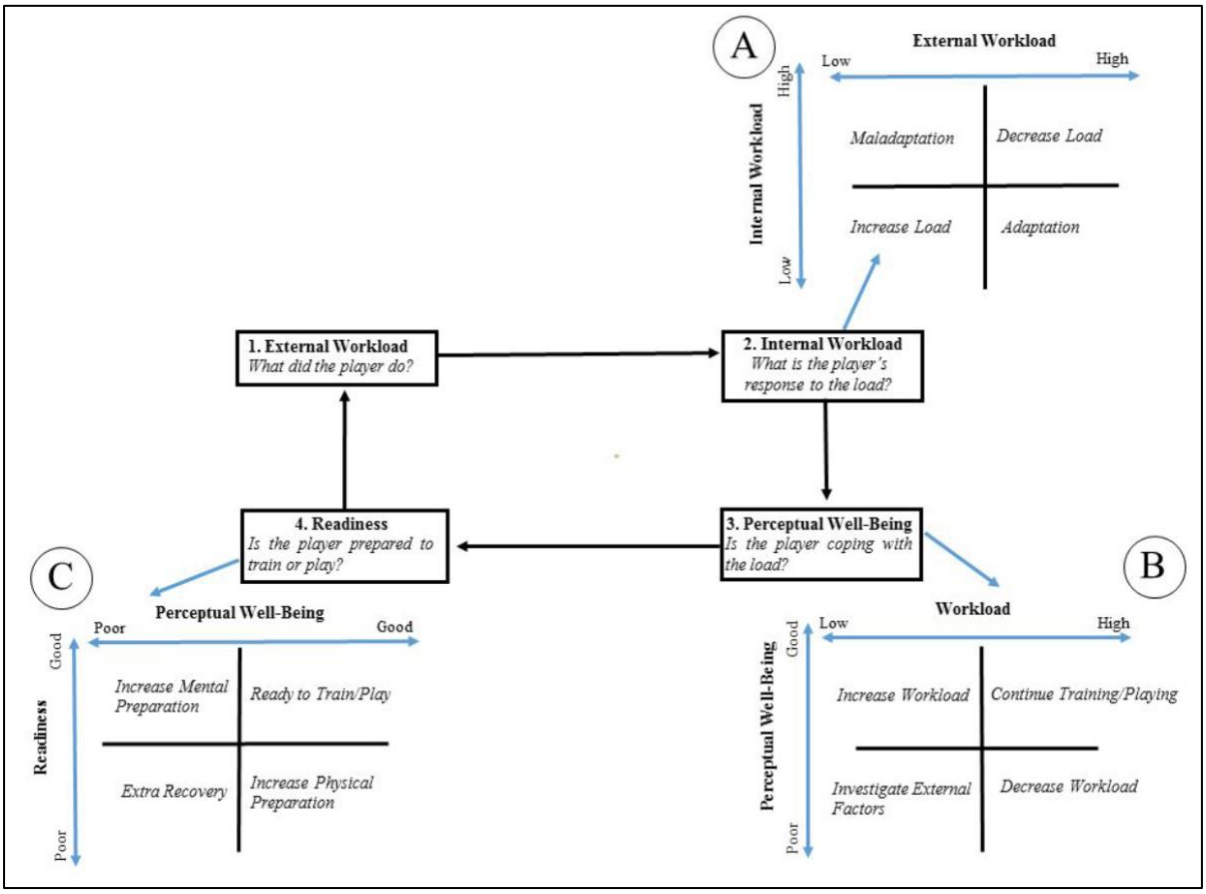


Figure 2.1 The athlete monitoring cycle as depicted by Gabbett et al. (2017).

2.2.2 Internal and External Load

Once the need for monitoring has been recognised, the challenge for the practitioner is to identify the solution and innovations suitable to answer the question (Torres-Ronda & Schelling, 2017). In a recent consensus statement, the authors defined the internal load as the biological stressors imposed on the athlete (both physiological and psychological) and the external load as the objective methods of the work performed by the athlete (Bourdon et al. 2017). These are two important measurable constructs within the training process (Impellizzeri, Marcora, & Coutts, 2019). Examples of the types of measure used to monitor training load are shown in Table 2.1. In this table, the internal and external measures are presented, but it is worth pointing out that some of these are used to measure

the response to training load (denoted by *). Information is displayed which describes the critical features of the monitoring method including cost, how easy it is to use and whether it is valid and reliable. In team sports, such as rugby league, measures need to be able to be used on a daily to weekly basis. In addition to validity and reliability they must have the necessary implementation factors or practical considerations that will lead to the best experience and output (e.g. quick turnaround of data, athlete buy-in) (Saw et al., 2015b). This has contributed to the measures such as Global Positioning System (GPS) and accelerometery technology, heart rate, Rating of Perceived Exertion (RPE) and wellness questionnaires having such success (Akenhead & Nassis, 2016; Saw, Main, & Gastin, 2016; Starling & Lambert, 2017; Taylor, et al., 2012). Biochemical and hormonal measures, which have just as much levels of evidence for use with athletes, are not used as frequently because they lack this practical value (McGuigan, 2017). Common methods in use by rugby league teams also benefit from the fact that athletes and coaches can easily understand these metrics. For example, muscle soreness, sleep quality and distance are quite self-explanatory when compared with explaining how glutamine-to-glutamate ratio, salivary cortisol or full psychological inventories translate to performance. Whilst some measures offer more academic use, applied sport measures for monitoring athletes should add value to the organisation by translating data into actionable decisions.

Table 2.1 Common methods used to monitor training load and responses (Bourdon et al., 2017)

Method	Cost	Hardware needed	Software needed	Ease of use	Valid	Reliable	Used to interpret	Used to prescribe	Variables
Internal Measures									
RPE	L	N	Y/N	H	M–H	M–H	Y	Y	Single variable in AU (time dependent)
Session rating of perceived exertion	L	N	Y/N	H	M–H	M–H	Y	Y	Single variable in AU (time dependent)
TRIMP[4]	L–M	Y	Y	M	M–H	M–H	Y	N	Single variable in AU (time dependent)
Wellness questionnaires*	L	N	Y/N	M–H	M	M–H	Y	Y/N	Ratings, checklists, AU scale measures
Psychological inventories (eg, POMS, Rest-Q-Sport)*	L–M	N	Y/N	M–H	M–H	M–H	Y	Y	Ratings, checklists, AU scale measures
Heart-rate indices	L–M	Y	Y	H	H	M–H	Y	Y	Heart rate, time in zones, HR variability/recovery measures, etc
Oxygen uptake	H	Y	Y	L	H	H	Y	Y	VO_2, metabolic equivalents
Blood lactate	M	Y	Y/N	M	H	H	Y	Y	Concentration
Biochemical/hematological assessments	M–H	Y	Y/N	L	H	M–H	Y	Y	Concentrations, volumes
External Measures									
Time	L	Y	Y/N	H	H	H	Y	Y	Units of time (s, min, h, d, wk, y)
Training frequency	L	N	N	H	H	H	Y	Y	Session count
Distance/mileage	L	Y/N	Y/N	H	H	H	Y	Y	Units of distance (m, km)
Movement repetition counts	L	Y/N	Y/N	M–H	H	M–H	Y	Y	Activity counts (eg, steps, jumps, throws)
Training mode	L	Y/N	N	H	H	H	Y	Y	Weight training, run, cycle, swim, row, etc
Power output	M–H	Y	Y	L–M	H	H	Y	Y	Relative (W/kg) and absolute power (W)
Speed	L–M	Y	Y/N	M–H	H	H	Y	Y	Speed measures (m/s, m/min, km/h)
Acceleration	L–M	Y	Y	L	H	H	Y	Y	Acceleration measures (m/s^2)
Functional neuromuscular tests	L–M	Y	Y/N	M	M–H	H	Y	Y	Countermovement-jump and drop-jump measures
Acute:chronic-workload ratio	L–M	Y/N	Y	M	M–H	M–H	Y	Y	Size of acute training load relative to chronic load
GPS measures	M	Y	Y	M	M–H	M	Y	Y	Velocity, distance, acceleration, time in zones, location
Metabolic power	M	Y	Y	L–M	L–M	M	Y	N	Energy equivalent
Time–motion analysis video (automated)	H	Y	Y	L	M–H	M	Y	Y	Velocity, location, acceleration
Time–motion analysis video (nonautomated)	M–H	Y	Y	L	M–H	M	Y	Y	Velocity, location, acceleration
Accelerometry	M	Y	Y	L–M	M–H	M	Y	N	*x-y-z g* force
Player load	M	Y	Y	M	M	M	Y	Y	Single variable in AU (time dependent)

Abbreviations: L, low; M, medium; H, high; Y, yes; N, no; AU, arbitrary units.

*Measures of training response.

Athlete monitoring has gained importance as research has continued to show the link between inappropriate load management, illness and injury (Soligard et al., 2016; Schwellnus et al., 2016). The rugby league player perhaps has greater risk due to saturated competition calendars alongside ever increasing training and game demands. Practically speaking it is important to have an integrated approach (Bourdon et al., 2017), sometimes refered to as a mixed methods approach, where a combination of both internal and external measures of the training stimulus are used. Halson (2014) describes the importance of this by explaining that it may be the relationship between internal and external loads which reveal whether an athlete is fresh or fatigued. For example, two rugby training sessions may be the same in terms of duration, distance and speed (external load). But they may have totally different heart rate response and RPE (internal load) on each of the sessions. This also works the other way as players may give the same RPE for two contrasting sessions in terms of distance and duration. Hence there is the benefit of recording both internal and external load to generate a full picture of the training stimulus.

When using any type of method to monitor athletes from an academic and applied perspective it is important to understand the validity and reliability of the measure. In rugby league GPS measures and RPE are common methods to monitor external and internal load, the validity and reliability of which are discussed below.

2.2.2.1 External Load via Global Positioning System (GPS) Technology

In recent years, monitoring the external demands in rugby league has largely utilised GPS technology. GPS units provide information based on the principle of trilateration (Larsson, 2003). Through the acquisition of signals from at least four satellites, and rate

of change of signal frequency (Doppler Shift), information on distance covered, speed and the characteristics of in-game performance can be determined. The GPS portion of these microtechnology devices is primarily used to calculate distances and speeds but alongside other sensors (e.g. accelerometers and magnetometers) allows for quantification of collisions and forces. Early research into the validity of GPS identified that devices had greater validity with regard to measuring distance over longer duration tasks (Coutts & Duffield, 2013; Jennings, Cormack, Coutts, Boyd, & Aughey, 2010; MacLeod, Morris, Nevill, & Sunderland, 2009; Petersen, Pyne, Portus, & Dawson, 2009). Not surprisingly the speed and acceleration of running influences the validity of the distance calculated (Petersen et al., 2009; Jennings et al., 2010) which poses problems for sports such as rugby league given the high velocity, low distance change of direction movements (Aughey, 2011). More recent reviews have shown that GPS devices that record at higher frequencies have greater validity and reliability, with 10Hz models overcoming many of the limitations of 1Hz and 5Hz iterations such as quantification of high speed change of direction movements (Scott, Scott, & Kelly, 2016). However, due to the physical limits to human movement 15Hz devices have not been shown to be any more accurate than 10Hz devices (Scott et al., 2016) and in some instances performed worse than 10Hz (Johnston, Watsford, Kelly, Pine, & Spurrs, 2014). Therefore, as we await more studies with newer 15Hz+ devices, the 10Hz devices appear to be optimum.

Work rate movement patterns are most often reported using GPS technology, whilst accelerometer and impact data remain less commonly stated (Cummins, Orr, O'Connor, & West, 2013). This may be due to the uncertainty regarding the use of collision and player load data. For example, in a study by McLellan and Lovell (2012) the average

number of impacts identified through these devices was significantly higher than the actual number of collisions (hit ups and tackles) recorded through video analysis. Yet in another study no significant differences existed between collisions recorded using GPS devices when compared with video (Gabbett, Jenkins, & Abernethy, 2010). Furthermore, there were strong correlations ($r=0.96$, $p<0.01$) between the collisions identified on video and by GPS device. A follow up to this study which focussed on gameplay also confirmed these findings with Catapult S5 GPS devices identifying 97.6% of collisions during match play (Hulin, Gabbet, Johnston, & Jenkins, 2017). However, a subsequent study has cast doubts over the quantification of player load on Catapult devices when compared to the stated formula for calculation by the manufacturer (Nicollella, Torres-Ronda, Saylor, & Schelling, 2018). The research illustrates that some of the GPS devices may have greater validity for quantifying collision based demands than others. Whilst devices can categorise different thresholds of collision they are unable to distinguish between the initial contact from a tackle and the second or third player contributing to the tackle or the impact from the ground. Therefore, caution should be taken when interpreting collision data on GPS devices.

With the rapid development and release of new devices almost annually it is important that researchers and practitioners continue to assess the validity and reliability of these devices. A recent paper has confirmed the validity of the newest 10Hz and 18Hz devices on the market (Beato, Coratella, Stiff, & Iacono, 2018). Whilst such papers are beneficial variability exists between the different brands, there is often limited manufacturer information as to how metrics are calculated (Malone, Lovell, Varley, & Coutts, 2017) and therefore the general advice would be to be cautious when comparing data collected

from units sampling at different frequencies. This presents a huge challenge for the practitioner when upgrading equipment with the potential to lose valuable data. Furthermore, practitioners should follow strict protocols such as turning the GPS devices on and setting them down 10-15 minutes before use in order to download the almanac data from satellites (Duffield, Reid, Baker, & Spratford, 2010; Hoppe, Baumgart, Polglaze, & Freiwald, 2018; Vickery et al., 2014). From a practical point of view GPS devices are used heavily throughout the training season yet likely only calibrated once a year. Practitioners should be aware of signal quality due to the number of connected satellites and horizontal dilution of precision, as well as how the data is processed with the device brand and software used (Malone, et al., 2017). Due to other practitioner commitments and logistics these protocols may not always be followed. Rather than relying only upon the results of single research studies, care should be taken to ensure any data generated from GPS is accurate, valid and reliable via in house testing, calibration and the following of consistent protocols throughout the season. GPS data can be analysed post training and game in conjunction with wellness questionnaires to assist with training load prescription of subsequent sessions. Therefore, it is extremely important practitioners follow such methods so that erroneous poor quality data does not detrimentally effect change on an athlete's training programme (Malone et al., 2017). In order to understand the response to external load via wellness questionnaires it is paramount that both sets of data are recorded accurately with consistent methodologies.

2.2.2.2 Internal Load via Rating of Perceived Exertion

A very common method to monitor internal load in team sports is via the use of heart rate and Rating of Perceived Exertion. However, this can be challenging in rugby league due

to the contact nature of the sport which can dislodge heart rate monitors. Therefore, in rugby league practitioners generally use Rating of Perceived Exertion (RPE) as a way to quantify the internal load experienced by players. RPE consists of a self-reported rating of the exercise intensity and these measures are the most used single item scale in sports science (Halperin & Emanuel, 2019). Reporting RPE involves player assessment of afferent feedback from cardiorespiratory, metabolic, and thermal stimuli to enable an athlete to report how hard or easy an exercise task feels in the moment or after the training session (Eston, 2012). In general, many practitioners and researchers refer to the use of RPE scales developed and validated by Borg, including CR10 (Borg, 1982), CR20 (Borg, 1970) and CR100 (Borg & Borg, 2002). These RPE assessments differ in the scales and wording used with the 10-point scale popular in recent studies within high-performance sport that also assess wellness (Gallo et al., 2017). In applied practice and research the RPE values are often multiplied by the duration of the training session to give a session rating of perceived exertion (sRPE) (Foster et al., 1995).

Whilst RPE use is common, there are a range of methodological considerations that need to be taken into account to ensure this self-report item is used in a valid and reliable way. Firstly, there are numerous definitions and scales that can be used and this means they are often misreported and used inappropriately (Halperin & Emanuel, 2019). For example, a recent study into training load and wellness states that sRPE was recorded on a 1-10 scale with the semantic descriptors as very light to maximal exertion (Mendes et al., 2018). However, the original use of sRPE by Foster et al. (1995) and later by Impellizzeri and colleagues (2004) used different descriptors outlined in table 2.2. This is a common issue as other studies are reported to reference the CR10 (Borg, 1982) scale when in fact using

sRPE scales which have different number ranges and semantic descriptors (Eston, 2012). Any use of RPE should therefore be true to the original validated measure unless practitioners and academics have validated their new RPE scale.

Table 2.2 Borg's CR10 scale modified by Foster and colleagues (1995)

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

Session RPE appears to have the most utility for applied practice as it has become a simple and popular method for quantifying the internal load (Eston, 2012). Studies have supported the validity and reliability of this method when compared with heart rate measures (e.g. Herman, Foster, Maher, Mikat, & Porcari, 2006). If appropriate explanations are given to players and the original anchored, semi ratio scales are used then the subjective range of intensity can be considered equal between players (Impellizzeri, Borg, & Coutts, 2011). This allows for valid prescription and evaluation of

internal load. There is evidence that this method shows convergent validity with heart rate and blood lactate in the sport of rugby league (Coutts, Reaburn, Murphy, Pine, & Impellizzeri, 2003; Gabbett & Domrow, 2007; Killen, Gabbet, & Jenkins, 2010). Moreover, the number of tackles has shown moderate correlations (r=0.54) with sRPE in elite level rugby league (Coutts, Sirotic, Knowles & Catterick, 2008). Recommendations suggest that RPE should be used in conjunction with other single item measures such as fatigue (Halperin & Emanuel, 2019). Therefore, the incorporation of RPE alongside wellness questions may give greater clarity on the response to training and gameplay. Whilst external and internal measures have shown to be valid in research studies it still relies on the practitioner ensuring valid and reliable use in the host setting.

2.2.3 Monitoring the Response to Load

As established in the last section, in order to understand how an athlete is coping with the demands of sport it is necessary to quantify the internal and external training or match load (Borresen & Lambert, 2009; Gabbett et al., 2017). Allied to this, practitioners should assess the response to training and game-play. Rugby league has been shown to cause fatigue (McLellan, Lovell, & Gass, 2011a; Twist, Waldron, Highton, Burt, & Daniels, 2012) which can be defined as sensations of tiredness and associated decrements in muscular performance and function (Abbiss & Laursen, 2005). Therefore, it is important that practitioners investigate the physiological and psychological response to inform decisions around training and recovery. Twist and Highton (2013) discussed the advantages and disadvantages of the use of common methods for monitoring fatigue and recovery in rugby league players. Importantly, questionnaires were deemed as a measurement tool to use frequently (at a minimum weekly). Alterations in perceived

fatigue and muscle soreness have been shown to outlast reductions in neuromuscular performance and biochemical markers for elite rugby league players (Twist et al., 2012). Furthermore, increases in perceived soreness and fatigue could encourage a reduction in central drive that may result in a reduced work rate (Johnson, Gabbett, & Jenkins, 2013).

Monitoring via the use of wellness questionnaires as part of a wider toolkit provides a platform for effective decisions to be made regarding adaptation, recovery and performance. One frequent way this is done is by monitoring the training readiness of performers. This is where a practitioner determines how ready the performer is to train or to play a game. Based on this information a practitioner can make adjustments to training, recovery or lifestyle factors in the short or long term, to aid the preparation of the athlete. For example, an athlete experiencing lower body muscle soreness may benefit from reduction in high volume leg weights. Whilst there is no evidence of a specific test to quantify readiness (McGuigan, 2017) practitioners are advised to use an integrated approach of multiple measures to give an overall insight into the readiness to perform (Bourdon et al., 2017). In particular, subjective self-report measures show great responses to training stress (Saw, Main & Gastin, 2016). Sometimes it is useful to just talk to individual players and ask, "how do you feel today", and often it is the data from wellness monitoring practices that highlights to the practitioner the players in need of action. This is especially relevant in team sports with large squads. Wellness monitoring strategies are designed to alert practitioners to issues and to aid them with decision making. In addition to the internal and external demands it is also important to consider the non-training factors (e.g. nutrition, hydration, relationships, stress, sleep) which can impact upon the athlete (McGuigan, 2017) (see figure 2.2). The measurement tool which can give insight

into these areas is the wellness questionnaire. Firstly, it is important to discuss what is actually meant by the term wellness and wellness questionnaire.

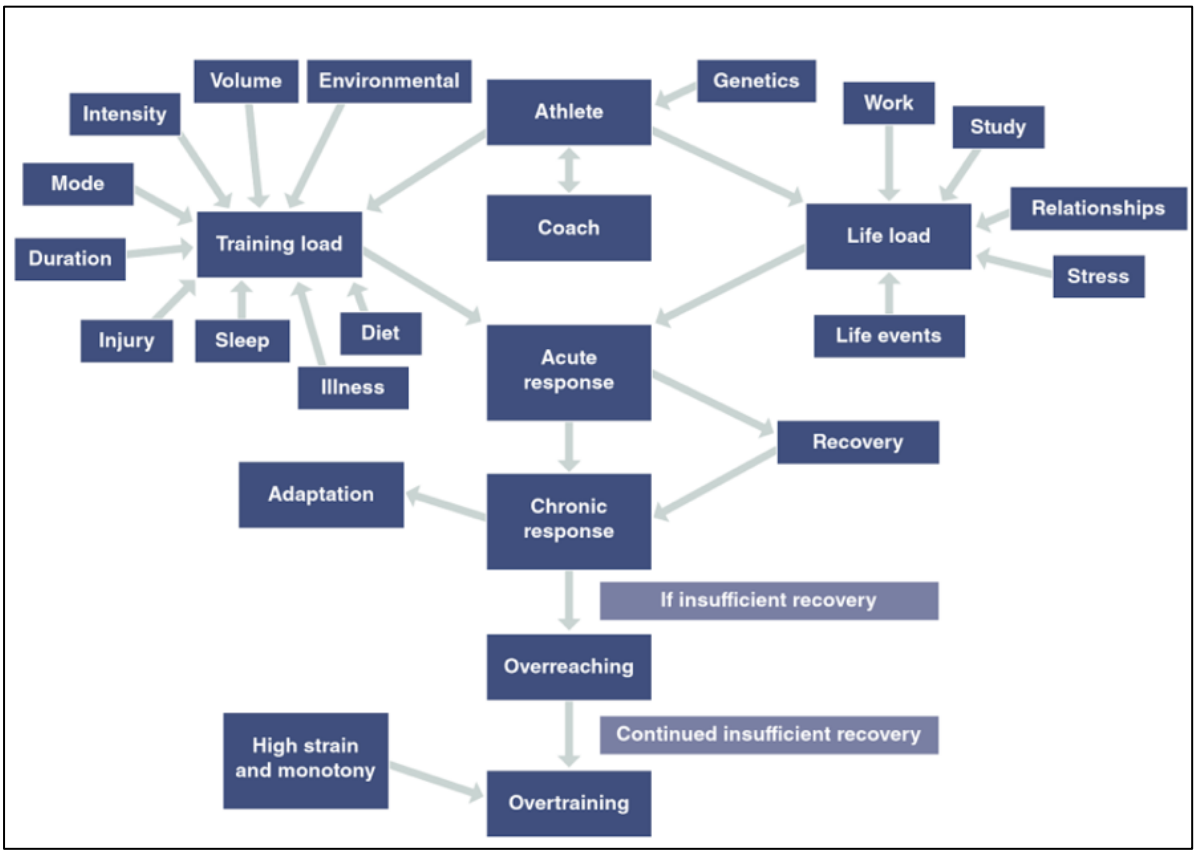


Figure 2.2 Considerations for monitoring wellness:
factors that impact an athlete, training load and their relationship to acute responses and overtraining (McGuigan, 2017, pp. 7).

2.3 Wellness Questionnaires

2.3.1 Conceptualisation: Defining wellness

A review of the literature from a health perspective reveals confusion with academic papers using a range of health-related terms to describe similar constructs to wellness such as wellbeing, quality of life and health (Rachele, Washington, Cockshaw, & Brymer, 2013). This is similar in the sporting literature, with studies often using wellness and

wellbeing interchangeably (Gastin, Meyer, & Robinson, 2013; Malone et al., 2018). In part this is due to a lack of a comprehensive definition of wellness and other terms. It is also due to the outcome measures employed to measure wellness with varying methods and customisations of questionnaires which reflect other constructs. This confusion is compounded by athlete monitoring software used in applied settings in which the term wellbeing is often used as a menu heading when the construct of wellness is perhaps measured within the questionnaire. To add to this confusion, the term Athlete Self Report Measures (ASRM) has been used within the sporting academic literature. This is a useful term but it is worth noting that it incorporates more than just questionnaires including other methods athletes can use to self-report subjective feelings including diaries and logs. Furthermore, practitioners often collect wellness data to gauge how ready the athlete is to perform. Therefore some studies that refer to training readiness or subjective fatigue incorporate the use of wellness questionnaires (Haaf et al., 2016). In these instances practitioners and academics can largely be measuring the same construct and so it is necessary to conceptualise what wellness is here within the literature review and further define it within the context of the rest of the thesis.

Away from sport, traditional views on wellness have evolved in parallel with the positive health movement after changes to the World Health Organisation's definition of health in 1946 (Rachele et al., 2013). One of the earliest definitions of wellness by Dunn (1959) characterises wellness as an integrated method of functioning which is oriented towards maximising the potential of which the individual is capable, within the environment that he is functioning. Hettler (1980) adds to this by explaining that achieving higher levels of wellness is an active process through which the individual becomes aware and makes

choices towards a more successful existence. Researchers have explored the components which make up wellness such as physical, social, emotional and psychological dimensions (Roscoe, 2009). It is clear that these early definitions which focussed on maximising potential within the wellness components are agreeable with sporting environments where athletes are evaluated on aspects of their response to training and readiness to perform.

Some of the components which make up wellness as defined in general health literature are more applicable to sport than others (Roscoe, 2009). It is these dimensions which generally form the questions within practitioner wellness measurement tools in applied settings and research in sport. Physical components of wellness, the degree to which an individual maintains and improves fitness levels (Hetler, 1980) and expectations of physical health (Adams, Bezner, & Steinhardt, 1997), are frequently monitored within sporting wellness questionnaires. Hetler (1980) believed it was important to monitor this aspect of wellness through monitoring body feelings, internal states and physical signs which is synonymous with monitoring internal load, external load and the response in sports settings. A wellness questionnaire is well suited to achieving this and to this end questions generally focus on muscle soreness and how an athlete feels from a physical perspective post training and gameplay. From a health standpoint, researchers have stressed the importance of good nutrition forming part of the physical component of wellness (Renger et al., 2000). Whilst these studies are useful for defining wellness components in general a large part of the dimensions are rarely investigated within sport (e.g. spiritual wellness). Instead wellness questions are usually focussed around the knowledge base developed through studies into fatigue, overtraining and stress.

Based on the general health definitions and current use of wellness questionnaires, which is subsequently documented, the following definition of wellness is used for the purpose of this thesis. Wellness is defined as *'a balance of physical, mental and social dimensions which allow an individual to cope with sporting demands, life circumstances and achieve an optimal state of being'*. It differs from wellbeing which is described as the balance point between an individual's resources and the challenges he or she faces (Bart et al., 2018) and concerned with happiness and contentedness with life (Rachele et al., 2013). Lundqvist (2011) conceptualises wellbeing as focussed around acceptance, personal growth, life and sport satisfaction. Global wellbeing is perhaps best characterised by off-field financial concerns, mental health (e.g. depression), preparation for life after rugby and support structures (Kruyt & Grobbelaar, 2019). Ultimately in the context of this research this is not the goal of practitioners monitoring their athletes. It is acknowledged that there is some cross over in the terminologies between wellbeing and wellness; wellness measures can inform on aspects of global wellbeing. However, the goal when using a wellness questionnaire is to monitor the athlete holistically by focussing on physical (e.g. muscle soreness), psychological (e.g. mood state) and/or social (e.g. team cohesion) aspects of wellness with the purpose to gauge the response to training and gameplay and determine how close they are to achieving their optimal state to perform.

2.3.2 Current Practice and Use of Wellness Questionnaires

A systematic review found that subjective self-report measures informed on acute and chronic training loads with superior sensitivity and consistency than objective measures (Saw, Main, & Gastin, 2016). In this review it was typical for increases in training load to decrease reported wellness whilst decreases in load improved wellness. The findings

of this review indicate that wellness questionnaires can be a simple and effective tool to obtain information on the response to training and readiness to perform. This can be seen in the high-level of use of wellness questionnaires in practical contexts (Akenhead & Nassis, 2016; Starling & Lambert, 2017; Taylor et al., 2012). However, there are limitations, most notably that optimal implementation of these measures are yet to be determined (Saw, Main, & Gastin, 2016). Equally there is a lack of consistent guidelines for use within sporting contexts with questionnaires differing in the number of items, scales and how education around completion is achieved. It is this implementation that influences the extent to which wellness is reflected and thus how data can be used in a meaningful way (Saw et al., 2015b).

Practitioners looking to use questionnaires as a method to monitor athletes have a daunting task at selecting an appropriate measure. Ostrow (1996) identified over 300 different questionnaires, scales and inventories that can be used within sport and exercise settings. In particular, sport psychologists have used questionnaires to assess emotions, sport psychological skills, anger, clinical relationships, stress, personality, motivation and commitment (O'Connor, 2004). Some of the questionnaires that have been used within research include the Competitive State-Sport Confidence Inventory (Vealey, 1986), Competitive State Anxiety Inventory-2 (Martens, Burton, Vealey, Bump, & Smith, 1990) and motivational scales (e.g. Seifriz, Duda, & Chi, 1992). However, many of these questionnaires have minimal use for athlete monitoring or wellness and focus on specific psychological constructs. There are however, a number questionnaires that have been used within investigations into the response to training load (Saw, Main, & Gastin, 2016).

These questionnaires directly apply to monitoring aspects of wellness and are summarised in Table 2.3.

Table 2.3. Questionnaires/Scales and Inventories used to monitor athletes (adapted from Saw et al., 2016)

Questionnaire	Reference	Items (n)	Dimensions	Time Frame	Answer Scale (n-points)	Primary Factor(s)
State Trait-Anxiety Inventory	Spielberger, Gorsuch, & Lushene (1970)	40	2	Now	4	Anxiety
Derogatis Symptom Checklist	Derogatis (1977)	90	9	Now	5	Distress
State Trait Personality Inventory	Spielberger et al. (1979)	80	8	Now	4	Emotions
Profile of Mood States (POMS)	McNair, Lorr, & Droppleman (1971)	65	6	1 week	5	Mood
Perceived Stress Scale	Cohen, Kamarck, & Mermelstein (1983)	14	1	1 month	5	Stress
Competitive State Anxiety Inventory-2	Martens et al. (1990)	27	3	Now	4	Anxiety
Daily Analyses of Life Demands for Athletes (DALDA)	Rushall (1990)	34	2	Now	3	Stress
Abbreviated POMS	Grove and Prapavessis (1992)	40	7	1 week	5	Mood
Société Française de Médecine du Sport overtraining (OT) questionnaire	Legros (1993)	54 +6	1	1 month	Yes/No, Visual Analogue Scale	OT Symptoms
Training Distress Scale	Raglin and Morgan (1994)	7	2	1 week	5	Mood
Mood Questionnaire	Choi and Salmon (1995)	42	1	Today	Checklist	Mood
Total Quality Recovery	Kenttä and Hassmén (1998)	1	1	Now	15	Recovery
Brunel Mood Scale	Terry, Lane, Lane, & Keohane (1999)	24	6	1 week	5	Mood
Athlete Burnout Questionnaire	Raedeke and Smith (2001)	15	3	Now	5	Burnout Symptoms
Recovery-Stress Questionnaire for Athletes (RESTQ-Sport)	Kellmann and Kallus (2001)	76/52	19	3 days	7	Stress, Recovery
Recovery-Cue	Kellmann Patrick, Botterill, & Wilson (2002)	7	3	1 week	7	Stress, Recovery
POMS Energy Index	Kenttä, Hassmén, & Raglin (2006)	15	2	Now	5	Mood
Multi-component Training Distress Scale	Main and Grove (2009)	22	6	1 day	5	Mood, Stress
Emotional Recovery Questionnaire	Lundqvist and Kenttä (2010)	22	5	Now	5	Emotions
Perceived Recovery Status Scale (PRS)	Laurent et al. (2011)	1	1	Now	11	Recovery
Training Distress Scale	Grove et al. (2014)	19	1	2 days	5	Distress, Readiness
Acute Recovery and Stress Scale	Kölling et al. (2015)	32	8	Now	7	Stress, Recovery

Table 2.3 shows that consistent use of questionnaires to investigate athletic preparation and performance commenced throughout 1970s to 1990s and developed throughout the 2000s to the present day. In particular these questionnaires have been used to investigate overtraining, initially with Profile of Mood States (Morgan, Brown, Raglin, O'Connor, & Ellickson, 1987). More recently the focus has been towards stress and recovery with use of questionnaires such as Recovery Stress Questionnaire for Athletes (Nicolas, Vacher, Martinent, & Mourot, 2019). In the main these questionnaires have sound psychometric properties including being theoretically derived, acknowledgement as to levels of validity and reliability, and referenced values for comparison (Saw et al., 2016). This makes the questionnaires well suited to research, but this pursuit of scientific credibility comes at a cost of practicality and usefulness (Vealey and Garner-Holman, 1998). The sheer number of items on the questionnaires makes it unfeasible to use with athletes on a daily or even weekly basis. Even the modified versions of the questionnaires can include 40+ questions (e.g. Modified POMS - Grove and Prapavessis, 1992). The scales used all differ in length and it is unknown what might be most effective with different athlete cohorts. The 11-point scale used in the perceived recovery status scale (Cohen et al., 1983) could be too lengthy for athletes to choose between whilst the smaller 3-point scale in the daily analyses of life demands for athletes (Rushall, 1990) could be too narrow and cause difficulties with interpretation alongside other scales (e.g. Borg CR10-RPE scale). Furthermore whilst these questionnaires can assess multiple dimensions, the primary factor is not wellness but a related component such as mood or stress level. Indeed, with many of these scales there is often no reference to physical components of wellness such as muscle soreness.

It is well accepted that simply combining items from multiple established measures can negate the psychometric properties (Saw et al., 2016). However, having an extremely

valid tool is of little use if athletes do not complete the questionnaire properly because it is too much of a burden. Neither is it if they do not complete it honestly due to socially desirable responses or due to fear of consequences, such as team selection, and respond in cultural sanctioned manner (Crowne & Marlowe, 1960). Creating customised and adapted questionnaires could possibly help to create engagement and thus increase the "practical validity" of the questionnaire (Vealey and Garner-Holman, 1998). Customised questionnaires also help to give focus to the dimension of wellness. For example, Hooper and Mackinnon (1995) recommended a customised approach to include several factors which contribute to overall wellness such as ratings of fatigue, muscle soreness, sleep, and enjoyment of training. This is precisely what the majority of sports teams do who use wellness questionnaires in applied environments (Taylor et al., 2012). They choose a small amount of questions which suit their players and sporting context. There have been a number of studies which have also followed these recommendations, as applied research has sought to bridge the gap between research and practice (Malone et al., 2017; McLean et al., 2010). Unfortunately these studies are often scant with details or fail to replicate the questionnaire they used in their methods, nor do they document the development and validation of the customised questionnaire. This is of little help when trying to identify which customised questionnaire is suited to which sport or individual positions/players within the sport.

2.3.3 Wellness Questionnaires in Rugby League

Reviewing the use of questionnaires in high-performance rugby league in the last decade, the majority of the studies have used customised versions of wellness questionnaires (Table 2.4). Only one study has used a psychometric questionnaire which was the RESTQ-Sport (Coutts & Reaburn, 2008). In the majority of cases, studies have used or adapted the questionnaire from McLean et al. (2010). Developed with Hooper and

Mackinnons' (1995) recommendations in mind this is one of few studies to actually reproduce the questionnaire within their publication. Within this study, and many that have followed, wellness questionnaires and investigations into self-reported results are secondary to the objective methods used within the study. As such brief details of the questionnaire development and validation, if any, are given. Nevertheless, McLean and colleagues' (2010) study found that the questionnaire was sensitive to detect changes in wellness across different between match cycles. This sensitivity of customised questionnaires based on this research has been replicated in studies thereafter providing support for the use of questionnaires with rugby league players (Fletcher et al., 2016; Johnston, Gabbett, Seibold, & Jenkins, 2014; Johnston et al., 2013b; Twist, Highton, Daniels, Mill, & Close, 2017; Twist et al., 2012). The major items featured within these wellness questionnaires revolve around questions on sleep quality, muscle soreness, stress, energy levels, and mood. Some questionnaires have also investigated aspects of nutrition and illness (Thornton et al., 2016). In most cases an overall wellness score is created by summing the different items of the questionnaires.

Table 2.4 Questionnaires used to monitor rugby league players.

Reference	Questionnaire	Factors	Scale	Results
Coutts & Reaburn (2008)	RESTQ-Sport	Stress, Recovery	7-point	RESTQ-Sport is a practical psychometric tool for monitoring responses to training in rugby league players.
McLean et al. (2010)	Customised based on Hooper and Mackinnon (1995)	Fatigue, Sleep Quality, Muscle Soreness, Stress, Mood	5-point	Questionnaire was sensitive to change and gave support for using this simple psychometric tool.
Twist, Waldron, Highton, Burt, & Daniels (2012)	Customised based on McLean et al. (2010)	Fatigue, Muscle Soreness, Attitude	5-point	Questionnaire was sensitive to change and gave support for using this simple psychometric tool.
Johnston et al. (2013b)	Same as McLean et al. (2010)	Fatigue, Sleep Quality, Muscle Soreness, Stress, Mood	5-point	Questionnaire was sensitive to change and gave support for using this psychometric tool on a daily basis.
Johnston, Gabbett, Seibold, & Jenkins (2014)	Same as McLean et al. (2010)	Fatigue, Sleep Quality, Muscle Soreness, Stress, Mood	5-point	Greater reductions in wellness following contact games compared with non-contact.
Twist et al. (2017)	Customised based on McLean et al. (2010)	Fatigue, Sleep Quality, Upper and Lower Body Muscle Soreness, Stress, Mood	5-point	Supports the use of subjective measures post-game but questions the use during intensified periods with congested fixtures.
Fletcher et al. (2016)	Customised based on McLean et al. (2010)	Upper and Lower Body Muscle Soreness	5-point	Questions were sensitive to change post-game and throughout the training week.
Fowler, Duffield, Lu, Hickmans, & Scott (2016)	Customised Wellness Questionnaire, Liverpool John Moores University Jet Lag Questionnaire (Waterhouse et al., 2000), Wisconsin Upper Respiratory Symptom Survey (Barrett et al., 2009)	Sleep Quality, Overall Wellness, Muscle Soreness, Jet Lag, Illness	10-point	Suggest the development of an athlete specific jet lag questionnaire.
Thornton et al. (2016)	Customised based on McLean et al. (2010) & Elloumi et al. (2012)	Illness, Food Quality, Sleep Quality, Mood, Muscle Soreness (6 sites)	Y/N, Symptoms Checklist, 10-point	Self-reports can be successfully used to give understanding to the interactions between stressors and susceptibility to illness.
Oxendale et al. (2016)	Single question on muscle soreness.	Muscle Soreness	7-point	Matchplay demands associated with muscle soreness.
Thornton, Delaney, Duthie, Dascombe (2017)	Customised based on Hooper and Mackinnon (1995)	Sleep Quality, Food Quality, Energy Levels, Mood, Stress, Muscle Soreness (5 sites)	5-point (sleep) & 10-point	Longer sleep durations reduced subjectively rated fatigue and improve wellness.
Caia, Halson, Scott, & Kelly (2017)	Customised Likert Scale	Sleep Quality and Duration	5-point & 10-point	Supports the use of subjective measures to monitor sleep in rugby league players. Players can overestimate sleep duration.

Despite the benefit of these studies advancing knowledge within the field of monitoring rugby league players, there is no consensus regarding the use and implementation of the questionnaire. Most studies seem to have used the questionnaire from McLean et al. (2010) because it is simple to use in applied environments and justified due to its use within previous academic studies. This questionnaire has its limitations though in the variety of questions used to inform on wellness, a lacklustre design, and terminology that could be difficult to understand for players. Thornton and colleagues' (2016) adaptation offered some variation by including illness symptoms and site-specific muscle soreness. But on the whole, questionnaire design seems to have stagnated and does not seem take into consideration research on overtraining, recent developments into implementation (Saw et al., 2015b) or internet based questionnaires used in applied environments. Most importantly, the lack of a clear development, validation and implementation process when using these questionnaires is a concern. Furthermore, details are lacking regarding how wellness questionnaires can be used within practice beyond being responsive to training load changes. There is a clear need to understand the conceptualisation, implementation and utilisation further within rugby league contexts.

2.3.4 Validation of Questionnaires

The wellness questionnaires that appear in contemporary applied rugby league research (Table 2.4) are perceived to have face validity and implementation better suited to monitoring wellness in applied practice. However, these wellness questionnaires lack the psychometric properties of other empirical questionnaires that have been used in sports performance research (Table 2.3). One prominent example that has been used within hundreds of investigations is the RESTQ-Sport (Kallus & Kellmann, 2016). A measure

of perceived stress and recovery the RESTQ-Sport contains 76 items, although shorter 52 and 36 item questionnaires also exist. This questionnaire has a theoretical basis, largely informed by Michael Kellmann's Scissor Model (Kellmann, 1991), that an increase in stress requires equal amounts of recovery to balance athlete ability to achieve optimum performance. A primary focus of the RESTQ-Sport is therefore on recovery, namely if an athlete is receiving enough recovery to balance the stress experienced. The RESTQ-Sport was developed over a considerable length of time, with a range of athlete participants and documented within a comprehensive manual (Kallus & Kellmann, 2016). Following this development subsequent independent studies have investigated the psychometric properties. Systematic development and validation are essential to achieving quality data, but it is important to note that questionnaire development is an ongoing process as measures are often refined and evolve through subsequent investigations. Initial validation and documentation of psychometric properties is the start of this process.

There are a number of ways to document the development and validation of a questionnaire. Due to the prevalence of investigations the RESTQ-Sport is a good example of this. The initial validation of the RESTQ-Sport involved an assessment of criterion validity involving comparison of the relationship of the RESTQ-Sport stress and recovery scales alongside outcomes on other well-established questionnaire measures, such as POMS (McNair et al., 1971) and Athlete Burnout Questionnaire (Raedeke & Smith, 2001). In these studies, the RESTQ-Sport stress scales were positively correlated to moods with the exception of vigour (Costa & Samulski, 2005; Kellmann & Kallus, 2001; Nederhof, Brink, & Lemmink, 2008) and facets of athlete burnout (Martinent, Decret, Isoard-Gautheur, Filaire, & Ferrand, 2014). The evidence within these studies

shows weaker correlations on the recovery scales of the questionnaire but nonetheless these correlations evidence the relationship with other constructs. For other self-report measures such as RPE the strength of the correlation can be assessed with objective physiological measures. For example, research by Borg showed a positive correlation of 0.85 between RPE and heart rate (Borg, 1962). Subsequent meta-analysis assessments involving studies on heart rate, blood lactate, oxygen uptake, ventilation and respiration can be described as yielding similar results albeit with some inconsistencies and weaker strength correlations (Chen, Fan, & Moe, 2002). Session RPE has been validated in similar ways with correlations to objective markers of training load including heart rate, training impulse (TRIMP), oxygen uptake, lactate threshold and movement characteristics (Haddad, Stylianides, Djaoui, Dellal, & Chamari, 2017). However, a major problem in assessing the validity of questionnaires can be the lack of other reference gold standards (Bellamy, 2014). This is true for wellness questionnaires due to difficulty in linking question items to high quality objective measures as with heart rate and RPE. In addition, whilst the assessment alongside other well-established questionnaire scores is interesting it may first be useful to assess wellness scores alongside other wellness questionnaires, training load or performance data (such as GPS, coach rating or practitioner assessment). This would allow for comparison of the suitability of the wellness questionnaire in addition to comparison against independent criterion measures using familiar tools from applied practice.

With this sentiment in mind, an important assessment of a questionnaire is the accuracy measuring the actual construct under observation. The construct validity has been investigated in a number of studies for the RESTQ-Sport with comparison to similar and

opposing construct measures. These predominantly focus on the correlation between the general stress and sport specific stress scales as well as the general recovery and sport specific recovery scales. Initial validation by Kellmann and Kallus (2001) showed positive correlations between these scales (Stress, $r = 0.05 – 0.80$; Recovery, $r = 0.19 – 0.86$) which has since been corroborated by other investigations (Costa & Sumulski, 2005; González-Boto, Salguero, Tuero, Márquez, & Kellmann, 2008). Furthermore, a number of factorial validity studies support the two-factor structure of the sport specific stress/recovery scales (Davis, Orzeck, & Keelan, 2007; González-Boto et al., 2008; Martinent et al., 2014; Nederhof et al., 2008). However, within these studies there are some concerning aspects of the questionnaire with factor analyses disconfirming the general stress/recovery structure (Davis et al., 2007) and supporting a reduction of up to 55 of the initial 76 items (González-Boto et al., 2008). Recent psychometric evaluations have also highlighted inadequacies with the hierarchical factor structure (Gnacinski, 2017). The inconsistencies with factorial validation of the RESTQ-Sport may stem from the use of a range of methodologies such as principal components analysis, exploratory factor analysis, and confirmatory factor analysis that make it difficult to accept which scales are problematic. With wellness questionnaires being predominantly used in applied practice it would make sense to first ask the experts in the field to determine the items suitable for monitoring wellness. Further validation of the items could be confirmed through several independent factor analysis studies in the future.

