



Ecological validity of self-reported wellness measures to assess pre-training and pre-competition preparedness within elite Gaelic football

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Abstract

The current investigation aimed to examine the ecological validity of self-reported wellness questionnaires, and specifically ‘Readiness to Train’ (RTT) as an indicator of pre-training and pre-competition preparedness within elite Gaelic football players. Thirty-seven ($n=37$) elite male Gaelic football players (age 26 ± 4 ; height 181 ± 15 cm, weight 86 ± 4 kg) were recruited for the current study which took place during the 2017 competition season. Participants were monitored using global positioning system technology (GPS; 10-Hz; STATSports Viper Pod; STATSports; Newry, UK) and a self-reported questionnaire (Metrifit, Health, and Sport technologies, Ireland) to provide measures of internal load (RPE; sRPE) external load (GPS variables) and wellness questionnaire (Likert scale: 1–5 response) response to training loads. Results showed that irrespective of the model that the percentage RTT prior to training or match-play was not associated with and running performance measures. Activity type ($p \leq 0.0001$), muscle soreness ($p \leq 0.0001$), sleep quality ($p \leq 0.0001$), and sleep duration ($p \leq 0.0001$) all effected subsequent running performance during training and match-play. Furthermore, post hoc analysis showed that specific GPS variables and accumulated training load across specific time durations impacted RPE and total internal training load. Our results indicate that RTT is a poor measure of pre-training and competition preparedness, with individual sub-scales of wellness more appropriate to measure preparedness within Gaelic football players. Practitioners should pay close attention to fluctuations in sleep quality, sleep duration, and muscle soreness when planning training loads. Also, accumulated training loads impact players running capacity and perception of RPE highlighting the importance of longitudinally planning within the Gaelic football training process.

Keywords GPS · Self-reporting questionnaires · Training load monitoring · Team sports

Introduction

Gaelic football is one of the national sports of Ireland [1–3]. This is an intermittent invasion field-based team sport characterised by high-intensity bouts of anaerobic exercise interwoven with sustained light to moderate aerobic activity [4, 3]. Athlete monitoring has become more evident within the Gaelic football training process over the past decade with objective and subjective analysis across training and match-play now commonplace. Indeed, global positioning system analysis of athlete running performance has shown that these athletes cover an average distance of 8–10 km over 70 min therefore high levels of aerobic fitness are desirable [1, 5, 6]. However, key moments of match play such as gathering possession, evading opponents and breaking tackles demand well rounded physical qualities such as high-speed running

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capacity and repeated effort ability in addition to strength and power qualities [5, 7].

The competition phase within elite Gaelic football runs from February–September during which teams compete for National League and All-Ireland Championship titles, playing up to 15 games between competitions [8]. A typical week at an elite level includes 1–2 gym sessions, 2 field sessions, and a match or training session at the weekend [8]. One to 2-week periods between matches are common during which time players' training load must be balanced to ensure an appropriate physiological stimulus is provided. The individual management of athletes during competition is challenging given that both playing position and the level of opposition influence the physical demands of match play [5, 6, 3]. Therefore, support teams strive for optimal player management strategies to ensure the right balance between fitness and fatigue to maximise performance levels and ensure athletes are not over-trained [9, 10].

Irrespective of the sport optimising athlete performance requires careful planning and manipulation of training load over the course of a competition calendar [11]. Central to this process is the longitudinal monitoring of an athlete's response across acute and chronic training load periods [2, 8, 12]. Athlete monitoring data provide coaches with useful information that may be used to prescribe and tailor training loads and reduce the incidence of injury in athletes [11, 13–15]. Research to date has predominantly focused on objective measures (physical, physiological, and biochemical) as a means of monitoring training response within team sport athletes [16]. Indeed, invasive methods such as biomarker assessment have been shown to fluctuate across training periods with elevated cortisol levels found in elite Gaelic football cohorts post-match indicating that a 48 h window may be required for optimal recovery from match play exertion [17]. In light of the invasive and fatiguing nature of biochemical and performance testing, many teams do not engage in these testing batteries with a major limitation of the literature to date being the focus on small data sets across limited time points [17]. Therefore, subjective self-report measures have received increased interest within the literature as a method of monitoring team sport athletes' response to training given their ease of use and simplicity of data feedback from athletes to support staff [18–22]. In support of this recent studies within AFL [23] and soccer [24] have shown that specific Z-scores of wellness measures are associated with reduced training outputs, providing support for the utilisation of simple and cost-effective measures such as wellness variables as a tool to understand training preparedness and response.