With regards to the responsiveness of a questionnaire in applied practice it is important to determine the sensitivity of the measure, such as comparing scores on the RESTQ-Sport in a period of intensive training with scores during a less intensive phase (Tibbert,

Morris, & Andersen, 2009). In a review of the responsiveness of the RESTQ-Sport, studies were identified across a range of sports with some items and scales more responsive to training load, performance, injury or illness (Gnacinski, 2017). Whilst this review also highlights concerns in some of the RESTQ-Sport scales, the measure has previously been shown to have utility in monitoring responses to training in rugby league (Coutts & Reaburn, 2008). In fact, responsiveness is often a strength of non-psychometrically validated wellness questionnaires in rugby league as the sensitivity of the measure to change is often evident (Table 2.4).

As wellness questionnaires are used frequently within training programmes it is necessary to assess the reliability of the measure, that is the consistency of repeated responses to the questions. One of the main statistics to analyse the reliability of questionnaires is through measuring the internal consistency using Cronbach's Alpha (Tsang, Royse, & Terkawi, 2017). It is notable that wellness questionnaires used in research do not document statistics on reliability (e.g. McLean et al., 2010). In contrast, empirical questionnaires such as the RESTQ-Sport have repeatedly shown acceptable Cronbach's Alpha test scores greater than 0.7 for most of the questionnaire scales (Elbe, Rasmussen, Nielsen, & Nordsborg, 2016; Kellmann & Günther, 2000; Mäestu, Jürimäe, Kreegipuu, & Jürimäe, 2006; Nicolas, Banizette, & Millet, 2011). High levels of test-retest reliability have also been shown for the RESTQ-Sport indicating stability in measurements over short term periods (Kellmann & Gunther, 1999). The challenge with wellness questionnaires is accounting for similar test and retest conditions, however, clearly some indication of internal consistency of future wellness questionnaires is warranted.

Although some issues exist in the validation of the RESTQ-Sport, the majority of the literature and subsequent uptake of the questionnaire for research studies indicates that this is an acceptable measure. Despite this large evidence base for questionnaires such as the RESTQ-Sport it is apparent that practitioners in some sports use non-validated, customised questionnaires (Taylor et al., 2012). It would appear that the existing validated measures cannot be used due to limitations such as too many questions or burdensome procedures (Saw et al., 2016). Whilst this needs further verification across sports, questionnaires should consider the development and implementation of the measures for applied settings (Saw et al., 2015b). From this practitioner perspective it is important to have valid and reliable measures, but also to have a questionnaire which has been developed and implemented to meet the practical challenges. If a questionnaire is valid and reliable but doesn't meet the implementation requirements of the team then the data will be of little value. Furthermore, from a research perspective, a persistence to use such a questionnaire which is not implemented successfully will influence the validity and reliability of results. A notable limitation with existing questionnaires is that they are used on a short-term basis whereas practitioners are likely to use wellness questionnaires more frequently throughout a season. Many questionnaires used to date have failed to account for these essential implementation features of applied practice, with recently developed questionnaires starting to tackle such issues as designing the measure to be used on a regular basis (Kellmann & Kolling, 2019). However, it is not just about reducing the number of items and future questionnaires need to thoroughly develop and implement questionnaires with respect to guidelines on implementation (Myers et al., 2012; Saw et al., 2016). It is clear that both the implementation and validation of the questionnaire need to be considered when developing new wellness questionnaires to be used in research and

practice. This would provide a number of key advantages such as ensuring that wellness data is accurate and trustworthy in performance decisions or research recommendations. Furthermore, the psychometric documentation of a wellness measure would guide practitioners in the development and validation of their own customised measures. Ultimately, these future advances would result in the creation of a higher quality questionnaire to measure wellness, moving away from questionnaires which are not validated or fit for the purpose of monitoring wellness on a regular basis in high-performance sports.

2.3.5 Theoretical Underpinnings and Associated Research

When developing wellness measures it is important to understand the approach a practitioner can take based on the current research, models and philosophies. Athlete monitoring is an area that has been growing exponentially in terms of research in recent years. It presents a challenge for the busy practitioner to grasp as the scientific literature is extremely vast and wide ranging, including physiological, biochemical, haematological, immunological, nutritional, and psychosocial aspects (Polman & Houlahan, 2004). This is further complicated by the confusion regarding terminology and loose definitions, not only with wellness (as established earlier) but particularly with overtraining, another key area for the practitioner to consider. This is not only unhelpful for practitioners but for coaches and athletes when attempting to explain key concepts and develop monitoring strategies.

Because the theoretical areas a practitioner needs to consider spans across a range of subject areas it is worth taking time to understand the definitions within physiology and

psychology. Many academics and practitioners often refer to the "demands" of training and gameplay. Usually this is from a physical perspective and includes variables such as distances, speeds and efforts as established in the internal and external load section above. Conversely, from a psychological point of view a similar term "stressor" is used to encapsulate a range of physical and psychological environmental demands associated with competitive performance (Mellalieu, Hanton, & Fletcher, 2006). These demands and stressors form a key focus for the practitioner to monitor when developing wellness measures. It is worth pointing out that stress is in fact neutral, and not to be confused with the emotional response of an athlete or their appraisal of the stressor (Selye, 1975). It is a negative response to a stressor, defined as "strain", which is problematic (Mellalieu et al., 2006). Of course, this response is attempted to be thwarted by the processes sports scientists use to result in an athlete's renewed ability to meet or exceed a previous performance, defined as "recovery" (Hausswirth & Mujika, 2013).

A key goal of a wellness questionnaire is to alert the practitioner to the stress / recovery balance. It is useful to be aware of the process of training and gameplay and the underlying physiological and psychological response. To achieve success, athletes need some periods of heavy training loads, often training multiple times per day, which will cause a negative wellness response (McGuigan, 2017). Furthermore, in team sports it is unknown as to how demanding the games will be week to week and the turn-around time between games can vary. The demands of competitive sport throughout the season can elicit a state of fatigue, a reduction in physical and psychological performance (Hausswirth and Mujika, 2013). Practitioners looking to develop wellness questionnaires will mostly be concerned with this acute fatigue that manifests itself physiologically and

psychologically week to week. Whilst the athlete is fatigued performance will suffer, but at this acute stage, disturbance can be recovered within hours or days. Nevertheless, it is important to monitor this period to make sure training and recovery is optimal, and to prevent the development of unwanted outcomes. Insufficient recovery combined with excessive training, gameplay and other stressors over a prolonged period can lead to overreaching and overtraining (Meeusen & De Pauw, 2017).

2.3.5.1 Overtraining

Considerable research has been conducted into understanding overtraining. Consensus has led to defining overtraining as a verb to describe a process of intensified training that could result in overreaching and overtraining syndrome (OTS) (Halson & Jeukendrup, 2004). The difference between overreaching and OTS is the amount of time needed for performance restoration (Meeusen et al., 2013). For the practitioner, it is perhaps best to consider this on the overtraining continuum (Figure 2.3). Short-term decrements in performance without severe psychological, or other lasting negative symptoms is termed functional overreaching (Meeusen et al., 2013). Often regarded as a normal and a harmless part of intense training, the reduction in performance takes days or weeks to recover. If intense training continues athletes can progress to a stage of non-functional overreaching where there is stagnation in performance that takes weeks to months to recover (Meeusen & De Pauw, 2013). There is then further progression, and subtle differences, to the OTS which takes even longer to recover from (months to years). OTS is also referred to as Unexplained Underperformance Syndrome (UUPS). In both cases the word 'syndrome' reflects the multifactorial aetiology (Meeusen et al., 2013), whilst the UUPS definition aims to emphasise the other factors in addition to training which may

be causative, such as poor nutrition or significant life stressors that lead to maladaptation (Lewis, Collins, Pedlar, & Rogers, 2015).

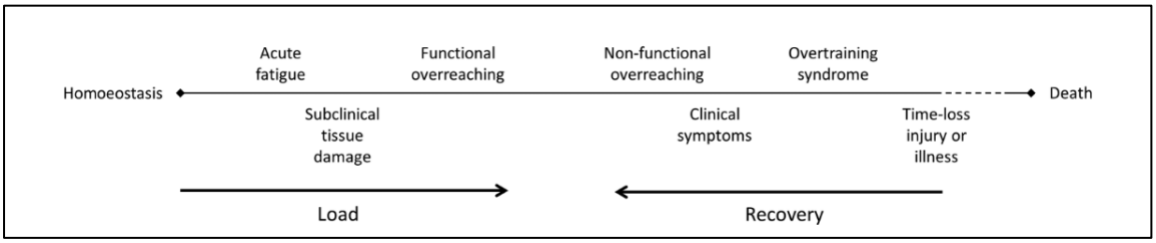


Figure 2.3 The Overtraining Continuum (Fry, Morton, & Keast, 1991).

Deterioration along the overtraining continuum usually stops, for athletes, at time-loss injury or illness (Schwellnus et al. 2016). For team sports and wellness questionnaires, the focus is likely to be on the acute end of the continuum through to non-functional overreaching. For example, the fatigue of training and games that has an impact to cause short term decrements in performance that can be recovered within days. OTS, which can take months to recover, is something that is often more prevalent in endurance and individual sport athletes (Kreher and Schwartz, 2012). However, the literature in this area offers extremely valuable insights for team sports as many of the same stressors and symptoms present themselves throughout the continuum. By monitoring athletes over time it allows a practitioner to develop a profile of when an athlete is healthy and ready to train, overreached or in need of recovery (Smith & Norris, 2002). Hence a wellness questionnaire is useful as both an acute and longitudinal monitoring method.

The practitioner should have an awareness of the range of stressors that can affect performance, with special focus to the areas pertinent to the sport. Originally, research on overtraining focussed specifically on the training factors, such as the implications of

training at high loads and intensities. It is also important for the practitioner to monitor the non-sport stressors (Meeusen et. al, 2013), for example significant life events. McGuigan (2017) illustrates some of the factors for a practitioner to consider from both training and life load (Figure 2.2). These factors result in an acute response and, as training days accumulate, a chronic response that leads to adaptation or maladaptation. This is a great, simple overview for the practitioner. However, it is important to bear in mind the complexity of the interactions between stressors. Polman and Houlahan (2004) summarise this well by acknowledging the interactive and cumulative nature of potential stressors (Figure 2.4). The measurement and analysis of each stressor in their own right presents a challenge, let alone the interactions of the stressors. Much research on overtraining has continued to search for single diagnostic markers, in particular with physiological or immunological systems (Kreher & Schwartz, 2012). Yet these systems (e.g. immune system) are inherently complex in their own right. Nutrition for example has direct implications for performance and interactions with training load. But it also substantially interacts with the biomedical factors of the individual which in turn could impact illness and indirectly performance. Several guidelines on reliable markers to detect overtraining have been set out (Schwellnus et al., 2016). However, none of the currently available markers meet all the criteria and so a combination of recording training load, using questionnaires, and direct observational methods is recommended (Meeusen et al., 2013).Wellness questionnaires can investigate a range of aspects pertinent to fatigue and overtraining rather than a single construct. For example, boredom, lack of sleep and stress are often cited as symptoms of overtraining (Meeusen et al., 2013) and all can be identified through questionnaire.

It is worth pointing out that the practitioner needs to have a holistic approach when assessing overtraining and monitoring wellness. For example, the practitioner cannot view training load as a purely physiological perspective because it interacts with other psychological stressors. The monitoring tool used doesn't have to be diagnostic, but it can provide an alert of the overall wellness of a performer and guidance to aspects for further investigation. For example, wellness questionnaires allow for an overview of many factors in Figure 2.4. As well as indicating a low overall wellness score, it may alert the practitioner to a problem area such as poor sleep quality, which could then be investigated further.

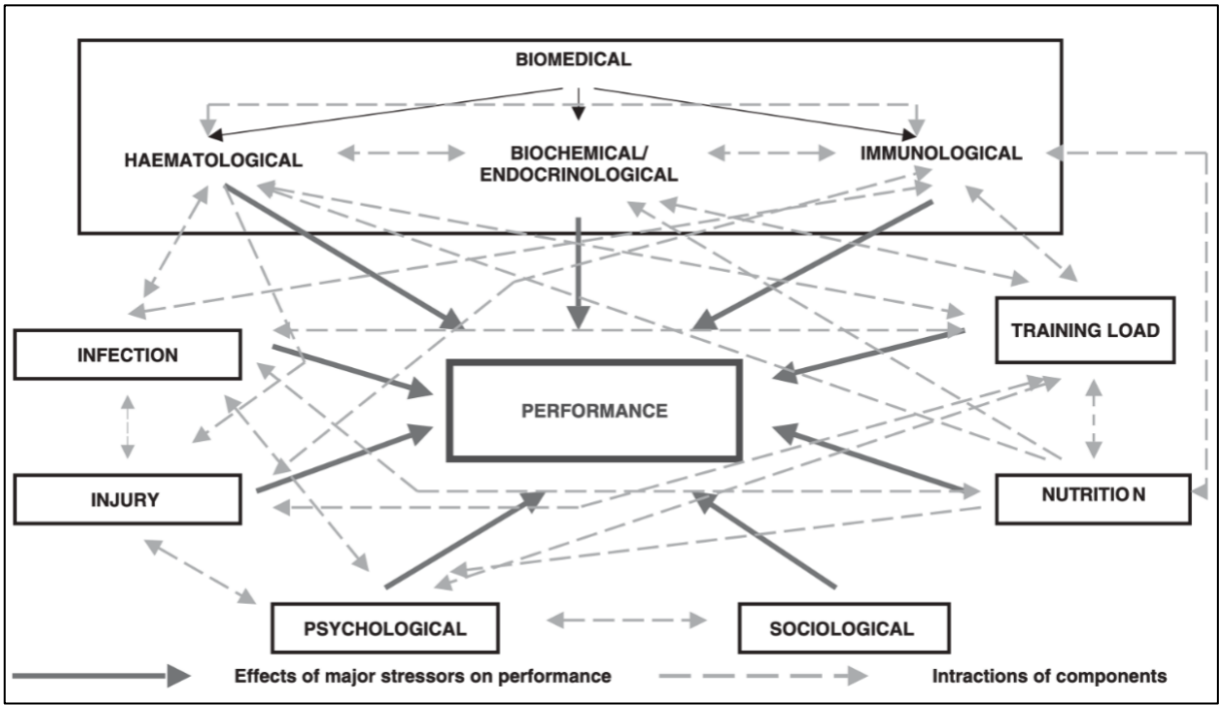


Figure 2.4 A multicause diagram on the effects of various stressors on performance (Polman & Houlahan, 2004)

2.3.5.2 Related Theoretical Models

The practitioner needs to remember that stress is necessary within elite sport. This is perhaps best demonstrated in models of the physiological response to an acute training stimulus which show that a complete lack of stress can be problematic. The General Adaptation Syndrome (GAS) Model (Selye, 1950), Fitness-Fatigue Model (Banister, Calvert, Savage & Batch, 1975) and the Stimulus-Fatigue-Recovery-Adaptation Model (Haff, 2012) all show that the initial stress (stimulus) elicits fatigue and leads to improvements in performance (as well as potentially leading to overtraining). Without the initial stress, adaptation cannot occur. Therefore, whilst a lack of stress will lead to a lack of fatigue, it can also lead to a lack of adaptation and thus decreased performance. This is something that has been reiterated recently, that undertraining as well as overtraining can lead to negative outcomes such as injury (Bourdon et al. 2017). Exposure to a high load (stress) can offer protective benefits to players once they have adapted to the stimulus (Malone et al., 2017). Therefore, a wellness questionnaire and other monitoring tools should also focus on values which might show an "over-recovered" athlete or under-developed training profile (e.g. consistently low training load and high wellness).

There are a plethora of models and hypotheses that attempt to explain overtraining. There is certainly no model to explain it all but there are some useful elements for the practitioner to organise their thoughts and to help explain to coaches and practitioners the reasons behind wellness monitoring strategies. These models can also inform the practitioner on the areas to analyse, and thus questions to ask, within any customised

questionnaires. Table 2.5 provides an overview of the key studies outlining models to understand monitoring of overtraining.

Table 2.5 Related theoretical models for monitoring wellness

Authors	Year	Model	Key Points
Selye	1965	General Adaptation Theory	Any specific stressor not only affects a given physiological system, they affect and interact with every other system. Proposes finite amount of general adaptation energy used to buffer and overcome stressors. Does not overstress the effect of training but highlights interaction of stressors.
Smith	1986	The Cognitive Affective Stress Model	Burnout/Overtraining is the result of a series of stressful events perceived to be overwhelming. This model depends on the cognitive appraisal as the focus and therefore negates the possibility of other factors. In particular, the large amount of evidence that includes contribution from physical or training stresses (Polman & Houlahan, 2004).
Silva	1990	Negative Training Stress Response Model	Training results in physical and psychological stress. The model incorporates supercompensation cycle of training and acknowledges the positive and negative effects of training. However, because the emphasis is placed on training stressors other non-sport or psychosocial stressors are excluded.
Coakley	1992	The Empowerment Model	This model regards stress as the symptom of burnout which is caused by the social organisation of elite sport. The model has perhaps highlighted an additional cause of stress rather than the primary cause of overtraining (Polman & Houlahan, 2004).
Kenttä and Hassmén	1998	Training / Recovery Model	This model introduces the idea of monitoring the recovery process in addition to training. However, the claim that inadequate recovery from training is the principal causative factor in overtraining negates the impact other non-sport stressors play.
Schmidt and Stein	1991	Sport Commitment Model	The sport commitment model is based on the idea that positive and negative factors associated with participating in the sport such as rewards, costs, satisfaction, alternatives, and investment can fluctuate. Constructs such as overtraining or burnout will be determined by these areas, for example a decrease in rewards, high investment and decreased satisfaction. The model is perhaps more focussed towards a recreational level rather than elite level sport.

Table 2.5 continued.

Authors	Year	Model	Key Points
Kelley	1994	The Stress & Burnout Model	Burnout is the end product which is mediated through personal/situational and burnout variables. If these variables are prolonged and there is a continued increase in stressful interactions, then burnout will result. These factors can be said to influence perceptions which in turn are linked to burnout. There is a lack of emphasis on training and physiological issues associated with overtraining.
Garcés & Vives	2003	Integrated Model	This model incorporates and connects many of the ideas that have come before. It proposes five interrelated elements which influence the onset of burnout. These include: the situations favouring burnout; cognitive appraisal; personality variables; dimensions burnout is expressed; and consequences across the biopsychosocial spectrum. As with past models, the focus is on psychological constructs rather than holistically incorporating training, physical symptoms, or even perceptions of physical symptoms.
Kellmann	1991	The Scissor Model of Stress & Recovery	Identifies that in situations of stress there is a need for recovery. The model states that individuals have a capacity for withstanding stress, but this capacity can be exceeded and recovery might not be able to buffer the impact of stress. As stress increases recovery becomes correspondingly more necessary. The model is perhaps too simplistic and doesn't account for too much recovery and lack of training being detrimental to performance.
Polman and Houlahan	2004	The Cumulative Stress & Training Continuum Model	Revised the Kenttä & Hassmén (1998) model to show the interactions are complex, web-like, cumulative, and synergistic. This model acknowledges that many of the symptoms of overtraining can result without the effects of excessive training stress i.e. that non-training stressors could be a reason for an athlete failing to cope with training load. Whilst comprehensive it is difficult to put into action a monitoring strategy for all the web of interactions.
González-Boto, González, & Márquez	2008	Integrative Model of Overtraining	Takes into account the models from previous research: overtraining depends on a series of elements that can be clustered into three interdependent fields: determining factors, internal process of overtraining and results or consequences. Accounts for both the physical and psychological factors as well as personal appraisal. Fails to denote what happens if too much recovery and not enough training stress.

Meeusen et al. (2013) provide a comprehensive review and consensus statement on overtraining including assessment strategies. For a detailed description from a pathophysiological perspective the reader is referred to Kreher & Schwartz (2012). Whilst from a psychological perspective both Polman and Houlahan (2004) and González-Boto, González and Márquez (2008) provide detailed accounts of the developments of models to date that explain overtraining.

As discussed previously, a useful way to view the response to exercise and gameplay in sport is on the overtraining continuum where inadequate recovery can lead to maladaptation (Figure 2.3). Ideally the performer would train (stress/stimulus), experience fatigue from that training, go through a recovery process (possibly have a super-compensation effect) and ultimately return ready to perform the following week (Haff, 2012). Recovery is an essential component for adaptation and prevention of negative outcomes such as overtraining. This is highlighted extremely well in Kellmann's Scissor Model (1991) and Kentta and Hassmen's (1998) stress-recovery model. Practitioners should therefore give focus to monitoring the recovery process in addition to the stressors.

Unfortunately, monitoring for wellness is not as simple as recording stress and recovery in isolation. Whilst the stressors are cumulative, interactive and synergistic (Polman & Houlahan, 2003) other determining factors, such as an athletes' appraisal of the stressor, play a part in this complexity. The Integrative Model (González-Boto, González and Márquez, 2008) provides a template to understand some of these issues in the development of overtraining. This model integrates common aspects of stress-recovery

and burnout theories, advancing from earlier models to show that the presence of overtraining depends on three interdependent fields: determining factors, internal processes and consequences (Figure 2.5). It is certainly worth considering this model when developing wellness measures as the model illustrates the imbalance between stress and recovery, the determining factors a practitioner needs to monitor, analyse and react to in order to increase adaptation and readiness to perform.

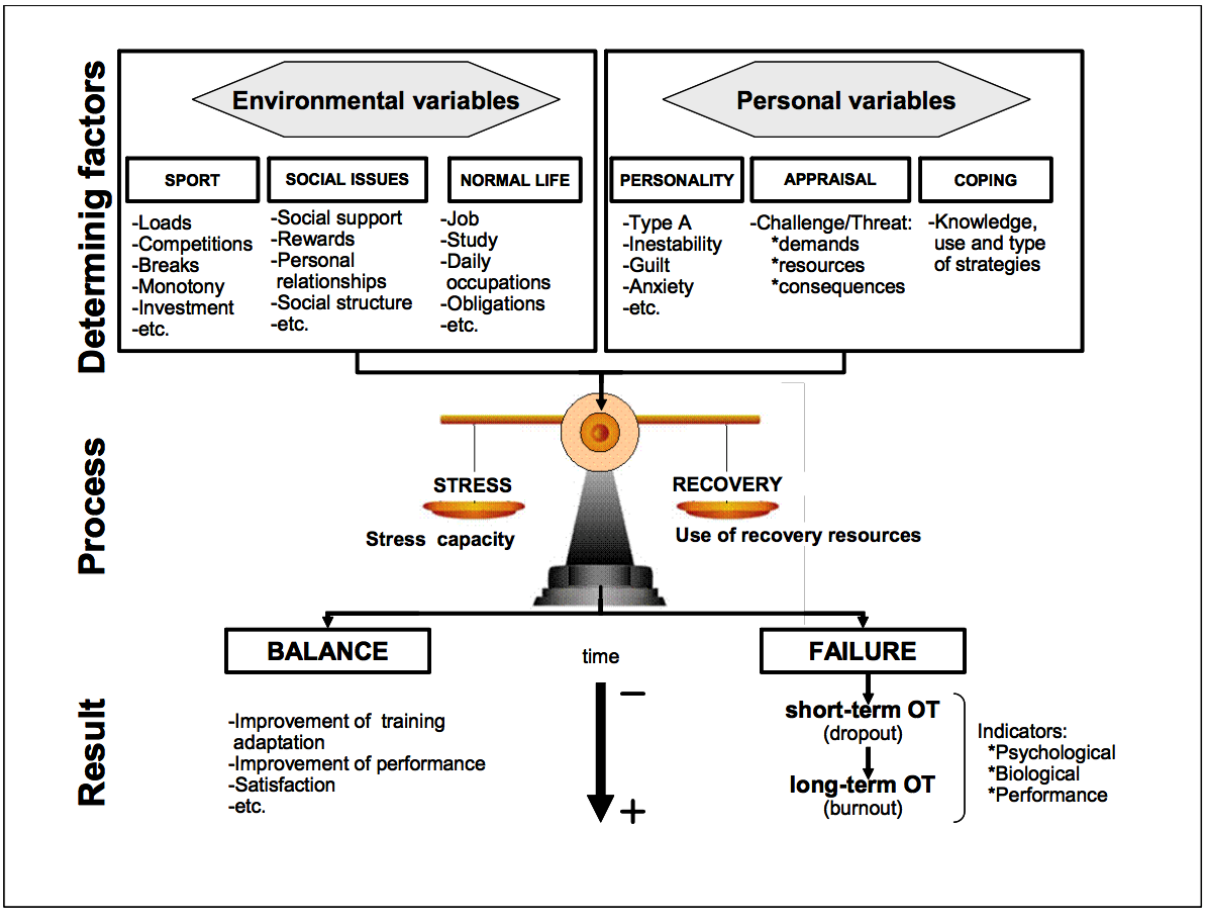


Figure 2.5 Integrative Model of Overtraining (González-Boto, González, & Márquez, 2008).

Within the determining factors section of the model there are two categories: Environmental and Personal Variables. They are the demands and pre-requisites that favour a negative response or adequate recovery and optimal wellness (González-Boto, González and Márquez, 2008). The determining factors per se do not induce a negative response but it is the individuals stress capacity and use of recovery recourses that have a major impact on the consequence of balance (adaptation/improvement) or failure (overtraining). This shows the importance of the sports scientist in recognising training demands, knowing their athletes, the training responses and prescribing recovery in order to ensure that the performer is ready to perform. It is also important to understand which recovery strategies are most effective. The wellness questionnaire can ultimately sit at the heart of this model as a monitoring method that encapsulates aspects of the determining factors, process and result.

2.3.6 Summary on Wellness Questionnaires

From a practitioner perspective, there are now a plethora of psychometric questionnaires, to monitor wellness aspects. It is currently unknown as to the exact prevalence and details of use of wellness questionnaires within high-performance sport, but research indicates that validated psychometric questionnaires are used sporadically at best, with practitioners opting to use customised questionnaires (Taylor et al., 2012). Based on a review of the literature there is no one single dimension (e.g. mood) which can be recommended for monitoring in its own right but athletes should report on their subjective wellness regularly (Saw, Main, & Gastin, 2016). A combination of customised questions for the sport may help to inform on overall wellness (Hooper and Mackinnon, 1995) but this should be balanced with validity and reliability in mind (Saw et al., 2016).

Customised questionnaires used within rugby league research have a lack of detail regarding the validity, reliability and development of the questionnaire. Theoretical models, such as the Integrative Model of Overtraining, can aid a practitioner in understanding an athletes' response to training and gameplay. Whilst this information is useful for developing knowledge around the rationale for using wellness questionnaires and other monitoring strategies, a huge challenge can then be the implementation and actual utilisation of the questionnaire. Hence, the final section of the literature review on practical considerations.

2.4 Practical Considerations for Athlete Monitoring

Practical considerations have been recommended in academic texts when implementing monitoring systems in sport (Table 2.6). Whilst this information is useful it is often broad, wide ranging and lacks any real structure as to what element to focus on first. To some extent this was combated in one research paper by Saw, Main and Gastin (2015b) which interviewed athletes and practitioners on the use and implementation of wellness questionnaires. They made use of a Social Ecological Model to frame barriers to implementation within the measure itself (i.e. the questionnaire) and the social environment (e.g. player buy-in). This study has helped to categorise aspects which impact upon implementation of wellness questionnaires. However, these aspects are likely to be specific to the sport and no further studies exist which have explored individual sporting contexts. Moreover, a framework for dealing with these practical considerations regarding implementation is still lacking.

Table 2.6 Practical considerations for developing monitoring systems based on McGuigan (2017); Halson (2014).

Practical Considerations for Monitoring Systems
• Uses tools that are valid, reliable and sensitive to change
• Easy to use with intuitive design
• Quickly collects information
• Feedback to athletes and coaches is quick
• Presents results that are easy to understand by athletes and coaches
• Can be used with or without internet connection (e.g. when travelling away from the training ground)
• Is within the organisations budget
• Can provide individual athlete information and group information
• Identification of a meaningful change should be simple and efficient
• Does not rely on a one-size-fits-all approach
• Can be adapted for different athletes and/or sports
• Does not require excessive human resources
• Delivers information that practitioners can use to make changes to training programmes

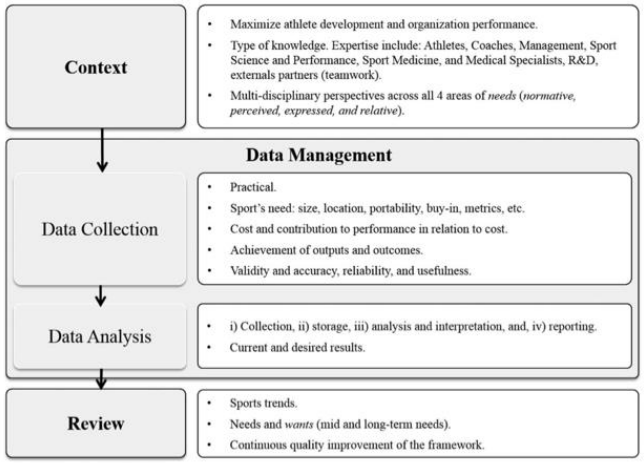
Factors that should be considered by the practitioner in order to fully implement an effective monitoring practice include knowledge of the individual athlete such as their history of injury, illness and psychosocial components. Also, an understanding of the coaching philosophy, sporting context, along with knowledge of the individual may help to generate buy-in to the process of monitoring. Furthermore, inclusion of the athlete in the process of developing the monitoring methods, such as the wellness questionnaire, may be beneficial. Wellness questionnaires should be used to inform rather than dictate

training, and to achieve this it is important to discuss with all stakeholders how the data will be managed and used (Saw et al., 2016).

2.4.1 Handling Data

One of the first practical considerations should be to establish the data handling process of the practitioner and organisation. This is important to the success of the wellness questionnaire as the data handling process contains the areas that implementation takes place. Several data handling processes have been detailed in academic sports literature (Figure 2.6) which include the processes of implementing monitoring technology (Torres-Ronda & Schelling, 2017), within data analysis (O'Donoghue & Holmes, 2014) and specifically for wellness questionnaires (Saw, Main, & Gastin, 2015b). Practitioners often modify or add to these processes in order to suit their own needs for their team or athletes (e.g. 2.6d - Weaving, 2018). Quality implementation across each of these areas is important for the successful use of wellness data.

2.6a



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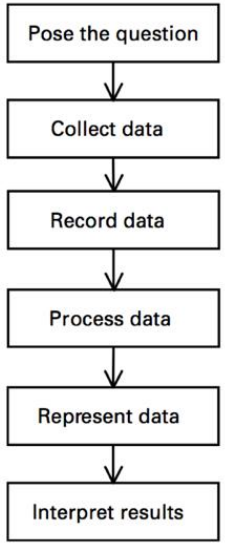


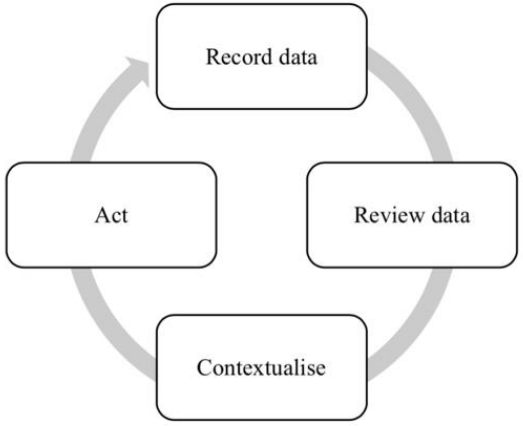
Stage 1 P – Pose the Question

Stage 2 C - Collect the data (collecting and recording)

Stage 3 A – Analyse the data (processing and representing)

Stage 4 I – Interpret the results

2.6c



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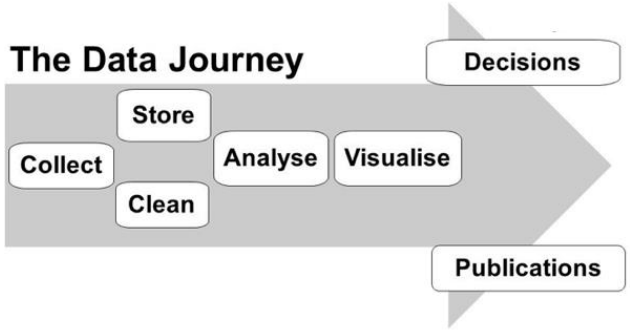


Figure 2.6 The Data Handling Process

2.6a Torres-Ronda & Schelling (2017), 2.6b Graham (1990) as used in O'Donoghue & Holmes (2014), 2.6c Saw, Main & Gastin (2015c) and 2.6d Weaving (2018).

A commonality in all of these examples is the three broad areas of data handling identified as data collection, data analysis and decision making (Figure 2.7). These are very much the cornerstones of handling data and are consistent with the stages set out by Graham (1990). The initial step is to have some organisation and planning primarily to establish the purpose and details of how the wellness data will be collected. At this stage it is important to pick out the key performance indicators and question items for the wellness questionnaire that are specific to the sport. Practitioners should operationally define each item or metric with clarity and unambiguous terminology (Williams, 2012), which at some point should be conveyed to athletes and staff. The collection of data may involve some movement or sorting of the data (such as transferring it into statistical software) to prepare for analysis. Once data has been collected, or even as it is being collected, analysis of the data takes place. In addition to the practitioner, players often review their own data and assess their response in comparison to previous entries. Data analysis may involve pre-designed calculations or decision support flagging systems to highlight important results (Robertson, Bartlett, & Gastin, 2016). Reports and visualisation of the data are often prepared for distribution to coaches, players and other relevant parties. At this stage the data may be combined with other training load data depending on the purpose. As the practitioner begins to interpret the data they enter the decision-making phase, deciding on the action required or informing the coach on their recommendations. All reports should be tailored to the audience with attractive and informative information that is communicated to the coach or athlete (Buchheit, 2017). A number of actions that can be taken by using wellness data have previously been identified (e.g. feedback, training modification, referral) (Saw, Main, & Gastin, 2015c). It is then important to review the

effectiveness of the process, both in the short and long term, to ensure quality implementation throughout each stage.

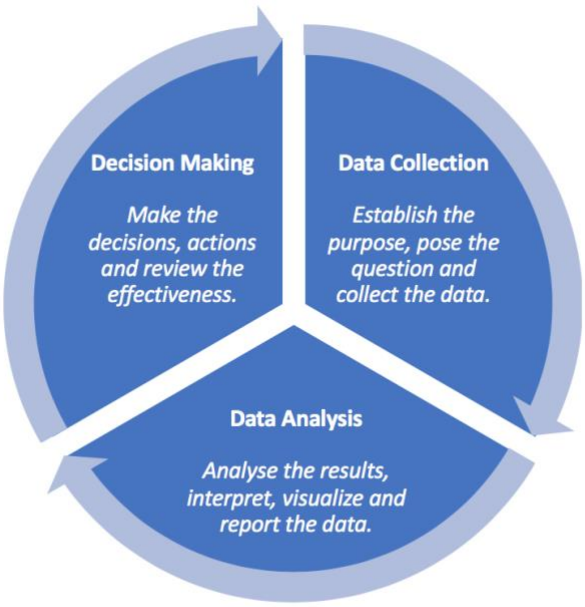


Figure 2.7 *The Wellness Data Handling Cycle*

A particular aspect of handling data that modern day practitioners should be cognizant of is the current laws and regulation surrounding data. In 2018 a reform of data protection strengthened the rules to give transparency in a data heavy world (European Commission, 2018). Certainly within sport the past decade has seen teams collect more and more personal data of athletes. Players are often told that the reason for data collection is to improve performance, but there is the potential to disguise other motives. For example, sports science data has the potential to indicate a decline in an aging performer through collected wellness (e.g. muscle soreness trends), fitness testing (e.g. V02Max) and GPS data (e.g. high-speed distance covered in games). This may limit an individual's ability to obtain a new contract. If a player is to comply with completing wellness questionnaires

then it should be made clear to them what the data may or may not be used for. This could easily be achieved at the point at which players sign contracts and via appropriate in-house education. Generating trust is essential to the use of wellness questionnaires and athletes reporting honestly. Outlining the use of data is thus an important step and athletes should be given the opportunity to have more control over their personal data.

2.4.2 Designing Wellness Questionnaires

There are many factors to consider when deciding upon the content of the questions within a self-report questionnaire. Research has identified that self-reported responses can be influenced by features of the questionnaire including question wording, format and context (Schwarz, 1999). For example, patients have been shown to report symptom frequencies vastly different dependent on the scales being used (Schwarz & Scheuring, 1992). A primary concern is therefore if the content of the questionnaire is valid, reliable and sensitive. Short and simple questionnaires have been proposed and used in rugby league to identify fatigue, muscle soreness and wellness trends post-game (Johnston, Gabbett, & Jenkins, 2013a; McLean et al., 2010; Twist et al., 2012). However, these studies do not document the validation or implementation process of the wellness questionnaire assuring the reader that similar questionnaires have been shown to be valid and reliable (Vries, Michielsen, & Heck, 2003). The reference referred to in these studies actually assess the use of questionnaires in the measurement of work related fatigue in occupations as diverse as agriculture, construction and public sector government. Verification of the question items and consideration of questionnaire length, the ease of understanding, question ambiguity, as well as consideration for different aspects of validity (e.g. face, content, concurrent) should be considered in the development of

questionnaires (Jones, Lane, Bray, Uphill, & Catlin, 2005). Content should be assessed for bias or leading questions in addition to how the questions may be interpreted or perhaps weighted to calculate wellness. As discussed earlier, the questionnaire should have "practical validity" and be sensitive to change. Research testing a 5 to 10 item customised design wellness questionnaire within a sporting context would be a beneficial addition to the field. It would be worthwhile for academics and practitioners to validate wellness questionnaires within their environments rather than simply port for use existing non-validated scales. There should certainly be more detail or appendices within publications to justify the use of the chosen wellness questionnaire.

A common concern with self-reports is that a respondent may answer in a socially desirable way where they edit their response in order to avoid a negative self-presentation (Schwarz, 2006). In sport, the issue lies in athletes reporting favourable responses or underreporting unfavourable responses (Saw, Main, & Gastin, 2015b) and perhaps being influenced by the expectations of coaches (Coutts, 2016). For example, injuries are often underreported as they can be perceived as a sign of weakness (Ekegren, Donaldson, Gabbe, & Finch, 2014). There is often concern that information will be used inappropriately or against what the player desires. It may therefore be important for practitioners to explain the level of confidentiality to which the players' information is subjected. For example, whilst players will always be able to be identified it may be worthwhile to educate that wellness data will only be seen by practitioners with a legitimate need. Ensuring a level of confidentiality over respondents' answers may give players confidence to report accurately and reduce social desirability effects as seen in other self-reports (Bradburn, Sudman, & Wansink, 2004).

2.4.3 Influence of the Practitioner and Coach

The coach and staff are individuals that can greatly influence the implementation of wellness questionnaires within the organisation. The wellness data and associated decisions should be concomitant with the coaching team and staff because they play a pivotal role in determining the monitoring tools to be implemented (Burgess, 2016). Research in sports psychology on Unexplained Under Performance Syndrome (UUPS) and organisational stressors has highlighted the influence of the coach on wellness. In many psychological models the coaching environment plays a determining role in the development of UUPS and acute changes in wellness. For instance, in the Stress and Burnout Model (Kelley, 1994) personal, situational and burnout variables influence the perception of stress, which can lead to exhaustion through prolonged increases. In fact, stressors within the organisation are likely to be critical to determining wellness and performance of the athlete (Arnold & Fletcher, 2012). It is noteworthy that many of these organisational stressors identified in high-performance sport (Fletcher, Hanton, Mellalieu, & Neil, 2012) are aspects which are under direct control of the coach and staff within the organisation. It is the job of coaches and performance staff to deliver effective training sessions to develop the performers, ensuring they are ready for competition. In rugby league it has been shown that the choice of training drill will impact on the perceptions of load experienced (Lovell, Sirotic, Impellizzeri, & Coutts, 2013; Weaving, Jones, Marshall, Till, & Abt, 2017). Through appropriate coaching, modification of training and by taking stressors into account coaches can have a positive influence on the physical and psychological wellness of their athletes.

Fundamentally, utilising wellness questionnaires is a complex aspect of athlete monitoring with many practical challenges and barriers to implementation (Saw et al., 2015b). It has the potential to be seen in a negative light; the big brother surveillance that prevents players from training and playing. Indeed, athlete monitoring strategies have the potential to be misused, especially as practitioners aim to justify and demonstrate their contribution to the 'performance pie' (Collins, Carson and Cruickshank, 2015). Therefore, practitioners need to contemplate the academic and practical considerations when implementing and utilising wellness questionnaires.

2.5 Key Limitations to Address

This literature review has discussed a wide range of areas to provide an overview of athlete monitoring and the use of wellness questionnaires in high-performance sport, including the context of rugby league. There are two notable limitations that have been identified within this review and evident in practices within high-performance sport. Firstly, there is a lack of knowledge on the implementation of wellness questionnaires within sport and rugby league. Implementation of questionnaires is crucial to successful use of these measures in practice and practitioners require guidance on the approach for their context. Secondly, the wellness questionnaires that are currently used in research and practice are not fit for purpose. This is largely due to the lack of documentation on the development of the questionnaires and limited evidence of validity and reliability. Collectively these limitations pose a threat to the accuracy of wellness data that is collected and subsequently used in performance related decisions in practice and academic recommendations in research. By addressing both of these limitations it will help to achieve better quality wellness data for use in practical decisions and research

investigations. With a more robust monitoring tool player wellness improvements through the provision of training and recovery can be achieved. Furthermore, it opens the possibility for use of wellness data within future research studies to better inform on wellness in high-performance sport.

2.6 Chapter Summary

Athlete monitoring provides information to influence the training programme by quantifying internal load, external load and the response to the load. Whilst monitoring is now commonplace within high-performance sport a practitioner should first establish the reason for doing so and the data handling process which in turn will help guide the measure and method selection. Time should be spent developing working relationships with athletes to develop trust and honest reporting of perceptions. GPS, RPE and wellness questionnaires are frequently used in rugby league due to their high practical value. Wellness questionnaires can monitor athletes' perceptions from a physical, psychological and/or social perspective. These subjective measures have shown superior sensitivity and consistency in reflecting training load over objective markers. Whilst they can be used in isolation they are best used as part of a mixed methods monitoring toolkit. A range of validated psychometric questionnaires and custom designed ones exist for practitioners to use to monitor aspects of wellness. Customised designed wellness questionnaire are geared around applied practice by being easy to use and feedback efficient. However, practitioners should bear in mind the underpinning theory, models, validity and reliability which inform questionnaire design and monitoring approaches. Within rugby league, wellness questionnaires have been sensitive to detect subtle changes in the response to game-play and the training week. However, there is a lack of information on how these

questionnaires have been developed and validated. Consensus is lacking regarding the implementation and utilisation within rugby league environments. Therefore, the aim of this thesis regards exploring the use and implementation of wellness questionnaires in high-performance sport with the goal of developing a framework for successful implementation in rugby league. The first step in doing this is to understand how wellness questionnaires are being used in high-performance environments before focussing in on their use in rugby league.

CHAPTER 3

Study 1: How do high-performance sports teams use wellness questionnaires?

3.1 Introduction

From previous investigations into the overall use of athlete monitoring measures it has been stated that self-report measures are common. Yet there are no published sources which have focussed their investigations specifically on how practitioners utilise wellness questionnaires in high-performance sport. It is thought that customised questionnaires form the predominant measure, therefore it is necessary to investigate the different types of customised measure in use. This includes the variety of question dimensions, the scale of response, frequency of completion, and methods of wellness data analysis. This study aims to investigate these areas alongside how practitioners evaluate the success of using a wellness questionnaire, with a view to guide future development and utilisation of self-report measures.

Athlete monitoring and the collection of data within high-performance sport continues to develop providing useful information to determine training load (Bourdon et al., 2017), recovery status (Kellmann et al., 2018), monitor injury risk (McCall et al., 2014) and generally inform sports science decisions. Monitoring via the use of wellness questionnaires has been shown to be a popular method to achieve these goals. Indeed, Taylor and colleagues (2012) identified that self-report questionnaires were the most commonly used method for monitoring fatigue and recovery responses amongst a variety of high-performance sports. This importance has been further acknowledged within surveys in high-level football (Akenhead & Nassis, 2016) and rugby (Starling & Lambert, 2017). Wellness questionnaires are popular for a variety of reasons, namely that they are cost effective and exhibit a relatively easy form of data collection compared to some other markers of fatigue and recovery (Burgess, 2016). Whilst research has highlighted the

importance of the wellness questionnaire the specific details on how they are used (such as the questions, scales and frequency of use) and successfully implemented warrants a deeper analysis.

Attention must be given to the data collection, analysis and decision making taken through the use of wellness questionnaires within high-performance sport in order to determine how their successful implementation can be achieved. Recent studies have begun to address the issues such as the guidelines for selecting (Saw et al., 2016), collecting (Düking, Achtzehn, Holmberg, & Sperlich, 2018) and analysing (Robertson et al., 2016) athlete monitoring data. Sports teams regularly participate in research studies to advance their own practices as well as the field of sports science. There has certainly been an increase in the amount of research using self-report questionnaires in rugby league in recent years (e.g. Mclean et al., 2010; Thornton et al., 2017; Twist et al., 2012). Yet research regarding the actual use of wellness questionnaires in applied environments is still limited. From previous investigations, customised questionnaires that report muscle soreness, sleep duration, sleep quality, and fatigue are dimensions cited as being used (Taylor et al., 2012). These are often favoured over empirical research questionnaires due to their brevity of assessment which is said to help with player compliance to completing the questionnaires. However, compliance under team and individual sports using customised questionnaire is mixed (Saw, Main, Gastin, 2015a), which suggest other factors could influence the utility of questionnaires.

Indeed, other factors which influence the implementation of self-report measures have been identified (Saw et al., 2015b). Implementation is concerned with the way a

programme is put into practice and delivered to participants (Durlak, 2015). Research primarily in health and education has often turned to implementation science to assist in putting innovations into practice in such a way that it meets the desired outcome (Meyers et al., 2012). One such publication details the success factors of a new hospital information system (Prijatelj, 1999). The author states that there are three stages: pre-implementation, where a clear vision from practitioners is needed; implementation, where key team-players must navigate negativity, interpersonal conflicts, and hidden agendas; and post-implementation, the ongoing evaluation, and training practitioners must pursue. There are many parallels with this type of research and the recent adoption of technologies and athlete monitoring in sport. Indeed, authors within sports science have begun to document evidence-based models on how best to use monitoring strategies and navigate the challenges of implementing monitoring in high-performance environments (Saw et al., 2016; Thornton, Delaney, Duthie, & Dascombe, 2019; Torres-Ronda & Schelling, 2017). However, questions remain as to the extent practitioners are following these new guidelines of best practice for implementing wellness questionnaires.

What is clear is that significant challenges exist for sports science practitioners when implementing wellness questionnaires. Many practitioners allude to the challenges of applied environments such as match scheduling, adherence by players, athlete and staff buy-in, sport traditions and staff availability (Burgess, 2016). Saw and colleagues (2015b) conducted a study to determine the factors that influence the use of self-report measures at a national sporting institute in Australia. It was found that factors associated with the measure (modality, accessibility, time of completion) and the social environment (buy-in, reminders to complete) were prime drivers in the successful implementation of self-

reports. The authors highlighted a social ecological framework and illustrated the interrelation of the factors on compliance, data accuracy and athletic outcomes. However, this accounts for a handful of sports and with organisational factors playing a role within implementation it is important to assess the challenges and barriers faced by other practitioners within their unique environments. Practitioners are always looking to solve these challenges and it is useful to assess how they are achieving this.

The purpose of this study was therefore to gather information on the use of wellness questionnaires according to practitioners in high-performance sport. It was hypothesised that practitioners would largely be using a variety of customised questionnaires, but common themes would exist in regard to achieving successful implementation.

3.2 Methods

3.2.1 Survey Design

A survey was designed to assess how practitioners in high-performance sport teams implement and use wellness questionnaires. The survey was split into three sections; (1) demographic information including the type and level of sport participants worked in, (2) details of wellness monitoring practices such as the number of questions and the type of scales used, and (3) items assessing the level of implementation of the wellness questionnaire. Questions were developed from the knowledge generated within the scientific literature surrounding athlete monitoring, self-report questionnaires, and implementation. This was combined with practical experience of the research team in monitoring athletes. The survey was designed to be quick to complete, taking up to a maximum of 10 minutes. The platform used for the survey was an online website that

could be accessed globally (SurveyMonkey Inc., Palo Alto, California, USA). This platform was deemed appropriate to satisfy data protection and privacy concerns of participants as well as offering a functional service to facilitate the process from design through to analysis. The survey had a total of 23 questions including closed response, ranking questions and Likert scales (see Appendix B for questionnaire).

3.2.2 Participants

Participants were recruited via a network of links between the research team and high-performance sports teams. In order to compensate for this convenience sample the survey was posted on social media to make it open to any individual who worked as a practitioner within high-performance sport and used wellness questionnaires with their athletes. The response rate of the individuals who clicked the link to the survey was 77%. A total of 122 participants completed the survey in full and comprised of sports scientists (n=47), strength & conditioning coaches (n=40), high-performance managers (n=16), medical practitioners (n=8), coaches (n=6), performance analysts (n=3) and sports psychologists (n=2). Participants worked in a range of high-performance sports which included working with elite first team (n=73, highest standard of senior competition), elite youth athletes (n=24, including academy teams) and others (n=25, including a mixture of standards such as high school and college athletes) (Figure 3.1). As the survey was focussed on understanding the content, purpose of use and implementation of wellness questionnaires it was directed at staff, rather than players, who had a full understanding of these aspects.

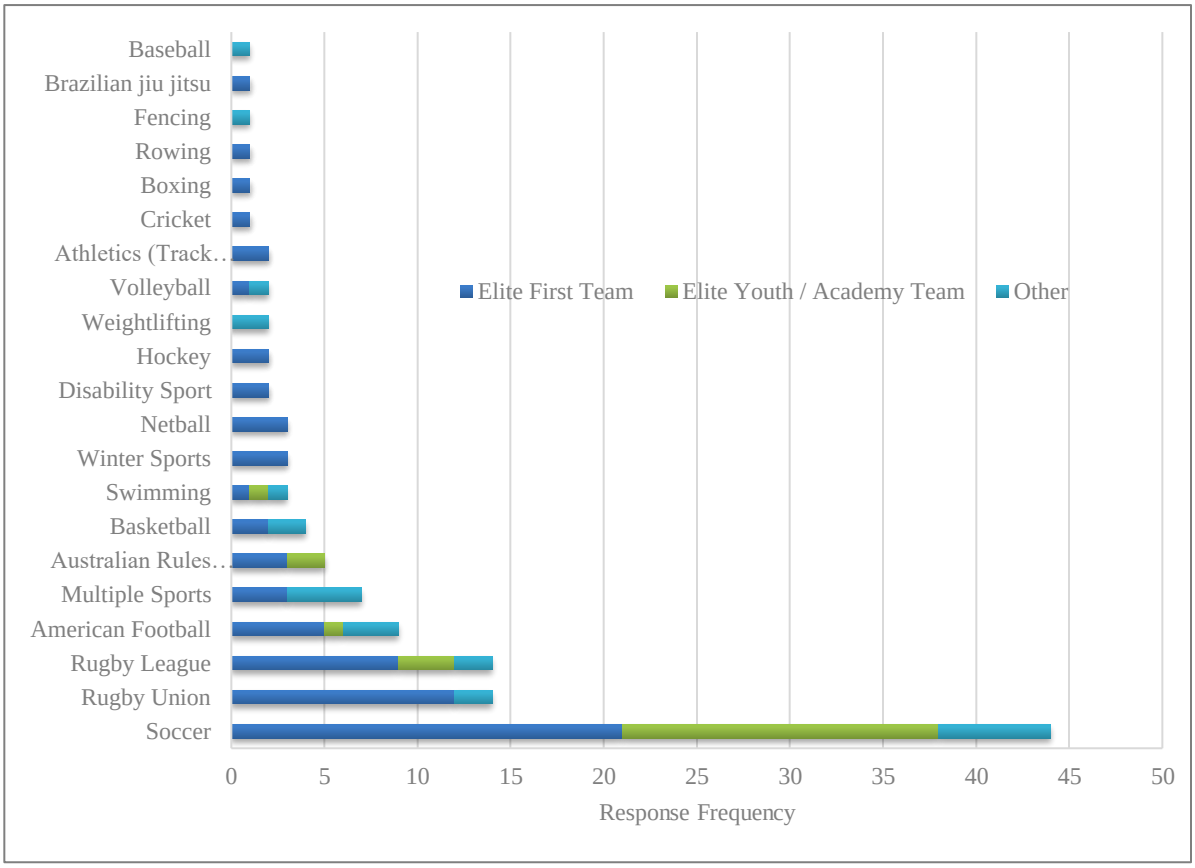


Figure 3.1 Participant demographics. *(The response frequency is the number of participants representing different sports with the colour acknowledging the level of performance)*

3.2.3 Procedures

The protocol and research was approved by the University of Central Lancashire ethics committee (Unique Reference number BAHSS 587). Participants were contacted electronically (email and private messaging), given a brief explanation of the research and provided with a link to participant information and to the survey. Respondents who participated via social media similarly had a brief explanation of the content of the survey and a link to the same participant information and survey. Participants were informed that consent to participate in the survey was implied by completion and that they could exit the survey at any point by closing their web browser. The final question in the survey asked participants if they would be willing to take part in follow up questioning.

Participants could agree by submitting their contact details or keep their answers anonymous by ignoring the question. This method of follow up has been previously used in sports settings (Taylor et al., 2012). A total of 46 participants indicated their desire to participate in the follow up questioning. These individuals were contacted and asked to answer three open-ended questions regarding details on successful implementation of wellness questionnaires. Participants were also asked to provide details on wellness a) data collection, b) data analysis and interpretation, c) decision making and actions, and e) evaluation.

3.2.4 Statistical Analysis

Following data collection, statistical analysis of results was completed using Microsoft Excel (Microsoft, 2017). This included frequency analysis were results were reported as absolute values and percentages. For questions were participants had to rank in order of importance, a points system was used similar to previous survey research (McCall et al., 2014). The following criteria was applied throughout: All = 100% of relevant participants; Most = ≥ 75%; Majority = 55 - 74%; Approximately half = ± 50%; Approximately a third = +30%; Minority = ≤29%. One question asked participants to rate their agreement for items to include in a wellness questionnaire via a Likert scale. These answers were grouped as “Accept” (Very Important + Important) or “Reject” (Of Little Importance + Unimportant) as per previous research (Starling & Lambert, 2017). Finally, open response data from the follow up questions were imported into NVivo software (QSR International Pty Ltd. Version 11.4.1, 2017). They were then coded using a qualitative data analysis approach based on Miles, Saldaña, & Huberman (2014). This process involved carefully reading the responses and identifying similar themes through a data coding process.

Responses were re-read several times and themes checked for consistency with other academics in the research team.

3.3 Results

3.31 Use of Wellness Questionnaires in High-performance Sport

The majority of respondents (74%) reported that wellness questionnaires were used every day (40%) or at least every day participants were in training (34%) (Figure 3.2). A minority of respondents used weekly (7%), monthly (5%) or other frequencies (14%).

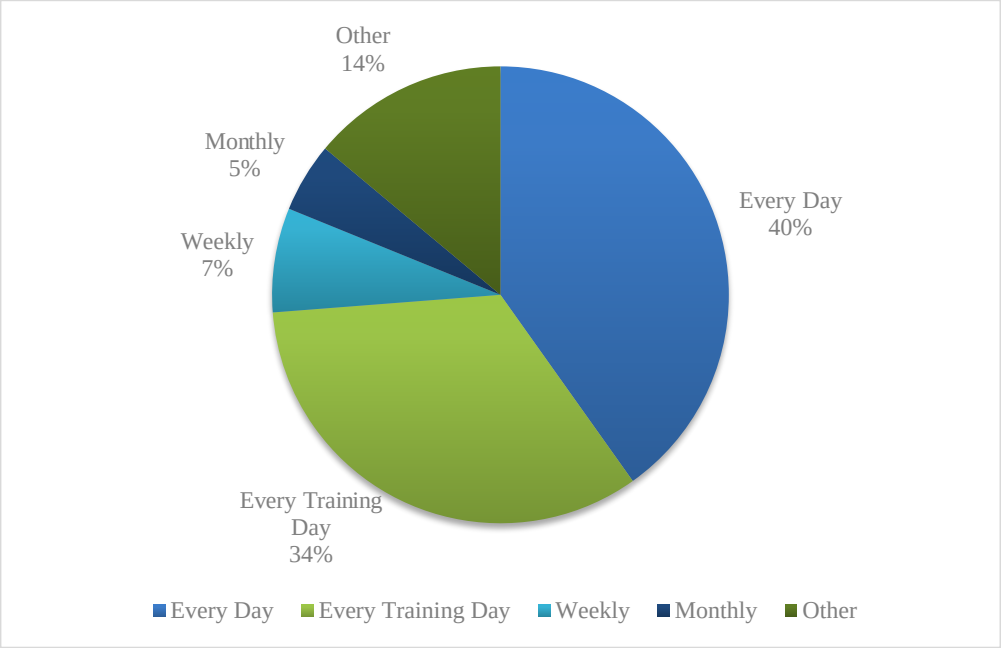


Figure 3.2 **Frequency of administration of wellness questionnaires** (n=122)

93% of those who responded used customised designed questionnaires whilst 7% favoured empirical questionnaires. Most (90%) indicated that the survey had between 1 and 10 questions (1-5= 46%, 1-10= 44%). Whereas, fewer participants used the longer 1-15 (7.5%) and 15+ item questionnaires (2.5%).

Participants often used more than one type of scale with approximately half of the respondents favouring numbered (48%) or a combined worded and numbered scale (49%). Least favoured were worded only (9%), other scales such as emojis or images (7%) and dichotomous scales (5%). When analysing the wellness data there was a large range in the techniques used with the majority of respondents simply observing changes (70%). Other common approaches included using mean (48%), z-scores (34%) and standard deviations (33%). It was less common for practitioners to use the percentage change (21%), smallest meaningful change (22%) and coefficient of variation (8%). Practitioners considered muscle soreness to be the most important item to include on a wellness questionnaire with a total of 100% acceptance. Other items, including measuring sleep (99%), illness (96%), player comments (94%), Non-training stress (93%) and RPE (91%) had a large percentage of respondents favouring the use (Figure 3.3).

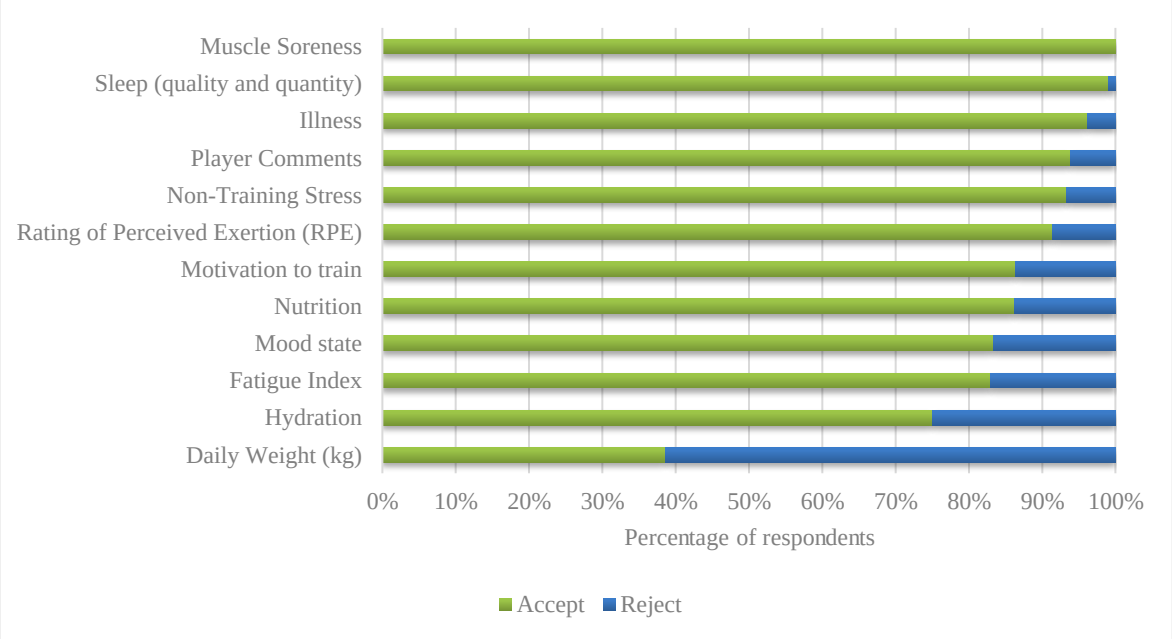


Figure 3.3 Importance of items to include in a wellness questionnaire.
"Accept" = combined 'very important' and 'Important', "Reject" = 'Of little importance' and 'Unimportant' (n=122).

3.32 Levels of Implementation

The majority of practitioners (74%) reported that the completion rate of their questionnaire was above 75%. A total of 26% of all respondents had a completion rate lower than 75%. Wellness questionnaires were the most important monitoring strategy for practitioners followed by GPS, training details and RPE. Sleep tracking wearables, monotony calculations, biochemical, hormonal and immunological tests were less favoured.

Practitioners mainly used the wellness questionnaire to identify training readiness, monitor the response to training and attempt to prevent overtraining, illness/injury. It was less favoured as a method to prescribe recovery and assess non-training parameters. A large range of decisions were said to have been taken with the use of wellness data with most practitioners completing follow up chats with players (91%), decisions regarding individuals (90%) and training modifications (89%). The majority of practitioners also made player referrals to other practitioners (65%), decisions on recovery (60%) and regarding the full team (57%). It was less common to use wellness data to make performance decisions (31%) (for example being used in team selection).

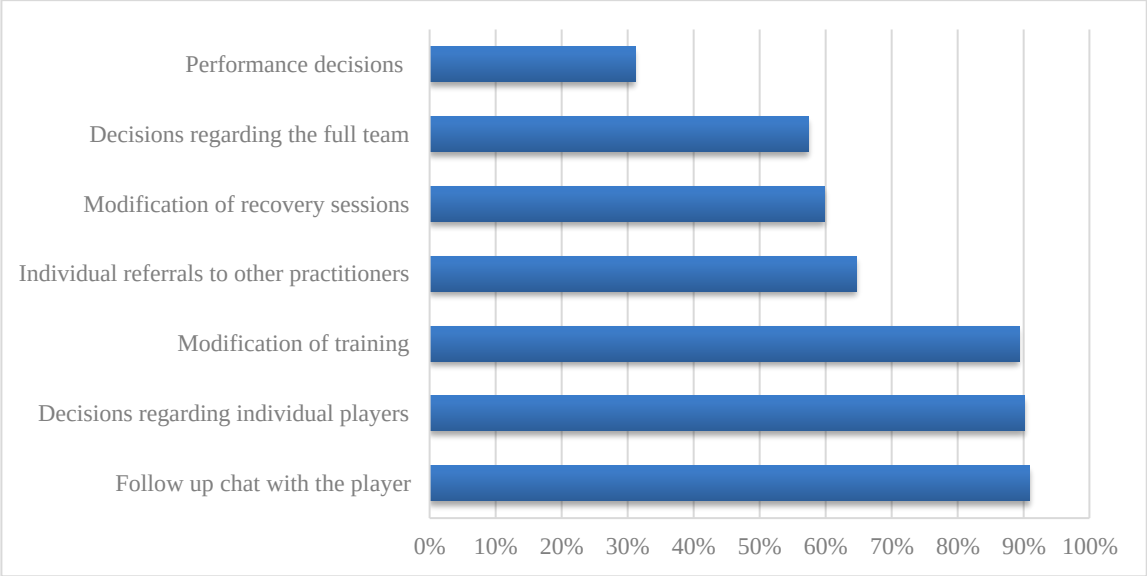


Figure 3.4 How wellness data is used to make decisions
(n=122).

Approximately half of practitioners (54%) rated the implementation of wellness questionnaires within their team or sport as good or excellent. Of the remaining respondents, 35% stated that implementation was satisfactory and 11% poor or very poor. Practitioners were asked to rate the factors that influenced implementation the most. A points and ranking system (arbitrary units) indicated that practitioners perceived factors associated with the organisation (344) to be most important followed by the measure (304), individual (279) and inter-personal factors (271). However, factors associated with the individual (75%) were most likely to have been be put into practice than factors associated with the measure (67%), organisation (65%) and interpersonal (55%). In particular, most practitioners (75%) felt they had delivered sufficient education so that players and staff understood why it was used and who benefitted from it. Most also had a key staff member to champion the use of the questionnaire (83%) and the majority of practitioners provided regular feedback (66%).

In regard to the measure, 93% of practitioners agreed that they had a questionnaire which was easy to use and took little time to complete. 55% felt they had a questionnaire which could be used anywhere including without internet connection and just over half of participants felt satisfied with the data output and visualisation (55%). Most respondents (75%) stated that their organisation regularly used data to inform their decisions. The majority confirmed that they had set clear guidelines around the use of this data including awareness of data protection (66%). Approximately half (46%) stated they had insufficient resources to get the most out of the wellness questionnaire. 59% of practitioners said that they ensured players were honest in their response and not influenced by others. To encourage completion of the questionnaire most practitioners would remind players (80%) rather than using punishments (26%). Most practitioners had adapted their questionnaire based on experience (75%) and over half continually reviewed how the questionnaire was being used (56%).

3.33 Achieving Successful Implementation

Practitioners identified five key areas they looked for in judging if successful implementation of wellness questionnaires had occurred with their athletes (Table 3.1). Several challenges were highlighted in regard to achieving successful implementation. Establishing high compliance rates, buy-in of athletes and generating support from the wider multidisciplinary team was the most common challenge. In particular the onboarding of new players, encouraging and educating them amidst the monotonous nature of routine completion. Ease of use of the questionnaire was said to be the biggest challenge for some practitioners. This was certainly the case for teams with a limited budget to spend on apps or websites which might improve accessibility. Lastly,

practitioners saw challenge in developing validity, reliability and trust in the data. In particular, the honesty of players to complete the questionnaire presented challenges to interpreting the data. It was also highlighted that coaches can influence this by how they use the data and practitioners experienced difficulties in getting coaches to listen and make decisions which did not always result in restricted training sessions for players.

Table 3.1 *Implementation Outcomes: Key themes of successful implementation of a wellness questionnaire.*
(participant number in brackets)

Higher Order Theme	Representative Meaning Unit
Athletic Outcomes	Seeing Improvement. There must be an action and protocol associated with every question. A staged intervention and loop back. (P02)
Compliance	Successful implementation means it has 100% adherence and completion by athletes. There cannot be gaps in terms of players or days with data missing. (P04)
Data Accuracy (Validity & Reliability)	Successful implementation has to begin with education and anchoring to the wellness scale…do the athletes really know what they are answering to? Are they anchored to the scale to know what a "5" is? Or what a "6" is? And how the two differ? (P10)
Simplicity of the system	A wellness programme in which all the players can fill in and find easy to do so. (P01)
Meaningful Data	A wellness questionnaire that provides data that informs the coaching process. (P09)

Data Collection: Practitioners chose their questionnaires based on, or using a combination of, literature, experience and conducting a needs analysis of factors associated with the measure and individual. In regards to the use of scientific literature, some practitioners conducted literature reviews of contemporary research in athlete monitoring whilst others based their questions on scales used in research (e.g. McLean

et al., 2010). Some practitioners took a multimodal approach using questions based on Hooper & Mackinnon (1995), total quality recovery (Kenttä & Hassmén, 1998) and RPE (Borg, 1962) on a daily basis whilst using the Recovery Stress Questionnaire for Athletes (Kallus & Kellmann, 2016) monthly. Other practitioners took the approach of using their applied experience of teams they had worked with previously, their own philosophies of what they believe are important, common sense of what worked with their athletes and opting for a combination of broad questions to then direct precise questions at individual athletes. Needs analysis involved investigating factors that influence performance, using individual historical data to highlight significant areas and identifying aspects of the measure suited to the environment (e.g. paper vs technology based).

Data Analysis and Interpretation: Practitioners were limited in explaining the details of statistical methods used but acknowledged that to achieve successful implementation within their analysis they focused on obtaining meaningful data. This ultimately means data that informs the coaching process or individual athlete outcomes. Practitioners explained that the level of analysis needs to be precise enough to enable a rationale that can be explained to coaching staff for any decisions that follow. In this regard, triangulation of data alongside other physiological and performance data was viewed as essential. One practitioner identified that they could best interpret wellness data when triangulated with training load (at least 1 internal and 1 external measure), individual characteristics (e.g. fitness, age and social background) and contextual factors (e.g. scheduling of fixtures, players role within the team). However, pulling all these data points together for analysis was considered a major challenge.

Decision Making and Action: Practitioners highlighted that one challenge in using the data from wellness questionnaires is that often sports scientists simply advise and the ultimate decisions come from the manager. Practitioners stated that they attempted to develop objective frameworks for decision making including algorithmic processes and decision trees to follow up on responses to questions. This sometimes took the form of additional questions being used if a player reported high or low values (e.g. if there was a high muscle soreness score players may be asked for the location and why they think they feel sore). Wellness data involved education, discussions, and meetings with staff and athletes in attempts to educate and establish self-management skills of athletes when they are away from team environments.

Evaluation: The consensus was that if it helps to inform decisions then it adds value, but the specifics surrounding how wellness questionnaires are appraised was challenging. Overall practitioners detailed a range of ways to review the success of wellness questionnaires demonstrating that it is difficult to measure any impact of the wellness questionnaire individually. It was sometimes evaluated in combination with other athlete monitoring strategies for example how effective the overall toolkit was at ensuring players were fit for games. Sometimes wellness data was evaluated in comparison with other markers, in critical reviews and in reports. Such reports were said to help sustain the process of using wellness data by engaging coaching staff and athletes. Practitioners also investigated the way individuals interacted with questions and how responses fluctuated over time. If some questions had zero variance or didn't match with conversations between athlete and staff then these were removed or replaced. Lastly, it was evident that practitioners were conscious of evaluating the factors

surrounding implementation such as buy-in, feedback, the measurement scale and verbiage used. They were constantly looking for ways to improve the implementation through experience, new research, and continuous professional development with the goal to influence the behaviour and self-management practices of athletes.

3.4 Discussion

3.4.1 The Use of Wellness Questionnaires in High-performance Sport

This study assessed the use and best practices of implementing wellness questionnaires according to practitioners in high-performance sport. Previous surveys assessing the monitoring of athletes have examined 55 participants from multiple sports (Taylor et al., 2012), 41 football practitioners (Akenhead & Nassis, 2016), and 55 respondents from varying levels of rugby union (Starling & Lambert, 2017). These studies have conducted their surveys over specific geographical locations including Australia and New Zealand (Taylor et al., 2012); Europe, Australia and United States of America (Akenhead & Nassis, 2016); and rugby teams from South Africa, Namibia and Zimbabwe (Starling & Lambert, 2017). This research study was open to participants worldwide and had a total of 122 participants from several different continents reflecting the global status of wellness questionnaire use and implementation. Furthermore, the participants within this study were from multiple support roles within high-performance sport reflecting all views of those involved with using wellness questionnaires.

In the population surveyed, the majority (74%) of participants acknowledge that wellness questionnaires are completed by players daily or at least every training day. This is consistent with previous findings in which over half of the respondents indicated the use

of self-report measures daily (Akenhead & Nassis, 2016; Starling & Lambert, 2017; Taylor et al., 2012). With such routine completion it is perhaps no surprise that, as hypothesised, 90% of participants used brief customised questionnaires. These questionnaires were between 1-10 items, although practitioners were split on the use of 1-5 (46%) and 1-10 (44%) questions. This is similar to the findings of Taylor and colleagues (2012) were practitioners used 5-12 items on customised questionnaires. It has been recommended that practitioners choose existing empirical questionnaires (Saw et al., 2016; Taylor et al., 2012), however, this research confirms that practitioners still persist with their own customised questionnaires. With the high variability and individualised nature of monitoring training load, stress and recovery and the unique contextual factors of the socioecological environment this is understandable (Saw et al., 2015b). However, to uphold scientific rigour practitioners should follow recommendations (Saw et al., 2016) and complete their own in-house evaluations of the effectiveness, validity and reliability of their wellness questionnaires.

Past research has identified the use of Likert type scales with self-report measures (Taylor et al., 2012). This study showed that whilst these scales are used there are a range of options to consider with most practitioners choosing to use a numbered only scale or a combination of worded and numbered scale. Some practitioners chose to use emojis or images only and this could reflect the context and individuals, adjusting the questionnaire to be easier to use. This needs careful consideration, any changes to existing questionnaires can negate their psychometrically validated properties (Saw et al., 2016). However, it is acknowledged that such adjustments might improve the ecological validity and buy-in to use the questionnaire. Because of this customisable nature practitioners are

free to choose questions they deem appropriate for their athletes. This predominantly centres around muscle soreness which is in agreement with previous research (Starling & Lambert, 2017; Taylor et al., 2012). Practitioners in this study recognised the monitoring of illness as an important question. Previous studies have highlighted the usefulness of self-reports in monitoring illness (Matthews, Pyne, Saunders, Fallon, & Fricker, 2010; Svendsen, Gleeson, Haugen, & Tønnessen, 2015) and this may enable practitioners to identify symptoms and refer players to medical personal.

Previous surveys on monitoring athletes have found wellness questionnaires to be extremely valuable (Akenhead & Nassis, 2016; Starling & Lambert, 2017; Taylor et al., 2012). This survey also found that practitioners place importance on the wellness questionnaire above other monitoring strategies. Although it should be acknowledged that this could be reflective of the cohort of participants given that the focus of the survey was on wellness questionnaires. Despite this importance only half of participants rated the implementation of the questionnaire as good or excellent, illustrating improvements can be made. Indeed, practitioners identified many different factors and challenges that can impact on the level of implementation achieved.

Saw and colleagues (2015b) have previously identified a social ecological model which places factors associated with the organisation, measure, interpersonal and individual at the heart of influencing the utility of wellness questionnaires. Practitioners in the current survey believed the most important of these factors was associated with the organisation, such as having the right culture, staffing and structures. However, the factors associated with this area were not covered as extensively in practice as those associated with the

individual (e.g. generating buy in and providing feedback). It is possible that this is because organisational factors can be fixed and often out of a practitioner's control (e.g. having sufficient resources). Whilst in general some of the factors and challenges to implementation were similar in nature to those exposed previously, they can be considered unique to the sporting environment (Saw et al., 2015a). Furthermore, it is important for practitioners to be specific about the factors that influence implementation so they can target improvements. Consequently, it is recommended that they are considered allied to the implementation areas of data collection, analysis, and decision making rather than just implementation in general.

3.4.2 Achieving Successful Implementation

In agreement with the hypothesis there were commonalities identified within the outcomes of implementation. This study identified five *implementation outcomes* from follow up questions, three of which were consistent with earlier research (Saw et al., 2015b). The first of these was *Athletic Outcomes*, the main objective of the wellness questionnaire is to influence positive athletic outcomes were players feel good, ready to perform and overtraining, injury and illness are negated. This is difficult to achieve without another outcome of successful implementation, *Meaningful Data*. Practitioners commented that the wellness data should inform the coaching process. In order to do this, questions need to be tailored to the individual and the goals of the team. For practitioners it would be beneficial to learn from the lessons from the integration of performance analysis data into the coaching process (Wright, Carling, & Collins, 2014) and to consider the way in which data is discussed and decisions sold to players and staff (Collins et al., 2015). If there is no variation in response or a limited data set is gathered, then it impacts

on the usefulness of the data. Coaching staff often play an important role here because they implement decisions and as such determine if the data is meaningful to influence practice. Furthermore, the analytics in use impacts upon interpretation and so a third implementation outcome of *Data Accuracy* should be considered. Data needs to be reliable and practitioners were particularly concerned with the anchoring of questions to the Likert scale and education, so athletes fully understand what they are answering. This would seem a positive step to take as it is much more difficult to monitor a team's worth of questionnaires than attempt to educate players to complete the questionnaire in the same way.

A number of factors such as the design of the questionnaire and coordination of reminding players to complete it were said to interrelate and result in the overall *Simplicity of the System*. Practitioners realised that the measure athletes use to complete the questionnaire needs to be easy to use with 93% claiming their practice reflected this. However, the measure should also be easily accessible for players and the whole system should facilitate data handling. Only 55% indicated their questionnaire could be used anywhere which poses some challenges when teams are away on training camps or in locations without internet connections (Halson, 2014). Some of these factors associated with the measure will also impact on the outcome of *Compliance*. Poor compliance results in missing data which is a challenge for practitioners when analysing data. Previous investigations have shown compliance to be highly variable, with team sport athletes showing as low as 8 ± 18% compliance over a 16-week period (Saw et al., 2015a). In comparison, compliance within the survey results was positive with the majority (74%) having greater than three-quarters of respondents complete their wellness questionnaires.

However, in the follow up questions some practitioners claimed that in order for implementation to be truly successful 100% adherence was required.

It is important to consider that wellness questionnaires and other methods are best used as part of a toolkit. When monitoring training load, it is recommended to use an integrated approach of internal and external measures (Bourdon et al., 2017). The more measures that are used, the more data is collected and often the greater the challenge to deduce what is meaningful. Practitioners in this study commented that it was the triangulation of a range of methods that best inform a practitioner. In order to achieve successful implementation of a wellness questionnaire it needs to be integrated alongside the rest of the monitoring measures and with a clearly defined process of how the data will be processed and used (Gabbett et al., 2017).

Various models have been recently proposed as to how best to implement wellness questionnaires (Saw et al., 2016) and other athlete monitoring technology (Torres-Ronda & Schelling, 2017). Such studies are most welcomed to aid practitioners in the development of their approach and, from the current study, it seems that practitioners are implementing such practices, at least in parts. For example, needs analysis, consideration of the literature, data collection and analysis. However, when following current guidelines, it is important to acknowledge the limitations and realities of the applied world as identified in this study. For example, often practitioners do not initiate a new monitoring programme or have the luxury to make a fresh start. They must adjust, evaluate and re-promote existing strategies. They face challenges such as onboarding new athletes into the programme during the season. Therefore, it may be worthwhile for

practitioners to use the five *Implementation Outcomes* identified in this study as a simple way to evaluate the extent of successful implementation of a wellness questionnaire within their organisation.

3.5 Conclusion

It is worth acknowledging that whilst wellness questionnaires were most favoured this may simply reflect the cohort of practitioners who willingly completed the survey. The range of practitioners (sports science, medical, strength & conditioning) perhaps favoured various methods and so the results could be practitioner dependant. The benefit of this study was that it reflected a large range of sports but in order to be comprehensive about achieving successful implementation it may be worthwhile for studies to go in depth regarding a particular sport or practitioner. Although, lessons can still be learnt from smaller sports where monitoring may not be as frequent and other domains where successful implementation has occurred.

In summary, this study has conceptualised wellness questionnaire use and implementation in high-performance sport. Most practitioners used brief customised questionnaires that are tailored to their environment and individual players. A range of analysis techniques were used with most observing changes, using averages and standard deviations. Decisions were taken regarding individuals including personal follow up on responses. In order to achieve successful implementation it may be worthwhile to focus on the *Implementation Outcomes* identified in order to structure the evaluation process.

3.6 Synopsis

The aim of this study was to gather information on the use of wellness questionnaires according to practitioners in high-performance sport. A cross sectional survey design was used to investigate current practice, in particular if the wellness questionnaires used by practitioners were validated and developed with consideration for implementation. It was evident from the results that wellness questionnaires are an important tool for informing decisions around the training process. Despite this importance there was a lack of consensus with regards to the development and validation of the customised questionnaires. Most practitioners utilised wellness questionnaires which had not been validated, thus giving rationale to the thesis aim of developing and validating a new wellness questionnaire.

The practical applications for this study apply to practitioners utilising wellness questionnaires in sport. The proposed five *Implementation Outcomes* for evaluating the success of the wellness questionnaire provide an important end-phase of assessment within a framework for successful implementation. Practitioners can gauge how successful implementation of a wellness questionnaire has been by reviewing the compliance, simplicity of the monitoring system, accuracy of the data including validity and reliability, how meaningful the wellness data is at informing decisions, and the extent to which the data is used to result in positive athletic outcomes as explained in this study.

There are a number of limitations to be aware of for this study with the majority stemming from the methods employed to investigate the problem. The use of a survey means that there is the potential for dishonesty or social desirability whereby practitioners may have

presented the monitoring at their club in a favourable way. To combat this the survey was anonymous except in the case were practitioners were involved in the follow-up questions. In addition, a survey requires participants to fully understand the question and whilst all questions attempted to be clear practitioners may not have comprehended why the questions were asked, thus affecting their response. Notably some of the questions were difficult to analyse due to the nature of data collection using Likert type scales. Therefore, previously utilised methodologies within similar studies were followed to conform to accepted standards (McCall et al., 2014). However, there were still challenges particularly with responses placed in rank order using arbitrary units, as it is difficult to identify how meaningful these numbers are. Nonetheless the use of simple frequency analysis was favoured as a method for simple and clear interpretation for the target audience of this work.

Given the fast-paced nature and changes with monitoring in applied sport future research should look to confirm or refute the findings in this study. This should be completed on a regular basis at least every two seasons across sports to account for any advancements which are primarily led from applied practice. This study has given a global overview of the use and implementation of wellness questionnaires. The outcomes for implementing a wellness questionnaire have been identified, for example it is necessary to gauge the levels of compliance, however it is unknown what factors actually influence the compliance rate and other *Implementation Outcomes*. Therefore, the next step for research should be to identify and address the factors which can influence implementation. These studies should focus on individual sports or teams in order to give depth of understanding with regards to implementation. Understanding the implementation within different

working environments will allow for wellness questionnaires to be appropriately developed with end-users in mind (Donaldson & Finch, 2012), resulting in greater chance of the wellness questionnaire being ecologically valid and fit for purpose.

CHAPTER 4

Study 2: Factors influencing the implementation of a wellness questionnaire in rugby league

4.1 Introduction

Study 1 reflected a large range of sports to give an overall understanding about the conceptualisation and utilisation of wellness questionnaires in high-performance sport. Nevertheless, implementation of wellness questionnaires can be said to be context dependent (Saw et al., 2015a). Therefore, in order to draw comprehensive conclusions about achieving successful implementation it is necessary for studies to go in depth regarding a specific sporting context and complete case studies within one organisation. As such the following study attempts to understand the factors which may influence the implementation of a wellness questionnaire in a rugby league context.

Wellness questionnaires have shown promise to be an acceptable way to monitor wellness in rugby league (Coutts, Reaburn, Piva, & Rowsell, 2007; McLean et al., 2010). However, study 1 identified that the difficulty in practice often lies in implementing the method within the sports setting. Implementation research for athlete monitoring in sport is still in its infancy and there is a significant lack of research into wellness questionnaire use within rugby league. The only investigations into the use of self-report methods have been across a breadth of sports (Saw et al., 2015b). Implementation for wellness questionnaires is important because obtaining data is very much dependant on athlete compliance (Saw et al., 2015a). However, practitioners using other methods of monitoring should take note, because poor implementation ultimately impacts on the long-term sustainability of monitoring (Durlak & DuPre, 2008). In rugby league such challenges have been highlighted when using GPS technology, where information can be ignored by coaching staff to the detriment of player health and wellbeing (Jones, Marshall, & Denison, 2016). These issues and frustrations could be detrimental to the wider sports science and

performance analysis industries which very much depend on the use of data. Poor implementation results in poor quality data and inadequately informed decisions. It is therefore clear that practitioners should consider all aspects of how wellness monitoring will be implemented accounting for the large investment of time, knowledge and resources to do this effectively (Saw et al., 2016).

In contrast to the sporting literature, there has been much research on implementation in health and educational settings. In general, implementation is defined as the way a programme is put into practice and delivered to participants (Durlak, 2016). The level of implementation achieved has been found to be one of the most important aspects to influence programme outcomes (Durlak & DuPre, 2008). In the world of sport, practitioners are quick to utilise new athlete monitoring technologies and strategies before they have been tested or comprehensively researched, in the hope of influencing positive athletic outcomes as per the working fast and slow approach (Coutts, 2016). It is important to understand that success not only hinges on the technology or strategy used but also the quality of the implementation. Such innovations can fail not only because they are ineffective but because of poor implementation (Durlak, 2016).

Saw, Main and Gastin (2015b) identified perceived factors influencing implementation of self-report measures with athletes and staff from a range of elite sports. Factors said to influence implementation related to the measure and the social environment (including organisational, inter-personal and individual factors) which were conceptualised within a social ecological model. The perceived factors were said to interrelate and influence the desired outcomes of implementation such as compliance, data accuracy and athletic

outcomes. As implementation is unique to the sporting context, it is important to explore different sports, performance levels and cultures in order to identify the important factors for best implementation within specific environments.

As such, this study focusses on elite rugby league and the particular context of a team's implementation of a wellness questionnaire in the European Super League. The objectives of this study were to identify the perceived factors influencing implementation across the areas of data collection, analysis, and decision making. The study sought to establish how these factors can be modified to improve the experience of using wellness questionnaires with players and staff. It was hypothesised that the findings would support previous research in identifying factors influencing implementation that are associated with the measure and social environment.

4.2 Method

4.2.1 Participants

A stratified purposeful sample of 14 players and 6 staff members consented to participation in this study. Participants represented an elite level rugby league team in the European Super League. Players covered a range of positions (7 backs, 7 forwards) and had been at the club for a minimum of 1 season and maximum of 14 seasons (4.4 ± 3.5). This equated to 1546 elite level playing games at the participating club. The sample contained a mixture of international representative players as well as rookie professionals to encapsulate the full range of players who used wellness questionnaires. Participating staff were practitioners from the disciplines of sports science, strength and conditioning, performance analysis and physiotherapy. All staff either viewed, collected, analysed or

used wellness data as part of their daily roles. No sport specific coaches were interviewed as they didn't meet these criteria. Staff had been at the club for a period of 1 to 3 seasons (2.1 ± 0.9). All participants had at least one year's familiarity using wellness questionnaires with 80% having greater than 2 years' experience.

4.2.2 Approach to the Problem and Wellness Questionnaire

A pragmatic research philosophy was taken using both an inductive and deductive approach attempting to understand what has already been identified as important at influencing implementation of wellness questionnaires and advancing understanding by analysing new data within the context of rugby league. The pragmatic philosophy is aligned with interpreting actions and activities associated with everyday practices (Stringer, 2007). It supports the methodology within this study as it is closely aligned with the identification of real-world processes and functions (Cruikshank, Collins, & Minten, 2013; 2014; Wright, Carling, Lawlor, & Collins, 2016). In addition to this approach, the lead author was a sports science practitioner within the club for six seasons prior to the interviews, developing the trust of players and staff to allow for honest responses. However, due to the nature of this role caution had to be taken not to bias or let practitioner led ideas influence responses. Interviewing thus took a standardised approach across participants by reading each question exactly as worded and probing neutrally to avoid interviewer-related error (Fowler, Fowler, & Mangione, 1990). Questions for the interview were developed via comprehensive observations of the use of wellness questionnaires over 6 seasons, discussions with the research team and sports science staff working within other elite rugby league contexts. The final questions used within the study were refined and decided upon by the research team.

The wellness questionnaires referred to in this study were in-house custom-built self-report measures, grounded in research, and developed from existing protocols in previous seasons. Players had used a number of different questionnaires including the common 5-item wellness questionnaire used across rugby league research (Mclean et al., 2010). The questionnaire used before this investigation covered 10 items assessing the acute responses to training and match play on a 1-10 scale. These included questions on sleep, muscle soreness, nutrition, energy levels, mood state and levels of stress, ratings of perceived exertion, and weight. The majority of time the questionnaire was accessed and used through online proprietary software, although on occasions practitioners collected data in person.

4.2.3 Procedure and Analysis

This study was approved by the university ethics committee at the University of Central Lancashire. Interviews took place at the team high-performance training centre and were conducted by the lead author. Interviews were approximately 15 minutes in duration and were recorded. Participants were informed that the research sought to understand the current practice of the use of wellness questionnaires. Semi structured interview questions were developed to identify the key factors of implementation, address any positives and negatives of wellness questionnaire use, and understand how the current questionnaire could be improved. Participants were asked to elaborate and prompted for additional information were necessary.

Recordings of interviews were transcribed and checked for accuracy before being

imported into NVivo software (QSR International Pty Ltd. Version 11.4.1, 2017). A qualitative data analysis approach based on Miles, Saldaña, & Huberman (2014) was followed alongside a data coding framework (Gratton & Jones, 2004). Analysis was completed alongside data collection. Participants were grouped into players (P01-P14) and staff (P15-P20) to assist with data analysis. Data was carefully read and statements relating to the three objectives were identified and assigned codes in a process of descriptive coding. The data was then re-read, several times, to search for statements related to these initial categories. Patterns were sought out and important points noted in memos to understand the key implementation factors. The data was re-read a final time in relation to each code, confirming or refuting the key factors involved and identifying the codes that illustrate the analysis.

All coding was organised as suggested by Biddle, Markland, Gilbourne, Chatzisarantis, and Sparkes (2001) into higher and lower order themes. Upon completion of coding the wording of themes and codes were compared with current research and adjusted to match existing terminology, in an attempt to aid the practitioner. Novel themes and codes were created for new ideas and were existing terminology didn't align with the current study.

4.3 Results

In total 24,390 words were transcribed from the interviews, coded and analysed within NVivo. As per previous investigations (Saw et al., 2015b) within this research area the themes of the results are explained under the headings below with coded examples from interviews given in Tables 4.2-4.5. It was identified that the effectiveness of implementation within the areas of data collection, analysis and decision-making

depended on higher and lower order themes associated with (1) The Organisation (2) The Measure (3) Inter-Personal and (4) Individual factors. These *Implementation Areas* and *Implementation Factors* are summarised in Figure 4.1. The research identified 4 novel higher order themes nested within the organisation including context, process, personalisation, and coaching staff. Twenty-three original lower order themes were also identified which are represented in Tables 4.2-4.5 by "*".