The utilisation of self-reported questionnaires to assess player wellness is now commonplace with bespoke questionnaires typically preferred due to logistical constraints

of assessment within team sports cohorts [21, 22]. These questionnaires typically consist of a set of questions that players rank on an ordinal scale (e.g. 1–5) [22]. Fatigue, muscle soreness, sleep, and mood state assessment formulate the key wellness-oriented components of most questionnaires [19, 21, 25, 26] given their association with training outputs, injury and overtraining [9, 20, 23, 25, 27]. Given the popularity of these self-reported assessments, there has been an increase in commercial companies, providing online platforms allowing practitioners to readily assess athlete wellness via smartphone or tablet devices. Recently within Gaelic football, specific online platforms have begun to provide a composite wellness score referred to as 'readiness to train' (RTT). This is a composite percentage score based on a joint weighting system and a cumulative wellness score generated from athlete responses [28]. Previously, McGahan et al. [28] observed that RTT values fluctuated across seasonal training periods, suggesting that RTT may be a useful tool to monitor adaptive responses to subtle changes in training and game load within elite Gaelic football players [28]. In line with these findings, coaches and medical staff would typically review individual RTT data through a holistic approach daily to best manage individual athlete workloads to ensure optimal preparedness to train and compete [29]. However, for RTT to have a practical application, any meaningful deviation of this metric should be reflected in reduced training or match-play outputs thus showing the ecological validity of the measure within the Gaelic football training process. However, to date, this has not been investigated within an elite Gaelic football cohort.

The effect of multiple games and practice sessions over the course of a season on recovery markers is not fully understood with respect to elite Gaelic football. Nonetheless, wellness measures have been found to display increased sensitivity to subtle changes in training load compared with biochemical or physical performance tests [18]. There is also evidence that pre-training wellness data may provide information about an athlete's ability to perform within a training session or match [20, 23, 24, 26, 27]. However, the challenge for many practitioners is balancing training stimulus whilst minimising the risk of injury and overtraining [11]. Therefore, monitoring tools must be practical and provide high quality and meaningful data to aid coaches' ability to manipulate training load within team sports settings. Given the above, the current investigation aimed to examine the ecological validity of self-reported wellness questionnaires, specifically RTT as an indicator of pre-training preparedness within elite Gaelic football players. Secondly, we aimed to understand the association between RTT, running performance variables, and RPE training load during a competitive season.

Methods

Subjects

Thirty-seven ($n = 37$) elite Gaelic football players (age 26 ± 4 ; height: 181 ± 15 cm, weight 86 ± 4 kg) were recruited for the current investigation. Players were current members of the All-Ireland winning squad from the previous 2017 season at the time of the investigation. All players were informed of the benefits and risks of the investigation prior to signing an institutionally approved informed consent document to participate in the study. All experimental procedures for this study were approved by a local Research Ethics Committee (Dublin City University REC).