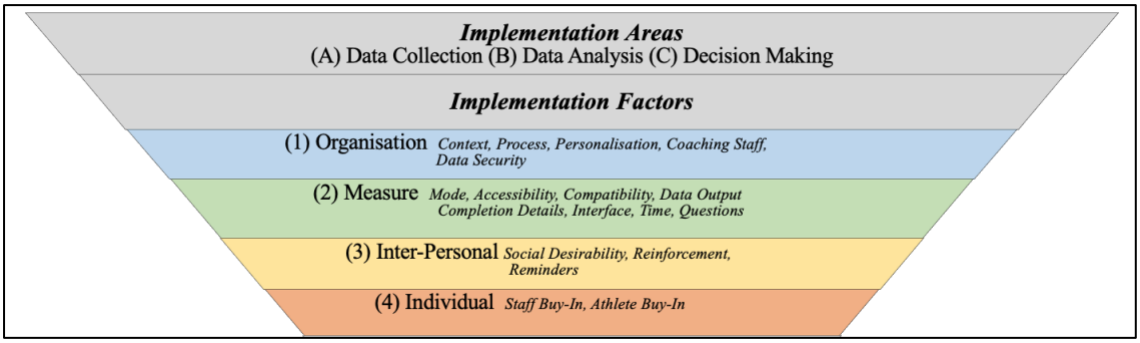


Figure 4.1 Implementation Areas and Factors

Table 4.1 Factors associated with the Organisation. *Note: Participant number in brackets e.g. (P01)*

Higher Order Themes	Lower Order Themes	Raw Data Themes
Context	Scheduling*	If a lot of players are sore there is usually a reason why, like a short turn around. Or something like that so it is a good idea to change the way we are training. (P01)
		I think if you were too soft the players might catch on and be like oh yeah it was a really light session today. So, I think you have got to manage it. You know if you have a longer window between matches you might say well right let's push it anyway. If you have got a quick turnaround, then you can use it and say recovery is more important. I think we do that but it is about finding that middle ground of maybe tweaking stuff so that it is not that obvious, that the players don't think it is easy but you have taken the data on board and the players are aware that you may have made small adjustments. (P15)
	Other Data	Then you can see not just daily but you can look back and say well I think I need more sleep. Because if it is just one day you are not thinking about others and you don't see the bigger picture. I think I had a poor sleep last night, but I don't think I have had 3 poor nights in a row. So, it would be good to look back on it and see how it is going over a month or a few weeks. (P06)
		Obviously, some games you play you might not do a lot of carries, you might be a bit fresher from the week, sometimes you might do more carries than everyone. And you might struggle. You might be feeling sore because you have made more tackles or carries (P09)
	Sport Characteristics*	If they needed to fill anything out for me I would always go in-between lunch and a meeting because I know they are just relaxing, they are not doing anything, they have trained. It is kind of like an in-between phase. And if it wasn't then I would target them after training. You have just got to pick your moments really when you know they are not busy and they are willing to do it. Because if you pick a time when they are busy and they are not as interested they are just going to fob it off and give you poor results. They won't give it you as accurately. (P18)
		Yeah, yeah. Let's say if lads were still outside obviously you can't go in, you don't want to interrupt them if they are doing a kicking session. You don't want to go over and say... If some lads are putting gear away you don't really wanna go and stop them from doing that by asking them questions. Sometimes there was individual meetings, like leadership meetings or backs meetings straight after training. So, I couldn't go and get the RPE at that time. So, there was a few time constraints to think about. Also, my own time constraints. If there is something else, if there was something I need to do straight away. So even though after training I would go and get the RPEs, if training needed to be video rendered or some stats needed doing for a meeting that was coming up, we had to get that done first. Some lads might feel a bit differently if I go straight away compared to if I go, I don't know two hours' time after they've eaten. After they have eaten they may not be as sore and they think 'oh what did we do, how was I feeling at this time'. So, I think timing plays a massive part in it. (P19)
	Resources*	Ideally it would be fantastic if we had the technology, if we had the money, to have an iPad that were up on the lockers and you could just fill it in. (P20)
	Culture*	You don't want to be going around saying 'I'm sore I don't want to train' but if that's what it is for, do you know what I mean? (P04)
		I think it is like an alpha male environment, they don't want to seem soft and trying to beat somebody. There is always competition, even if it is trying not to be as sore as somebody else, it is a competition so there was a lot of that going on. (P20)
		I think it is fine. Whatever information you guys (sports science / coaches) need really. If you feel you are getting what you need I think the questionnaire that we have now is good. (P01)
		I just think that sometimes I have heard comments in the past where players are saying I bet the staff don't even look at this. (P07)

Table 4.1 continued.

Higher Order Themes	Lower Order Themes	Raw Data Themes
Process	Defined Roles*	My role was mainly just making sure everybody actually did the questionnaires.... So I tended to collect it and get the players to do it. Somebody else would analyse it and a different person would address the players as well should there be any need. And that was somebody a little bit higher up. (P18)
	Action*	I think sometimes it is like you fill it in and you are sore, but nothing really changes. You are doing it but nothing changes so then you still go out to train on a Monday and Tuesday when you are still sore going out and bashing each other about. Then you are still sore come the week after and towards game day. So whether or not that can be changed within how they change training sessions. Because obviously when you start playing week in and week out and you are a couple of games deep then you can start to feel sore even into the tail end of the week still. (P03)
		I think we should have something that we can offer them. If they just need advice, or training, or if they are struggling with their meals can the chef give them something to take home - eat what we give you so you don't have to think about it. Alongside some supplements as well. (P15)
		I would probably say there is more action than analysis just basically going off raw results. Before it was then put into 'proprietary software' and it was there printed out - soon as it was on paper it was then addressed. (P18)
	Routine*	I just think filling it in can be pretty easily forgotten about. It's just important to get into a routine of doing it. I wasn't too bad last season and I got the hang of it filling it in. But I definitely think that it is something that's good and useful. (P09)
		You know if you say - you can't start your prehab until you have done this. And then make it part of the schedule. So it is wellness - prehab - weights. Like eating your breakfast every morning, it becomes part of the day. And if you have not done your wellness questionnaire you can't start your prehab. You wouldn't not prehab then go into weights, this is the same. Make it a routine than rather in your own time. (P12)
Personalisation	Tailored Questionnaire*	I think that is good if you are doing it for one person individually. And then giving feedback and mentioning things so you know the coaches are taking on board what you are saying. I know sometimes you can use it and you are feeling sore and thinking, training hasn't changed, it is still hard. But I think if you are doing it personalised and saying to them we have looked at your scores and today you are going to do this, so then you are not working your upper body or something like that then that is good. (P05)
		I reckon it is probably...the more detail you want in it the more you need somebody to quiz them on it. It has to be one to one, people aren't going to go into that much detail if they are doing it on their phone. (P12)
		I don't want to go too far, but I wish sometimes when you look at it and go - say if we can't do training outside and then it should be individually, I reckon. Because most of the time we should be outside (on the training field) but some guys, the older players, might need to taper down and do a fitness session on the bike because of this or that. I think it should be more specific to each individual. (P14)
	Knowing Your Athlete*	No no, I got a feel for that over time. So, I know if someone loves a good whine and a moan they are going to put lower values anyway and that kind of thing. It is subject to knowing your players I would say. (P18)
Coaching Staff	Approach*	Just being straight up and saying what was this, what was this, what was this? Don't try and have a conversation with them at the same time as you won't get anything done. Just get your wellness done! (P18)
		I think if you were too soft the players might catch on and be like oh yeah it was a really light session today. So I think you have got to manage it. I think we do that but it is about finding that middle ground of maybe tweaking stuff so that it is not that obvious, that the players don't think it is easy but you have taken the data on board and the players are aware that you may have made small adjustments. (P15)
		Just be direct with them. Be direct upfront with them and say, go and ask some of the questions straight up. Don't, don't mess around. Just say right well what's your RPE today, how is your soreness, how is your sleep. That is what I found it to be the best way at the time, while we were doing it. (P20)
	Proficiency*	(Creating reports) they were easy, for us. But whether they would be for a novice who is not really used to the system I am unsure. Because it was quite fiddley to export the data. To know which place to click on and then to go to which graph... Obviously the different graphs were good but which one that was needed, you know the pie chart, the bar chart, that type of stuff. It was a bit fiddley. So, I'd say not the easiest but you know it was doable. (P19)
Data Security	Data Security	I wouldn't say it was an issue as to who had access to it because it is password protected so unless you have an account you are not getting in. (P18)
		I could have took it anywhere, I could have been taking it over to another rugby team. I don't think they (players) were bothered. But I think they trust what we did and the process that we had. I think they knew it was a case of that we just wanted to make sure they were all right. (P20)

4.3.1 Factors Associated with the Organisation

Context

These factors were circumstances of the sporting setting that affected the application of the monitoring strategy, the extent to which data was understood and the extent to which decisions were actualised. Participants identified that turn-around between games, stage of the season and different training days during the week had an influence on the decisions that could be made. Practitioners had to consider the number of days before the next game within their analysis and manage the training load accordingly. Players acknowledged that certain games or turn-arounds could elicit greater soreness amongst the whole team and so scheduling holistic changes in these instances would be appropriate.

The wellness questionnaire was recognised as being part of a toolkit of monitoring strategies. Practitioners referred to other data (e.g. GPS, Heart Rate, physiological testing and performance statistics) to assist with their analysis and put the wellness results into context. Players understood and encouraged the development of using other data sets to give light to the wider picture on their response to training and readiness to perform.

The characteristics of the sport and team such as regulations, traditions, groupings and interactions of the environment were an important consideration, exposed particularly within the data collection. Staff had to judge the most appropriate time and location to enforce reminders, picking their moments to accrue accurate data and ensure compliance. Financial, technological and human resources were recognised as a limiting factor in the development of data collection and analysis. The ideal culture, a complex multidimensional area consisting of the collective beliefs, values, work styles and

relationships within the sporting organisation was deemed an essential pre-requisite for implementation of a wellness questionnaire. Players were content to allow the sports science staff to collect athlete monitoring data, with the majority viewing the wellness questionnaire as useful. Challenges for implementing into a rugby culture were highlighted, it was often described as an alpha male environment were players didn't want to act as if they were sore. Differences existed between rookie and senior players in regards to their responding, younger players were described as more susceptible to hiding their true perceptions, resulting in untrustworthy data. Staff described the need for constant education and strategies to build a positive culture in respect of monitoring by making others aware of the reason behind the use of the wellness questionnaire and preventing negativity amongst the group that could result in unwanted outcomes (e.g. low compliance).

Process

This consisted of the management aspects that helped to achieve the integration of the wellness questionnaire. Participants identified the importance of how the monitoring strategy fits within the coaching process. Efficient and effective processes through the development of clearly defined staff roles within data collection, analysis and decision making helped to achieve this. Likewise, a structured routine for completing the questionnaire was deemed beneficial for increasing adherence. The most important process for the players was seeing the data they submitted being used to influence decisions regarding training and performance. They commented on their frustrations at sending data into a void where it may not get used.

Personalisation

The extent to which the monitoring could be individualised was deemed advantageous. Players recognised that a tailored questionnaire could be better suited to meeting their personal needs (e.g. as an injured player). They commented that this may help decisions to be personalised such as adapting training for a senior player rather than team wide alterations. For staff, personalisation in the data collection was evident, such as the best way to approach a player to remind them to complete their questionnaire. Knowing their athletes individually, for example their typical responses or ability to cope, played part in the decision's practitioners took.

Coaching Staff

The coaching approach was deemed important to the implementation of the questionnaire. This included themes related to data collection such as the approach taken to remind players and enforce punishments for poor compliance. The interpretation of the data and decisions made could reflect the personal theories of the coach, highlighted by one practitioners' comment on how they might manage decisions, including finding a middle ground between using the data and not being 'too soft'. The proficiency of practitioners to use the proprietary software was an important consideration as it was explained that training and experience was needed to develop analytical skills to implement the questionnaire.

Data Security

Information was stored online through the proprietary software. Staff also downloaded information onto laptops. Two staff members acted as system administrators controlling

access to the data and issuing password protected accounts for individuals to gain access. This was deemed sufficient to prevent data breaches. Very few players were concerned about data security. It was suggested that further education or reminders could be given to clarify how secure the data is, who has access and the full details of how it is used. Staff commented that the lack of concern was likely due to the trust they had developed with the players.

Table 4.2 Factors associated with the Measure.

Higher Order Themes	Lower Order Themes	Raw Data Themes
Mode	Mode	Phone. I think phone is easy enough. Everyone's always on their phones so that's best. (P04)
		It is good online because it works it out for you. You don't have to go around. There is no paper trail. So I would definitely say on the players phones is the way forwards. Because that's the same as anything these days it's all electronic. (P15)
		It is tough to say really because I think from a personal point of view if I was a player I'd rather it be done there and then. So, if I was thinking from their point of view I'd think someone come and ask me so I wouldn't have to think about it. Whereas from our point of view as analysts or members of staff, I would have thought it would be better for us to have it online, so it is all already there for you. So, I suppose it is from which point of view you are looking at. (P19)
Accessibility	Technology	Can you get it so it like pops up onto your main screen of your phone (e.g. a push notification)? Or like a message sort of thing so you could just swipe it and it goes straight to the questionnaire to complete. That would be the ideal because you go into the system and everybody is forgetting their passwords, you are typing in your email address and then your password. And you are getting into it but then waiting for the screen to come up. Then you've gotta search through wellness, you click on wellness. If you can just have a message and click it and your straight there to go through it. Something a bit quicker that comes straight onto the home-screen of your phone. It pops up at 8am in the morning and it is there then. And it might even alert you every hour, say if you have forgot to do it, every hour till you complete it. It may be good if it didn't let you use your phone for anything else until it is completed! (P03)
		I know (redacted player name) didn't have any access to his account so I had to get him to do it on paper... He told me he never had a password. Or if he did have a password he didn't use it properly and said he couldn't gain access to his account. So I had to follow him around with a piece of paper and a pen. (P18)
	Location	Challenges include making sure you have all equipment. If we are out at a different training field and there's no power for laptops we may not be able to record data. It would be all on bits of paper. If we are outside, you know if it is wet the paper might get wet. Windy it might just blow away. You know that type of stuff it can be tough. And then obviously if players have come from different venues then they may go off in different directions, go off in their own cars, go off in small little groups, some may go to lunch, some may go home, it could be difficult to collect as much detail as we wanted. (P19)
	One-System*	It wasn't overly difficult, but it wasn't the easiest format to use. I'd say there could have been an app for them to just do it on. You know whereas it was just a website and you had to put a link to it on your home screen. Then staff filling it in online. Surely there should be an app for us all just to do it. All just on one app and we can see when someone's done it or not done it so it would come up as notifications. Maybe that's an easier way of doing it instead of the home screen. (P19)
Compatibility	Applications*	Export straight to excel or something, yeah definitely, I think that would be really important. (P19)
	Synergy*	I usually do it on my phone. Set my alarm and do it before I get out of bed. (P01)
	Hardware / Software	The only thing I've got is the software I have is old, some people have it updated where you can scroll, mine doesn't do that. Because it is not an app you can't update it, you have to put a link to it on your home screen. (P10)
Completion Details	When	I know in the past we have tried to do this before were the players get it done first thing in the morning so you (the practitioner) can get a better idea. It would be better to say before 10am or something. But at the moment it is just before we do a field session isn't it, or whatever (it is)? But I think to get it before 10am would be ideal. (P02)
		Obviously the most useful thing is having it done before training, there is no point doing it just before we are going to train. You know it has to be done in enough time and it has to be simple enough to collect the data and do something with it. That is really important, I have seen flashy ways of monitoring things but if you can't get the information in quick enough and analyse it and then use it, then there is no point doing it. (P16)
	Where*	Ideally you want it done before a certain time during the day so the coaches have got time to analyse it and address any issues before the day is done. So, like between 8am till 2/3pm. So it is kind of a case of getting it done as soon as they come in but if they are in meetings or there is split sessions or it is pre-season and you have half on the pitch outside and then swapping, then the players are having lunch...you can say to them as many times as you want do your wellness for me but if they are busy they are not going to do it. (P18)
	Frequency	I reckon every training day with the day before your day off you have a chat with someone to say whether you need something on your day off (recovery, treatment, training). If you are completing it on your day off, it is your day off. Usually 9 times out of 10 you chill, so you don't wanna fill something in. So I reckon the day before is when you would have a chat. (P10)
Interface	Appeal	I think it is quite simple. There is more ways to improve it like giving more detail and diagrams. But whilst that might improve it as a wellness questionnaire will that improve the process? I don't know. (P16)

Table 4.2 continued.

Higher Order Themes	Lower Order Themes	Raw Data Themes
Interface	Usefulness*	They only thing I'd do what I have done on other ones is you know like the body parts (diagram) because when you do lower body soreness you might not necessarily be sore, you might have a dead leg maybe or a sore shoulder. I've seen the ones where they have body parts and if you are sore you just select that region. (P12)
Time	Staff Challenges*	It was a long time in a case of when something else needed to be done and then a couple of them... Yeah there was a couple of them always doing extras outside more than others. So, I'd have a couple come in, I'd get their RPE's then have to go back into the office do some more work and wait for the others to come back. So, the actual time taken from start to finish is quite a long time but it is just dispersed really so...I'd say yeah, it probably took longer than it should. (P19)
	Speed	I don't know if you can do it so it takes less time, so it is quicker. So you know like on the page, instead of going through all the questions one by one and selecting the score, you have got like a table and then you can just click the section or box for each question a lot quicker. (P03)
	Burden	It was fine it was just part of the normal schedule. It depends doesn't it. Some players were a lot harder to get it done more so than others. And it was just a bit of a nightmare just constantly nagging and nagging and nagging. And you do the same battle every day. But it is one of those things, it wasn't really a problem. Just a case of making sure they are all done and the ones that weren't done, I just told the lead practitioner and he made them go and do it. (P20)
		I think every day you can do it, there is not an issue with that. Every day when you're in training certainly. Even on your day off to get the trends or whatever, just fill it in. (P03)
		I don't think it was a pain to fill in. It only takes 5 minutes to complete. (P04)
Questions	Type*	Definitely. Obviously, there are a lot of lads who won't understand what a lot of that means if it is sports science based. Staff may be ok with that role specific terminology but if you ask someone who hasn't been to school then they are probably going to struggle with that. So, a lot of players thinking 'am I sore? Yes', instead of having some technical language, I think that is much better. (P19)
	Scales	I think you need a scale to interpret it more specifically. Which is probably something I would look at addressing. Maybe rather than saying on a scale of 1 to 10 give them 1 to 5 and say it is this, this, this and this. With words and there is no in-between. It is very broad at the minute. Just, narrow it down a little bit. Maybe give less margin for interpretation and make things more specific. Rather than a scale of 1 to 10 give them options with content, happy, disheartened all that kind of thing. (P18)
	Number of Questions*	I just think the more you ask you are setting them up for as if there is something wrong. (P16)
		I think what you don't want to do is try to give them too many to do. Because then it is like, you know, if you have to got do it every single day. And don't get me wrong a lot bought into it but then sometime stuff like that can get a bit boring very quickly. And if you've got to do it every day and there's loads of questions some of them can't be bothered, they just wanna mess around with their mates and focus on the training. So, I think it is trying to get a balance between getting the right questions and then not too many. (P20)
Data Output	Indicator	I suppose it is just a first indicator on anything what is going on with that individual. Then that will lead to me speaking to them. Sometimes it can flag something up and then when you speak to the individual there is nothing actually there. So I think it is just a first alert really for monitoring the training load and the wellness. it is limited, I suppose it doesn't really tell you what is going on, it just gives you an indication on say lower body soreness or whatever it is. (P16)
	Analytics*	It is good online because it works it out for you. You don't have to go around. There is no paper trail. (P15)
		Maybe a bit of a review every quarter or something were you come back and say the week building up to this game these were your scores. Maybe you could correlate that to your performances in the game or something like that. (P07)
		You could almost look at that compared to games. When you think you have played good and when you've not. Because you don't really correlate anything at the moment as you don't see those results side by side. (P12)
	Visualisation	Well maybe at the end of that then (the table), say for example your score out of 100% is there and after you have filled it all in you get a percentage of how you maximally feel on your best day to how you are feeling that day. (P03)

4.3.2 Factors Associated with the Measure

Mode

Participants had previously used self-report questionnaires using technology (smart phone, tablets, computer) and paper-based versions. Participants preferred the use of technology and in particular via smart phone. For players this was more convenient, they explained that they always had their device with them to complete the questionnaire. However, it was apparent that players could easily forget to complete the questionnaire using this mode and therefore some players expressed interest in using a paper-based version that staff could present to them in person. For staff this meant the *Implementation Areas* of data collection and analysis were very time consuming and had a greater risk for peer-influence in responding. The consensus was that the use of technology better facilitated the data collection, storage and analysis.

Accessibility

The majority of players found the wellness questionnaire to be easily accessed using technology. On occasions there were issues such as players forgetting log-in details, passwords, or experiencing slow service due to Wi-Fi problems. Staff members had the responsibility to explain and ensure access for all players and to manage any issues they experienced, acting as a system administrator for the proprietary software account. They explained that this could have been made easier by having a smart phone app, rather than a website, which could have acted as one integrated system. A further challenge existed when away from the home training venue on training camps. This made it difficult to

collect, store and review data as it depended on internet availability, access to power sources for laptops and logistical challenges.

Compatibility

Participants experienced hardware and software compatibility issues with smart phones, laptops and operating systems. Technology updates (e.g. players changing to a new model of smartphone) caused difficulties in using the questionnaire. However, the use of technology was seen to be synergistic in that alarms or messages could be used to remind players to complete the questionnaire and it had the potential to be used for further communication. Allied to this, the integration and compatibility with external applications helped practitioners with analysis and reporting.

Completion Details

Players and staff acknowledged the importance of completing the wellness questionnaire in the morning so that the data could then be used to manage decisions across the training day. With the use of technology this could be completed away from the training ground but realistically it was as soon as players entered the training ground that they would complete the questionnaire. Players were happy to complete the questionnaire every training day with some saying that daily completion was not a problem as long as they saw the relevance for completion. However, most players acknowledged they did not like to complete it on their days off whilst staff were cognizant of too much completion resulting in questionnaire fatigue.

Interface

The interface of the questionnaire was very simple, a series of questions and a scale for selection. Players felt this clean interface was uncomplicated and ideal for entering scores and sending off to the practitioners to review. Players and staff didn't see a need to develop interface to generate more appeal. However, some participants did acknowledge a benefit to changing interface if it provided more information, such as a diagram to give location of muscle soreness.

Time

Players didn't view the questionnaire as being a time burden. They recognised its utility and commented that it was quick to fill in, less than a minute once familiar with the questions. Further improvements to increasing the speed, whether by easier access or user interface changes were welcomed. Staff did experience challenges associated with time. They noted that the measure had to be designed to be able to deal with their time pressures ensuring data was collected, analysed and reported before training. For them, the process could become a burden, engaging in a daily battle to remind players to fill in questionnaires. It could often take a long time to collect data and it caused interruptions to other workflow patterns.

Questions

Players responded that they were happy with the number of questions answered when it was a maximum of 10. Practitioners were very conscious of not having too many questions, each one had to give value to analysing wellness in the context of the response to training and readiness to perform. Players were concomitant with this belief as they

demonstrated that it was important for them to see the relevance in the questions being asked. Individualised questions thus offered a greater appeal. The scales used were 1-5 and 1-10 with higher values indicating better wellness (e.g. lower soreness, more positive mood state). Most participants preferred 1-10 because it offered similiarity to the RPE scales that were used, however, some questioned the length of the scale preferring to attribute their perceptions into words rather than numbers. Wellness questions were said to offer simplicity and a user-friendliness compared with other athlete monitoring measures that made results, interpretations and explanations more accessible to players and coaches. Practitioners sensed that constantly probing for more information may cause players to erroneously worry something is wrong. They therefore paid close attention to the wording of questions and posed them in a neutral or positive frame (e.g. How fresh do you feel? Opposed to how sore do you feel?).

Data Output

For staff the wellness questionnaire data outputted by the proprietary software was there to act as an indicator into wellness and readiness to perform. It was thought of as an alert system, part of a wider toolkit to identify issues that could be followed up. Participants felt the analytics was important, players theorising on potential comparisons or reviews they would like to see outputted and presented. Staff liked the automaticity of the system. Once set up, calculations were made by the computer and important results flagged. It was suggested that there was room for development with the analysis and reporting as the system was fiddley and complex, particularly for a novice. There were also limited options for visualisation of data for staff and players.

Table 4.3 Inter-personal Factors

Higher Order Themes	Lower Order Themes	Raw Data Themes
Social Desirability	Peer-influence	I know sometimes if a practitioner comes around with a sheet you are looking to see what everyone else has put because you don't want to be that person that thinks something is harder than what it was. (P05)
	Honesty*	I think the lads do get the whole thing of it now where it is just an honest score, if you are feeling sore you are feeling sore. So, I think we have all taken that on board. (P06)
		If you pick a time when they are busy and they are not as interested they are just going to fob it off and give you poor results. They won't give it you as accurately. (P18)
		I think that all comes down to the trust of the staff. So, we are all doing stuff for them. We are not just checking on them for no reason. We are doing it for a reason. If they do say 'I am so tired, I am so sore' - we are going to tailor training to that. I mean obviously we have to expect them to tell the truth as well... they have to tell the truth and not just put a 10 because they are tired, and they don't want to train the next day. You know, but they have to realise that the reason why I was going around was not to say, 'right have you done this, have you done this?'. The reason I was going around was...right ok we need to do this for a reason, I think that's really important. (P19)
Reinforcement	Punishments	Three strikes and £50 or something. Yeah, I think that is good. I don't know what other players think but it would probably come from the senior lads. (P01)
		If the players are late they've got a forfeit or a fine and that's for being a minute late. Whereas this is something that we are implementing as a club and it's not got a severe consequence as being late for training. So maybe you get the guys involved and you could put it on the fine system. And if you don't complete your wellness then everyone is aware. You get a forfeit. (P15)
Reminders	Reminders	When the practitioner text then I would realise I would need to do it. (P11)
		Gripes for me are the players, as they are, are lackadaisical and they probably don't buy into it and realise how important it is. So you have to keep nagging them to fill it in. But it is for their own good. I suppose it is just one of those things, we pepper them a lot with other things as well so they've got a lot on their mind. (P16)

Table 4.4 Individual Factors

Higher Order Themes	Lower Order Themes	Raw Data Themes
Staff Buy-In	Staff Buy-In	I know when we put together the weekly reports, I know they got read and I know they were a key part of the meetings prior to the match, that type of thing. I know that it got discussed. Which does show some buy in from the staff. (P19)
	Championing	Yeah, I think that helps because it is an easy thing to forget that. It wouldn't be if somebody was constantly on about it but if we just got small reminders it would definitely help. One of the practitioners last year was pretty good at that, he used to nag you but you would get it done every day. But he did take some stick with it, It's not a nice job that though! (P02)
Athlete Buy-In	Relevance	I think it is a pretty good idea. I felt it was recognised most when players had marked themselves down as feeling sore, you could tell training sessions were modified a bit. But I wouldn't say there are any bad points to it. (P02)
		Saying (to the players) that it is not because we are checking up. It is not because we are thinking 'oh well they've not done it, so we are just going to check them. It is all for them. The reason why we are doing it is all for them. So, I think it is really important for them to understand that. (P19)
		Trophy's. I just think something like that. If you can prove it and back it up. Who do players look up to? I think the easiest way to look at it is how would you get the younger lads to buy into it for the future. I think if you got your senior players doing it week in week out, then the younger players will follow. And they will get respect for that. (P20)
	Education	I think it would be worthwhile explaining to everybody that it is completely confidential. You are not going to be judged on it. I think there is a perception sometimes that if you put 3s and 4s on certain things that you are coming across as a bit soft. I don't know if the head coach actually looks at it but maybe if it said this is confidential and just from a performance point of view, this doesn't go to the coaches. The coaches don't have any input on it, they don't need to know how you are feeling. This is just from a performance point of view, so sports science, strength and conditioning practitioners and it doesn't go any further than that. So, you can actually be more honest. (P07)
		I think it is pretty simple really. How hard the game has been, you know, relates to what we do on the training field. We can't go full on if we have had a real tough game because our bodies won't be able to take it. So, I do understand why we do it yeah. (P09)
		Explain to them the benefits of it. Show them an example of one day's data - this is what we do with it, this is where it actually comes from, this is how we work with it. Just show them and explain to them because if they don't know there is nothing they can do about it. (P18)
	Feedback	If you had a one on one meeting with each player, some might not be interested, but players who want to know - you could have a bit of a feedback meeting with them. Maybe every 12 weeks or just before we are coming into a big period, say like in the last 6 weeks... In these games these were your scores. (P07)
		I reckon on our phones but as well as doing that speak to us. So, if we have a score that is 5 or under, come to us and say - you have put this on let's have a chat about why and if there is a lot of us get us all in (as a group). (P10)
		I just want some data back or some feedback or something, so I know why I was dropping down two weeks after. Because I might have lost weight not through not eating enough but through poor sleep or training more or something else. I feel like my loads are always high - so say we do shoulder press and guys do 35kg, I will do 40kg on the whole set. And then that comes into soreness, and then I feel sore because my loading was a lot. That's me. And that's why I look on it. I like it. (P14)
	Self-Monitoring	I always look at those things because I want to improve. I think even giving some of the data to me - this is what you did at the weekend. And explaining to us what it all means. (P10)
		I know (player name redacted), he was very much into it. He was really all about his performance, he was very professional in that respect. (P20)

4.3.3 Inter-Personal Factors

Social Desirability

There was no indication that players reported favourable responses to influence decisions on a regular basis although staff were cognizant of the potential for this to occur. It was therefore important for players and staff to trust each other in regards to reporting and using the data. This included tailoring their approach to develop trust by giving personal feedback and collecting data at times when players would not "fob it off". If players were in groups socialising or busy with other tasks, then there was a risk for peer-influence. This was particularly evident when collecting RPE data, players calling out scores they may have heard another player report. Likewise, when collecting results on paper players were susceptible to peering over the sheet or asking to see what other players had put.

Reinforcement

There was some interest from staff and players to punish those who failed to complete the questionnaire. For staff this was about conveying the importance of monitoring by making players culpable and having a consequence for failure to complete the questionnaire. Punishments in the form of fines (monetary and other) were suggested. Fines had previously been used by the team but discontinued to avoid forced completions and inaccurate data by players simply wanting to avoid punishment.

Reminders

Staff stressed the importance of using reminders as players often forgot to fill in the questionnaire. Any form of reminder was useful, with staff executing this in person or via messages on smart phones. Players suggested the use of posters in the training facility to

act as a reminder when they walk into the building. Staff suggested that it was useful to collect data on paper at the same time as issuing a reminder whereas on smart phones a link to login could be given so players were one click away from completion.

4.3.4 Individual Factors

Staff Buy-In

Staff buy-in was deemed important across all implementation areas and staff defined roles. It was also important for senior staff members to be seen to buy-in by players and staff. This included coaches who were not privy to individual data. For example, one staff member commented on frustrations of collecting data but seeing no real output of use by other staff members, which in turn questioned his own buy in. However, others pointed to weekly reports as justification that the data was talked about and used. For players, a key staff member championing the use of the questionnaire, issuing reminders and feedback was said to be instrumental in player compliance and understanding.

Athlete Buy-In

There were many reasons across the higher order themes that could facilitate the buy-in of players with the questionnaire. The relevance of why athlete monitoring is done was at the heart of these reasons. It was important for players to see that monitoring was completed for positive reasons linked to their performance. If players perceived data collection to be irrelevant or a form of unnecessary surveillance, it acted as a turn-off to buy-in. It was suggested that one of the ways this could be achieved was through greater education and explanation of the benefits. Feedback acted as another avenue to link between player responses (data collection) and performance decisions. Strategies had to

be repeated regularly in order to ensure sustainability of the monitoring process. Overall, there was a spectrum of buy-in levels and whilst it was encouraged that some individuals pursued self-monitoring, staff viewed too much ownership negatively.

4.4 Discussion

This study is the first to investigate implementation of a wellness questionnaire within a European Super League team. Many factors perceived to influence implementation were identified. Specifically, participants identified 18 higher order and 44 lower order themes said to influence the use of the wellness questionnaire (Figure 4.1-4.4). The findings support previous literature in sport (Donaldson, Gabbe, Lloyd, Cook, & Finch, 2018; Ekegren et al., 2014; Finch & Donaldson, 2010; Shrier et al., 2014) and non-sport settings (Durlak, 2016; Durlak & DuPre, 2008; Meyers et al., 2012). Most notably, as hypothesised, the paper supports the findings of Saw and colleagues (2015b) who investigated the implementation of a wellness questionnaire across a broad range of sports and performance levels. This research identifies a large degree of overlap with the addition of several novel influencing factors. In addition, there were 23 original lower order themes identified. By no means is this an exhaustive list but it gives examples from a particular dynamic relevant to the sport of rugby league.

The findings lend support to the use of a Social Ecological Model (SEM) previously developed for self-reports in sport (Saw et al., 2015b) and widely accepted in health literature (McLeroy, Bibeau, Steckler, & Glanz, 1988; Stokols, 1995). The SEM accentuates the interconnections between the specific environment and the individual's personal attributes (Stokols, 1995). This study identified three broad areas of data

collection, data analysis and decision making as key areas implementation takes place. These steps in the process of handling data reflect various models in literature (Graham, 1990; Saw et al., 2015c). Ultimately, it is the combined quality of implementation across all these areas that results in successful outcomes. Simply having great data collection resources and analytical systems is futile if the practitioner doesn't have the power to leverage the data into making decisions. The following sections discuss the identified factors that influence implementation in relation to these data handling areas.

4.4.1 Data Collection

"I think it is like an alpha male environment, they don't want to seem soft…there is always competition, even if it is trying not to be as sore as somebody else." (P20)

One of the most important influencing factors for monitoring, identified by respondents, pertained to the culture within the organisation. The majority of players responded that they were content to provide any information that staff required. However, there existed uncertainty and a machoism that threatened the collection of accurate data. Quite often this can be commonplace in sport and has been previously exposed in the underreporting of injuries, which are perceived as a sign of weakness or a factor that influences team selection (Ekegren et al., 2014). This highlights the importance of the role rugby league practitioners and coaches play in establishing a positive monitoring culture. A significant avenue to do this is via education to establish the purpose and relevance for monitoring (Saw et al., 2016). As research on implementation in other domains points out, staff should avoid working in secrecy and communicate continually and accurately to the rest of the team so that there is a positive message in regards to the use of wellness data

(Prijatelj, 1999). Indeed, when sports science staff promoted a monitoring routine players confirmed they were more likely to input their data. Not only does this promote a better workflow but it is a strategy recognised in the implementation of many empirical self-report measures such as Total Quality Recovery (Kentä, Hassmén, & Kellmann, 2002). Further support from staff via the use of reminders and punishments were regarded as useful strategies to promote data collection. In particular, the championing of the questionnaire by a member of staff who issued constant reminders and promoted the benefits greatly assisted in players completing the questionnaire on a daily basis. Having a direct approach in conversations to remind players facilitated the data collection process. Such support and advocation has been acknowledged as an important driver to implementation in other contexts (Meyers et al., 2012).

The use of technology to collect data is ever prominent within modern day sport. Research has shown how the use of technology can facilitate the collection of data throughout a 24-hour period (Düking et al., 2018). Of course, for staff, the use of an online system was positive in speeding up the time it took to collect and store data. However, this sometimes happened to be negated by the failure of devices or compatibility issues and so caution should be taken that staff are trained with the appropriate proficiency to use and solve common problems experienced by end users. Whilst technology can be used to visually enhance questionnaires, interviewees showed no interest in generating extra appeal, preferring the simple design and intuitive interface. This is in contrast to Saw et al. (2015b) where participants described a less clinical, attractive interface as more appealing to athletes. This further highlights that each sporting context is unique, and practitioners should develop an understanding of what is suited to their own particular sport and

individuals. A commonality between the studies was the user-friendliness of the questionnaire, acknowledged in the question design being simple and concise; a fine balance between collecting enough data and not placing too much burden on players. It was recognised that additional support from stakeholders within the organisation through the allocation of financial and human resources could enhance the data collection process. Therefore, whilst wellness questionnaires can be fantastic options for monitoring on a budget (Clubb & McGuigan, 2018) additional provision may be required to realise their full potential. If this investment occurs then practitioners should justify the benefits to all stakeholders to ensure the viability of wellness monitoring in the long term (Saw et al., 2016).

Data security is becoming an ever more prominent concern in the sporting world. Previous research identified data security as the single theme associated with the organisation (Saw et al., 2015b). In this study, data was stored on laptops and uploaded to an online system all of which were password protected and deemed sufficient by all stakeholders. In this regard, the players showed a substantial level of trust with regard to how the data was processed and stored. Indeed, such uploading and storage of wellness data generates concerns around individual privacy and the potential misuse and commercial use of data (Düking, Hotho, Holmberg, Fuss, & Sperlich, 2016). With these concerns in previous research around privacy, recent high profile data breaches of large technology corporations (Apple, 2013; Facebook, 2019; Yahoo, 2017), and new data protection laws across Europe (General Data Protection Regulation), this is an important *Implementation Factor* to ensure data continues to be inputted accurately and used appropriately. Furthermore, with the desire of players to have ever more personalised

questionnaires this increases the sensitivity around personal medical and self-report data. Therefore, it is important for practitioners to uphold scientific rigor and ethical awareness when developing their data collection process (Clubb & McGuigan, 2018).

4.4.1.1 The Design of the Measure and Data Collection

"I just think the more you ask you are setting them up for as if there is something wrong." (P16)

Players and staff were satisfied with the number of questions used (up to 10) but they were certainly cautious of probing too much. They worried that too many questions may force players to overthink and worry something is wrong. In a study by Schuman and Presser (1981), 61.5% of participants chose to select a response from a list that it is important for children "to think for themselves" in order to prepare them for life. However, when no list was provided only 4.6% chose a response that could be assigned to this category. Similarly in sport, self-reports can be said to increase an athlete's self-awareness of their psychophysiological cues (Kellmann, Patrick, Botterill, & Wilson, 2002; Saw et al., 2015c). There is therefore a danger that without appropriate education, constant probing and reminding players to think about how sore they feel could have adverse effects. Conversely, self-reports could foster positive effects on psychological indices such as confidence and motivation when administered appropriately (Saw, Main, Robertson, & Gastin, 2017). Questionnaires are often viewed as measurement devices to obtain information from players. What may be overlooked is that questionnaires are also a source of information that players draw upon and contemplate over, in order to provide this useful data. Therefore, education and information contained in the questionnaire

could be constructed to persuade players to have a more positive outlook on their perceptions; that they feel good, not too sore and ready to train and play in the game ahead. Of course, this should be carefully balanced with data validity, reliability, and understanding the individual response to each question allied to the purpose and goal of the questionnaire.

Technology continues to play a huge part in facilitating the design of the questionnaire, data collection, storage, analysis and output of data. Research in clinical settings has shown that high compliance and user satisfaction can be generated using web-based tools on a frequent basis (Brochmann et al., 2016; Bush et al., 2005). The design of the questionnaire is important because it is the means by which players interact with the questionnaire. Within wellness studies, such details are rarely described in detail despite the importance of questionnaire design in establishing player compliance and accurate data (Robson-Ansley, Gleeson, & Ansley, 2009). Rugby league players identified the use of smartphones, computers and websites as the preferred mode within the interviews. In addition to facilitating data handling, the use of technology reminded players to complete their questionnaire by issuing prompts or setting alarms. This is a strategy which has been used in wellness research were emails can act as a prompt for players to complete questionnaires (Sawczuk, Jones, Scantlebury, & Till, 2018). However, a small number of players in the current study preferred to use paper. This is similar to other research where participants had options and used either electronic or paper-based modes (Brochmann et al., 2016). Ultimately, a paper-based system does offer benefits such as helping to reduce the time spent on smartphones and other electronic devices which could be detrimental to performance (Duke & Montag, 2017; Kitson, 2017). Other non-technological approaches

should therefore not be disregarded, providing the organisation has the resources (e.g. to manually input data to online systems) and buy in of players to use that modality.

Despite some of the benefits of using technology there are also drawbacks which were evident in comments from players and staff. The benefit of technology speeding up the process of collection and analysis can be offset by the time investment required in staff training, software updates and compatibility issues. It was common for participants to forget their passwords and struggle to log into the system within the rugby league team investigated. Access problems were particularly evident when away from the training venue. In such cases it is important to be able to use systems offline (Halson, 2014) and strategies should be thought through in advance to account for these issues. For staff, the design of data export and visualisation could be complicated to use. Although such concerns didn't result in participants viewing the questionnaire as a burden, it is easy to see how poor question content and design features could lead to frustration, low compliance and inaccurate data. To this extent, players often requested improvements which would allow log-in and questionnaire completion to take less time. Ultimately, it is likely that technology will feature somewhere in the data handling process in high-performance sport. It is currently the best means by which to facilitate this process and provides a mechanism to aid communication between parties (Saw et al., 2016). However, the ease of use and establishing design features that can be tailored to the organisation using the questionnaire should be a key focus when deciding upon the wellness measure.

4.4.2 Data Analysis

"I know I will look at the wellness and some of the players, it is not that I trust more but I feel I will get a more honest opinion off some of the players opposed to others. I know what sort of opinion I will get off some of them. And it is finding out what is normal for that individual with their wellness. Because some are constantly sore, some are constantly tired. That's just how they are so you can't just make a judgement on that because he is always tired, or he is always sore. There is nothing wrong with him, that is just the view on his body." (P16)

Whether wellness is used to measure the response to training in conjunction with training load (Bourdon et al., 2017) or to assess recovery from performance (Kellmann et al., 2018), the consensus is that a multidisciplinary multimodal approach is used. It is the combination of using wellness as part of a toolkit in an integrated approach that allows a practitioner to see the full picture. For wellness questionnaires in particular, a practitioner's knowledge of the athlete can influence the interpretation of the data in rugby league (Hunwicks, 2018). It is this additional context of knowing the individual athlete, that provides context in which to understand the data and make a decision.

In this study, the wellness questionnaire was regarded as one method that was part of a wider toolkit of monitoring strategies. The use of other data was important for both players and staff to analyse and interpret wellness data. This multi-modal approach to analysis is consistent with research findings that single monitoring variables, including wellness, discriminate poorly in regards to performance change (Crowcroft, McCleave, Slattery, & Coutts, 2016). In order to gain a comprehensive understanding of how players

respond to training and gameplay practitioners are advised to contextualise changes in training load, fitness and fatigue measures (Coutts, Crowcroft, Kempton, Kellmann, & Beckman, 2018). In particular, for this research, participants commented that the schedule was a contextual factor which was said to impact on the analysis and subsequent decisions that could be taken. Research in rugby league has shown that different between match micro-cycles elicit subtly different recovery profiles (McLean et al., 2010). Players were conscious of such contextual factors as between match micro-cycle influencing their response and suggested staff should interpret this accordingly in their analysis. The practitioner must also consider the stage of the season and other contextual factors of the week's game. For instance, a cup final week, a week with travel, short or long turn arounds are all contextual factors which influence the data that can be collected, how it is analysed, interpreted and the decisions that can be made. It is therefore important that practitioners take care not to simply chase the numbers and consider wellness data in the overall context of optimising preparation and performance (McGuigan, 2017, p.99).

Allied to this approach, practitioners gave a limited insight into the statistical analysis that takes place. Indeed, the use of applied analysis techniques is very much a progressive area within the monitoring literature, particularly for monitoring individuals and wellness (Sands, Kavanaugh, Murray, McNeal, & Jemni, 2016; Ward, Coutts, Pruna, & McCall, 2018). As with data collection, technology played a role in speeding up the analysis process by automatically custom flagging data. The consensus was similar to other research in that, for staff, wellness was a first indicator that led to the practitioner following up with a personal chat or investigating other data (Saw et al., 2015b). A criticism was that players didn't receive any direct feedback from the system when they

completed the questionnaire, participants desiring some form of personal analysis and visualisation once they had submitted their data. Such an enhancement to questionnaires has the potential to encourage self-monitoring and the associated benefits including motivational and behavioural influences (Saw et al., 2017). Additional frustrations with the analytics and visualisation came from staff too, due to technical hindrances and competencies required to use analytical software. Whilst there is scope for developing these skills through staff training much of the nuances of the learning process occur through hands on use in-season. In truth, allied to any scientific and statistical approach there was an art to analysis and interpretation. The experience of staff to know their athletes, their typical responses and set meaningful flagging systems was a key determinant within the analytical process that is consistent with the literature (Robertson et al., 2016; Saw et al., 2015c).

The many different types of measure that can be used mean that every empirical or customised questionnaire will have a different way to analyse data. A key criticism of self-reports, collectively, is their subjective nature and the potential for players to manipulate their responses (Carling et al., 2018; Saw et al., 2015a). However, the subjective nature is also their strength when players report truthfully and consistently as it allows practitioners access to personal perceptions of how an athlete is feeling across psychological, physiological and social domains. The key challenge exists in educating players on how to answer the questionnaire and prevent any favourable responses that could be harmful to data analysis. In this research, practitioners explained that they were able to successfully limit socially desirable responses through a mixture of education, communication and being reasonable in their requests to develop honesty and truth

amongst all stakeholders. This existed as a two-way process, for players to trust that decisions were being made in relation to their performance and for staff that players responded truthfully and used information appropriately. In summary, data analysis involved conducting a statistically valid assessment of the data, recognising any contextual factors at play within the organisation and balancing this with the knowledge of how an individual typically responds.

4.4.3 Decision Making

Various decisions or actions can be taken using wellness data which have been previously documented (Saw et al., 2015c). For this study participants desired to see the data in use and became frustrated if they felt their responses were being submitted into a void were information was either not used or no feedback provided. The key decisions that could be taken revolved around modification of training and recovery. Some practitioners commented on other decisions and responses to low scores on wellness questionnaires including advice or referrals, such as poor nutrition scores prompting the outcome of the chef preparing take home meals. Ultimately, players were satisfied if no changes or decisions were made as long as they were informed of the reasons for doing so. This emphasises that feedback is vital to the buy-in of athletes in the use of wellness questionnaires. Furthermore, it shows that monitoring wellness is best implemented as a cyclical process from data collection through to feedback, review and re-collection. Importantly, not all players wanted high levels of feedback and players suggested the use of optional feedback meetings alongside the use of tailored reports. This acts as a strategy to suit all parties with those requiring more feedback able to acquire it, thus maintaining players levels of buy-in. However, it remains a balance for the practitioner to dedicate

time within the training week to support such provision and relies on support within the organisation.

It has been previously outlined that individualisation is important within athlete monitoring (Borresen & Lambert, 2009; Bourdon et al., 2017; Kellmann et al., 2018). Indeed, there is large between and within individual differences in wellness which should be accounted for (See Study 4). Whilst decisions were identified that dealt with the team collectively, participants also recognised that players would show different responses to training and gameplay, and that wellness data could be used to tailor decisions individually. This was particularly evident for older players or injured players. Recent studies have progressed our understanding of monitoring the individual and analysing data in applied environments (Ward et al., 2018). For instance, the use of flagging systems (Robertson et al., 2016) and other statistical approaches (Sands et al., 2016) are useful for obtaining quality information usable for decision support. An important next step is to assess the actual decisions that can be taken within the organisation as a whole and for the individual. Allied to the analysis, it may be worthwhile for practitioners to develop a list of actions or strategies they can take in preparation, so that decisions can be made quickly and effectively under the pressures of the working week. It should also be considered as to what impact these decisions have in order to perfect and sustain the monitoring process. For example, in this study, staff produced weekly reports that were used to review and discuss self-report data, amongst other information, in team meetings. These meetings helped to give staff satisfaction that data was being used or at least discussed. It was evident that any perception of the lack of using data posed questions to staff buy-in and could thus impact upon the motivation to collect and analyse data.

Therefore, in a similar way to players, it was important to educate and feedback how information was integrated into decisions to satisfy staff. Ultimately this is an important factor to consider, as the buy-in of staff is crucial to the long term sustainability of wellness questionnaires, with studies showing that support greatly increases compliance in sport (Saw et al., 2015a) and non-sport settings (Lochman et al., 2015).

Through the interviews it became clear that the relevance of the question to a player's performance was crucial for athlete buy in and generating meaningful data that could be used in decisions. For example, one individual recognised the importance of sleep to performance but questioned the relevance of monitoring it, "if someone says they felt fresh but had a poor night's sleep what would you do differently to that? (P11)". Whilst all questions have some level of importance it is critical for stakeholders to recognise the reason for monitoring and the decisions that can be taken with the data. Recent research has shown that certain variables are perhaps better suited for determining readiness to train whilst others suited to identifying the response to training (Govus, Coutts, Duffield, Murray, & Fullagar, 2018). Therefore, having a clearly identified purpose and guidelines for decisions that can be made in relation to each question is a necessity (Saw et al., 2016). It is also important to identify what each player identifies as relevant to their own performance, exemplified by another player commenting on his use of sleep data, "I think I had a poor night's sleep last night but I don't think I have had three poor nights in a row. So, it would be good to look back on it (P06)".

4.5 Conclusions

This research lends support to the use of the social ecological model (Saw et al., 2015b) to identify factors influencing implementation within rugby league environments. Overall it is important to take into account the unique setting at the organisation in which wellness questionnaires are used, the communicative process and design features of the measure, as well as the interpersonal and individual factors within the social environment. The influencing factors outlined in this research were part of an ongoing process. Many of the problems experienced, and influencing factors recognised, developed after the wellness questionnaire was put into place. Therefore, wellness questionnaires require dedicated staff members to enter into a continuous process to educate, feedback and solve technical issues to ensure successful implementation and sustainability.

It is worth acknowledging that this study only identified factors perceived to be influencing implementation amongst players and staff (sports science, S&C, medical). These participants were chosen as they are the main end-users of the wellness questionnaire in operation within this organisation. However, other individuals such as coaches and senior management, whilst not directly involved on a daily basis, can influence the extent to which the wellness questionnaire is implemented through their approach to using wellness data and allocation of resources. Thus it may be worth considering the thoughts of these individuals in future assessments. Furthermore, it could be argued that a limitation of this study is that it only focussed on the implementation of a wellness questionnaire in one rugby league team. However, implementation cannot be fully understood without reference to the type of sport, team and players. The approach taken in this study has allowed for factors influencing implementation to be covered in

depth, in order to point other practitioners in the direction of factors to consider. Practitioners are thus recommended to complete such reviews with a view to improving the process of using wellness questionnaires within their own organisation. In order to do so they can use this study as a template to review their own data collection, analysis and decision-making process and identify factors regarding the organisation, measure, interpersonal and individual that may impact upon implementation. By doing this it is hoped that this will encourage compliance, data accuracy and positive behavioural changes associated with performance.

4.6 Synopsis

Study 1 identified that practitioners are currently using non-validated wellness questionnaires and that the success of a wellness questionnaire hinges on quality implementation. Previous investigations have established the importance of implementation and factors that may influence the success of implementation and use of wellness questionnaires (Duignan, Slevin, Caulfield, & Blake, 2019a; Saw et al., 2015b). However, these studies lack depth within the context of a single sport or team. The next step within this thesis has thus been to identify factors that could influence the implementation of a wellness questionnaire within the context of rugby league. Case study interviews were completed and factors influencing implementation within the sport have been identified.

Previous research into implementation of self-report measures have listed similar factors but crucially contained no framework for practitioners to evaluate their own teams (Duignan et al., 2019a). This investigation supports the use of the Social Ecological

Model used by Saw et al. (2015b). Together with the *Implementation Outcomes* identified in study 1 this acts as a framework for evaluating and identifying *Implementation Factors* which influence the successful use of wellness questionnaires. The integration of these two aspects are summarised within the *Successful Implementation Framework* proposed in the General Discussion (Chapter 7).

It must be reiterated that the *Implementation Factors* identified within this study are from one team in rugby league. This limitation means that the factors are perhaps not an exhaustive list and that other teams within the sport should be investigated. Furthermore, future research should also investigate other practitioners within the organisation who are involved in the use of wellness questionnaires aside from performance staff. The factors which influence implementation are essential for the development of wellness questionnaires. Practitioners should account for the factors when developing wellness measures to use with their team. As identified in study 1 and supported by literature in this area (Duignan, Slevin, Caulfield, & Blake, 2019b), it is important to ensure that the data collected is accurate, valid and reliable. However, wellness questionnaires previously used in rugby league research have not been validated (e.g. McLean et al., 2010, Twist et al., 2012). Furthermore, these studies using wellness questionnaires assure credibility by referencing other similar validated scales from non-sporting research (Twist et al., 2012). It is clear that a wellness questionnaire for use in rugby league needs to be validated and developed, with consideration for the *Implementation Factors* identified within this study provided.

CHAPTER 5

Study 3: Development and validation of a new wellness questionnaire for rugby league

5.1 Introduction

The majority of practitioners within high-performance sports teams use customised wellness questionnaires (Study 1). Published research investigations in the sport of rugby league also use these customised designs yet often fail to describe in detail how they were developed and assessed for validity and reliability (e.g. Mclean et al., 2010; Twist et al., 2012; 2017). Furthermore, these research papers do not account for the guidelines recommended when developing wellness questionnaires (Saw et al., 2016). Nor do they detail the implementation considerations outlined in the previous chapter (study 2). It is essential that any new questionnaire has been rigorously tested to ensure that it is psychometrically sound and fit for the purpose of monitoring wellness. This is perhaps one of the greatest challenges when using wellness questionnaires. This study describes how a new wellness questionnaire was developed to be used in rugby league.

5.2 Methods

5.2.1 Experimental Approach to the Problem

The experimental approach to developing the new wellness questionnaire was formed of four phases. It was necessary to develop a wellness questionnaire from an empirical, theoretical and practical perspective. The approach was based on recommendations for developing questionnaires (Tsang et al., 2017), wellness guidelines (Hooper & Mackinnon, 1995; Saw et al., 2016), implementation research (Meyers et al., 2014), including the findings of studies 1 and 2, and methodologies of previous psychometrically validated questionnaires (Kölling et al., 2015; Laurent et al., 2011; Lundqvist and Kenttä, 2010; Raedeke & Smith, 2001; Rushall, 1990). The procedures used within the four phases of development of the new questionnaire are outlined below.

5.2.2 Participants

Twenty-seven elite level rugby league players (Age 24±4 years; Stature 182±6 cm; Body Mass 98±9 kg) gave written, informed consent to take part in this study. All players were full time professional athletes, many of whom were representative internationals who regularly follow the protocols of using wellness questionnaires. All players in the study participated in training and gameplay throughout the study period. Four applied practitioners and three university academics were involved in the construction and development of the new wellness questionnaire and also gave consent to participate. The research was approved by the University Ethics Committee at the University of Central Lancashire, and operated in accordance with the principles of the Declaration of Helsinki.

5.2.1 Procedure 1

In order to construct the questionnaire 14 players and 6 staff members were interviewed as per the methods of the previous chapter. These participants were asked about their preferred question items, the format of the wellness questionnaire and the influencing factors which would make completion of the questionnaire easier. Commonalties in the response were sought out through a process of descriptive coding of the transcripts. These were used to inform the approach to developing and constructing the questionnaire items described within the phases 1-4.

5.2.2 Procedure 2

Participants within the rugby league team were provided with a list of question areas and asked to indicate whether each item could be used to reflect player wellness and readiness to perform in training or gameplay. Data was collected after a team meeting on individual

paper handouts. Players were instructed that there were no right or wrong answers and to complete the list with honesty in relation to their own preparation for training and games. The yes and no answers for each question area were totalled and percentages for the group compared alongside values from the question areas practitioners identified in study 1.

5.2.3 Procedure 3

Once a list of question areas and items were developed, four practitioners working at the rugby league club were asked to participate in a group discussion to refine the questionnaire content. Participants were asked to comment on the relevance of the questions to applied practice and if they would be useful to inform decisions regarding preparation. A draft questionnaire was created which was then discussed amongst the academic research team. These participants were asked to comment on the suitability of the questions from a theoretical perspective, the wording and semantics of the questionnaire.

5.2.4 Procedure 4

In order to assess aspects of validity, reliability and suitability of the new questionnaire players completed both an existing wellness questionnaire (Mclean et al., 2010) for a period of 3 weeks followed by completion of the new wellness questionnaire, also across 3 weeks. Players completed the custom-made wellness questionnaires immediately after breakfast before their first training session each training day (approximately 8.00-10.00 AM). Both questionnaires involved the completion of several questions which were summed to give an overall wellness score. A comparison of the two questionnaires was made assessing the implementation outcomes suggested in study 1, including the range

of responses, compliance, simplicity of the system, and how meaningful the data was for practitioners.

For the new questionnaire a Pearson's product-moment correlation was run to assess the relationship with each question item and the summated wellness score. A Cronbach's alpha test was also run to give an overall reliability coefficient for the wellness questions. Throughout the collection of data for the new wellness questionnaire assessments were made as to the overall performance of players in training and gameplay. Performance scores were given for every individual player after each training or game by two expert rugby league coaches with over 15 years' experience working in the sport. Coaches were instructed to give an overall assessment of player performance compared with the expected performance on a graded scale between 1 (Very Poor) and 10 (Excellent). Coaches were accustomed to such assessments due to regularly conducting performance profiling of players each season following published procedures (Weston, Greenlees, & Thelwell, 2012). They were asked to consider the performance as a whole taking into account attack and defence in relation to technical, tactical and physical performance indicators of the club. The assessments were conducted within 30 minutes of training and game-play. Each coach completed their assessment without knowledge of the assessment made by the other coach. A Cohens kappa test indicated a good level of agreement between the two coach assessments, 0.80 (95%CI, 0.60 to 0.99). These performance scores were correlated with wellness data to assess if the questionnaire acceptably measured the readiness of players to perform.

5.3 Phase 1: Initial Considerations in the Construction of a New Questionnaire

5.3.1 Purpose and Identification of Dimensions

The purpose of the new questionnaire was to monitor wellness throughout a longitudinal period of the regular season in order to inform practitioners on the response to gameplay and readiness to perform. Many questionnaires are multidimensional meaning they are composed of related components that inform on the construct being measured (Tsang et al., 2017). A fundamental step in the development of the wellness questionnaire involved identifying appropriate question dimensions to use based on the purpose of the questionnaire. In general, these were initially informed by the dimensions identified by practitioners in study 1 and in accordance with literature reviews on overtraining (Fry, Morton, & Keast, 1991) and wellness monitoring (Saw, Main, & Gastin, 2016). These included questions related to muscle soreness, injury, illness, sleep, fatigue, energy levels, mood, nutrition, non-training stress and general wellness. All of these question dimensions are consistent with previous recommendations (Fry et al., 1991; Hooper & Mackinnon, 1995; Saw et al., 2016). An important factor in the design of the questionnaire identified in study 1 was the brevity of the question list. It therefore wasn't possible to have multiple questions for each dimension as seen in other questionnaires, for example the numerous questions on five dimensions (anxiety, dejection, excitement, anger, happiness) that form the construct of emotion in the Sport Emotion Questionnaire (Jones et al., 2005). Therefore, the focus was to include question dimensions relevant for different practitioners as well as informing on overall wellness. In particular, questions were selected based on the work of Lewis, Collins, Pedlar, and Rogers (2015) who promote an interdisciplinary approach to monitoring (i.e. nutrition, physiology,

psychology). The new questionnaire encompassed aspects linked to practitioner roles in rugby league (e.g. sports scientist, strength and conditioning coach, sports psychologist and medical practitioners). For example, Meeusen and colleagues (2013) highlight a range of nutritional considerations which could help to prevent overtraining such as preventing a negative energy balance and ensuring adequate fluid intake. Questioning rugby players on the quality of their nutrition and fatigue levels would help to give insight to this area for the sports scientist and club nutritionist. Likewise, poor quality sleep has been shown to impact recovery of rugby league players (Skein, Duffield, Minett, Snape, & Murphy, 2013) and together with physical aspects of wellness such as muscle soreness would help inform strength and conditioning coaches on training prescription. Disturbances in mood state have been linked to underperformance (Meeusen et al., 2013) and details on negative affective states are useful for sport psychologist intervention. It is worth noting that the dimensions sought to inform on these areas alongside other monitoring strategies rather than exclusively highlight issues in their own right. The wellness questionnaire was to be used to give insight into wellness and act as a flagging system for further investigation as part of a multi-modal strategy.

5.3.2 Feasibility & Stakeholder Engagement to Use the New Wellness Questionnaire

When starting out developing monitoring strategies it is important for practitioners to think clearly about the context and if it is suitable for the use of wellness questionnaires, as the necessary steps are taken to prevent misuse or overuse of data (Collins et al., 2015). This includes deciding on the measure and if it is a fit with the context the practitioner is working in. Not all environments are suited to the use of wellness questionnaires and data driven approaches. Some authors have presented narratives in which data use within

rugby is perceived as a dangerous weapon, used to exert control over players (Williams & Manley, 2014) or where the monitoring strategies that continue to be implemented simply didn't work with the coaches (Jones et al., 2016). Carling et al. (2018) highlight some of the genuine limitations of self-reports. They state that players can be reluctant to provide information on their perceptions, that it is a challenge to collect data as it depends on the match result and that if information is collected players may not be honest. To this extent, assessments and capacity building strategies were conducted in phase 1. These focussed on the levels of engagement and feasibility, which is ultimately a continued process in the development and use of the questionnaire. If the culture is not receptive to the use of wellness monitoring, then this needs to be identified. There is then an opportunity to educate as to why the data is used and persuade those within the organisation that such monitoring may be necessary.

In the development of the new questionnaire guidelines were followed to develop a supportive culture, commitment, mutual understanding and transparency amongst all stakeholders as outlined by Saw et al. (2016). Findings from player interviews indicated players were keen on the use of wellness data, describing that they were receptive to the use. However, some uncertainties existed and in these instances players expressed a desire to find out more about the how and why wellness is monitored. Therefore, it was decided that a planned educational meeting of all parties as to why wellness data is used would be provided (in Phase 4) to help solidify a positive collective culture for the use of the wellness questionnaire.

Rugby league is not without its challenges to implementing monitoring. The financial situation of teams in the UK is described as bleak with clubs often failing to generate profit (Wilson, Plumley & Barrett, 2016). An effect of this could be felt within sports science departments as financial and human resources play an important role in the level of provision. On one level a wellness questionnaire could be said to be suited from a financial point of view (Clubb & McGuigan, 2018) but detailed analysis requires staffing, software and time considerations. In the current investigation, the rugby league team was deemed to have sufficient resources to implement a new wellness questionnaire as they had already been using an online system, described to be effective, which could be modified to develop a new questionnaire. Furthermore, good processes were evident through the identification of defined roles and routines with sufficient human resources. A key element in team planning is identifying the role each staff member plays (Prijatelj, 1999). Indeed, different staff members were proposed to be responsible for data collection, analysis and decisions throughout the implementation of the new questionnaire. Importantly some of the staff roles to use wellness software needed training and it was at this phase were this was provided through one to one tutorials with staff from the website and software of the new wellness questionnaire. This included details on the log-in, administration of accounts, flagging and reporting of data.

5.4 Phase 2: Creating a Structure for Implementation of the New Questionnaire

5.4.1 Data Handling Process

It is essential that practitioners have an organised plan as to how the wellness questionnaire will be implemented and utilised in practice. This phase involved further

clarification of the individual roles and responsibilities to oversee the process of using the wellness questionnaire. In accordance with the findings in study 2, the *Implementation Areas* of data collection, analysis and decision making were outlined with a clear plan as to how each of these processes would be completed and who they would be delivered by. Each *Implementation Area* can impact on the following, for example a poor data collection will pose challenges to data analysis and limit the decisions that can be made. Likewise, if data collection is of high quality with high completion rate, a poorly planned and resourced data analysis process will still limit the decisions that can be made. Poor decisions or a lack of feedback may influence the levels of compliance and therefore data collection. In sum, equal consideration should be given to developing each *Implementation Area*.

The planned data handling process was to collect the wellness data before morning weights/rugby training, at the same time each day (approximately 08:00-10:00). The sports science staff would analyse data before training took place, contextualising the data with other data sets (e.g. training load), S&C coaches, the director of performance and/or the sports psychologist. An initial quick analysis would take place by flagging low values across the team within the website used to collect the data. However, this would not offer any individualisation or account for past results, therefore data was proposed to be exported to Microsoft Excel for these comparisons. Decisions regarding the team and individuals including adjustments to training prescription or follow up chats would ensue, ideally before morning weights or rugby field sessions. All players would complete the same questionnaire as it allowed for global trends to be monitored in addition to the individual.

The *Implementation Areas* used within the team can be considered analogous with Saw and colleagues (2015c) (Data collection = Record data, Data Analysis = Review Data, Decision Making = Action). However, in the cycle identified previously (Saw et al., 2015c), the authors outlined a step labelled contextualisation, whereby knowledge of personal circumstances, personality traits and other variables were taken into account when interpreting an athlete's data. Interviewees also discussed this process but not just in the analysis and interpretation of results. Throughout data collection, the context of knowing an athlete was said to aid implementation (e.g. knowing the best temporal opportunities to remind a player to complete the wellness questionnaire). The communication between staff that the wellness questionnaire can afford existed across all *Implementation Areas* of data collection, analysis and decision making. As such, the contextualisation step was viewed as an important underlying action in the planned monitoring process, rather than a core step in its own right.

Despite the direct impact training and recovery prescription has on player wellness, coaches generally have little formal education in the area of fatigue, recovery and monitoring (Nash & Sproule, 2018). Therefore, it was important to educate coach and staff around the process of monitoring wellness within this phase. Not least because a practitioners monitoring approach has wide reaching implications for the collection of data and the extent to which data is used (Burgess, 2016). Practitioners in study 2 identified that being direct with players often resulted in the most trustworthy information being provided. Therefore, staff were instructed to be direct when issuing any reminders or attempting to collect data; for example, keeping the focus on asking for wellness data

and avoiding other conversation, giving feedback when players asked and following up with players to discuss meaningful results. This tailored approach was designed to have a positive impact on athlete perceptions and understanding of wellness via the recommendations provided by players, in addition to implementation research on staff support and data management practices (Ekegren et al. 2014). Importantly, the development here was geared around staff proficiency in the process of data collection, analysis and decision making.

5.4.2 Questionnaire Completion Format

The questionnaire was designed to be self-administered by players using an internet-based system which could be accessed by smartphone. Players would always have access to the questionnaire in the home training environment through the club Wi-Fi. Interviews with players highlighted that this was the preferred method throughout the team for staff and players. Electronic questionnaires were said to ease the burden on staff for data collection and analysis. It also allowed reminders to be issued with links to the questionnaire. A self-administered format via smartphone completion attempted to increase the privacy around completion and reduce socially desirable responses. The online nature of questionnaires means they are often accessible for the players at any time throughout the day. Therefore, clear guidelines for completion were set to complete wellness immediately before weights (or rugby) to ensure players completed the questionnaire at the same time each day.

5.4.3 Face Validity and Item Reduction Phase

Once the initial dimensions had been decided, a list of question areas were composed and entered an item reduction phase. Previous wellness questionnaires often have too many

questions and it was necessary to tailor the questionnaire to dimensions which were most appropriate to rugby league athletes. The first stage was to question athletes and staff on the relevance for each question area. Table 5.1 reports the percentage of rugby league players and staff who perceived the wellness questions to be relevant. It also includes the percentage of practitioners from study 1 who accepted the questions as relevant.

Table 5.1 Percentage of rugby league players and staff (N=20) and Study 1 Practitioners (N=122) indicating that the wellness item was relevant.

Wellness Item	**Rugby League Sample**	**Study 1 Practitioner Sample**
Muscle Soreness	100	100
Sleep (quality & quantity)	95	99
Illness	75	96
Player Comments	60	94
Non-Training Stress	80	93
RPE	90	91
Motivation	90	86
Nutrition	80	86
Mood	95	83
Fatigue	100	83
Hydration	75	75
Weight	80	39

It was decided by the research team that there should be a high level of agreement between both samples in order for questions to be used in the new wellness questionnaire (>79%

relevance in both groups). The results indicated the question areas of muscle soreness, sleep, non-training stress, RPE, motivation, nutrition, mood, and fatigue should be used. A large percentage of the rugby league sample had indicated that weight and RPE were important wellness items. This may have reflected the monitoring already performed at the club, and after further assessments (see Phase 4) they were proposed to be collected but not within the wellness questionnaire itself. This was due to the timing of completion for RPE as the questionnaire was completed in the morning and the poor correlation of weight to overall wellness.

5.4.4 Item Format

In order to determine the item format, an investigation was completed using a previously published wellness questionnaire used in rugby league studies (McLean, et al., 2010). This questionnaire has been adapted for use in other studies in rugby league but generally uses a 5 point a Likert scale (McLean et al., 2010). Although proven to be sensitive, the investigation cast doubt on the practicality and meaningfulness of the information this questionnaire provides. A noteworthy finding was that the range of results across the questions was extremely low, for example one player out of 278 responses selected a sleep score of "1-insomnia" and only six players responded by selecting "2-restless sleep" (Figure 5.1). As practitioners identified in study 1, the questionnaire should have a greater spread of data within the scale on the different training days. This small five-point scale lacked variation and limited the meaningfulness of results as numerically a movement of 1 seems small but on the scale is likely to be vastly different. In the development of the new questionnaire a larger ten-point scale was chosen, and this alleviated this problem creating a greater range of options. Furthermore, it was felt that a 1-10 scale would be

comparable and perhaps easier to understand as it reflected the other commonly used scale of RPE. This approach is also consistent with the perceived recovery status scale (Laurent et al., 2011).

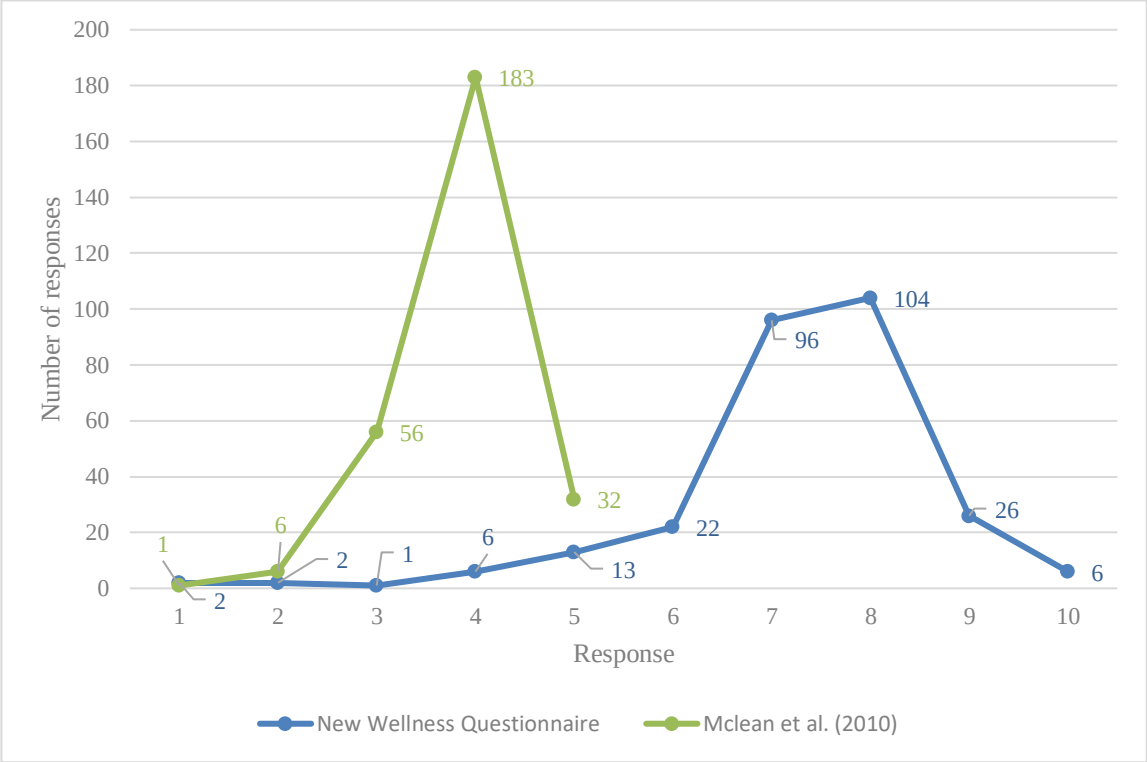


Figure 5.1 Range of response for question item on sleep quality.

A further problem with this existing measure (Mclean et al., 2010) is that it uses a Likert-type scale and therefore the data can be considered ordinal. This severely limits the data analysis that can occur because the distance between items is not measurable. For example, if "5. feeling great" and "4. feeling good" are used to indicate muscle soreness it is not possible to assume the distance between these points are equidistant, even though the numbers prescribed to the response are (Sullivan & Artino, 2013). To combat this, the new questionnaire opted to use semantic differential scale consisting of words players would typical use to describe their perceptions placed at the ends of a numbered 1-10

scale. This type of scale creates more of a continuous measure, opening up the possibility to use means and standard deviations if data is normally distributed.

5.4.5 Item Development

An important step in the design of the questionnaire was to improve the readability and comprehension of the questions. Previous questionnaires in rugby league have used language which is perhaps unsuitable for the population such as “insomnia” (Mclean et al., 2010). This does not encourage compliance because wellness content should be tailored to the athlete and sport in an attempt to increase appeal and minimise disagreeable factors (Saw et al., 2015a). In the development of the new questionnaire, the wording of the questionnaire was assessed, and changes made through consultation with players and the team sports psychologist. Questions should be easy to understand with simple grammar and familiar, unambiguous terms (Schwarz, 2006). Therefore, several recommendations for the wording of questions were followed (Artino, La Rochelle, Dezee, Gehlbach, 2014; Leung, 2001). The new wellness questionnaire embraced short and simple sentences, such as, “How do your upper body muscles feel?”. The questions were designed to be precise and asked for one piece of information at a time, “Rate the quality of your nutrition in the last 24 hours”. It also included detailing semantics (e.g. explaining what “really sore” and “very poor sleep” actually means) as well as giving a pragmatic understanding of what questions were trying to achieve (a high quality sleep gives an indication on player recovery, if a player experiences consistently poor sleep this may lead to practitioner intervention e.g. sleep hygiene assessment or scheduling later training sessions) (Grice, 1975). The labelling of scales was customised to account for the

perceptions of players with simple, unbiassed terminology by being framed in a neutral or positive way e.g. how do you currently feel as opposed to how stressed do you feel?

In previous development of questionnaires, such as the DALDA, information booklets, instructions and definitions have been constructed and participants asked to comment on their comprehension of the information (Rushall, 1990). Practitioners should address the limitations that are inherent with self-reports by providing players with education to understand the relevance for the question, the context in which the question is asked and how the information will be used (Schwarz, 2006). Therefore, attempts were made to educate players through a team meeting so that each player could at least attempt to respond in the same manner. Players were given standardised verbal instructions that were reiterated consistently in subsequent follow up meetings. Players had opportunities to ask questions and were told to contact the head of sports science at the club if they had any problems understanding the items. It is unrealistic to believe that each individual will perceive a dimension in exactly the same way. However, with this education, players were encouraged to be consistent within their perceptions and it was proposed that team analysis would account for the individual (e.g. by using individualised z-scores and radar charts – see Study 4). A benefit of using a wellness questionnaire daily is that there is easy access to the players to deliver reiterations and messages regarding completion. For example, at the start of the training session before weights the sports scientist would explain the training day, remind players to complete their wellness and provide guidance regarding dimensions or scales.

5.4.6 Content Validity

As per Lundqvist and Kenttä (2010) a qualitative item analysis was performed by an expert panel of practitioners and academics to confirm the suitability and clarity of the questions. This content validation occurred by a sports scientist, strength and conditioning coach, sports psychologist, and a director of performance working within rugby league. This was alongside three members of the academic supervisory team including a professor and accredited sports psychologist. The areas identified from the item reduction phase were deemed to be suitable by all individuals. However, it was decided that muscle soreness should be split into upper and lower body soreness which would assist with informing decisions around recovery and training prescription. Rather than probe too much into athletes' personal lives a question around non-training stress would simply ask "how do you currently feel?" on a 1-10 scale between stressed and relaxed. This simple question would act to inform the sports psychologist by way of flagging an athlete which may then require further investigation. Based on the development outlined above the following questionnaire was proposed (Table 5.2) and the following operational definitions developed through similar definitions in research and player understanding (Table 5.3).

Table 5.2 A New Wellness Questionnaire.

Wellness Item	New Wellness Questionnaire
Sleep Quantity	**1.** How many hours sleep did you get last night? (open response)
Sleep Quality	**2.** What was the actual quality of your sleep last night? Very poor----------Very good 1 2 3 4 5 6 7 8 9 10
LB Soreness	**3.** How do your lower body muscles feel? Sore----------Fresh 1 2 3 4 5 6 7 8 9 10
UB Soreness	**4.** How do your upper body muscles feel? Sore----------Fresh 1 2 3 4 5 6 7 8 9 10
Motivation	**5.** How energetic do you feel to perform? Not at all----------Extremely 1 2 3 4 5 6 7 8 9 10
Non-Training Stress	**6.** How do you currently feel? Stressed----------Relaxed 1 2 3 4 5 6 7 8 9 10
Fatigue	**7.** How fatigued or generally tired do you feel? Extremely----------Not at all 1 2 3 4 5 6 7 8 9 10
Mood	**8.** How would you grade your mood state? Sad/depressed----------Happy/Optimistic 1 2 3 4 5 6 7 8 9 10
Nutrition	**9.** Rate the quality of your nutrition in the last 24 hours: Unhealthy----------Very healthy 1 2 3 4 5 6 7 8 9 10

Table 5.3 Wellness operational definitions.

Wellness Item	Operational Definition
Sleep Quantity	The total amount of hours the player has perceived to have slept.
Sleep Quality	The self-rated satisfaction of the sleep experience.
LB Soreness	A self-reported rating of pain or discomfort in the lower body muscles including major muscles of the legs: quadriceps, hamstrings, calf muscles.
UB Soreness	A self-reported rating of pain or discomfort in the upper body muscles including major muscles of the chest, back and arms.
Motivation	An assessment on how enthusiastic the player is to perform in training.
Non-Training Stress	A general assessment of stress an athlete is exposed to that is outside the team led physical training regime. For example, personal relationships, logistical issues and major life events.
Fatigue	An assessment of the sensations of a players tiredness and associated decrements in muscular performance and function.
Mood	A self-reported rating of a player's state of mind.
Nutrition	An assessment of the quality of a player's nutrition in the last 24 hours.

5.5 Phase 3: Assessment and Modification of Implementation Factors

Phase 3 largely concerned the on-going process once the questionnaire had been constructed and implementation to familiarise players with the wellness questionnaire had begun. Every effort was made in Phase 2 to plan and account for the *Implementation Factors* which could impact data collection, analysis and decision making. However, the *Implementation Factors*, which were originally identified in study 2, were deemed part of a continuing process of management. It was therefore necessary to have methods in place to account for and manage some of the *Implementation Factors* as players began to complete the questionnaire. This largely involved ensuring the staff had the technical abilities to administer the challenging parts of the wellness questionnaire. It was proposed that this would involve resolving any problems that arise through the use of the

questionnaire. For example, it may become evident that players are copying the response of other players after several months of using the questionnaire (social desirability). A practitioner would need to know the options available and have the technical ability to resolve this issue quickly, which may involve altering the mode of delivery (online questionnaire to individually asking to record data on paper), creating a more personalised questionnaire, or educating players as to how information is used. Several real time fixes were proposed to assist with the implementation of the questionnaire outlined below. It is worth noting that these were designed to be quick, short-term assessments and action rather than detailed observation and evaluation which takes place in the next phase.

5.5.1 Factors Influencing Implementation

Education was delivered to promote a positive monitoring culture, and this included the explanation that wellness monitoring was geared around the preparation of players, that it was individual specific and data would remain private between the player and sports science team. It was clarified that all data was stored securely through a password protected system and that the data would not be used to make performance decisions such as team selection or contract negotiations. It was explained that players should report truthfully and honestly so a profile of their response to training and gameplay could be analysed rather than promoting an alpha male environment were soreness was a sign of weakness. Each question and scale were explained to players. This included having precise operational definitions for each question area (Table 5.3). All players were in agreement that they understood the question and would complete consistently based on their perceptions on the given training day.

Factors associated with the measure (wellness questionnaire) were accounted for in the construction of the new wellness questionnaire. This included the use of a simple internet-based questionnaire system that players had been accustomed to for several seasons. In the development of the new questionnaire, accessibility and compatibility had been reviewed to ensure each player had access, that they knew their passwords to log in and could do so on their smartphone. Players were instructed that in the event of issues arising such as not having their phone or compatibility issues, a computer would be made available for completion of the wellness questionnaire.

No punishments would be used for incompletion of the wellness questionnaire, although players were not told this. Reminders would be used if players had not completed their wellness data before training, issued by the sports science team in person or by personal message on smartphone. If data had still not been submitted, then sports science staff would make an attempt to collect the data in person via pen and paper. This approach would be used sparingly and in these instances players reminded about the necessity to fill in the wellness questionnaire on their phones. If players failed to complete the questionnaire multiple times then a follow up chat would be issued by the head of sports science or director of performance to reiterate the educational messages of previous meetings, operational definitions and attempt to get the player on-board with consistent completion.

Feedback mechanisms were deemed important at this stage in order to resolve challenges with staff and player buy-in. It is important to feedback to players in order to educate and motivate them to complete the questionnaire but also to staff in order to communicate,

discuss and influence any changes that need to be made. Often with self-administered questionnaires there is nobody present to clarify the meaning of the questions (Schwarz, 2010). However, sports practitioners are in the unique situation were not only are the same questions asked daily but practitioners have direct access to the respondents. This provides an opportunity to improve the response accuracy and quality of obtained data by regular clarification and delivery of a standardised message across the team (Schober & Conrad, 2002). Staff buy-in is important to continually educate and remind players on why they are completing a wellness questionnaire. Three staff members were identified to play a role in reminding players to complete the questionnaire, explaining questions and giving feedback to players throughout the training day. Such program champions have been seen to play an integral role in advocating and supporting implementation within health programmes (Study 2; Durlak & DuPre, 2008). A weekly report template was designed and was produced to feedback to staff alongside training load and performance data. This would be discussed at a team meeting and acted as a method to create staff buy-in. Players would also be given individual feedback through follow-up conversations and group messages in team meetings. Offering feedback in a way that provides opportunities for further learning and skill development is recommended to improve quality implementation (Meyers et al., 2012). Therefore, the daily interactions from program champions with players in scheduled and unscheduled meetings planned to foster buy-in and guidance on accurate completion, by providing feedback tailored to recipients addressing planned objectives, such as how wellness data had been used (Torres-Ronda & Schelling, 2017).

5.6 Phase 4: Validation, Reliability and Evaluation of Outcomes

5.6.1 Construct, Concurrent and Convergent Validity

Once an appropriate pool of items had been determined for use it was necessary to assess if these items were measuring what they claimed to measure and could be implemented successfully. The construct validity measures the degree to which scores on the questionnaire relate to other measures (Tsang et al., 2017). This can be achieved by assessing the concurrent validity which is the association of a questionnaire with accepted standards (Tsang et al., 2017). However, for wellness queationnaires there are either no gold-standard measurements for individual items (e.g. muscle soreness) or the gold-standard measurement is too impractical for use (e.g. sleep quality and polysomnography). Even the use of existing questionnaires is somewhat problematic as customised versions have not been thoroughly validated whilst the longer-length questionnaires, which have been validated, actually investigate other related constructs rather than wellness. Therefore, wellness results were assessed by a practitioner assessment using other common monitoring methods. For example, muscle soreness was assessed by a rehab practitioner assessment, sleep quality with wearable sleep monitoring watches (Readiband), fatigue with training load and periodised training plans, nutrition ratings with food diaries, a selection of mood scores by the sports psychologist. All questions showed a high level of face validity and players and practitioners commented that they preferred the new questionnaire over previously used measures. In cases were practitioners were unsure whether athletes had responded appropriately, education was provided by explaining the question and scale of the wellness questionnaire.

The ultimate aim of a wellness questionnaire is to assess the '*physical, mental and/or social dimensions which allow an individual to cope with sporting demands, life circumstances and achieve an optimal state of being'*. The focus is thus to quantify the response to training and/or how ready an athlete is to perform. Therefore, an overall wellness score should be at least moderately correlated (>0.3) with performance in subsequent training sessions. In order to test this hypothesis, wellness data from three weeks of the season was correlated against coach-rated performance scores in an assessment of convergent validity. As detailed in the procedures, coaches rated the performance of individual players after each training session or game. The coach performance scores were graded between 1-10 following familiar methods used in player performance profiling. Wellness scores were summated using the 8 questions on the 1-10 scale. Overall, a Pearson's correlation coefficient indicated that there was a significant positive relationship between wellness and coach rated performance, $r(23)= 0.74$ $p< .001$. Of course, in reality there are many contextual factors which determine the performance, but this assessment acts as a satisfactory proxy that the wellness questionnaire is a valid instrument to quantify training readiness.

It was important to assess the degree to which the selected questions converged on wellness and determine whether any items should be omitted. A Pearson's product-moment correlation was used to assess the relationship between overall wellness and each individual item on the questionnaire. Each question item showed a strong correlation (>0.59) with wellness apart from self-reported weight which showed no correlation (Table 5.4). Of course, this is due to weight remaining relatively stable across the study period whilst the other items fluctuated throughout days of the week. Whilst weight may

be important to monitor it offered a limited insight from a wellness point of view, at least in the short term within rugby league athletes. Therefore, it was removed from the questionnaire and collected separately.

5.6.2 Internal Consistency

A test for internal consistency was used to assess whether the selected questions were consistent in measuring the construct of wellness. An overall wellness score was determined by summing all values which used the 1-10 scale (i.e. all values apart from sleep hours). The 8 items that were summed to give an overall wellness score had a high level of internal consistency, as determined by a Cronbach's alpha of 0.84. It has been recommended that a Cronbach's alpha of at least 0.70 is achieved to signify adequate internal consistency (Nunnally, 1978). If the result of the reliability of the test is greater than 0.90 this could indicate that there are too many questions asking the same thing in different ways (Streiner, 2003). Clearly, the results for the new wellness questionnaire were between these two values and thus all questions were deemed appropriate intercorrelated indicators for overall wellness.

Table 5.4 Correlation of wellness items

	Wellness	Hours Sleep	Sleep Quality	LB Soreness	UB Soreness	Motivation	NT-Stress	Fatigue	Mood	Nutrition	Weight
Sleep Hours	.543**	1	.677**	.352**	.356**	.377**	.238**	.378**	.222**	.347**	.070*
Sleep quality	.635**	.677**	1	.312**	.346**	.369**	.321**	.418**	.291**	.370**	-0.021
LB Soreness	.712**	.352**	.312**	1	.599**	.645**	.243**	.503**	.197**	.396**	-0.003
UB Soreness	.748**	.356**	.346**	.599**	1	.616**	.301**	.486**	.247**	.485**	-.134**
Motivation	.775**	.377**	.369**	.645**	.616**	1	.269**	.601**	.211**	.561**	-0.054
NT-Stress	.631**	.238**	.321**	.243**	.301**	.269**	1	.508**	.751**	.148**	0.067
Fatigue	.782**	.378**	.418**	.503**	.486**	.601**	.508**	1	.476**	.352**	0.043
Mood	.593**	.222**	.291**	.197**	.247**	.211**	.751**	.476**	1	.164**	.080*
Nutrition	.634**	.347**	.370**	.396**	.485**	.561**	.148**	.352**	.164**	1	-.096**
Weight	-0.025	.070*	-0.021	-0.003	-.134**	-0.054	0.067	0.043	.080*	-.096**	1

**. Correlation is significant at p<0.01. *. Correlation is significant at P<0.05. N=833.

5.6.3 Evaluation of Outcomes

A final evaluation was conducted using the *Implementation Outcome* areas from study 1 and wellness implementation guidelines (Saw et al., 2016). This comparison is presented in Table 5.5. The comparison takes into consideration the details provided in Mclean and colleague's (2010) original published paper as well as the testing conducted as part of this study. In summary, the new wellness questionnaire met more guidelines for implementation than Mclean and colleagues (2010) questionnaire.

Table 5.5 Evaluation of the new questionnaire

	Mclean et al. (2010) Questionnaire	New Wellness Questionnaire for Rugby League
Number of Items	5	9
Scale	5-point	10-point
Scale Type	Likert	Semantic Differential
Theoretically derived?	Based on recommendations from Hooper and Mackinnon (1995) only.	Yes
Rationale for instrument selection	No	Yes
Questionnaire Wording	Not athlete specific and some complex language e.g. “insomnia”	Simple language tailored to rugby league players
Questionnaire implementation	Unknown	Developed through 4-phase development process
Range of response in study 3	Lower range	Greater range
Simplicity of completion	Simple questionnaire to complete. Unknown modality. Possibly via pen and paper which is time consuming but could be adapted for completion via internet-based system.	Simple internet-based questionnaire that allows for quick data collection and analysis.
Meaningful data	Difficult to analyse question items due to Likert scale.	Results in interval data.
Athletic outcomes	Sensitive to change	Sensitive to change
Education provided to players	Unknown	Yes
Stakeholder engagement	Unknown	Yes
Time frame	08:00-11:00	08:00-10:00
Valid	Unknown	Yes
Reliable	Unknown	Yes
Reference Values	No	Yes (Study 4)
Period of familiarisation	Unknown	Yes
Methods of reinforcement	Questionnaire handed to the athlete	Reminders
Compliance in study 3	81%	88%

5.7 Conclusions

The present study has reported on the development and initial validation of a new wellness questionnaire in rugby league. Evidence has been provided that suggests the content of the wellness questionnaire is valid and each question appropriately reflects the construct of wellness. The new wellness questionnaire is composed of more items than previous wellness questionnaires used in rugby league (Mclean et al., 2010) although there is overlap in some of the questions. These questions have been shown to have high internal consistency in the measurement of overall wellness. It is important to note that the new wellness questionnaire was developed with implementation guidelines (Saw et al., 2016) and through consultation with players and staff in a high-performance rugby league team. Whilst every effort has been made to account for a valid measure and factors influencing implementation, this is ultimately an ongoing process that must be managed in the future use of the questionnaire (Newton & Shaw, 2013).

Validity can be described as the single evaluative judgement of the adequacy of the wellness questionnaire (Newton & Shaw, 2013). Ultimately it is not an all or none construct but a matter of degree and therefore the new questionnaire could have greater validity within some environments than others (Hughes, 2018). This study has comprehensively documented the process of constructing and developing a wellness questionnaire in much more detail than any wellness questionnaire used within published research. It has established the appropriateness of the new questionnaire to measure wellness in the rugby league environment under investigation.

5.8 Synopsis

For a self-report measure to be highly regarded and accepted by the academic community it must document the development of the measure and psychometric properties (Saw et al., 2016). Furthermore, for wellness questionnaires to inform practical decisions it is important that data collection is accurate (Duignan et al., 2019b), valid and reliable (Saw et al., 2016). However, it is evident that in both research (McLean et al., 2010) and practice (study 1) there is a reliance on non-validated customised wellness questionnaires. Furthermore, study 2 identified that there are many factors to influence the implementation of a wellness questionnaire in rugby league, yet there is often no record of consideration of these when developing a wellness questionnaire in research or applied practice. This study follows recommendations of previously validated questionnaires (Kölling et al., 2015; Laurent et al., 2011; Lundqvist and Kenttä, 2010; Raedeke & Smith, 2001; Rushall, 1990), guidelines on implementation (Meyers et al., 2014) and developing questionnaires (Tsang, Royse, & Terkawi, 2017) to generate a new valid and reliable wellness questionnaire. Through a four-phase development process the wellness questionnaire was shown to have high levels of face validity, construct validity, reliability and consideration for implementation within a rugby league context.