Experimental approach to the problem

An observational design was used to retrospectively analyse daily subjective wellness questionnaires, training load, and GPS data collected during the 2017 season. A total of 86 collective training sessions consisting of 2190 individual observations were included in the final analysis (Jan 2017–Sept 2017). Players that completed < 3 sessions were excluded from analysis, additionally no data was collected during the mid-season break in April due to sub-elite club-based commitments of players which is the norm within elite Gaelic football teams. All field-based training sessions were completed on a full-length GAA grass field, with gym sessions completed by all players in line with a typical Gaelic football training week. Within all training and match-play sessions, players were permitted to drink water at libitum. Subjective wellness data (mood, sleep quality, sleep duration, energy, soreness, diet, stress, health) were aggregated across a daily and weekly period during the period. These aggregated scores allowed for a ‘readiness to train’ percentage (RTT %) to be automatically calculated for each player. The subjective internal and objective external demands of collective training were quantified using RPE [30] and GPS technology respectively [1, 3, 4, 5, 6, 7]. All data were categorised across the full season but also for descriptive purposes categorised into three specific phases of pre-season (Jan–Feb 2017), early in-season (Mar–June 2017), and late in-season (July–Sept 2017).

Data collection

Wellness and readiness to train (%) assessment

Participants completed a daily subjective wellness questionnaire (MetriFit, Health, and Sport Technologies Ltd) before 14:00 every day during the observational period.

The questionnaire consisted of eight specific questions split across seven descriptors of wellness ranked on a 1–5 ordinal scale and sleep duration which was computed via hours (0–12 h). The descriptors were as follows: (1) Mood State (1 = very irritable, 5 = excellent mood); (2) Sleep Quality (1 = didn’t sleep at all, 5 = had a great sleep); (3) Energy Levels (1 = very lethargic, 5 = full of energy); (4) Muscle soreness (1 = extremely sore, 5 = not sore at all); (5) Yesterday’s Nutrition (1 = all meals high sugar/processed food, 5 = no added sugar/processed foods); (6) Stress (1 = extremely stressed, 5 = totally relaxed); (7) Health (1 = sick in bed, 5 = never better). The contribution of each descriptor to the overall RTT (%) value was dependant on their weighting. Mood State, Energy Levels, Muscle Readiness, Stress, and Health each accounted for up to 15% of the overall RTT score. Sleep Quality and Yesterday’s Diet up to 10% each, while Sleep Duration was up to 5% of the overall RTT. The maximum individual RTT value attainable was 100%.

Internal training load assessment

Athletes’ internal training load both intensity and training impulse was assessed via the modified Borg CR-10 rating of perceived exertion (RPE) Scale [30, 31]. RPE is a commonly used monitoring tool in field sport athletes. This scale has been shown to correlate with recognised physiological markers of training intensity [30, 31]. All RPE recordings were obtained from each player 30 min after the end of each training session in a blinded methodology [30, 31]. Each RPE value was multiplied by the session duration to generate an arbitrary unit (AU) and internal training load impulse for the specific session [2, 8]. Arbitrary units were collated across the observational period to provide an understanding of the training load completed by players on a daily and weekly basis [2, 8, 23].

External training load

Across the observational period, all athletes wore an individual global positioning system device recording at 10-Hz (Statsports Viper Pod, Newry; Northern Ireland; UK) within all training and match-play sessions [32, 33]. This specific GPS (10-Hz, Statsports, Viper Pod) has been validated across sport-specific movements previously and shows acceptable validity and reliability [34, 35]. To avoid inter-unit variation all participants were assigned the same unit for all training and match sessions [34, 35]. A vest was tightly fitted to each player, holding the receiver between the scapulae. All devices were always activated 15 min before the data collection to allow the acquisition of satellite signals in accordance with the manufacturer’s instructions [34, 35]. In addition, to avoid interunit error, each player wore the same GPS device during each competitive match [34, 35]. After

recording, the data were downloaded to a personal computer (Inspiron 15, Dell Technologies, TX, USA) and analysed using a propriety software package Statsport Viper version 3.2 (Statsports, Newry; Northern Ireland; UK). All data were exported retrospectively and stored within a bespoke internal and external training load database (Excel, Microsoft, Redmond, USA). Within this data, base running performance measures were stored and reported across the following operation definitions: total distance (m), high-speed distance ($m; \geq 4.47 \text{ m s}^{-1}$) maximal velocity (m s^{-1}), accelerations (m s^{-2}), decelerations (m s^{-2}), high metabolic load distance ($m; \geq 25 \text{ W kg}^{-1}$), dynamic stress load (AU) [1, 3–7, 36, 37].