Practical applications of this study are twofold. Firstly, previous wellness questionnaires in rugby league research have not been validated or developed with consideration for implementation. The majority of studies have used or adapted the measure used by McLean and colleagues (2010) which was shown to have limitations. It is time to move away from these unvalidated questionnaires and the current wellness questionnaire developed within this study acts as a robust and psychometrically documented measure

for use in rugby league. Secondly, the four-phase development process used within this study acts as a template for other practitioners to validate and develop their own wellness measures within their team.

The primary limitation to be aware of with this research is that there are a number of other validation methodologies that could be proposed including association with training load, correlation with measures of fatigue and other stress/recovery questionnaires. There are several challenges to validation of this nature such as identifying other gold standards of measuring wellness dimensions. Ultimately, psychometric documentation can evolve as the questionnaire is refined through further validation and reliability studies with rugby league populations (Saw et al., 2016). Indeed, this is evident with other similar questionnaires such as the RESTQ-Sport (Tibbert et al., 2009). The items used in the current questionnaire had been chosen by rugby league players, staff and experts in monitoring, and confirmed by practitioners in study 1. It was important to take this practical approach as recent developments in monitoring have originated from experts in the field. In the future, factor analysis to reduce dimensionality and confirm the questions needed within rugby league contexts would be beneficial. Furthermore, the testing of this questionnaire in other populations will confirm the suitability of this questionnaire to other contexts. Crucially, future investigations need to identify normative wellness values for rugby league populations and determine further aspects of using the wellness questionnaire in practice.

The next step within the thesis is therefore to asses using this wellness questionnaire in practice and to generate normative values for rugby league populations. This includes

determining when is best to collect wellness data during in-season training weeks, how data can be analysed and interpreted across the team and individual players. This will result in a validated questionnaire informed by research and practice with appropriate guidelines for use and implementation in rugby league.

CHAPTER 6

Study 4: Monitoring individual and team wellness in rugby league through the use of a new wellness questionnaire

6.1 Introduction

The previous study developed and validated a new wellness questionnaire to be used in rugby league. This included taking into consideration the factors which may influence the implementation of the questionnaire explored in studies 1 and 2. Consideration should now be given to the utilisation of the new questionnaire. In particular, there are currently no normative values for wellness questionnaires in players who participate in rugby league and neither are there clear guidelines for monitoring the wellness response of individuals in addition to the team as a whole. This final case study addresses these issues as well as investigating when wellness data should be collected, how information can be interpreted and visualised to inform practitioner decisions.

Much of the wellness data collected by practitioners remains unpublished particularly at competitive phases of the season. Of the data that has been published the majority is from acute phases of the rugby league season (Fowler et al., 2016; McLean et al., 2010; Twist et al., 2012), non-elite levels of performance (Johnston et al., 2013b; Sawczuk et al., 2018) and other sports such as AFL (Gallo et al., 2017; Gastin et al., 2013) and soccer (Abbott, Brownlee, Harper, Naughton, & Clifford, 2018; Malone et al., 2017; Watson, Brickson, Brooks, & Dunn, 2017). Raw wellness values are often hidden within the analysis, for example by use of z-scores, and therefore no normative values can be linked back to questionnaire use in rugby league. Different stages of the season pose different challenges for practitioners and there is a distinctive lack of an insight into the wellness response throughout play-offs or leading up to the Grand Final. Moreover, questions remain regarding the use of the wellness questionnaire in rugby league. In particular, identifying when data should be collected to obtain sufficient information to make decisions and

encourage routine compliance. Players in study 2 claimed they were not averse to completing the questionnaire every day, but it is unknown as to how feasible this is. Furthermore, once data has been collected there is no consensus on how this can be interpreted and visualised to inform decisions.

High-performance sports teams have long been leaders in collecting and storing performance and training data (Sands et al., 2016). Sands and colleagues (2016) state that such data should have the ultimate goal of answering the question "If the competition were today, how would the athlete perform?". It is an important question but one in which it is often difficult to give a definitive answer. One of the greatest challenges with self-reported wellness data is said to be determining what constitutes an important change (Coutts & Cormack, 2014). The usefulness of a measure is associated to its ability to distinguish between normal fluctuations and those that show a meaningful change and require action (Study 1; Saw et al., 2018). Very small changes in wellness data might be a relevant indicator that impacts performance. In regard to the analysis of wellness data it is a fine balance between statistical rigour and the realities of monitoring in the applied world. Best practice is likely to follow an evidence-based approach using the latest research alongside coaching expertise (Ward et al., 2018). A number of considerations have previously been reviewed in regard to decision support flagging systems (Robertson et al., 2017). However, many of the proposed analysis techniques chosen by practitioners in order to interpret their wellness data remain at a basic level, with 70% of the participants in study 1 simply observing changes. Only 22-34% incorporated smallest worthwhile change, z-scores and standard deviations. This could be due to the unfamiliarity of analysing ordinal self-report data that exist on different scales, as the

majority of other athlete monitoring data points are continuous variables. Nevertheless, analysis, visualisation and interpretation of wellness data is an area that warrants attention.

In addition, research papers and commentaries have highlighted the importance of monitoring the individual within the team (Ward et al., 2018). Rugby league teams often feature a mixture of players from the UK, France, Australia, New Zealand, Fiji, Papua New Guinea, Samoa and other countries. These individuals come with a unique make up of psychological and physiological features. Allied to this is their individual ability to tolerate load and their perceptions of how they are feeling. This information is valuable to practitioners in order to attempt to individualise the training programme. However, there is limited documentation of monitoring individual wellness within rugby league. Signs and symptoms of fatigued and overtrained athletes are individual (Meeusen et al., 2013). Therefore, it is important to consider how to identify individuals at risk and in need of practitioner support.

6.1.1 Aims and Objectives

The aim of this study was to investigate the utilisation of a wellness questionnaire including the monitoring, analysis and interpretation of wellness data during a 10-week period of the rugby league season. In order to achieve this aim there were four main objectives:

a) To describe the typical measurements and responses observed from monitoring the wellness of elite rugby league players during the Super 8s phase of the European Super League.

b) To establish what constitutes best practice around using wellness questionnaires in rugby league environments by documenting team wellness across different training days. This data will help to inform when and how often to use wellness questionnaires. It is hypothesised that there will be low variation in wellness response post-game and that it will fluctuate as players recover at different rates throughout the week, returning to low variation on matchday.

c) To investigate individual differences in wellness data and how a practitioner might analyse, interpret and visualise this data. It is expected that there will be large variation between individuals as is common with other self-report measures such as RPE (Robertson et al., 2016).

d) To comment on individualised analysis and visualisation techniques best suited to monitor wellness of rugby league teams and players during the competitive season.

6.2 Methods

6.2.1 Participants

Twenty-eight elite level professional rugby league players participated in this study (mean ± standard deviation; Age 26.14 ± 3.95 years , Mass 95.63 ± 8.55 kg, Stature 183.57 ± 5.56 centimetres). All participants volunteered from one European Super League team and were full time professional athletes who were given a full briefing of the requirements of this study. All players and the team consented to the use of the wellness and performance data for this research and the University of Central Lancashire gave ethical approval for the following analysis (BuSH 168).

6.2.2 Design

This study analysed daily wellness, rating of perceived exertion (RPE) and training load data during the Super 8s competition phase of the European Super League. Specifically, this consisted of a 10-week period including 9 competitive games, 26 rugby training sessions, 20 weights sessions and 28 video sessions. 2 games were lost and 7 games were won, including a winning streak of 5 consecutive games as the team won the ESL Grand Final. Players completed recovery training sessions and strategies throughout this period which were in part informed by the use of the wellness data. The turn-around between competitive games ranged from 7 (6 occasions), 8 days (2 occasions) and 13 days (1 occasion).

6.2.2.1 Questionnaire Design

A new customised questionnaire was created, developed and validated in study 3 (Table 5.2). Questions were designed to assess players perceptions with the view to monitor the response to training and gameplay. All questions were framed in a neutral or positive way and included 9 items assessing lower and upper body muscle soreness, sleep quantity (hours), sleep quality, motivation, non-training stress, fatigue, mood and nutrition. Operational definitions for these questions were provided to players and described in an educational meeting to clarify the aims of the wellness questionnaire (Table 5.3). The questionnaire featured a semantic differential scale consisting of words players would typical use to describe their perceptions placed at the ends of a numbered 1-10 scale. An overall wellness score was determined by summing all values which used the 1-10 scale (i.e. all values apart from sleep hours). The 8 items that were summed to give an overall

wellness score had a been shown to have a high level of internal consistency, as determined by a Cronbach's alpha of 0.837.

6.2.3 Data Collection

Data collection was implemented as part of the team's regular preparations. Throughout the study period parts of the data collected were used to inform decisions. To account for this a diary documented any contextual information relevant to the analysis of data within this research.

6.2.3.1 Self-Reported Wellness

Players were asked to complete the wellness questionnaire every morning for a period of 68 days. On training days it was requested that players complete the questionnaire before any training took place (approximately 08:00-10:00). Players did this via an online website accessed through smartphones which had been designed for ease of use and quick completion (The Sports Office, Wigan). Questions were answered by selecting a response along a sliding scale for each question. If players failed to complete the questionnaire then practitioners would offer reminders in person and via team communication messages on non-training days. Players were prompted on the importance of an honest completion and the details of each question were explained prior to the study commencement in a group meeting. This included an explanation of what the data would be used for (i.e. to inform on training readiness but not on team selection).

Players were used to completing such questionnaires and had done so for the first half of the season. A difference was that players would complete the questionnaire every day.

Overall compliance was monitored throughout this period resulting in 71% ± 12% completion. This was calculated by averaging the daily compliance for each training day (Table 6.2). Players only completed the wellness questionnaire if they were fit and available to play in upcoming games. Whilst this number changed weekly it was deemed that a full compliance of 100% would need at least 17 individual player entries for any day ≥ Matchday+3 and 13 individual player entries for Matchday, Matchday+1 and +2. This equated to approximately 75% of the team on each training day.

Table 6.1 Questionnaire compliance percentage

Training Day	Compliance %
MD+1	77%
MD+2	59%
MD+3	74%
MD+4	88%
MD+5	59%
MD+6	82%
MD	50%

6.2.3.2 Internal Training Load

Players completed a rating of perceived exertion assessment by answering how physically demanding they perceived rugby training, weights sessions and gameplay to be on a scale from 0 (rest) - 10 (maximal) following previously used guidelines and scales (Foster et al., 1995; Impellizzeri et al., 2004). Throughout training sessions the collection of this information took place between 10-30 minutes after each session (weights or rugby). Due to post-game commitments players recorded their game RPE at Matchday+1 before recovery sessions. All RPE scores were multiplied by session duration (minutes) to give the session rating of perceived exertion training load (s-RPE) (Foster et al., 1995). All

players had been familiarised with these protocols for several months preceding the investigation.

6.2.3.3 External Training Load

Details of training days were recorded including the amount of time (minutes) each player spent completing each training session (weights, rugby and video). During rugby training and games players wore commercially available Global Positioning System (GPS) Devices (Viper Pod, STATSports, Co. Down, N. Ireland). GPS units were worn in a specialist mini pouch inside training vests or playing jerseys. These pouches were padded, and located in the upper centre area of the back, approximately at the level of the first thoracic vertebrae (McLellan & Lovell, 2013). The devices captured GPS data at a sample frequency of 10 Hertz (Hz) allied to a 100Hz triaxial accelerometer and gyroscope. There were no contraindications to wearing these devices in games or training and players had become accustomed to wearing them for several seasons. GPS devices have been previously used to determine in game and training session characteristics of elite rugby league players in the European Super League (Black, Till, O'Hara, Davidson, & Jones, 2017; Evans et al., 2015; Evans et al., 2018; Twist et al., 2014; Waldron et al., 2011; Weaving et al., 2017). GPS devices sampling at 10Hz have been shown to be the most valid and reliable units to date (Scott et al., 2016) and have improved validity and reliability than earlier lower sampling devices (Jennings et al., 2010; Varley, Fairweather, & Aughey, 2012). As suggested by Bourdon et al. (2017), each player was allocated an individual GPS unit to use throughout the study period in order to minimise inter-unit variability. GPS devices had previously been used at all facilities prior to the commencement of the study and it was determined that a satellite signal could be acquired

at each venue. All devices were activated prior to each training session and game, in accordance with the manufacturer's guidelines, to give enough time for satellite signal acquisition to occur. For the purpose of this study, Total Distance (Metres), High Speed Running Distance (HSR) >5 $m.s^{-1}$ and HSR per minute of training/gameplay were used from the collected GPS data to give indication on the volume and intensity.

In addition to GPS data, the amount of tackles completed by both teams were recorded to give an overview of the amount of collisions experienced during gameplay. All data were collected by an independent analysis company (Opta, Leeds) whose typical client system of coding has been shown to be reliable when used with trained operators (Liu, Hopkins, Gomez, Molinuevo, 2013).

6.2.4 Data Analysis

All collected data were either downloaded or imported to Microsoft Excel (Microsoft Corporation, Washington, USA). Post-training and gameplay all GPS data was downloaded using manufacturers software (Viper PSA, STATSports Co. Down, N. Ireland) and again collated with other data in Excel. Each training day was coded in relation to the Matchday + the amount of days post-game, through to the following game. Only training days up to 6 days post-game were included within the analysis. The mean/median ± standard deviation for self-reported wellness was calculated for each of the training days and weekly periods. In addition, the mean ± standard deviation for internal and external training load was calculated for each week of the Super 8s competition. Individual self-reported wellness mean ± standard deviation was calculated for Matchday+1, Matchday+4 and Matchday+6.

The minimal detectable change (1.96 x standard error of measurement x square root of 2) and Z-Scores were calculated for team and individual data. A z-score conveys a data point as the number of standard deviations (SD) away from the mean. To demonstrate how z-scores can be modified (Coutts & Cormack, 2014) to account for the individual and team baseline values the following formulas were used:

Team z-score = (Data Point – 10-week group mean) / 10-week group standard deviation

Individual z-score = (Data Point – 10-week individual Matchday+ mean) / 10-week individual Matchday+ standard deviation

Normal distribution tests, a one-way analysis of variance with post hoc tests, a hierarchical multiple regression, Pearson's correlation coefficient, and an independent samples Kruskal-Wallis test were all completed using SPSS version 25 (SPSS Inc, Chicago, USA).

6.3 Results

6.3.1 Wellness Across Different In-Season Training Days

Data across the 10-week period revealed that the lowest average team wellness was recorded at MD+1 (43.99 ± 8.53) and incrementally rose to the highest wellness on MD (61.42 ± 4.53). Similarly, the highest variation (standard deviation) was recorded at MD+1 and lowest at MD. A one-way analysis of variance was conducted to determine if any differences existed between the overall reported wellness on different days within the

training week. Wellness was normally distributed as determined by Shapiro-Wilk's test ($P < .05$) but there was heterogeneity of variances, as assessed by Levene's test of homogeneity of variances ($p < .0005$). Welch's ANOVA revealed a significant difference between wellness on different training days, Welch's $F(11, 127.591) = 28.498$, $P < .0005$, $p\eta^2 = 0.383$. Games-Howell post hoc tests revealed there was a significant difference in wellness post-game at MD+1 (M=43.99, SD= 8.53) to all other training days ($P \leq .0005$). Matchday to post-game saw the largest reduction in wellness score with a mean reduction of 17.44, 95% CI [13.65, 21.22]. Pre-game (MD+6) to post-game saw a similarly large reduction of 15.48, 95% CI [12.00,18.96]. The only values that did not show a significant difference to pregame wellness were matchdays ≥ +5. There was also no significant difference between wellness 1 day before a game and wellness results on the morning of the game. Graphs 6.1 and 6.2 visualises the change in mean wellness on different training days.

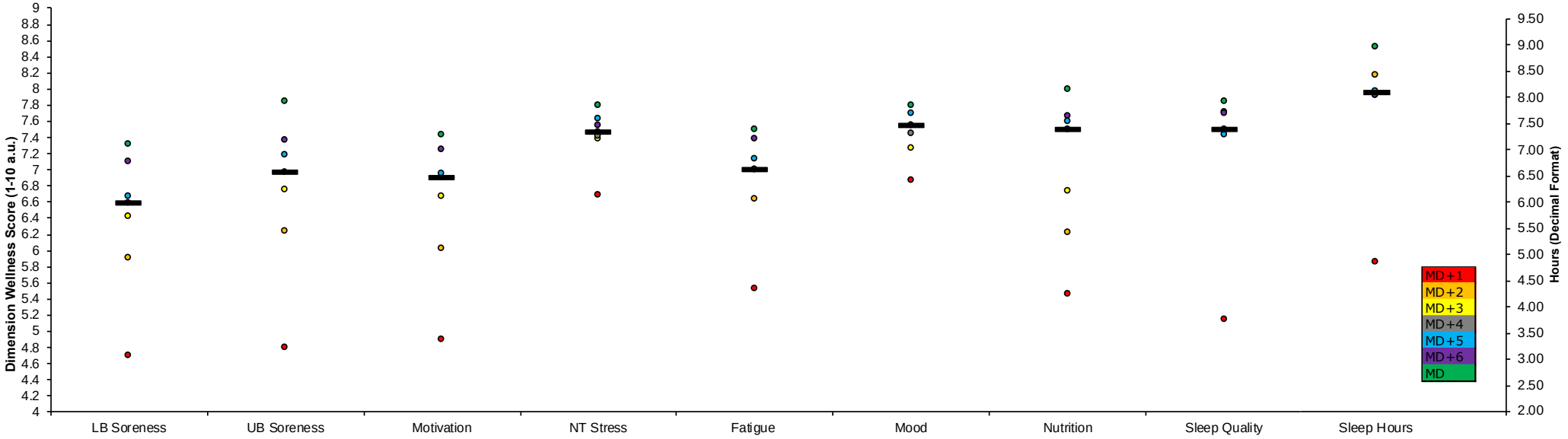
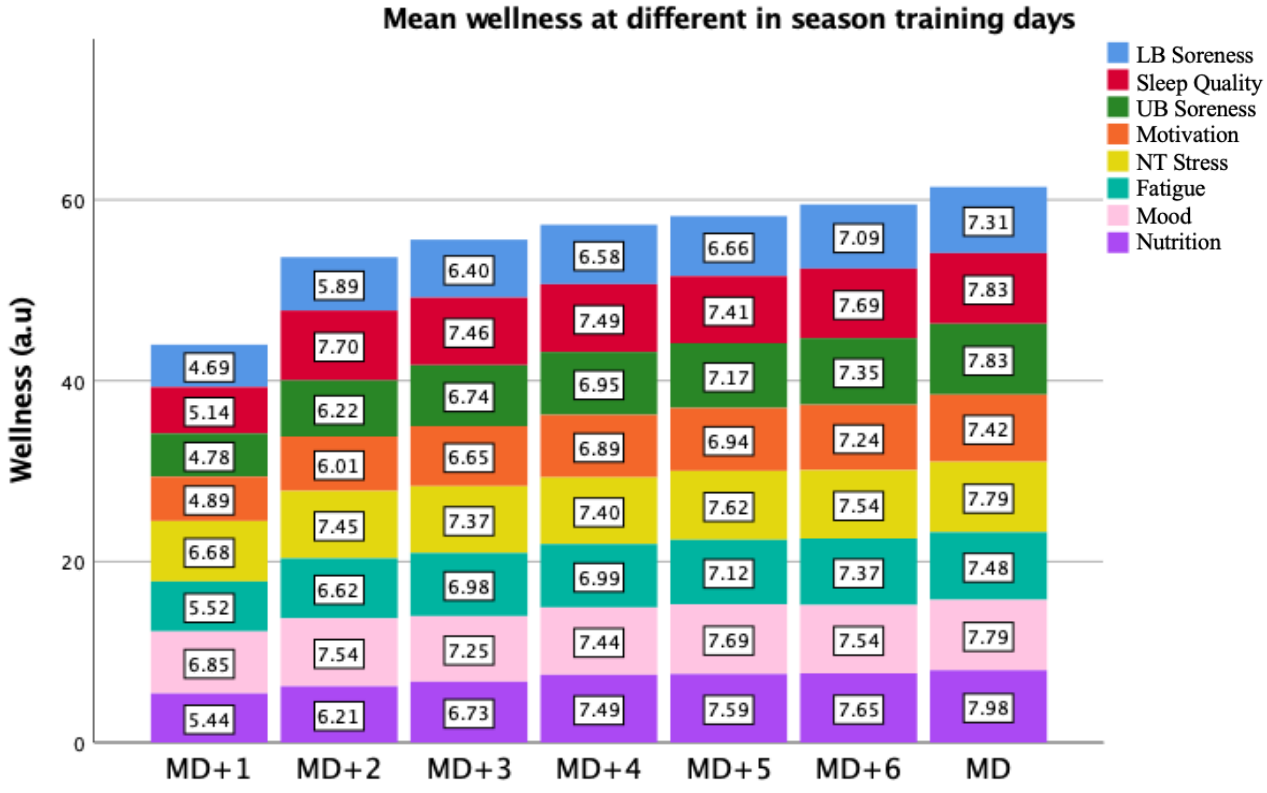


Figure 6.1. Average wellness item scores across a 10-week period for different training days
Coloured circles represent mean in-season training days from the key in the bottom right of the graph. Black line indicates median values.



Wellness	Mean	43.99*	53.64	55.58	57.24	58.2	59.47	61.42
	SD	8.53	6.81	6.46	4.93	5.11	5.15	4.53

Figure 6.2 Mean Wellness at different in-season training days.
**Significantly different to all other training days.*
No significant difference between MD+5 and MD+4; MD and MD+6

6.3.2. Wellness Across Each Training Week

Table 6.2 shows the wellness, training and game load over the course of the Super 8s (10 weeks). Table 6.3 shows the individual wellness items per week flagged using z-scores. When wellness data were analysed for normality by week the Shapiro-Wilk's test indicated a non-normal distribution. Further analysis of medians and standard deviations revealed players felt at their best in overall wellness at Week 5 (60.0 ± 4.6) and at their worst at Week 7 (56.5 ± 8.7). An independent samples Kruskal-Wallis H test revealed a significant difference (p= .022) in wellness between the weeks. Pairwise comparisons indicated these differences were all between week 5, and weeks 3 (P=0.47), 6 (P=0.015), 7 (p=0.008).

Training load (s-RPE) was at its highest at week 4 (1872) and lowest in week 8 (387). The highest game load (s-RPE) occurred in Week 5 (477) whilst the lowest game load was in Week 1 (362). Figure 6.3 illustrates the change in wellness allied to training load throughout the 10 weeks with data converted to z-scores for comparison to weekly average.

Table 6.2 Wellness and Training/Game Load

Week	Wellness (median)	Training sRPE	Video Analysis Time (mins)	Training Distance (m)	Training High Speed Running (m)	Game sRPE	Game Tackles (n)	Game High Speed Running (m)	Game Result
1	57	731	115	5172	398	362	525	453	W
2	58	793	99	6332	461	437	618	424	L
3	57*	1095	112	9011	636	421	682	354	W
4	57	1872	85	10096	735	-	-	-	-
5	60	900	92	7623	347	477	788	365	L
6	56.5*	951	145	8106	516	468	659	306	W
7	57*	660	127	5348	306	438	614	386	W
8	57	387	99	4454	296	402	542	414	W
9	57	655	100	6755	318	467	693	304	W
10	57	542	97	4653	244	-	-	-	W

**Significantly different to week 5. Note: No game at week 4. Conclusion of study period at end of training week 10. W=Won, L=Lost.*

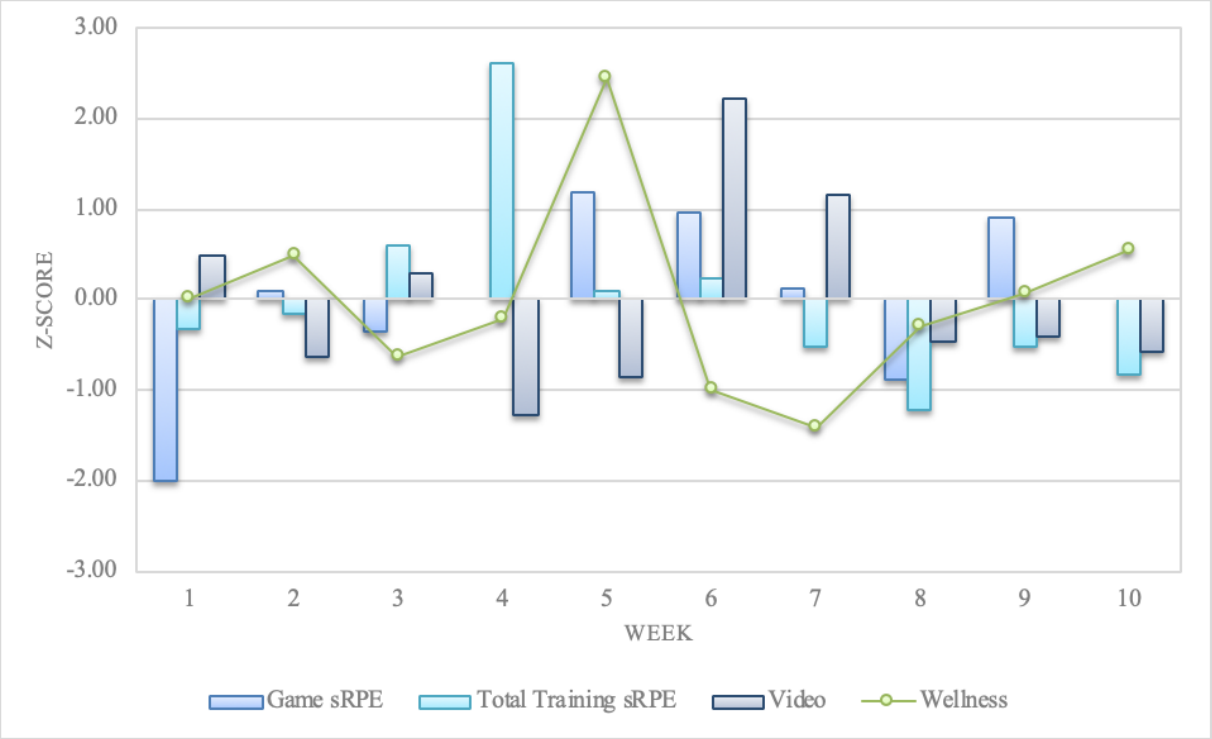


Figure 6.3 Wellness and training load Z-scores across the training weeks.

Table 6.3 Team average wellness items per week flagged using z-scores

Week	Sleep Hours	Sleep Quality	LB Soreness	UB Soreness	Motivation	NT Stress	Fatigue	Mood	Nutrition
1	8.14	7.39	6.70	6.94	6.77	7.26	6.94	7.37	7.23
2	7.81	7.32	6.70	6.92	6.79	7.62	7.11	7.59	7.21
3	7.92	7.44	6.33	6.86	6.57	7.29	6.94	7.30	7.02
4	7.93	7.37	6.38	6.86	6.63	7.61	6.96	7.51	6.99
5	8.22	7.68	7.11	7.54	7.21	7.78	7.35	7.70	7.52
6	7.78	7.25	6.49	6.82	6.61	7.05	6.80	7.10	7.12
7	7.59	7.27	5.83	6.48	6.52	7.51	6.74	7.51	6.82
8	7.76	7.41	6.45	6.70	6.68	7.34	7.06	7.35	7.23
9	7.69	7.32	6.60	6.79	6.79	7.40	7.13	7.44	7.23
10	7.71	7.16	6.80	6.91	6.85	7.61	6.93	7.70	7.38

Note: negative z-score equates to poorer wellness; Positive z-score equates to a recovered profile of wellness.

	≥ 1.5 z-score
	≥ 2 z-score
	≤ -1.5 z-score
	≤ -2 z-score

Pearson's correlation coefficients showed a negative relationship between wellness at MD+1 and all values apart from high speed running. However, only one of these was significant and that was a strong negative relationship between wellness and number of tackles $r(6) = 0.80$ p= 0.17. A hierarchical multiple regression was run to determine if the addition of the variables in table 6.2 (Tackles, High Speed Running, Game sRPE and Distance Total) could be associated with Wellness at MD+1. The best model to predict wellness at MD+1 was using Tackles and High-Speed Running. The multiple regression model statistically significantly predicted Wellness at MD+1, $F(2, 5) = 17.760$, p = .005, adj. R_2 = .83. Both variables added statistically significantly to the prediction, p < .05. Regression coefficients and standard errors for the intercept were (B=105.19, SE =12.49); for tackles (B = -0.065, SE= 0.011); and for High Speed Running were (B= -0.054, SE = 0.017).

6.3.3 Analysis of Individual Player Wellness Data

Figures 6.4-6.6 shows a scatter plot of the mean and standard deviations for individual players evidencing a large within and between individual variation in wellness data across the different training days. Appendix C shows the individual mean wellness, standard deviation and standard error of measurement for each player across MD+4, MD+6 and MD+1. It also shows the flagging system values used to calculate the individualised minimal detectable change, z-score of 1.5 and z-score of 2 for each player. Using this individualised flagging system, the minimal detectable change identified the most values (104) followed by Z-score ± 1.5 (54) and Z-score ± 2 (13) across MD+4, MD+6 and MD+1. Within the analysis several case study examples were highlighted through the use of this flagging system which are presented and discussed within the Discussion section.

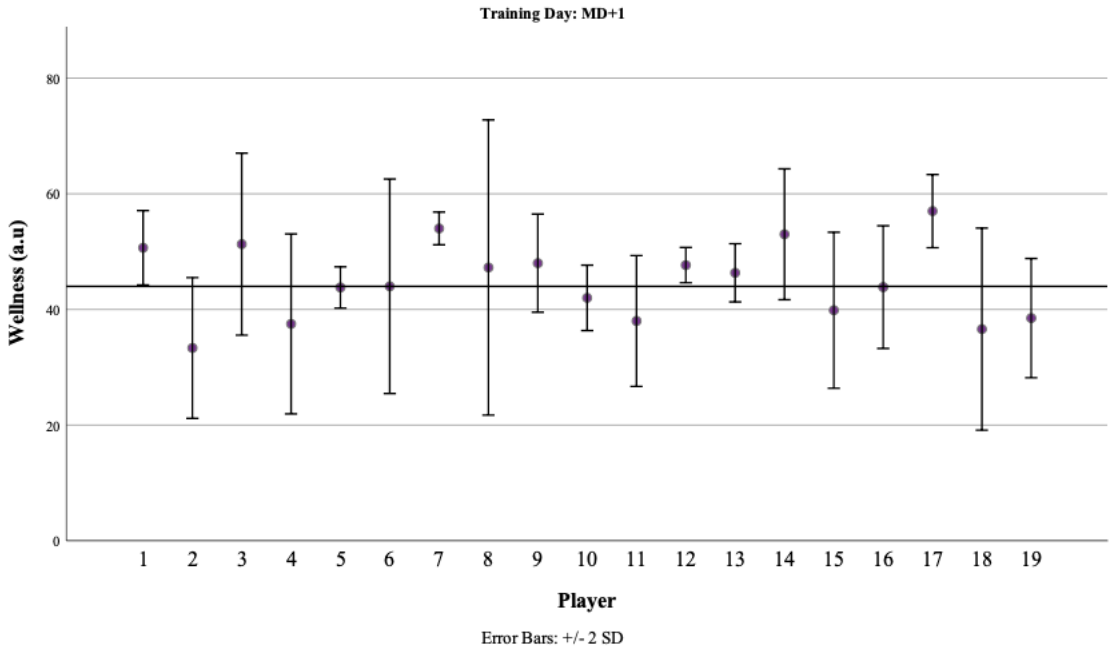


Figure 6.4 *Individual Wellness at Matchday+1*

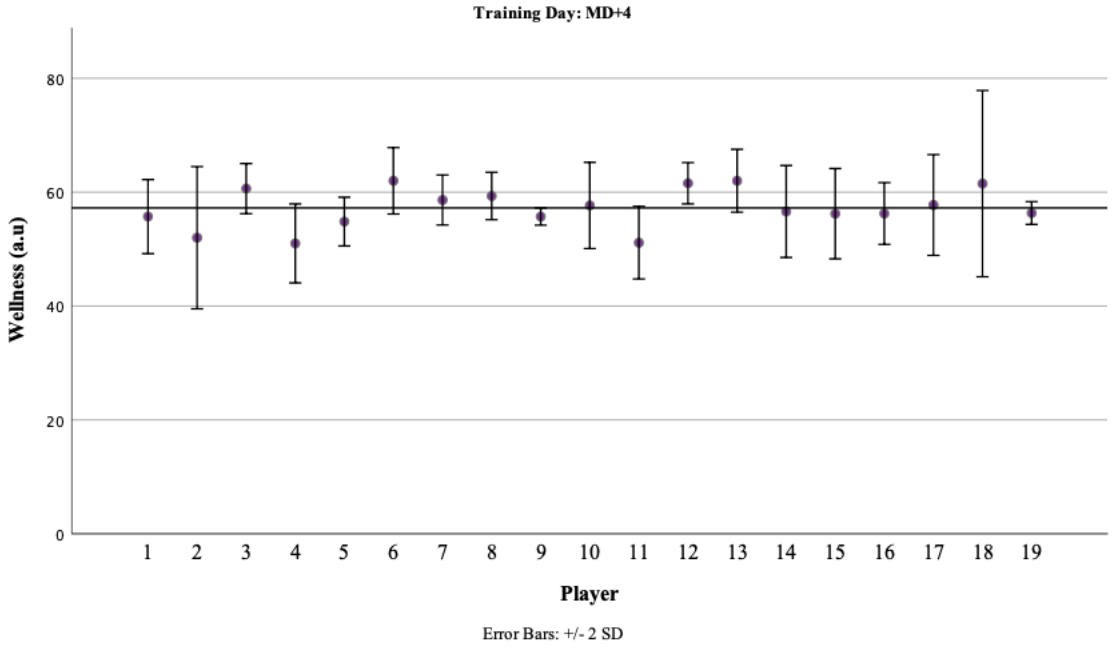


Figure 6.5 *Individual Wellness at Matchday+4*

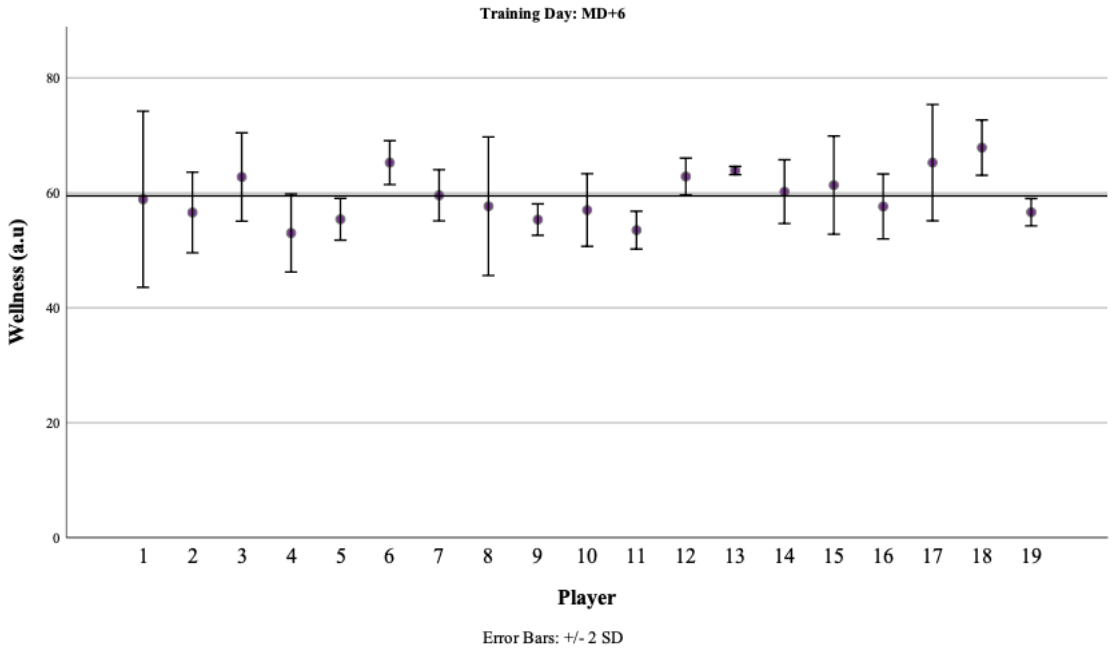


Figure 6.6 *Individual Wellness at Matchday+6*

Table 6.4 Number of athletes flagged as a notable change in wellness

Training Day	Minimal Detectable Change	Z-Score ±1.5	Z-Score ±2
MD+4	46	24	6
MD+6	47	21	7
MD+1	16	9	0
Total	109	54	13

6.4 Discussion

6.4.1 Wellness Across Different In-Season Training Days

One of the aims of this study was to describe the typical measurements and responses observed from monitoring the wellness of elite rugby league players during the Super 8s phase of the European Super League. The typical weekly trend was for wellness values to be significantly reduced post-game (MD+1) and gradually improve throughout the week until their highest values at game day (MD). The largest load and most demanding physical activity within the week was match-day and therefore it would be expected that the greatest decrements in wellness fall at MD+1. This reduction and subsequent improvement is in agreement with previous investigations using wellness measures in rugby league (McLean et al., 2010; Twist et al., 2012). The only day not to show a significant difference to Pre-game (MD+6) wellness were days ≥ MD+5. This indicates that it takes at least 4 days post-game for wellness values to return to optimal levels, which is again consistent with previous findings (McLean et al., 2010).

All individual questions were reduced immediately after the game at MD+1. Within the wellness questions post-game values showed an increase in muscle soreness, reduction in sleep quantity and quality, reduced mood, increased stress, and poorer nutrition. This reduction was particularly evident for the number of hours sleep players achieved with an average decrease of approximately 4 hours for players who participated in the game. Night-time competition has been previously shown to shift sleep-wake patterns in elite athletes, including rugby league players, resulting in reduced quantity and quality of sleep (Caia et al., 2017; Fullagar et al., 2016; Shearer, Jones, Kilduff, & Cook, 2015). There are a number of possible explanations which have been proposed to explain this

phenomenon including a later bedtime on match-days (Fullagar et al., 2016), which could be extended due to travel in some games; increased exposure to light (Malone, 2011); post-match demands and obligations (e.g. media interviews) and scheduling meaning players are late to bed and then must wake early for recovery sessions (Caia et al., 2017). These findings highlight the need for practitioners to be conscious of such a reduction in rugby league players sleep, particularly during late night kick-offs. Players in this study combatted this reduction by increasing the number of hours sleep the night before the game and the following night after the game. This is consistent with previous findings in rugby league (Caia et al., 2017) and rugby union (Shearer et al., 2015). An increase in the number of naps on non-training days may also have facilitated recovery from sleep reduction, however, this study did not document the amount of naps. Interestingly, the average sleep recorded throughout this stage of the competitive season (7.8 hours per week) was higher than previously reported values for rugby league players (6.9 hours) (Caia et al., 2017). The present results could reflect the overestimation in self-reported sleep versus those of activity monitors (Caia et al., 2017). Or it could be that the data collected within this study across 68 days and 28 individual players is more reflective of sleep in rugby league players than previous investigations which assessed 7 players over 7 days of the competitive season (Caia et al., 2017).

One of the biggest challenges with using wellness questionnaires is the burden placed on the athletes to complete it regularly (Saw et al., 2015a). In this study the players were asked to complete the questionnaire on a daily basis regardless of whether the team were training or having a rest day. Overall compliance was respectable (71%) in comparison to other research which has shown levels to range between 8-84%, dependant on support

to complete the questionnaire (Saw et al., 2015a). There were no adverse effects to performance in completing the questionnaire on a daily basis. Furthermore, no erroneous values or outliers were found to suggest players were not taking completion seriously. Therefore, at important times within the competition, such as the Super 8s or play offs, it may be beneficial to use a daily questionnaire to monitor athletes and provide focus around the overall team goals such as individual preparations to be ready to train/play. However, there were challenges to daily completion with staff having to issue regular reminders to complete the questionnaire and lower compliance on days away from the training ground. Players were unaccustomed to completing the questionnaire on matchdays and staff issued fewer prompts as players were left to prepare for the game, this was reflected in the lowest completion rate out of all training days. With this in mind, analysis of the data revealed that there was no significant difference between pre-game wellness (MD+6) and matchday wellness. This raises the question if both of these sets of data are needed and it would make practical sense to remove the matchday questionnaire as the data can realistically only be used to compare with post-game data rather than intervene in preparations for the game. Pre-game (MD+6) to post-game wellness (MD+1) saw a similar large reduction to the matchday data and this would be suitable to use instead. Likewise, there was no significant difference at MD+5. Under the current team scheduling MD+5 was usually on the players' day off from training. Given the results that there was no significant change in wellness compared to the next day at MD+6 (pre-game) and the challenges of getting players to complete the wellness away from the training ground, it may be worthwhile to remove the questionnaire on this day too. Such changes would be beneficial in removing some of the burden and monotonous nature of completing the questionnaire every day and consistent with player preferences (Study 2).

Reminders were fundamental to ensure certain players completed the questionnaire and strategies to improve completion warrant further investigation.

No study has explored the variation in wellness data across the different training days in high-performance rugby league. Analysis of the variation in wellness data is important to establish the usual fluctuation within the training days. In sports science performance testing a high variation is associated with a high level of "noise" and difficulty in establishing worthwhile change (Hopkins, 2004). However, when using questionnaires a practitioner is trying to identify meaningful variation in the response to training and match-play. A low variation, or lack of despite changes in training demand, could indicate an absence of sensitivity in the questionnaire or a limited range of responses from individuals. This would make the questionnaire redundant as no useful information would be gained from the questionnaire completion – we would know that players would always respond in the same manner at the same time every week. This study identified that this was not the case as players responded with variation across each training day. It was hypothesised that post-game players would feel sore and consistently score low on the wellness scale resulting in low variation. However, MD+1 showed the largest variation between and within individuals across the training week. The high variation the day after the game indicates that it would be beneficial to collect wellness data on this day. There are large fluctuations in how players respond to game-play and therefore knowing how a player perceived their muscle soreness, mood and overall wellness provides practitioners with a starting point as to how much recovery will be needed and how the following training week should be structured. Of course, players may play different amount of minutes, be involved in a range of different game demands, sustain injuries, and be

involved in other events (e.g. poor performance) which could influence overall wellness. Attempting to account for all these variables can be challenging, particularly amongst teams with a small budget or low staffing numbers and resources. Therefore, a wellness score can give an overall insight into the different responses of players to rugby league match-play, placing the focus not on what has happened (e.g. distance run) but on how an athlete has reacted to the activity and what a practitioner now needs to do to make sure the player is ready to perform the following week.

6.4.2 Wellness Across Each Training Week

One of the benefits of this research was that the scheduling and turn around between games was very consistent throughout the study period. There was a minimum of 7 days between each game which allowed for comparisons to be made across the training weeks. Wellness at week 5 was at its highest value across the team and was significantly higher than weeks 3, 6 and 7. Week 5 followed a period of intense training but crucially no rugby fixture. The load experienced in games is the biggest contributor to player fatigue and decrement in wellness (McLean et al., 2010) and this was reflected within the wellness scores in this study. Analysis of game data revealed a negative relationship between load and wellness with the number of contacts and running demands being good indicators of wellness post-game. Whilst other variables didn't show statistically significant results there were often correlations, and such information could be worthwhile for practitioners to make sense of the physical demands of the game. In addition, it is important to consider other psychological and non-sport factors which could influence wellness (McGuigan, 2017). Weeks 7-8 were very important in ensuring the team finished in playoff positions, 9-10 were semi-final and grand-final training weeks. The results of games and stressors

during these weeks should be considered when interpreting results. For example, Mood and non-training stress were heightened the week following a poor defeat (Table 6.3). Sleep quality was slightly reduced (flagged via 1.5 z-score) at week 10 which could possibly indicate nervousness or excitement leading into the Grand Final.

Monitoring the training load and other data in conjunction with wellness is an important step to interpreting and informing decisions around the training process. This can be seen in weeks 8-10 (Figure 6.3) as training load is tapered in comparison with earlier weeks as wellness remains stable. There were many correlations between the different training load variables, however, only tackles showed a significantly strong negative correlation with wellness post-game. In an attempt to assist practitioners to understand the links between training load and wellness a hierarchical multiple regression showed that the number of tackles and high-speed running was a good indicator of wellness post-game. These two values make up some of the most demanding elements of game-play through collisions and high-speed play, lending further support to ensuring wellness questionnaires are interpreted alongside other data sets. Furthermore, the importance of monitoring other aspects of performance was highlighted as longer duration of video meetings were used to prepare players with coaching content at weeks 6 and 7. This encapsulates some of the off-field demands placed on players, following defeat and at an important time in the season. It is perhaps no surprise that following the high load of previous weeks (4-6) and greater expectation to perform (weeks 6-7) that wellness was at its lowest globally across the team.