Statistical analysis

A mixed model analyses with repeated measures was conducted on running performance, training load and RPE with the following variables as covariates: % RTT, Mood State, Sleep Quality, Energy Levels, Muscle soreness, Nutrition, Stress, Health, Total Distance High-Speed Distance, Accelerations, Decelerations, High Metabolic Load Distance, Dynamic Stress Load, Session Duration and Accumulated Training Loads across the previous 7 days. This exploratory analysis focused on (a) wellness markers that may impact training and match-play performance and (b) external measures of training load that can be controlled or manipulated by coaches in a given training session. To accommodate the effects of multicollinearity in the covariate variables a principal component analysis was conducted using % RTT, sleep duration, sleep quality, muscle soreness, and mood

state. The corresponding derived components (Total Distance, High-Speed Distance, Internal Training Load; Session Duration and RPE Intensity) were treated as covariates with activity type (athletic development, practice session, match) as a fixed effect and time as a repeated measures effect in separate mixed analysis models. Post-hoc stratified analyses were performed for activity type and comparisons were made using Wald ratios and Satterwhaite degrees of freedom. Analyses were performed using SPSS software version 24 (IBM Corporation, NY, USA).

Results

The mean \pm SD duration, RTT, and loading across specific session types are shown in Table 1. The wellness scores across three specific phases of the season are shown in Fig. 1. HSR and RTT across the phases of the season are shown in Fig. 2.

PCA

The relationship between time components was examined using correlation analysis and no major correlation existed within the model with respect to off-diagonal elements. Additionally, each player's individual time series over the period were examined and no significant autocorrelation was found between time points. Thus, a diagonal covariance structure was deemed most appropriate for the random time (repeated measure) component. The major

Table 1 The duration, RTT (%) and internal load variables with respect of session type across the study period

	Match play	Pitch session	Rehab session	Athletic development
Duration (min)	70 \pm 5	92 \pm 20 [^]	50 \pm 10 ^{**}	61 \pm 8
RPE (1–10)	8 \pm 1 [*]	6 \pm 3	7 \pm 3	6 \pm 3
sRPE (duration \times RPE)	521 \pm 200	647 \pm 234 [^]	350 \pm 76 ^{**}	357 \pm 83 [§]
Total distance	8869 \pm 1544 [*]	6256 \pm 1654 [^]	4089 \pm 1897 ^{**}	–
Relative distance (m min^{-1})	122 \pm 15 [*]	73 \pm 26 [^]	82 \pm 33	–
High speed running (m)	1561 \pm 878 [*]	1018 \pm 324	966 \pm 523	–
High metabolic load distance (m)	1636 \pm 897 [*]	1138 \pm 289	912 \pm 321	–
High metabolic load distance (m min^{-1})	25 \pm 8 [*]	14 \pm 8	22 \pm 9	–
Accelerations (<i>n</i>)	113 \pm 34	133 \pm 34 [^]	81 \pm 23 ^{**}	–
Decelerations (<i>n</i>)	95 \pm 23	98 \pm 21	84 \pm 36	–
Maximal velocity (m s^{-1})	9.98 \pm 0.98	9.98 \pm 0.98	9.78 \pm 0.89	–
Dynamic stress load (AU)	821 \pm 178	435 \pm 219 [^]	389 \pm 174	–
RTT (%)	86 \pm 9 [*]	82 \pm 8	65 \pm 9 ^{**}	77 \pm 8

Data reported as mean \pm SD

*Significant difference between match-play and other session types $p \leq 0.001$

[^]Significant difference from pitch session and other session types $p \leq 0.001$

**Significant difference between rehab session from other session types $p \leq 0.001$

[§]Significant difference from athletic development sessions and other session types $p \leq 0.001$

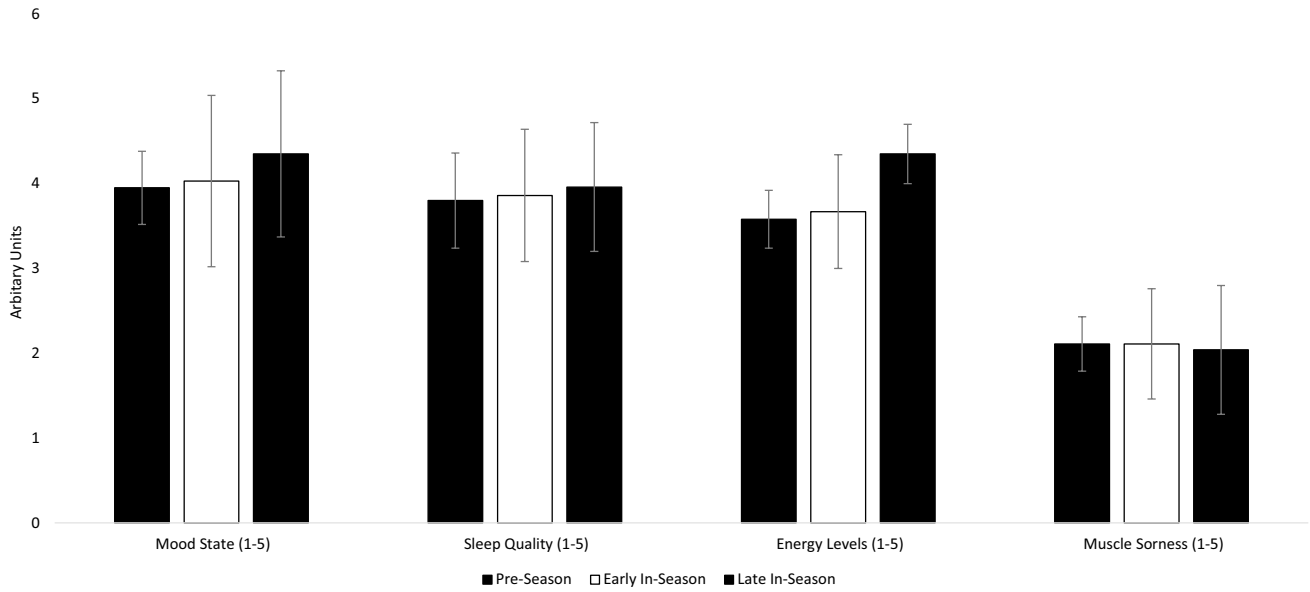


Fig. 1 Wellness measures for Gaelic football players across three distinct training phases. Data are presented as mean ± SD