6.4.3 Analysis of Individual Player Wellness Data

A critical question within athlete monitoring in rugby league is determining how best to analyse and interpret data of individual players. With the development of modern technologies and the assessment of players on a daily basis it has never been more feasible to monitor the individual player within the team. This is therefore a topic area that has received attention of late within academic journal articles as practitioners strive to develop their methodologies (Bartlett, O'Connor, Pitchford, Torres-Ronda, & Robertson, 2016; Gastin et al., 2013; Ward et al., 2018). Few studies, however, have focussed on the analysis of wellness data which presents unique challenges to other common data sets used. For example, as identified in this study, there is large within and between individual variation in the data due to the subjectivity of the specific wellness questions. This has previously been shown in other applied settings when using subjective scales such as RPE (Robertson et al., 2016). Furthermore, wellness poses challenges to data analysis and interpretation because it is often collected on a daily basis and uses Likert-type scales which have limitations for assessment using parametric or non-parametric tests (Sullivan & Artino, 2013). It would be beneficial for practitioners to use a questionnaire with a continuous scale as seen in the methods within this study which results in interval data rather than an ordinal scale. Researchers have also highlighted several future recommendations to develop the analysis of monitoring the individual within decision support systems (Robertson et al., 2016). With regard to monitoring individual wellness in rugby league, there are notably three key areas that apply that have yet to be comprehensively established. These are the robust selection and justification of wellness questions, the guidelines for flagging individual values in the decision support system, and the development of visualisation techniques to improve interpretation.

When collecting wellness data, the robust selection and justification of wellness questions is of utmost importance. There are many challenges to constructing a valid and reliable questionnaire and simply combining aspects of questionnaires can negate established psychometric properties (Saw et al., 2016). However, to be effective in applied settings the personal experience of practitioners and context specific customisation are aspects which typically inform practice as they are crucial to successful implementation and continued use (Study 1 and 2). In this research, the questionnaire was based on theory, previously validated and customised to help ensure daily use. Throughout the investigation the daily, weekly and individual variation in wellness highlighted that it was sensitive to change. Wellness questionnaires often use summated scores of several individual items and the new wellness questionnaire used in this study had a high internal consistency across the items, as assessed by Cronbach's Alpha. Unfortunately, previous investigations using customised wellness questionnaires rarely discuss the reliability of the questionnaire. Those that have, generally assess the coefficient of variation and find large percentages (7% - 25%) between different training days (Gastin et al., 2013; Montgomery & Hopkins, 2013; Roe et al., 2016). This is understandable because it is not realistic to control for all training and non-training factors during the season or pre-season (Roe et al., 2016) and ultimately the wellness questionnaire needs to be able to identify variation. The reliability of using a summated score based on several questions is important to consider as previous investigations have shown summated scores are more sensitive to measure performance changes than any individual wellness variables (Crowcroft et al., 2016). Individual wellness variables are important in their own right too and within particular sporting contexts may be useful to inform on the response to training, such as the relationship between muscle soreness and training load in college

football players (Govus et al., 2018). It is therefore useful for practitioners to observe the overall wellness value and then delve deeper into the individual questions if necessary. Indeed, separate players in this research showed different variation in overall wellness and individual wellness questions. For some, a lack of variation could make questions redundant and this should be carefully monitored. To this extent there is the potential to personalise the questionnaire, however, this should be balanced by the need to make comparisons across the team and retain the items which make up the overall wellness summated score.

In addition to identifying the questions, practitioners also need to decide on how the results will be flagged in order to identify significant values. There are a number of challenges to consider here, not least that the format in which the data are analysed impacts on the inferences that can be made (Robertson et al., 2016). With the high inter and intra individual variability in wellness data individualised flagging systems are needed to provide comparable information. One approach would be to use the raw value scores and calculate the individual change necessary to elicit a flagged response. The benefit of using the Minimal Detectable Change (MDC) is that it takes into account the standard error of measurement of the wellness questionnaire and determines the minimal amount of change in the wellness score within an individual needed to be sure change is not simply due to measurement error (Stokes, 2011; Stratford et al., 1996; Stratford & Goldsmith, 1997). From the results in this study the minimal detectable change was calculated for each individual and resulted in the highest number of flagged scores across the three days analysed. The downside of using raw values is that they are not directly comparable between players because of the subjective nature of the questionnaire and

there is limited scope for comparing between questions and other data sets. Therefore, an alternative approach that allows for historical, between and within team comparisons is the use of Z-scores (Mclean et al., 2010; Schmidt, Register-Mihalik, Mihalik, Kerr, & Guskiewicz, 2012). A further benefit is that graded levels of sensitivity can be set by adjusting the Z-score used within the flagging system (e.g. Z-Score of 1.0 or 2.0). This could be used to highlight data that needs immediate action (e.g. Z-score 2.0) and one that needs to be monitored throughout the next day's training (e.g. Z-score of 1.5). This approach is flexible to prevent the system from flagging too many or too few responses. Previous investigations in elite athletes have used z-score thresholds of 1.0 and 1.5 but the use of any of the z-scores thresholds remains arbitrary (Saw et al., 2018). Ultimately, wellness flags should be made relative to the stage of the season and relative to typical weekly profiles (Gallo et al., 2017) and as such the results of this study provide normative data for the Super 8's phase of the European Super League Season. However, practitioners should establish their own individual wellness parameters and flagging systems within their own teams.

The additional benefit with the use of Z-scores and standard deviations lies in the ease of their visualisation. This is an important consideration in making sure data is interpreted, presented and communicated to coaching staff (Buchheit, 2017). Wellness data is perfectly suited to be plotted on a Statistical Process Control (SPC) charts to quickly interpret individual trends. The data on a SPC chart is plotted with respect to control limits which can be adjusted to represent the standard deviation above and below the mean. Upper and lower control limit lines can be set to flag any values that warrant further investigation. It may be beneficial to use data across a stage of the season or rolling

averages to calculate means and standard deviations (Ward et al., 2018). In the example within this research below, data is from the full Super 8's period.

Figure 6.7 Statistical Process Control Chart 1
Displaying individual wellness variables across the study period. Yellow lines = ≥ 2 standard deviations (SD) from mean. Red indicate ≥ 2SD threshold.

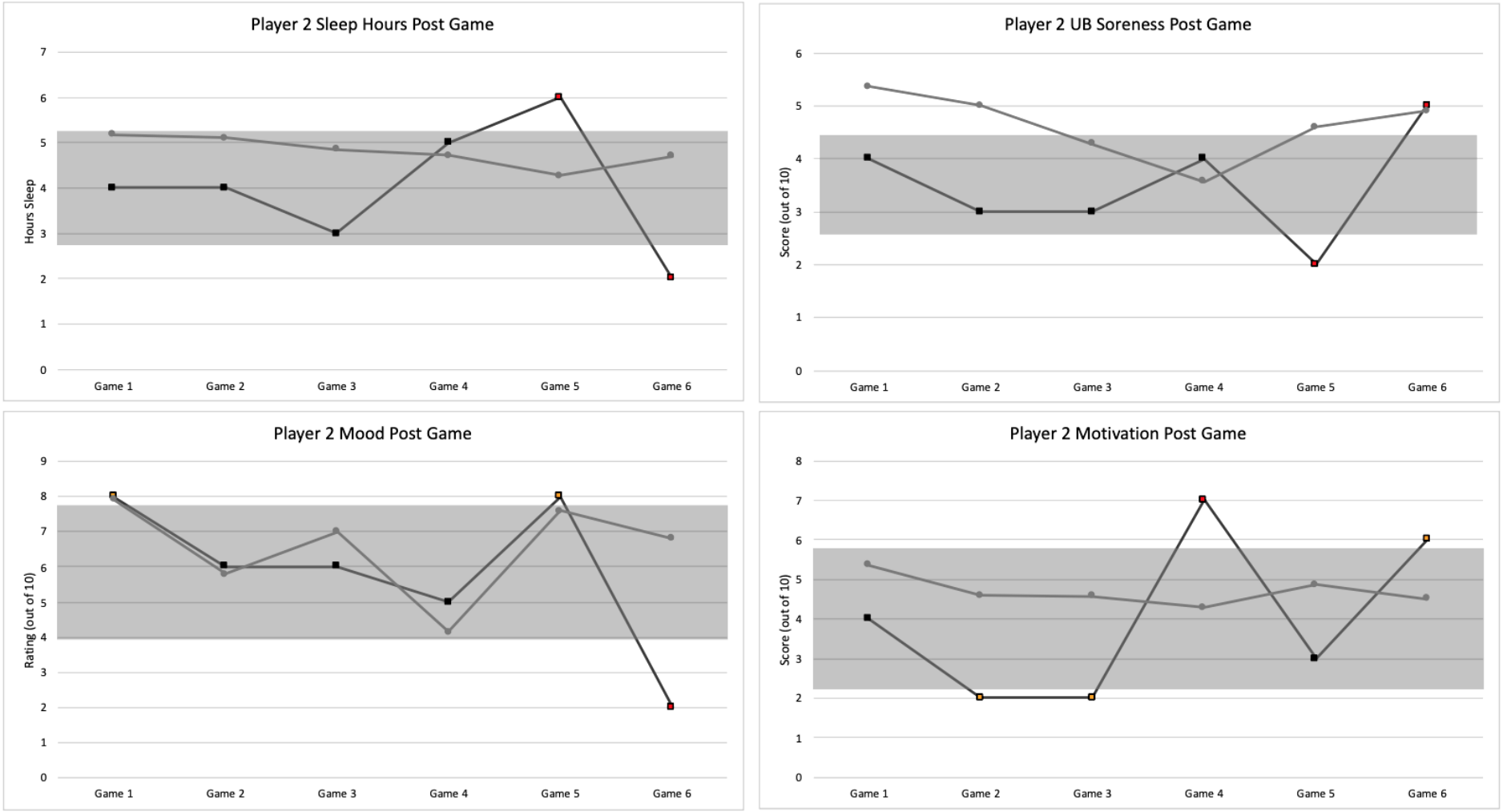


Figure 6.8 Statistical Process Control Chart 2
Displaying Individual wellness variables across 6 successive game weeks. Yellow indicate ≥ 1SD and Red indicate ≥ 1.5SD from mean values.

The wellness score or individual wellness variable in SPC charts is plotted across time and can be compared daily (Figure 6.7) or across similar training days (Figure 6.8). It may be worthwhile to use daily and specific training days interchangeably. For example, the plotted data in Figure 6.7 shows flagged data for low sleep hours which reflects the low number of hours sleep post-game. Therefore, in this instance a comparison with other MD+1 data may be used to identify if any of these values were abnormal within the post-game period in Figure 6.8. Alternatively, this can work in the other way, the low mood identified post-game 6 was the result of the player being sent-off. Looking at the daily mood data in Figure 6.7 the player's mood remained extremely low for several days after this event. Whilst the player reported feeling fine from a physical perspective clearly the sleep and mood alterations were affected by the performance. In this instance the player was referred to the team sports psychologist and this demonstrates the usefulness of data analysis through a simple flagging system, alongside data visualisation, to interpret wellness data and inform decisions. Research has shown match outcomes to influence ratings of wellness in football (Fessi & Moalla, 2018) whilst a range of positive and negative emotions are shown throughout the injury rehab process of athletes (Dawes & Roach, 1997). Practitioners should be aware of the influence they can have on this emotional response (Dawes & Roach, 1997). A wellness questionnaire can act as a flagging system to aid this and in some instances direct a practitioner to refer athletes for support from other appropriate staff (e.g. sport psychologist).

Whilst SPC charts allow for deeper investigations into individuals the use of z-score radar charts allow for comparisons between individuals. This is an efficient way to compare

several players allied to the flagging of values outside of standard deviations. In the example below (Figure 6.9) two radar plots are presented for absolute and z-score values.

These four players were chosen through a random selection and represent different positions across the team (Prop, Backrow, Outside Back, Halfback). When wellness data is viewed in relation to other individuals it can be difficult to interpret. Indeed, looking at the first radar plot it would be easy to deduce that player 3 is well recovered with respect to the other players. However, when these values are compared in relation to their average results in the second chart those values are within the normal variation and in fact the one concern we might have is for the lower body soreness of player 3. Radar plots like this allow for the incorporation of flagging systems with respect to past results through standard deviation. Furthermore, z-scores allow for the comparison across the different wellness dimensions and can be converted to standard ten scores to aid coach comprehension (Thornton et al., 2019). These analytical charts are simple to set up within commonly used office software so that the process doesn't become a time burden on practitioners. Athlete monitoring software and websites should also endorse such an approach to normalisation and interpretation of data. It is hoped that the promotion to use such charts will result in the correct interpretation of data and decisions that follow to support individual athletes within the team.

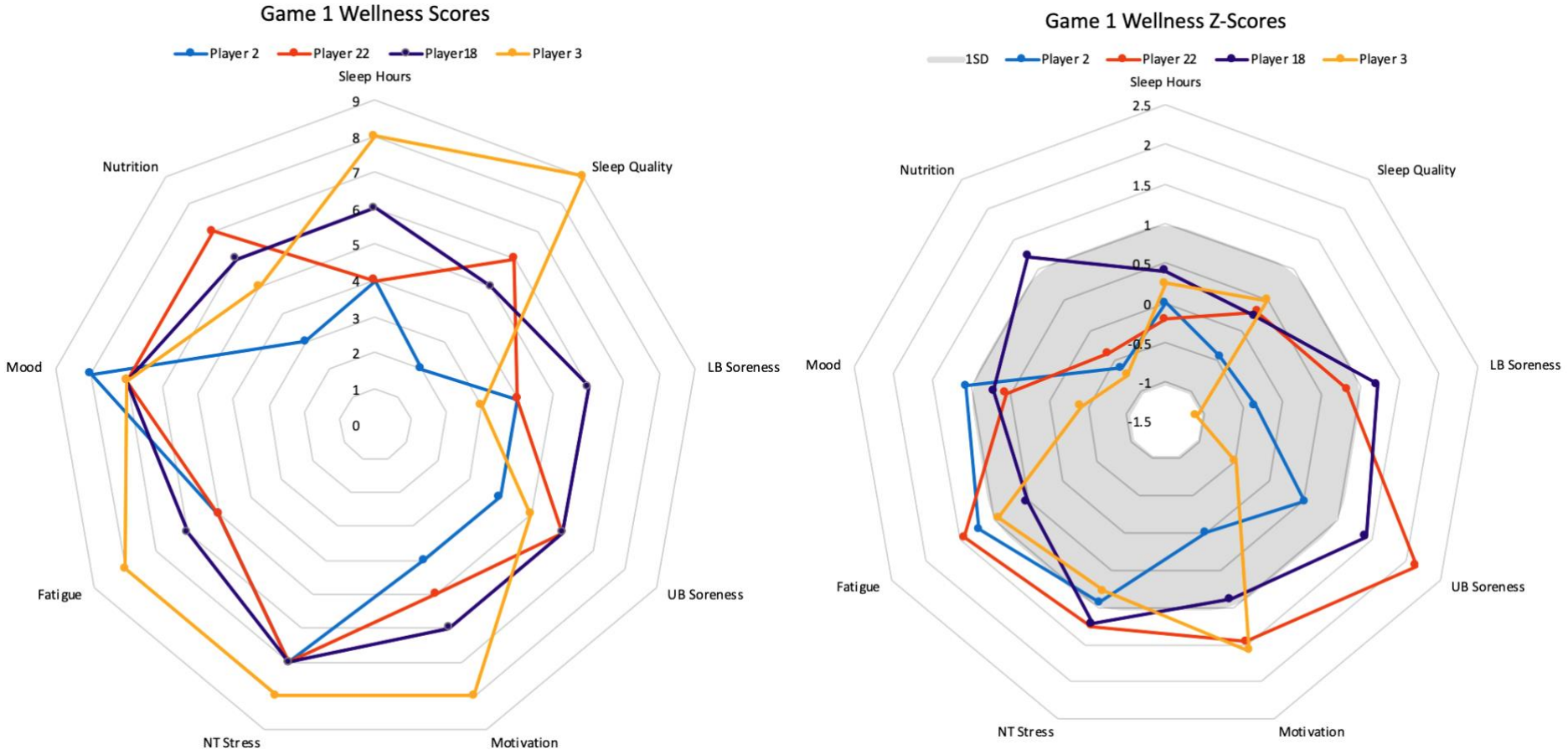


Figure 6.9 Radar plots for wellness data.
Absolute values and z-scores for Game 1 wellness.

6.5 Conclusion

A major finding from analysis of the matchday+ wellness data indicated the best days for practitioners to use the new wellness questionnaire within rugby league. The use of the questionnaire at MD+1, MD+3, MD+4, and MD+6 reduces the burden of a daily completion and provides adequate data for practitioners to utilise within preparations. This study found no contraindications to using a wellness questionnaire daily, but it is suggested that this should be done sporadically to avoid reductions in compliance and buy-in amongst staff and players. Monitoring weekly training loads allied to wellness can be important at informing practitioner's decision-making around training load and recovery. The questionnaire in this study showed sensitivity, high levels of reliability and questions that are suited to the use with rugby league players. Practitioners are advised to carry out their own reliability testing with their players when using this questionnaire. Furthermore, attention should be given to monitoring individual wellness within the team. To this extent, the use of SPC and radar charts can help to interpret, inform and present wellness information to coaching staff. Practitioners working in rugby league who seek empirically supported guidance for monitoring practices may draw upon the results, methods, and discussion presented in this chapter but should also use their own judgements and develop their own individualised monitoring strategies within their context.

6.6 Synopsis

This chapter has described the typical wellness responses to rugby league competition and training within the Super 8s phase of the European Super League season. It has demonstrated how wellness data can be collected, analysed, interpreted, visualised and

used. Through quantitative methodologies the research has identified the change in wellness data between days and the typical variation between and within individuals. This has allowed recommendations around the best practice for the collection of wellness data, the analysis techniques to identify meaningful change and the use of visualisations to aid practitioner interpretation when using a new wellness questionnaire developed for rugby league. The main practical application is that this study provides recommendations and normative data for use of a new wellness questionnaire which has been validated and developed with consideration for implementation in rugby league.

Within studies of this nature it is difficult to account for all aspects of the training load as well as the potential stressors inside and outside the training environment. For example, often players are split into smaller sub-groups and therefore training load and wellness response will likely differ between the sub-groups within the team. Furthermore, as identified in the study, large variation between and within individuals may be a response to the different loads and stressors individuals experience. This limitation may be addressed by focussing on recording the wellness of fewer individual players or positions. For example, Malone et al. (2017) investigated the training load and wellness response in the single position of a football goalkeeper. Future single player or position studies in rugby league may allow for quantification of the load and stressors experienced by players within and outside the training environment allied to wellness.

Crucially, there is now a wellness questionnaire which has been validated and developed with consideration for implementation with the population within this study. Therefore, academics and practitioners can have confidence in the normative values acquired within

this research. However, it is notable that there were still issues with compliance over the length of this study. It is unknown the extent to which educational and implementation strategies worked best to increase questionnaire adherence. Monitoring approaches are heavily reliant on the organisation and buy-in from stakeholders (Saw et al., 2015b). Future research should look to address these issues by determining which strategies work best to improve compliance with different cohorts of athletes.

Now that there is a well-developed and validated measure for monitoring wellness it is important to quantify the wellness response to other in-season periods. In particular it may be worthwhile to focus on demanding periods such as long-haul travel to a World Club Challenge competition, State of Origin, or Easter weekend round of fixtures in the European Super League. There is the opportunity to develop this questionnaire further and add to the normative values within this study. The collection of wellness data amongst training load has shown promise with the use of machine learning techniques for predicting future wellness (De Beéck et al., 2019). This can help with periodisation and the management of load and warrants further investigation. However, what remains integral to any future research is that the measure used to record wellness is validated and developed with guidelines as completed in this thesis. The following General Discussion presents a *Successful Implementation Framework* to guide practitioners to achieve this.

CHAPTER 7

GENERAL DISCUSSION

Synthesis of findings and presentation of a conceptual framework for the successful implementation of wellness questionnaires in rugby league

7.1 General Discussion

This thesis has presented research into athlete monitoring in the sport of rugby league with the major aim of contributing to the understanding and improvement in the use of wellness questionnaires in applied settings. The focus pertains to four studies on the conceptualisation, implementation and utilisation of a wellness questionnaire (Figure 7.1). The 5 aims of this thesis were motivated by a lack of guidance and a research to practice gap in the understanding of monitoring wellness in rugby league and high-performance sport.

7.1.1 Conceptualisation

To begin with a literature review was completed to evaluate the wide-ranging existing literature in relation to athlete monitoring and wellness questionnaires with consideration to the sport of rugby league. This review alongside the other studies helped to conceptualise what a wellness questionnaire is, the purpose of what it can be used for and the practical *Implementation Considerations* that need to be made. The general definition of wellness used within this thesis is *a balance of physical, mental and social dimensions which allow an individual to cope with sporting demands, life circumstances and achieve an optimal state of being*. A wellness questionnaire is thus used to monitor the athlete holistically by focussing on physical (e.g. muscle soreness), psychological (e.g. mood state) and/or social (e.g. team cohesion) aspects of wellness to gauge how close they are to achieving their optimal state to perform and/or monitor the response to training.

The literature review identified that there was a plethora of psychometrically validated questionnaires which had been used to monitor various psychological constructs in

athletes in relation to training load such as athlete burnout (Raedeke & Smith, 2001), recovery (Kelmann & Kallus, 2001), and stress (Cohen et al., 1983). However, these questionnaires were not measuring the construct of wellness and were too impractical to use with rugby league players on a daily basis. There was one wellness questionnaire which was prevalent within rugby league research (Mclean et al., 2010) and had been adapted for use in other studies (e.g. Twist et al., 2017). However, this questionnaire had limitations in the variety of questions and there was no evidence of any validation. From practical experience and research (Taylor et al., 2012) it appeared that practitioners were using their own customised questionnaires which hadn't been comprehensively validated. It was unknown as to the types, scales and item dimensions used on these questionnaires. Furthermore, there was little evidence detailing the implementation of the questionnaire which is vitally important to question comprehension, buy-in to monitoring, and honest response.

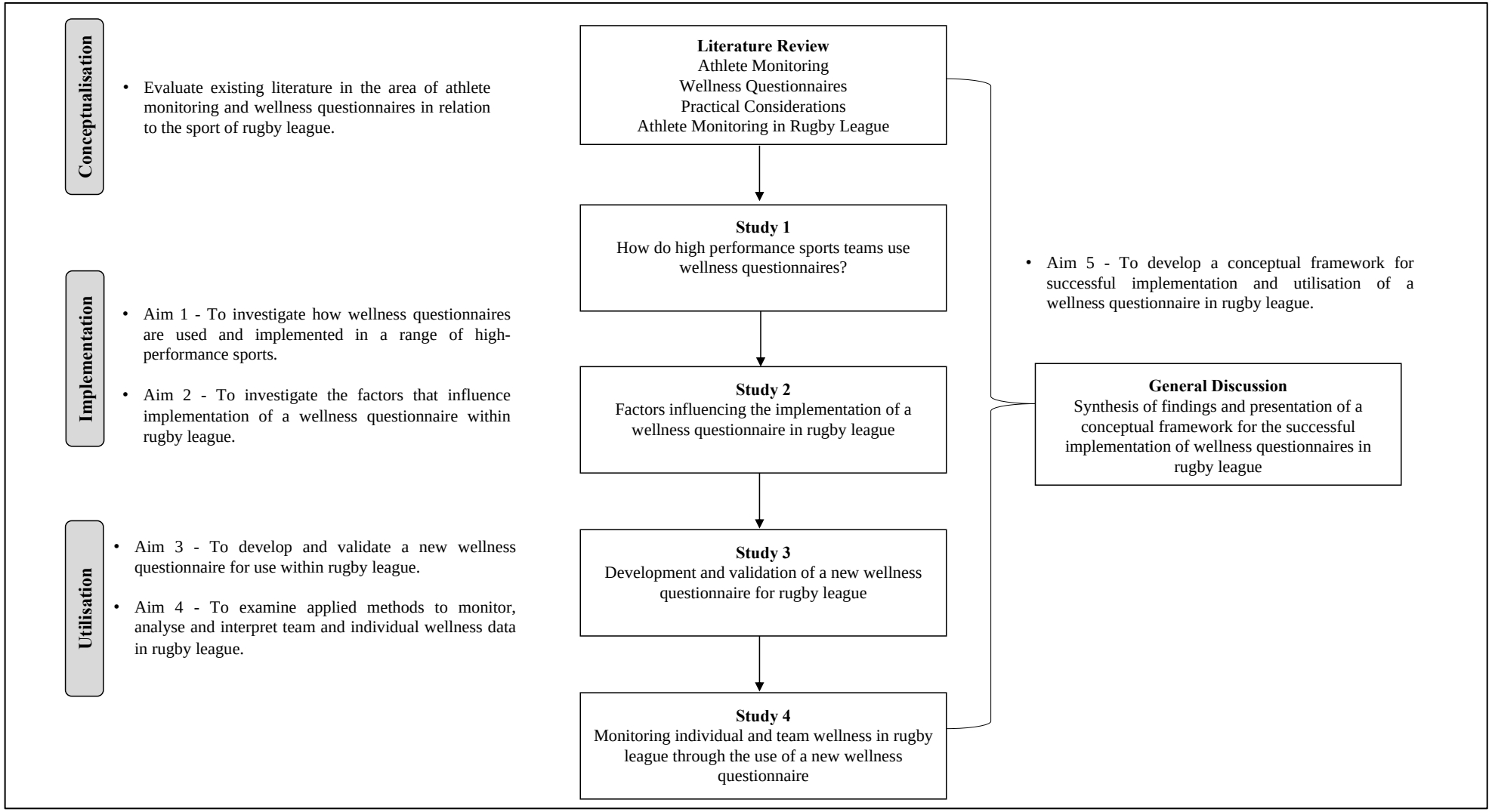


Figure 7.1 Outline of the research progress.

7.1.2 Implementation

Following the literature review, two qualitative studies thus attempted to understand the area of implementation of a wellness questionnaire and further conceptualise what wellness monitoring means to practitioners. These studies sought to build the foundations for developing a valid, reliable and sensitive questionnaire. In study 1 an international survey identified the details of wellness questionnaires in use by practitioners in high-performance sport. This included aspects such as the question dimensions, scales, levels of compliance and implementation. This led to development of several *Implementation Outcomes* for evaluating the success of the implementation of wellness questionnaires.

Three studies had previously surveyed practitioners to outline the modern-day monitoring studies of practitioners with elite athletes (Akenhead & Nassis, 2016; Starling & Lambert, 2017; Taylor et al., 2012). In all these studies wellness questionnaires have proved to be one of the most important monitoring methods. These studies focussed on monitoring methods in general and no survey had exclusively investigated the utilisation and implementation of wellness questionnaires within high-performance sport. This was despite many advances in monitoring and practically oriented research papers which make use of wellness questionnaires (Mclean et al., 2010; Twist et al., 2012). Study 1 therefore sought to progress understanding of this monitoring method used in applied practice and found there are a range of practitioners across sports who are interested in developing wellness questionnaires. These practitioners have tried different approaches in order to achieve successful implementation and a questionnaire which provides meaningful data to inform practice. It is paramount for such research studies in order to bridge gaps between research and practice. New practitioner-led developments bring new

ideas which can influence frameworks for large scale implementation across sport. This study has advanced and confirmed findings regarding the conceptualisation, utilisation and implementation of wellness questionnaires in elite sport. It confirms that practitioners largely utilise customised questionnaires on a daily basis to make decisions around training modification and recovery of players. It was previously unknown as to the exact details commonly used within customised questionnaires such as the scales and dimensions. These details were clarified and advance the understanding on the current methods used by practitioners. However, just because these are the most common doesn't mean they are the most effective and practitioners also provided comments on how successful implementation can occur across data collection, analysis, decision making and evaluation. This led to the development of several *Implementation Outcomes* that practitioners can focus on to evaluate the effectiveness of a wellness questionnaire. There still remains some disconnect between wellness questionnaires used in practice and some psychometrically validated questionnaires used in research. In addition to practitioners, it is therefore recommended that research studies that use customised questionnaires review the *Implementation Outcomes*, evaluating where they sit on the *Implementation Continuum* (Figure 7.1) and report these findings alongside the validity and reliability of the questionnaire.

One previous piece of research had investigated the implementation of wellness questionnaires across a range of sports (Saw et al., 2015b). A social ecological model was used to outline the factors influencing implementation and it was proposed that these factors are likely to be context specific. As such, study 2 of this thesis investigated the *Implementation Factors* that influence the use of wellness questionnaires in the context

of rugby league by interviewing players and staff who are the main end-users of the questionnaire. This study supports the use of the social ecological model. It identified similar factors confirming the benefit of categorising the *Implementation Factors* into those associated with the *organisation*, *measure*, *interpersonal* and *individual*. Within these categories a host of themes were identified relevant to the successful implementation of wellness questionnaires. These context specific findings provide an in-depth insight into barriers and challenges associated with the implementation of wellness questionnaires in rugby league. In particular, there was advancement to the knowledge base through the identification of several novel higher order themes (context, process, personalisation and coaching staff) and 23 lower order themes. Furthermore, the link of the *Implementation Factors* to the *Implementation Areas* provides a benefit for practitioners to focus their development of the questionnaire in order to achieve successful implementation.

A growing body of literature exists within health and education settings that supports the idea that implementation influences desired outcomes (Dubois, Holloway, Valentine, & Cooper, 2002; Durlak & DuPre, 2008). This was supported for the implementation of wellness questionnaires in rugby league and different sport settings in this thesis (studies 1 and 2). Research studies often make reference to implementation in comments that are often add-ins to the main investigation. For example, managers viewing monitoring strategies with scepticism and sporadic player compliance (Burgess, 2016). For wellness questionnaires, practitioners and researchers have started to acknowledge the many factors that influence implementation of monitoring (Study 2). However, some structure is needed to put these findings into use and Study 3 used a four-phase approach to develop

a new wellness questionnaire following previous recommendations for implementation (Meyers et al., 2012 ; Saw et al., 2016).

7.1.3 Utilisation

No published research exists which details the development and validation of a wellness questionnaire as academics and practitioners habitually follow basic recommendations of Hooper and Mackinnon (1995) or simply adopt questionnaires which have been published in research (e.g. Mclean et al. 2010). Even if a questionnaire is valid it needs to be implemented successfully in order to obtain honest response and buy-in from the players. Therefore, taking into account the factors associated with implementation (study 2) a new wellness questionnaire was developed and validated within rugby league in study 3. Validation is an on-going process as evidence is gathered throughout questionnaire use in different populations and scenarios (Newton & Shaw, 2013). The newly developed questionnaire was shown to have acceptable levels of validity and reliability when used within rugby league.

Following this, study 4 used a quantitative approach to understand the utilisation of the new questionnaire in rugby league. It investigated monitoring, analysis and interpretation of wellness data at team and individual levels in response to a 10-week period of the rugby league season culminating in a grand final victory. Players completed a customised wellness questionnaire every day for a period of 68 days. This is the first study to document player wellness for a group of elite rugby league players for this amount of time. Whilst there were no contraindications to everyday completion of the wellness questionnaire it was recommended to complete it every training day and remove the

questionnaire on game days and days off. There was no additional benefit to completion on these days. Training load correlated with wellness data, with higher contact and running demands associated with lower wellness values. Large within and between individual variation exists and can be accounted for by the use of individualised z-scores. This allows for personalised flagging and production of radar and statistical process control charts to visualise the data for easy identification of red flags.

The wellness questionnaire used in this thesis was developed and validated within a rugby league team and thus is suitable to use within rugby league and could be applied across other high-performance sports. However, it is not appropriate to simply just use this wellness questionnaire as it needs to be successfully implemented within the organisation and evaluated to ensure validity and reliability with the athletes being monitored. It is unlikely that there will be a wellness questionnaire that is the gold standard measurement tool across sport due to the necessity to customise and implement in relation to the context and individual athlete. Current guidelines often revolve around starting a new questionnaire (e.g. Saw et al., 2016) and study 1 identified that this is something practitioners don't have the luxury to do. Indeed, practitioners must onboard new athletes into an existing monitoring system during the season or they may not have the time to develop a new questionnaire before the season starts. There is a clear need for a comprehensive framework to bring together the research and practice on the implementation and use of wellness questionnaires. The studies of this thesis have contributed to the knowledge and understanding of this process of development and use. Thus, a conceptual model for the implementation of new wellness questionnaires is

presented below alongside the practical application guidelines for using wellness questionnaires.

7.2 Successful Implementation Framework

Figure 7.1 outlines a framework for the implementation of wellness questionnaires which has been developed through the studies within this thesis. This model incorporates the *Implementation Outcomes* previously identified (study 1), the *Implementation Factors* (study 2), and the four distinct areas of implementation which can be established through four separate phases of development (study 3). Notably the framework allows the practitioner to focus on either the implementation of a new questionnaire (phase 1-4) or the evaluation and enhancement of an existing questionnaire (phase 4-1). Initial *Implementation Considerations* for developing new wellness questionnaires should involve determining whether or not it is appropriate for the team to use a questionnaire by identifying the overall purpose and feasibility (Saw et al., 2016). A practitioner should then contemplate and plan the data handling process within the *Implementation Areas* including how information will be collected, analysed and used to influence decisions. Considerations should then be given to the *Implementation Factors* which may influence these areas. The final phase involves the evaluation of *Implementation Outcomes* to determine if implementation and use of the wellness questionnaire has been successful. For teams already using a wellness questionnaire the practitioner can follow the framework in reverse order. As the questionnaire is already in use it allows for the evaluation of the existing questionnaire first. If one of the *Implementation Outcomes* is poor then the practitioner can attempt to ascertain the *Implementation Factors* which may be causing this, identify *Implementation Areas* in need of improvement and then work to

make integration of the questionnaire more feasible from an organisational and stakeholder perspective.

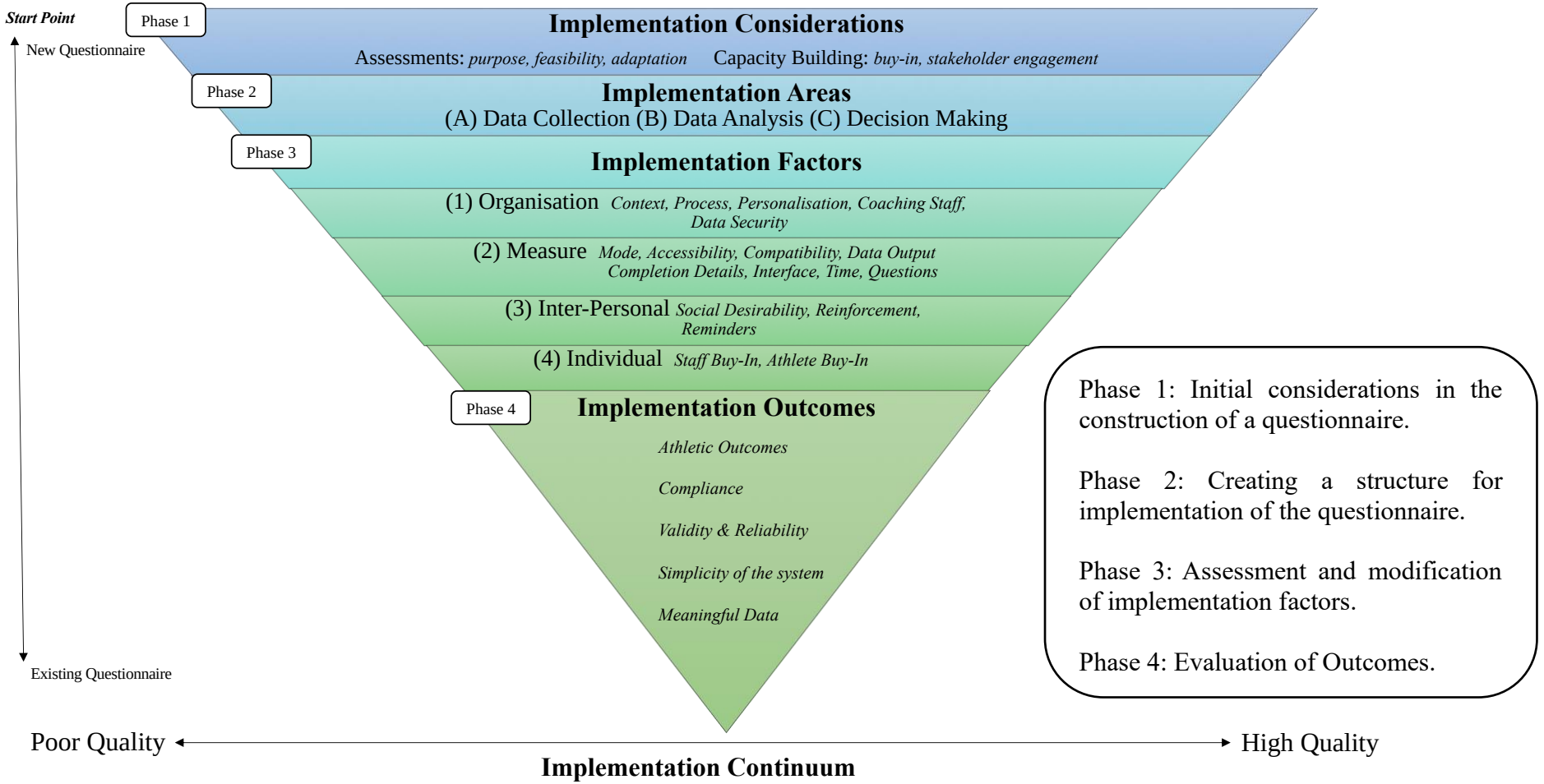


Figure 7.2 Successful Implementation Framework: A conceptual model for the implementation of a wellness questionnaire in rugby league.

At the heart of the framework is the social ecological model (SEM) of the *Implementation Factors* from study 2. Through comments made by participants in this study it was evident that each implementation factor and sub-theme can influence other factors and sub-themes. The SEM's nested structure outlines the different levels of factors (Organisational, Measure, Inter-personal, Individual) at play when implementing a wellness questionnaire and it exposes the interrelatedness of these factors within this implementation melting pot. Furthermore, this approach is inherently interdisciplinary (Stokols, 1995) and therefore suited to the application of monitoring wellness allied to training load/recovery in applied environments, which require a real synthesis of approaches at multidimensional psychophysiological levels (Heidari et al., 2018; Kellmann et al., 2018). The framework has been adapted in a way that allows the practitioner to focus on these major factors of implementation allied to the areas of data handling. When evaluating the wellness questionnaire it takes into account what practitioners value as successful implementation in Study 1. The frameworks 4 phases, which were utilised in study 3, are aligned with quality implementation guidelines (Meyers et al., 2012; Saw et al., 2016) but uniquely have the flexibility to work with new and existing questionnaires. It is acknowledged that *Implementation Factors* interrelate and no factor resides as more important than the others. There are likely *Implementation Factors*, *considerations* and *outcomes* which are unique to each environment that a wellness questionnaire is used. Nevertheless, the framework has been designed to give some structure for practitioners to contemplate when implementing wellness questionnaires.

7.3 Practical Application Guidelines

Table 7.1 provides a number of key questions and recommendations for the implementation and utilisation of a wellness questionnaire in rugby league. These recommendations are based on the studies within this thesis and link to the framework outlined in figure 7.1. These points are guidelines only as the implementation and use of wellness questionnaires is context and individual dependant. The key questions act as a summary of the process of what should occur at each phase of implementation. Accounting for each of these questions will help practitioners to achieve high quality implementation.

The recommendations provided in Table 7.1 are for use under scenarios were practitioners require a wellness questionnaire to be used on a frequent basis to monitor physical, mental and/or social dimensions which allow an individual to cope with sporting demands, life circumstances and achieve an optimal state of being. The wellness questionnaire should thus be designed for the purpose of identifying if an individual or team is ready to perform in training or matchday. It may also be used to monitor the acute and longitudinal response to training or match play. Ultimately the questionnaire is designed to be used to inform decisions to the training programme for both teams and individuals. To this end customised wellness questionnaires were used by over 90% of practitioners in study 1 and are recommended based on the use in this thesis. If the purpose is to measure a specific dimension only, for example mood state, then other psychometric questionnaires may be better suited (e.g. POMS). Therefore, these recommendations pertain to the use of wellness questionnaires as conceptualised in this thesis.

Table 7.1 Key Questions and Recommendations for the Implementation and Utilisation of Wellness Questionnaires in Rugby League.

Phase	Key Questions	Recommendations
Phase 1 Initial considerations in the construction of a questionnaire.	• What will be the purpose of using the wellness questionnaire? • Is it feasible to use a wellness questionnaire? E.g. are there adequate resources? • Do we have the buy-in from staff, players and other stakeholders? • Should we use an empirical or customised questionnaire? • What dimensions and questions do we need to assess and is there a theoretical and practical need to assess these dimensions? • Will it be possible to make adaptations to the use of the questionnaire and what do we anticipate on changing? • Will staff need any education and training regarding the use of wellness questionnaires?	• Customised questionnaires are recommended for use and currently used by over 90% of practitioners (122 practitioners surveyed) • Any customised questionnaires should be carefully designed at Phase 1 and 2 with in-house assessment as to the suitability for use. • Practitioners should pay attention the validity, reliability and sensitivity of the wellness questionnaire and review this periodically. The content validity and face validity can be developed in phase 1 and global evaluation on the validity and reliability in phase 4. • The questionnaire used in study 4 had a high level of reliability, practical validity and was sensitive to change in the rugby league cohort. If practitioners use this questionnaire or other psychometrically validated questionnaires they are still advised to follow the implementation phases. • Questions that are very highly recommended (90%+ of practitioners in study 1): muscle soreness, sleep (quantity/quality), illness, player comments, non-training stress, RPE. • Questions that are highly recommended (80-90% of practitioners in study 1): motivation to train, nutrition, mood state, fatigue index. • Questions that are less recommended (<80% of practitioners in study 1): hydration, daily weight. • A 10-point semantic differential scale is recommended for each question consisting of simple words players would typically use. • Educational and engagement strategies such as explanation within team meetings should be employed to develop a supportive culture around wellness questionnaire use.
Phase 2: Creating a structure for implementation of the questionnaire.	• Do we have a good structure for the implementation of the wellness questionnaire? • Who will be involved and responsible for data collection, data analysis and decision making? • What will be the process of data collection, data analysis and decision making? • Are there clear guidelines around questionnaire completion?	• It is recommended that wellness questionnaires are used post game at matchdays +1, +3, +4, and +6 on 7-day turn around between games. • It is recommended to limit the use of wellness questionnaires on rest days. • Wellness data should be analysed in conjunction with external and internal load. • Practitioners should ensure clear roles regarding data collection and analysis including who is responsible and who will report data and how. • The use of z-scores allows for flexible flagging, individualisation and comparison across dimensions/players. • A high variation should be expected at MD+1.

Table 7.1 Continued.

Phase	Key Questions	Recommendations
Phase 3: Assessment and modification of implementation factors.	• Do we have the capability to monitor and manage the Implementation Factors?	• Organisation: Practitioners should promote a positive culture and consider the context within the application of the *Implementation Areas*.
	• Do staff have the technical ability to provide modifications to assist with implementation?	• Measure: Focus on the creation of an online based questionnaire that facilitates ease of use, data analysis and application.
	• Are feedback mechanisms in place to relay information on the quality of implementation?	• Inter-Personal: Attention should be given to the use of reminders and programme champions to engage players to respond to the questionnaire with regularity. Practitioners should be aware of the potential for social desirability issues to occur.
		• Individual: Promotion and continued use of educational strategies to promote athlete and staff buy-in to the sustainable use of the wellness questionnaire.
Phase 4: Evaluation of Outcomes	• Are we able to evaluate the implementation and use of the questionnaire with a view to making improvements?	• Athletic Outcomes: Typical wellness profiles have been described in this thesis and can be used for comparison with other professional rugby league players e.g. Practitioners can expect a reduction in sleep quantity and quality at MD+1 / Player wellness is likely to be recovered by 4 days post game on 7day+ turn arounds. Practitioners should focus on determining the levels of feedback of information to athletes and staff on the use of wellness information in decisions.
	• Is the continued use of the wellness questionnaire sustainable?	• Compliance: Monitoring compliance through numbers of completion and setting targets based on the amount of players expected to complete the wellness questionnaire is recommended and helps to gauge the levels of buy-in.
	• What does successful implementation look like and where do the *Implementation Outcomes* sit on the *Implementation Continuum*?	• Validity & Reliability: In-house evaluation of the validity, reliability and sensitivity of wellness questionnaire should take place periodically. This includes comparison of wellness data to other indices and methods, the use of Cronbach Alpha testing, assessment of the variation and detail of individual player responses and consideration of the sensitivity of the questionnaire to changes in training load.
		• Simplicity of the system: Practitioners should review how easy it is to collect, analyse and make decisions using the wellness questionnaire through conversations with players and staff. At least one member of staff should act as system administrator to quickly resolve any issues e.g. players unable to log-in.
		• Meaningful data: Practitioners can focus on determining how effective the wellness questionnaire has been alongside other methods at the purpose it was designed for e.g. determining player readiness / prescribing recovery.

7.4 Implications for Practice

A number of implications for practice have been discussed within the synopsis of each of the individual studies. Taken as a whole there are two main areas that this thesis contributes to for practice; 1. Improvements to the implementation and use of wellness questionnaires; 2. The development and validation of a new wellness questionnaire.

Improvements to implementation and use of wellness questionnaires can be achieved through following the *Successful Implementation Framework.* There are many context specific lower-order *Implementation Factors* that were identified in study 2. Practitioners within rugby league and other sports now have an awareness of these and can plan for the factors when implementing their questionnaire. The large volume of lower-order factors could be challenging to manage due to the time constraints of applied practice. Therefore, the importance of the *Successful Implementation Framework* resides in the simplicity to focus on the four higher order *Implementation Factors*. It allows for practitioners to consider the implementation of their own wellness questionnaires through 4 simple questions; 1. Is the organisation set up to use wellness questionnaires? 2. Is the measure appropriate for this context? 3. Have the inter-personal factors been considered? 4. Have individual factors been addressed? Practitioners are encouraged to monitor these aspects and evaluate their questionnaire on a regular basis. Evaluation can be achieved by assessment of the *Implementation Outcomes* identified by practitioners in study 1. In relation to these questions in the rugby league team under review, it was deemed of critical importance for the *organisation* to facilitate the monitoring process through well-defined roles and actions, staff with proficiency in using questionnaires, and consideration for knowing the athletes and wider context of monitoring. The *measure* should support the

collection of valid and reliable data in a simple internet-based system with minimal burden on the player for data collection. *Inter-personal factors* should be geared around increasing the compliance and accuracy of the wellness data using reminders and programme champions. At an *Individual* level greater understanding for monitoring wellness through education and feedback should aim to develop buy-in across the team. These core *Implementation Factors* are integral to successful implementation and warrant consideration by practitioners using wellness questionnaires.

The development and validation of a new wellness questionnaire offers benefits to practitioners in applied environments as well as research. Notably, it was identified in study 1 that practitioners currently use various customised measures, often inspired by questionnaires used within research (e.g. McLean et al., 2010). The main limitations of these questionnaires are that they have not been validated, tested for reliability, or developed with regards to implementation factors. They contain a variety of questions with limited rationale, scales with limited range of response, a lack of normative values and in many studies the wellness data is often a secondary measure to other objective data that has been collected. Each limitation has its own implication for practice but collectively they threaten the accuracy of the wellness data and therefore the confidence in the decisions that can be made using this data. It is time for research and practice to move away from these measures which lack details on the development and psychometric properties. There are some empirical questionnaires which document validity and other psychometric properties (Saw et al., 2016; Table 2.3), however, these are not utilised very frequently by practitioners in applied practice. This is because they are difficult to implement on a regular basis due to the large number questions, assessment of a limited

number of dimensions (e.g. mood) and that they simply do not meet the purpose that stakeholders require. The questionnaire developed within this thesis addresses these limitations and contributes to progressing wellness measures to be used in the field. The new questionnaire in this thesis has high levels of face validity, construct validity and reliability. It has a range of questions to inform on player wellness, as well as other dimensions, and crucially meets practical implementation challenges such as placing minimal burden on the athlete. This questionnaire has been designed and developed for use with rugby league players and the psychometric documentation of using this questionnaire can evolve as practitioners within the sport, and beyond, begin to use this questionnaire in practice and research.

A key concern in applied practice is undertraining, as well as overtraining, and the idea that wellness questionnaires have a potential to promote thinking of how hard training has been. Wellness questionnaires are used as a tool to maximise the benefits of training and preparation, but this can ultimately result in players being removed from training sessions (Duignan et al., 2019a). Indeed, within interviews in study 2 there was concern that by quizzing players on how sore they feel, how tired they may be and how hard training had been that it could promote negative perceptions and lead to erroneous data and decisions. In a similar way, social desirability is a key issue for acquiring honest responses and accurate wellness data. From a practical perspective, these issues need to be considered within educational content instructing players on how to complete the questionnaire (i.e. without favourable response). Players and staff need to have this understanding from the outset, and this can be achieved through prearranged meetings in the phases discussed in study 3. This should include education for staff, principally that

this is a measure to be used as part of a monitoring toolkit that should not just be about identifying reductions to training load but a full range of decisions as identified by practitioners in study 1. Allied to this education, the new wellness questionnaire validated within this thesis addresses these issues by framing questions with neutral language and by using both positive and negative words at the ends of the wellness scale (e.g. how do your lower body muscles feel? Sore --- Fresh). With this neutrality in mind, the questionnaire does not ask any leading questions that may predispose to a favourable response. Furthermore, regular organised feedback to end-users of the questionnaire is important to ensure data accuracy and buy-in using methods as presented in study 4. The phases used within study 3 and the *Successful Implementation Framework* act as a template for other practitioners to reduce these limitations in the monitoring process using wellness questionnaires. Ultimately, the wellness questionnaire validated in this thesis has been developed to gain an idea of how athletes are feeling and neither promotes perceptions of how hard or easy things have been.

7.5 Limitations of the Thesis and Future Research Directions

The *Successful Implementation Framework,* key questions and utilisation recommendations for wellness questionnaires developed in this thesis is not an exhaustive list. In particular, the major focus of this thesis was within the context of rugby league and within one organisation. Of course, this was beneficial to develop the depth needed for the *Successful Implementation Framework,* but other teams and contexts warrant investigation to assess if these findings apply. Furthermore, analysis of wellness and training load data within applied environments is influenced by the turn-around between game and other contextual factors. Quantification of other in-season periods (e.g. World

Club Challenge or Easter Weekend) is warranted to reflect other periods of rugby league gameplay. With improvements in collection and storage of data a future direction that academics and practitioners should start to consider is the career long monitoring of wellness and training load. The biggest challenge to this will be enabling consistency in methodology in a quick changing world of monitoring. Whilst technology like GPS will change over the course of an athlete's career, the wellness question content could remain stable once the appropriate wellness dimensions are identified and the *Successful Implementation Framework* is followed.

This study focussed on the implementation of wellness questionnaires only. Other monitoring methods also experience issues with implementation, for example there can be large interest in a new technology, such as GPS, that can then wain over time. It is likely that some of the content of this thesis will apply to other forms of monitoring athletes, but this warrants further investigation to identify any differences to modify the *Successful Implementation Framework* for those monitoring methods. Because wellness questionnaires are used as part of a toolkit of monitoring strategies, alongside external and internal load, it can be difficult to isolate the phases to only questionnaire implementation and development. Future research should look to incorporate other methods into a global monitoring framework.

Throughout this thesis guidelines of implementation for wellness questionnaires have been developed in addition to recommendations of use within rugby league. The questionnaire used in this study was sensitive to change and developed with validity and reliability in mind. This was completed by following the recommendations of previously

constructed questionnaires and established within the context of the team using the questionnaire. It would be worthwhile for future research to conduct a study using different types of customised questionnaire to obtain insight into which dimensions and scales are most reflective of athlete wellness within different sports or teams. This is such a challenge due to the individual nature of monitoring wellness as some questions are more relevant to certain athletes, yet it is important to have a global questionnaire across the team for consistency. Therefore, it may be beneficial to investigate separate questionnaires which target specific groups, for example injured players. In this instance dimensions could be tailored with the injured athlete in mind with data aimed at the physio and S&C coach to aid progression of recovery and support global wellbeing as opposed to readiness to perform in game-play. Furthermore, such investigations could determine the specific qualities of the measure suited to achieving high compliance and implementation in differing scenarios (e.g. on tour vs season long, injured athlete vs fit athlete). Further work on integration with objective measures allied to wellness is warranted as advances in wearables occurs. This includes the incorporation of match statistics, technical, tactical, physical, social and psychological aspects of game-play to fully understand the wellness response for holistic monitoring of the athlete.

Compliance fluctuated throughout study 4 which has potential to impact the results obtained. Further research into why players are not completing wellness questionnaires and the educational strategies to engage them in the process is warranted. This perhaps exists at an individual level, but it would be beneficial to understand the strategies that could target groups to increase completion rate. Whilst education was provided and elements of the *Successful Implementation Framework* followed, it is unknown the extent

to which strategies allowed players to understand or buy in to the study. With players utilising internet-based questionnaires there is the potential to facilitate their understanding of wellness and recovery through e-learning material adjunct to the questionnaire. Such e-learning has shown benefits in other domains and could act as feedback to provide clarity on aspects of the wellness questionnaire and promote self-reflection (Feng et al., 2013; Haven & Botterill, 2003). Young athletes who perhaps don't understand the scale as much as an experienced player may need tailored education and future research could assess the utility of wellness education and feedback mechanisms. This includes greater understanding of the presentation and visualisation techniques that promote coach and player understanding of wellness data.

It should be noted that this research focussed on a case study of one team in rugby league (studies 2-4) and the network closely linked to the research team (study 1). However, the methods and findings are consistent with other studies (Saw et al., 2015; Starling & Lambert, 2017; Taylor et al., 2012). With the advancement in monitoring it is likely that studies assessing the use of monitoring should be completed regularly. This thesis concentrated on the use of wellness questionnaires by performance staff, but other individuals such as coaches and management play direct and indirect roles in wellness monitoring. Further attention could also be given to the non-sport load and stressors which can influence wellness. It is important to quantify the training load but this should be placed in the context of activity and stress of everyday life. Perhaps the monitoring of movement, heart rate, heart rate variability, sleep and nutrition allied to wellness outside the training environment would give a full picture on athlete wellness within and outside the training venue. There is a large ethical challenge to 24/7 monitoring, research should

aim to determine if it is actually necessary and provides data that informs practice. In addition to quantification of wellness and load, future directions can focus on the decisions that can be taken with wellness data. In particular, there should be a focus on the recovery strategies and decisions which could improve wellness. Ultimately, the wellness questionnaire has future longevity in that it could assimilate into a global wellbeing questionnaire following the retirement of players. Future research could assess the utility of such a questionnaire in aiding player transition post-career.

7.6 Final Conclusions

Given the growing anecdotal and evidence-based information on monitoring approaches this thesis has sought to increase understanding of the key steps needed to implement and use a wellness questionnaire in elite rugby league. This thesis was motivated by the lack of guidance in developing and using wellness questionnaires in rugby league. Over the last seven years during the production of this thesis there have been many research papers and practitioners which have offered advice and practical applications on monitoring (e.g. Burgess, 2016). However, whilst these soundbites were beneficial there maintained a lack of guidance as to how these could be implemented within a wider structure. For example, it is important to foster buy-in of athletes to use a wellness questionnaire through appropriate education and this is often talked about in research and practice. But as study 2 found, it is not as simple as only educating players as buy-in can be influenced by other factors such as the measure (e.g. accessibility) or the organisation (e.g. staff reminders). Furthermore buy-in could have impacts on data collection, data analysis or decision making. There has clearly been a need for a wider framework of which the *Successful Implementation Framework* now provides.

This thesis has provided a clear presentation that wellness questionnaires are an important tool within the athlete monitoring process. This is a tool that needs to be carefully managed in order to implement the questionnaire successfully to achieve appropriate collection, analysis and decision making with wellness data. The development and validation of questionnaires should be documented to ensure data quality, and the wellness questionnaire within this thesis acts as an acceptable measure for the purpose of monitoring wellness. The approach taken by practitioners within rugby league to use customised wellness questionnaires is justified as insight into rugby league competition demands and wellness response has been provided. Recommendations via the *Successful Implementation Framework* offers guidance for practitioners using wellness questionnaires in elite sport. In conclusion, the studies within this thesis provide support for the future sustainable use of wellness questionnaires as part of the athlete monitoring toolkit in rugby league.

CHAPTER 8

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CHAPTER 9

APPENDICES

Appendix A – Quinn, M., Sinclair, J., & Atkins, S. (2015).

Differences in the high speed match-play characteristics of rugby league players before, during and after a period of transmeridian transition.

Abstract

There is a paucity of information comparing competitive rugby league match play dynamics between northern and southern hemispheres. Notably, differences in the match demands of games played in an intensive period have not previously been reported. This study is the first to assess such demands, quantified using GPS/accelerometer technology, during a competitive three game period that comprised two games in England, interspersed with one game in Australia. The three games were completed over a period of 23 days. In-game data from fifteen elite level rugby league players were collected. The focus was to assess differences in activity profiles undertaken in each game. There were significant increases in the total number of high speed sprints, distance covered at high speed and acceleration/deceleration efforts undertaken in Australia when compared to England. No significant differences in other key performance indicators were observed. The current findings demonstrate minimal differences in the activity profiles of game play in elite professional rugby league, with the exception of high speed movement and acceleration/deceleration efforts. The European team were defeated in their game in Australia, with clearly higher levels of total high speed sprints, acceleration and deceleration efforts being observed in that game when compared with games undertaken in England. Such findings emphasise the continuing use of GPS/accelerometer technologies in determining in-game performance characteristics associated with likely success, though the milieu of factors contributing to success must be considered in entirety.

Keywords: rugby league, GPS, accelerometer, competition, high-speed, northern, southern, hemisphere, transmeridian travel.

1. Introduction

Rugby League (RL) is widely acknowledged for its relentless physical demands. Formed in the north of England in 1895 it is currently played worldwide. The two major club competitions are the European Super League (ESL) and the National Rugby League (NRL), located in Australia and New Zealand. The modern day game is characterised by forceful collisions, wrestling bouts, repeated high intensity efforts, high-speed running and low intensity recovery periods (Johnston *et al*., 2014). Research has shown games to illicit substantial muscular trauma and damage (McLellan and Lovell, 2012; Twist *et al*., 2012). McLean *et al*. (2010) state that if player fatigue and recovery is not managed appropriately, players may be at greater risk of underperformance. This is of particular importance during the weeks leading up to and following the World Club Challenge (WCC) competition (a game between the two best club teams in RL – the winners of the ESL and the NRL). The players are not only challenged by a high standard of opposition, but also experience transmeridian travel, a change in environmental conditions and the psychological rigours of being 'on tour' away from home comforts. To date, there is no published research relating to the effects of transmeridian transition upon competitive performance in rugby league.

Recently, the game has seen an increase in the use of sports science technology, such as the use of global positioning system (GPS) microtechnology devices, used since 2009 (NRL) and 2010 (ESL). This has led to a proliferation of published research assessing the physical demands of the game. The number of peer-reviewed articles assessing this sport has more than doubled in 5 years (Johnston *et al*., 2014). Many of these have used GPS technology, with the first studies assessing broad categories (i.e. forwards and backs) over a small number of games (McLellan *et al*., 2011) before moving on to investigate position specific demands across an entire season (Austin and Kelly, 2014). The focus of papers has shifted from investigating variables such as total distance covered to identifying critical performance indicators, in particular the influence of repeated high intensity efforts (Gabbett *et al*., 2013). Papers have added context to these demands by identifying the differences between winning and losing teams (Gabbett, 2013a), duration of match recovery times (Murray *et al*., 2014), activity cycles recognising how long the ball is in play (Kempton *et al*., 2013; Gabbett, 2015) and the demands across different field positions when attacking or defending (Gabbett *et al*., 2013). The latest papers have looked at the intensity of games across small in game periods (Delaney *et al*., 2015) as well as the tactical and technical differences that impact on a team's success (Gabbett, 2014; Hulin *et al*., 2014). Despite this increase in research only one study (Twist *et al*., 2014) has made explicit comparisons between the NRL and ESL. Anecdotally, the NRL is claimed to be superior, and is regarded as *"the best rugby league competition in the world"* (Gabbett, 2013a). In competitive matches between NRL and ESL, southern hemisphere teams have won more games against those from the northern hemisphere since 2008. However, evidence of the differences in demands of the game between the NRL and ESL still remain unclear, with studies yet to assess in-game physical demands of competitive matches.

To date, one research group has compared the demands of rugby league match play between hemispheres. Twist *et al*. (2014) used GPS technology to determine match play patterns in 88 NRL games, and 104 from the ESL. Their results identified that whilst lower to moderate intensity running efforts were higher in the European league, the dominance of relative high-speed distance running was greater in the NRL competition. This maintenance of high speed running in NRL matches raises interesting questions regarding this mode of activity as a key determinant of success. Whilst Twist *et al*. (2014) provided intriguing evidence of intra-seasonal patterns of movement, there has to date been no published reports of the demands of more intensive periods of match play by hemisphere.

International fixtures between northern and southern hemisphere teams require transmeridian travel over 12 time zones. Evidence suggests that this long distance travel can produce a detrimental effect on athletic performance due to jet lag, disruption of circadian rhythmicity and sleep deprivation (Leatherwood and Dragoo, 2013). For northern hemisphere teams, the WCC takes place at the start of the season, sandwiched between ESL games. Together with the travel demands, competing in a number of warm-up and competitive games, allied to training, results in an intensified period of physical performance. The purpose of this research paper was to assess this period of competition from the perspective of a northern hemisphere team, and to identify any differences in high speed elements of competitive ESL games and the WCC event. The study gave a unique opportunity to capture in season comparisons between ESL and NRL opposition, and give a cross-sectional snapshot of match demands throughout a challenging period of competition. It was hypothesised that the WCC game against NRL opposition would be the most demanding of a sequence of three games (2 x ESL; 1 x WCC) with GPS data showing greater values for high speed efforts and accelerations.

2. Methods

This study was designed to assess differences during in-game play between competitive games of rugby league undertaken over a three-week period, and between hemispheres. One professional rugby league team were tracked over the course of three games, to determine differences throughout in-game play, as measured using 5 Hz (with interpolation to 15 Hz) global positioning system technology, allied to 100 Hz accelerometers. Data was collected from players during three competitive matches; two in England and one in Australia. The game in the southern hemisphere was undertaken at the mid-point of the study. The key dependent variables were related to in-game movement dynamics, including average and maximum speeds, distances, accelerations and decelerations. Monitoring of performance during periods of intense bi-hemispheric competition will inform coaches and conditioners of the unique requirements for physical preparation and readiness in the elite travelling athlete, as well as the physical differences experienced between NRL and SL opposition.

2.1 Participants

Fifteen elite level professional rugby league players (Age 23±3 yrs; Stature 181±6 cm; Body Mass 97±9 kg) gave written, informed consent to take part in this study. Players represented the reigning ESL champions. Testing was undertaken between early February to early March 2014, to coincide with the start of the ESL campaign, and also accommodating the annual World Club Challenge match, held in Australia. This match is undertaken between the respective champions of elite European and Australian rugby leagues. All players were full time professional athletes, many of whom were representative internationals and were considered 'competition-ready'. The research was approved by the University Ethics Committee at the University of Central Lancashire, and operated in accordance with the principles of the Declaration of Helsinki.

2.2 Procedures

The current study used commercially available global positioning systems (SPI Pro XII, GPSports Systems, Canberra, Australia), sampling at 5 Hz with 15 Hz interpolation, allied to an inbuilt 100 Hz/8g accelerometer. An overview of the basic principles of GPS signal acquisition and processing has been reported previously (Schutz and Herren 2000; Cummins *et al*., 2013). These systems operate using a non-differential mode and provide retrospective or real time information on distance and speed. In the current study, all data were analysed retrospectively. Units were worn in a specialist mini playing shirt pouch, padded, and located in the upper centre area of the back, approximately at the level of the first thoracic vertebrae (McLellan and Lovell, 2012, 2013). All players had previous experience wearing these devices, and there are no contraindications to such wear during competitive game play. Integrated GPS/acceleromtery systems have been frequently used to determine the in-game characteristics of a number of invasion games (Boyd *et al*., 2011; Johnston *et al*., 2012; McLellan *et al*., 2011).

GPS units provide information based on the principle of trilateration. Through the acquisition of signals from four satellites, and rate of change of signal frequency (Doppler Shift), information on distance covered, speed and the characteristics of in-game performance can be determined. In a recent systematic review, work rate patterns are most often reported using GPS technology, whilst accelerometer data remain less commonly stated (Cummins *et al*., 2013).

2.3 Classifying Movement and In-game Demands

There remains a lack of agreement with regard to the classification of movements within games, particularly with regard to boundaries of absolute speed. Such a lack of consistency in the definition of speed zones negates meaningful comparisons of absolute demands of team sports (Cummins *et al*., 2013). Such standardisation of speed zones is proposed to be unfeasible, due to disparities in work-rate pattern activities, both within and between games (Cummins *et al*., 2013). Therefore, often 'club-centred' or 'software-centred' speed zones are used when analysing in-game GPS data. In the current study, classifications by speed zone were based on a simple description of efforts classified as 'high speed' (>5 $m.s^{-1}$). With this basic classification system, the following variables were assessed; total distance covered (m), distance covered at high speed (m), total number of high speed sprints, number of accelerations (>2 $m.s^{-2}$) and number of decelerations (> 2

m.s-2). These variables were also analysed compared to the amount of game time played and the amount of time the ball was deemed in play. Whilst GPSports units (SPI Pro XII) have demonstrated high intra- and inter- accelerometer reliability (Kelly *et al*., 2015) they have yet to be validated as a method for determining contact loads (Gabbett, 2013b). It is for this reason that impact data from this study has not been included, although some studies have identified the possibilities of using video and researcher led mathematical algorithms to classify collisions from GPSports units (Cummins and Orr, 2015).
Ball in play time was calculated as the amount of time the players were active in gameplay, accounting for stoppages such as injury and video referee decisions. This data was provided by an independent analysis service. The average temperature at each of the games and score line were also recorded.

2.4 Statistical Analysis
Following the determination of a descriptive profile (all data presented as mean ± SD), comparisons between games were assessed using a one-way repeated measures analysis of variance, with pairwise comparisons undertaken when required. The criterion for significance was set at $P \leq 0.05$. Effect size was determined using a partial Eta^2 calculation ($p\eta^2$). Post-hoc analyses were undertaken using pairwise comparisons. The Shapiro-Wilk statistic revealed a normal distribution for all variables. Statistical analysis was completed using the software packages SPSS version 21.0 (SPSS Inc, Chicago, USA).

1. Results
Descriptive data for all speed and distance analyses are presented in table 1.

Table 1. Comparison of distance, speed and contextual factors between the three games. (All GPS values are expressed as Mean ± S.D)

	Game 1 (England Game 1)	**Game 2 (Australia WCC)**	**Game 3 (England Game 2)**
Total distance completed per player (m)	5642 (1427)	5261 (1774)	5059 (1176)
Relative distance in metres per minute of game time played	78 (8)	78 (7)	73 (7)
Relative distance in metres per minute during time the ball was in play	97	120	108
Total distance per player at high speed >5 m.s-1 (m)	231 (167)	393 (172)	330 (163)

Distance at high speed >5 m.s^{-1} per minute of game time played	3 (2)	6 (2)	5 (2)
Distance at high speed >5 m.s^{-1} per minute of time the ball was in play	4	9	7
Total number of high speed (>5 m.s^{-1}) sprints per player	32 (23)	82 (32)	42 (24)
Number of high speed (>5 m.s^{-1}) sprints per minute of game time played	0.4 (0.2)	1.2 (0.3)	0.6 (0.3)
Number of high speed (>5 m.s^{-1}) sprints per minute of time the ball was in play	0.6	1.9	0.9
Total number of accelerations per player (>2 m.s^{-2})	67 (33)	144 (46)	75 (32)
Number of accelerations (>2 m.s^{-2}) per minute of game time played	0.9 (0.4)	2.3 (0.7)	1.1 (0.4)
Number of accelerations (>2 m.s^{-2}) per minute of time the ball was in play	1.2	3.3	1.6
Total number of decelerations per Player (>2 m.s^{-2})	95 (34)	164 (55)	94 (32)
Number of decelerations (>2 m.s^{-2}) per minute of game time played	1.3 (0.4)	2.5 (0.6)	1.4 (0.5)
Number of decelerations (>2 m.s^{-2}) per minute of time the ball was in play	1.6	3.7	2.0
Ball in play time (minutes)	58	44	47
Score	8-24 Lost	36-14 Lost	46-24 Won

Average temperature (degrees Celsius)	6	21	9

All data reflect whole-team averages, and are not stratified by position.

There was a significant increase in the total distance covered at high speed when playing in Australia compared to the two European games ($p=0.04$; $p\eta^2 = 0.36$). Similar increases were observed for the total number of high speed sprints ($p=0.001$; $p\eta^2 = 0.44$), number of accelerations ($p=0.005$; $p\eta^2 = 0.42$) and number of decelerations ($p=0.002$; $p\eta^2 = 0.60$). The significant increases remained for the number of accelerations when analysed per minute of game time played ($p=0.0001$; $p\eta^2 = 0.59$) and per minute of time the ball was in play ($p=0.0001$; $p\eta^2 = 0.44$). The data followed the same trend for decelerations when analysed per minute of game time played ($p=0.0001$; $p\eta^2 = 0.60$), decelerations per minute of time the ball was in play ($p=0.0001$; $p\eta^2 = 0.44$), for the number of sprints per minute played ($p=0.0001$; $p\eta^2 = 0.35$) and number of sprints per minute of ball in play time ($p=0.0001$; $p\eta^2 = 0.38$). The distance per minute during time the ball was in play in game two was significantly higher than the other games ($p=0.0001$; $p\eta^2 = 0.09$). These differences were manifested solely between the Australian game and the 'book ended' European fixtures. The total time the ball was in play differed significantly between all three games ($p=0.0001$; $p\eta^2 = 0.71$). No significant differences were observed for total distance covered or distance per minute of game time played.

4. Discussion

This is the first study to assess in-game match demands of competitive rugby league, for a travelling team, between northern and southern hemispheres. There was remarkable similarity in the total distance covered in the observed games. This was similar to that reported previously for Super League (Waldron *et al*., 2011) and NRL (McLellan *et al*., 2011; Twist *et al*., 2014). However, there was a significant difference in how this distance was achieved with a greater proportion of the distance covered at high speed in the WCC game. This fixture also saw a significantly greater number of high speed sprints, accelerations and decelerations compared with the regular season Super League games. Furthermore, these differences were accentuated when data was compared per minute of game time and per minute of time the ball was in play.

Of great interest is that the number of acceleration and deceleration efforts, combined with total distance covered at high speeds, were higher in the WCC than for either of the 'bookending' ESL games. It has been reported previously that greater relative distance high-speed running occur in NRL games than in the ESL (Twist *et al*., 2014). Our findings certainly confirm this observation, and provide evidence for the importance of high speed efforts engaged in within the NRL versus ESL competition. When total distance was analysed per minute of time the ball was in play there was a significant increase in the metres covered per minute in the WCC game. This further highlights the intensity and high speed nature of this competition when compared with the UK based games. It must be stressed that the WCC is a one-off game, undertaken early in the competitive season

(ESL) or immediately prior to season start (NRL). Despite the NRL not being in common 'in-season' phase when the WCC occurs, it is clear that the game does act as an excellent analogue for the demands of regular season competition, with higher levels of high speed running a critical aspect of physical performance.

Recent papers have shown that an increase in distance covered at high speed is a distinguishing factor between less successful and more successful teams (e.g. Hulin *et al.*, 2014). Indeed out of the three games in this study, the one lost by the biggest margin had the largest amount of distance covered at high speed. However, not all games in the present study followed this trend with the third fixture having a greater distance covered at high speed than game 1 (non SD), even though the fixture was won. It has been suggested (Hulin *et al.*, 2014; Evans *et al.*, 2015) that ball in play time can influence activity profiles too. Less time that the ball is in play limits the opportunity to perform physical work, but it also gives greater opportunity for rest and a potential to maintain high speed efforts. The results of the current investigation would follow this assumption, but nevertheless there are a large number of other factors that also have the potential to influence activity profiles. Of which, Kempton and Coutts (2015) have recently examined a number of these variables confirming their impact on activity profiles.

In particular, for this study, the WCC game was refereed under slightly different rules to ESL games. Two referees oversaw the game on field with the speed of the ruck anecdotally said to be quicker than the ESL. There was a vast difference in temperature, weather and pitch surface across the games in this study. Although previous research (Twist *et al.*, 2014) has found no link between the time of season on activity profiles, a recent study in the ESL (Evans *et al.*, 2015) showed high speed running demands to be greater than previous research when home games were played on a faster artificial 4G surface. Furthermore, travel demands are known to influence physical performance (Leatherwood and Dragoo, 2013). Whilst the team in this study used recovery methods and techniques to combat jet lag it is plausible that the detrimental effects influenced the maximum physical performance possible in games two and three. Although these factors may have had some impact it is likely that similar results would have been found if the game was to be played in the UK. This is because two of the leading factors that are thought to have the largest bearing on activity profiles are standard of competition and tactical and technical differences in performance (Hulin *et al.*, 2014). Sirotic *et al.* (2009) previously compared elite and semi elite athletes to find that playing intensity is significantly greater in elite competitions. The NRL competition is certainly perceived as a higher-level competition, and clearly the demands of the transition from ESL to NRL standard competition presented very different challenges for the European champions. The implications of maintaining high speed efforts, to overall game success, cannot be overstated (Twist *et al.*, 2014; Di Salvo *et al.*, 2010). In addition, a recent paper (Gabbett, 2014) demonstrated that tactical and technical differences are also associated with success, at least in semi-professional competitions. Indeed, a team who keeps the ball in play in an 'arm wrestle' with the other team will certainly have different activity profiles to a team who attempts to kick the ball out of play and slow the game by any means. Furthermore, the teams' technical effectiveness to do this will have bearings on the activity profiles. There seems to be a multifactorial relationship between activity profiles

and the technical and tactical effectiveness that results in success. It is conceivable that statistics from the games (tackle counts, hit ups, errors etc.) together with the video of the performance may elucidate a better overall picture on the physical demands recorded by the GPS units. The recognition of multimodal assessment of in-game play may be required to fully reveal the nature of competitive performance.

A key determinant of high speed performance, that has yet to receive great attention in contemporary literature, is that of acceleration and deceleration efforts. One of the major reasons for the paucity of information is the questionable validity of GPS devices to measure these variables. Kelly *et al.* (2015) demonstrated that whilst the units used in this study are capable of a consistent measure of acceleration they were often of lower magnitude than the criterion reference. Newer 10Hz GPS have been shown to be more accurate during linear movements (Varley *et al*., 2012). However, as Buchheit *et al.* (2014) suggest, acceleration and decelerations should be interpreted with a degree of caution. Few reports have been published identifying the role of acceleration and deceleration activity in professional rugby league matches (Gabbett, 2012; Johnston *et al*., 2014), instead focussing more on number of sprint efforts. Accelerations and decelerations are essential elements of rugby league performance, allowing for effective breaks to be made, tactical adjustments when in offensive/defensive formations and also when accepting forces generated in the tackle or play the ball. Our findings revealed that acceleration and deceleration components were very much higher in the WCC than during the 'bookending' competitive ESL games.

Optimisation of acceleration/deceleration efforts appears to be advantageous to the NRL team, and must be considered influential in the context of their success in the WCC game. Previous studies have indicated the association between acceleration and deceleration abilities (Gabbett *et al*., 2011; Gabbett and Wheeler, 2014). Optimisation of acceleration capability, and by extension deceleration, has been proposed to improve repeated high-intensity abilities in rugby league (Gabbett and Wheeler, 2014). Our findings confirm the role of acceleration and deceleration as an important characteristic of success in the WCC. Further research is needed to determine if such influence exists across the course of an entire season, between hemispheres.

It is worth noting that this study only investigated a small number of games. This is an obvious limitation as match-to-match variation in GPS data can be high (Kempton *et al*., 2014). However, ESL and NRL teams only met once every year at the time of study and simply increasing the number of games with the same team and players (with the same playing style) can expose a study to pseudo replication. Future investigations could take advantage of assessing a greater range of teams in the new structure of the WCC competition, as well as assessing other international rugby league events, individual positions, smaller periods of match-play and in-game statistics of technical and tactical performance. Lastly, current studies have not yet assessed demands of collisions, wrestle and repeat high intensity efforts involved in rugby league between hemispheres. This is a huge part of the demands of rugby league and a multimodal assessment strategy (GPS units/video/game stats) could be used to incorporate these demands alongside other important variables in future studies.

In conclusion, this study was unique in gaining access to an elite level rugby league team as they played games across hemispheres, and between leagues. As predicted the WCC game was the most demanding out of the series of games, as evidenced through greater high speed activity. It is clear that the role of high speed efforts, notably regarding acceleration and deceleration, will be a key issue for coaches and conditioners to consider when formulating preparatory plans for such events in the future. For northern hemisphere teams to excel in this fixture, particularly given hemispheric transition, a greater understanding of the role of acceleration and deceleration efforts is needed. The rapid transition between hemispheres and expectation to perform at consistently high levels presents significant challenges for support teams. Monitoring of athlete wellness and allusion to impacts on performance is an essential next stage of analysis, and should be considered with regard to in-game analysis, as reported in this study.

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Appendix B – Study 1 Survey

How do high performance sports teams implement and use wellness questionnaires?

Introduction to the Survey

Purpose of the study

You are invited to complete this survey via SurveyMonkey.com as a result of your involvement in high performance sport. The survey is part of PhD research that aims to determine how practitioners within team sports implement and use wellness questionnaires with their athletes. This survey should take 10 minutes to complete.

Do I have to take part?

No. Participation in this study is voluntary and it is up to you to decide whether or not you take part. Consent to participate in this study is implied by completion of the survey.

What is involved if I take part?

You will be required to complete a series of questions in three sections that outline your experience of using wellness questionnaires. These sections include background information such as the sport you work in, details on the type of questionnaire used and how it is implemented within your team. Completion of the survey will be completely confidential and anonymous. No data will be collected that will enable identification of the respondent or associated sports team unless you submit your details to participate in follow up questions.

What are the benefits to me taking part?

There are no immediate benefits from taking part. However, by completing the survey you will be helping to contribute to PhD research to establish how wellness questionnaires can be best used within elite sports.

What will happen to the information you collect?

Upon completion of data collection, data will be downloaded from the SurveyMonkey.com website and stored on password protected computers for a period of up to 3 years. The survey itself is password protected and data from the survey will only be accessed by those with a legitimate research need. The results will be written up and included in a PhD Thesis on the use of wellness questionnaires. In addition, results will appear in peer reviewed journals and academic conference presentations.

Privacy

This research does not seek to ascertain private organizational data. Information will not be used to credit or discredit the individual or organization in any way. It will be possible, if you wish, to be contacted to explain further information around the use of wellness questionnaires by providing your contact details in the final question. If you decide to leave this information blank you will not be able to be identified. This includes location data associated with IP addresses being recorded as the survey has been set up with 'IP Tracking' disabled. Please note that SurveyMonkey is located on an American server and thus subject to American Homeland Security laws such as the Patriot Act. Any contact details you provide will be used to contact you regarding this research only. Contact details will never be stored alongside responses and all identifiable information will be removed from results. All email correspondence will be deleted after data analysis has been completed.

Complaints procedure

If you have any concerns or complaints about any aspect of this study, you should ask to speak to the lead researcher whose contact details are stated below. Alternatively, or if you do not feel comfortable speaking with the research team, you should direct your query/complaint to the university ethics officer at officerforethics@uclan.ac.uk

Contact Details

Mark Quinn
University of Central Lancashire
mequinn@uclan.ac.uk

Thank you for taking the time to read this and please follow the instructions for completion below.

Survey Instructions

Please take your time and answer all questions independently and honestly to the best of your ability. If at any point you decide that you no longer wish to participate in this survey, simply close your web browser and your responses will be deleted. Once the survey has been completed it will not be possible to delete your responses and all complete data will be used for final analyses. This survey is anonymous. However, on the final page of the survey you do have the option to enter your contact details if you wish to participate in follow up questions regarding the use of wellness questionnaires.

This survey should take 10 minutes to complete.

Wellness Questionnaire Monitoring Practices

This survey refers to the practice of using wellness questionnaires. This includes any measure where an athlete self-reports their perceptions of their physical, psychological and/or soci al state. The measure may be used for, but is not limited to, purposes including assessing the readiness to train, the response to a training program or the susceptibility to illness/injury/overtraining.

1. **How often do your players complete wellness questionnaires?**
   Every Day
   Every Training Day
   Weekly
   Monthly
   Other

2. **How many items exist on the questionnaire?**
   1-5
   1-10
   1-15
   15+

3. **What type of scale is used? (please select all that apply)**
   Numbered Rating Scale (e.g. 1-10)
   Worded Rating Scale (Sore---Fresh)
   Both numbered AND worded (semantic differential scale)
   Dichotomous (yes/no, true/false)
   Other

4. **What type of questionnaire do you use?**
   Custom Designed
   Empirical Measure
   (Drop down select e.g POMS, ABQ)

5. **On average, what is the typical completion rate of the questionnaire?**
   Below 50%
   50 - 75%
   75 – 90%
   Above 90%

6. **Which of the following do you use to analyze data?** *Please tick all that apply.*

   Changes in raw score
   Mean (Average)
   Standard Deviations
   Z-Scores
   Coefficient of Variation
   Smallest Meaningful Change
   Acute to Chronic ratios
   Percentage Change
   Other (please specify)

7. **Which three athlete monitoring practices do you consider to be the most important within your sport?**
   Please number these based on first, second and third preference
   Wellness Questionnaires
   RPE
   GPS & Accelerometery
   Biochemical & Hormonal tests
   Immunological tests
   Heart Rate
   Performance Tests (submax cycling, CMJ)
   Movement Screening
   Session Data (e.g. time)
   Sleep tracking wearables
   Monotony and Strain Calculations
   Training Details – e.g. frequency, duration and mode of sessions

Power Meters
Other

8. **Which are the top three reasons why you monitor player wellness?** ***Once again, please indicate your first, second and third options.***
Assess training readiness
Monitor the response to training
Prescribe recovery
Prevention of Injury, illness and Overtraining
Assess non training parameters (e.g. sleep)

9. **Have you ever taken any of the following decisions based on or partly based on wellness data?** *Please tick all that apply*.
Decisions regarding individual players
Decisions regarding the full team
Modification of training
Modification of recovery sessions
Follow up chat with the player
Individual referrals to other practitioners (e.g. psychologist / physio)
Performance decisions (e.g. not selected to play)

10. **Purpose/DC**

What are your thoughts on including the following aspects in a wellness questionnaire?	Unimportant	Of Little Importance	Moderately Important	Important	Very Important
Daily Weight (kg)					
Fatigue Index					
Hydration					
Illness					
Mood					
Motivation					
Muscle Soreness					
Non-Training Stress					
Nutrition					
Player Comments					
Rating of Perceived Exertion (RPE)					
Sleep (quality and quantity)					

Implementation

11. How would you rate the implementation of and use of the wellness questionnaire within your team?

Very Poor
Poor
Satisfactory
Good
Excellent

12. What is the most important factor that influences your implementation of your wellness questionnaire? *please indicate your first, second, third and fourth priority.*

The organisation having the right culture, staffing and structures to facilitate the use of wellness data
The measure being easy to use, time efficient and outputting valid and reliable data
Players being honest and remembering to complete the questionnaire
The coaches and players actually buying in to using the data

13. Please rate your agreement with how much these are completed in practice:

	Strongly Disagree	Disagree	Undecided	Agree	Stongly Agree
We have set clear guidelines regarding data access (e.g. staff awareness of data protection)					
We have sufficient resources to get the most out of wellness questionnaires (e.g. staffing, time, financial)					
We regularly use data to inform our decisions					
We have a questionnaire which is easy to use and takes little time to complete					
We have a quetionnaire we can use anywhere (including without internet connection)					
We are satisfied with the level of analytics, data output and visualisation of results					
We ensure players are honest in their responses and not influenced by others					
Our staff encourage completion through reminders					
Our staff encourage completion through punishments					
Players and staff understand why we use the questionnaire and who benefits from it					
We provide regular feedback to players					
We have a key staff member who drives the use of the questionnaire					
We continually review how the wellness questionnaire is being used					
We have made adaptations based on experiences using the questionnaire					

Demographic Information

14. **Which of the following best describes your role?**
    Sport Scientist
    S&C Coach
    High Performance Manager
    Medical practitioner
    Coach
    Sport Psychologist
    Performance Analyst
    Other (please state)

15. **What is the main sport you currently work in? (dropdown e.g. Rugby Legue, Rugby Union, Soccer)**

16. **Please state the competition the team you work for plays in: (e.g. Premier League)**

17. **What is the gender of your athletes:**
    Male
    Female
    Mixed

18. **What is the level of sports performance you are involved in?**
    Elite First Team
    Elite Youth / Academy Team

Thank you and Follow-Up

Thank you for taking the time to answer the above questions.

Would you agree to be contacted for a follow-up telephone call or email regarding your responses?
No
Yes via telephone
Yes via email

If you answered yes, please supply your name, organization and the most convenient way to contact you below.

Privacy Notice: Your contact details will only be used to contact you regarding the study. Any information you subsequently provide will be recorded anonymously.

Appendix C – Individual player wellness values, standard deviations and flagged values

		Wellness			Flagging System				Count		
Player	Training Day	Mean	Standard Deviation	Standard Error of Measurement	MDC	z1.5	z2		MDC	z1.5	z2
Player 1	MD+4	55.71	3.25	1.31	3.64	4.88	6.50		1.00	1.00	0.00
	MD+6	58.88	7.66	3.09	8.58	11.49	15.32		2.00	2.00	0.00
	MD+1	50.67	3.21	1.30	3.60	4.82	6.43		1.00	0.00	0.00
Player 2	MD+4	52.00	6.24	2.52	7.00	9.37	12.49		2.00	1.00	1.00
	MD+6	56.57	3.51	1.42	3.93	5.26	7.01		4.00	1.00	0.00
	MD+1	33.33	6.09	2.46	6.82	9.13	12.18		1.00	0.00	0.00
Player 3	MD+4	61	2.20	0.89	2.46	3.30	4.40		4.00	2.00	1.00
	MD+6	62.75	3.85	1.55	4.31	5.77	7.69		3.00	1.00	0.00
	MD+1	51.29	7.87	3.18	8.81	11.80	15.74		1.00	1.00	0.00
Player 4	MD+4	51.00	3.46	1.40	3.88	5.20	6.93		1.00	0.00	0.00
	MD+6	53.00	3.39	1.37	3.80	5.09	6.78		2.00	1.00	0.00
	MD+1	37.50	7.78	3.14	8.71	11.67	15.56		0.00	0.00	0.00
Player 5	MD+4	54.83	2.14	0.86	2.39	3.21	4.27		3.00	2.00	0.00
	MD+6	55.40	1.82	0.73	2.04	2.72	3.63		3.00	0.00	0.00
	MD+1	43.80	1.79	0.72	2.00	2.68	3.58		1.00	1.00	0.00
Player 6	MD+4	62.00	2.92	1.18	3.27	4.37	5.83		3.00	2.00	0.00
	MD+6	65.25	1.91	0.77	2.14	2.86	3.82		3.00	1.00	1.00
	MD+1	44.00	9.27	3.74	10.39	13.91	18.55		2.00	1.00	0.00
Player 7	MD+4	58.63	2.20	0.89	2.46	3.30	4.40		4.00	2.00	1.00
	MD+6	59.57	2.23	0.90	2.49	3.34	4.45		3.00	2.00	1.00
	MD+1	54.00	1.41	0.57	1.58	2.12	2.83		0.00	0.00	0.00
Player 8	MD+4	59.33	2.08	0.84	2.33	3.12	4.16		2.00	0.00	0.00
	MD+6	57.67	6.03	2.43	6.75	9.04	12.06		0.00	0.00	0.00
	MD+1	47.25	12.76	5.15	14.30	19.15	25.53		2.00	0.00	0.00
Player 9	MD+4	55.71	0.76	0.31	0.85	1.13	1.51		4.00	4.00	0.00
	MD+6	55.33	1.37	0.55	1.53	2.05	2.73		2.00	2.00	0.00
	MD+1	48.00	4.24	1.71	4.75	6.36	8.49		0.00	0.00	0.00
Player 10	MD+4	57.67	3.79	1.53	4.24	5.68	7.57		1.00	0.00	0.00
	MD+6	57.00	3.16	1.28	3.54	4.74	6.32		1.00	0.00	0.00
	MD+1	42.00	2.83	1.14	3.17	4.24	5.66		0.00	0.00	0.00
Player 11	MD+4	51.13	3.18	1.28	3.56	4.77	6.36		2.00	2.00	0.00
	MD+6	53.50	1.64	0.66	1.84	2.46	3.29		2.00	2.00	1.00
	MD+1	38.00	5.66	2.28	6.34	8.49	11.31		0.00	0.00	0.00
Player 12	MD+4	61.57	1.81	0.73	2.03	2.72	3.63		2.00	1.00	1.00
	MD+6	62.83	1.60	0.65	1.79	2.40	3.20		1.00	1.00	1.00
	MD+1	47.67	1.53	0.62	1.71	2.29	3.06		1.00	1.00	0.00
Player 13	MD+4	62.00	2.76	1.11	3.09	4.14	5.51		1.00	1.00	0.00
	MD+6	63.88	0.35	0.14	0.40	0.53	0.71		8.00	1.00	1.00
	MD+1	46.33	2.52	1.02	2.82	3.77	5.03		1.00	0.00	0.00
Player 14	MD+4	56.60	4.04	1.63	4.52	6.06	8.07		1.00	1.00	0.00
	MD+6	60.20	2.77	1.12	3.11	4.16	5.55		2.00	1.00	0.00
	MD+1	53.00	5.66	2.28	6.34	8.49	11.31		0.00	0.00	0.00
Player 15	MD+4	56.22	3.96	1.60	4.44	5.94	7.92		3.00	2.00	0.00
	MD+6	61.33	4.27	1.72	4.79	6.41	8.54		3.00	3.00	0.00
	MD+1	39.86	6.74	2.72	7.55	10.12	13.49		1.00	1.00	0.00
Player 16	MD+4	56.25	2.71	1.10	3.04	4.07	5.42		2.00	1.00	1.00
	MD+6	57.63	2.83	1.14	3.16	4.24	5.65		2.00	1.00	1.00
	MD+1	43.86	5.30	2.14	5.94	7.96	10.61		1.00	1.00	0.00
Player 17	MD+4	57.75	4.43	1.79	4.96	6.64	8.85		1.00	0.00	0.00
	MD+6	65.25	5.06	2.04	5.67	7.59	10.12		1.00	0.00	0.00
	MD+1	57.00	3.16	1.28	3.54	4.74	6.32		1.00	0.00	0.00
Player 18	MD+4	61.50	8.18	3.30	9.16	12.26	16.35		3.00	1.00	0.00
	MD+6	67.86	2.41	0.97	2.70	3.62	4.82		2.00	1.00	0.00
	MD+1	36.60	8.73	3.53	9.79	13.10	17.47		1.00	1.00	0.00
Player 19	MD+4	56.33	1.00	0.40	1.12	1.50	2.00		6.00	1.00	1.00
	MD+6	56.63	1.19	0.48	1.33	1.78	2.38		3.00	1.00	1.00
	MD+1	38.50	5.15	2.08	5.77	7.73	10.31		2.00	2.00	0.00