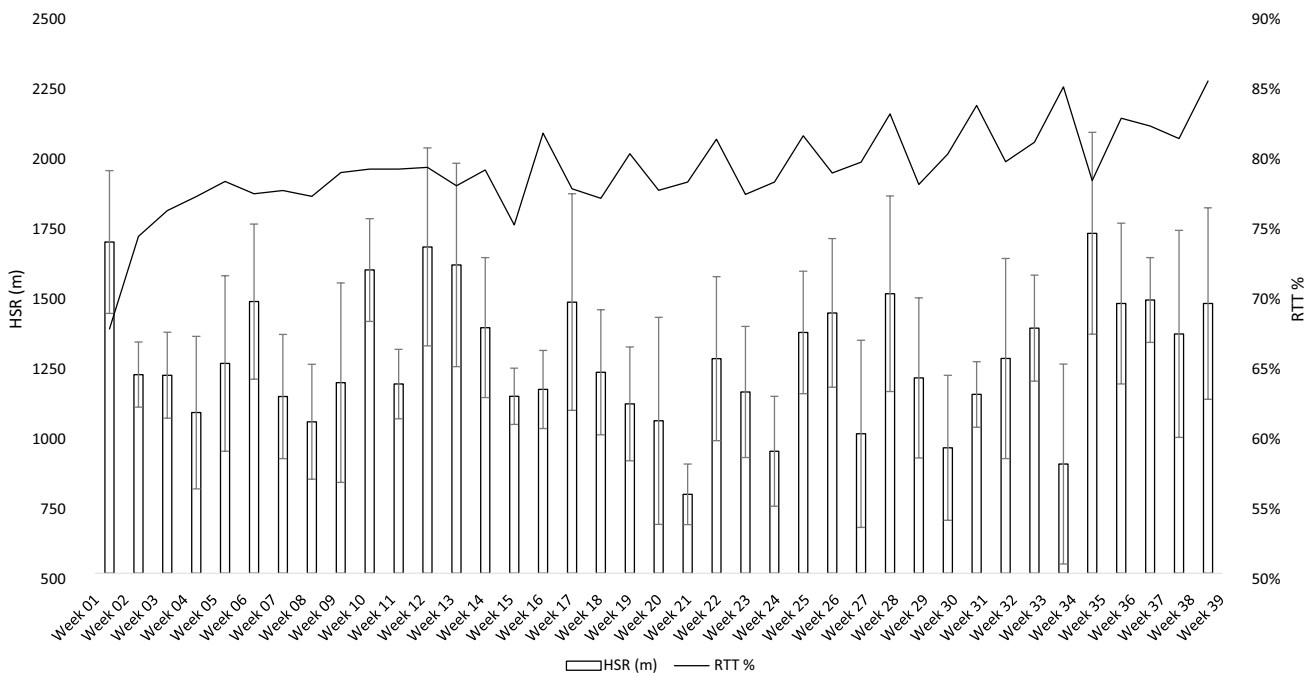


Fig. 2 High speed running and RTT (%) measures for Gaelic football players across weekly periods. Data are presented as mean ± SD

components of the PCA accounted for 94.7% of the total variation with respect to high-speed running performance across the observational period. The components can be considered as stress, mood state, energy levels, muscle soreness, sleep duration, sleep quality, and RTT. The analysis of the five rotating components can be seen in Table 2.

High speed running

Within the constructed model when high-speed running was controlled for activity type ($p \leq 0.001$, $F_{2,69} = 312.67$), mood state ($p \leq 0.0001$, $F_{1,345} = 15.47$), sleep quality ($p = 0.016$, $F_{1,391} = 3.98$), and sleep duration ($p = 0.047$, $F_{1,358} = 3.98$),

Table 2 Principal component analysis (PCA)

	Principal component matrix				
	C1	C2	C3	C4	C5
RTT (%)	0.836**	− 0.287	0.148	0.213	0.180
Mood state (1–5 scale)	0.893**	0.020	0.274	0.146	0.040
Sleep duration (0–12 h)	0.124	− 0.043	0.097	0.198	0.965**
Sleep quality (1–5 scale)	0.212	− 0.054	0.161	0.947**	0.194
Muscle soreness (1–5 scale)	− 0.098	0.984**	0.005	− 0.048	− 0.018

Extraction method: principal component analysis

Rotation method: varimax with Kaiser normalisation

Rotation converged in five iterations

**Significant interaction between PCA and variable $p \leq 0.001$

impacted players ability to generate high speed running across training and match-play with RTT ($p = 0.655$, $F_{1,488} = 0.98$) having no impact across the period. The post hoc analysis showed a significant effect for, previous days training load ($p \leq 0.001$, $F_{1,47} = 30.81$), accumulated training load across the previous two days ($p < 0.001$, $F_{1,69} = 39.67$), and accumulated training load across the previous 7 days ($p = 0.018$, $F_{1,80} = 5.58$).

Internal training load

Within the model when internal training load was controlled for activity type ($p \leq 0.001$, $F_{2,106} = 202.16$), muscle soreness ($p < 0.001$, $F_{1,291} = 16.39$), sleep quality ($p = 0.0312$, $F_{1,515} = 17.89$) and sleep duration ($p = 0.022$, $F_{1,475} = 5.12$) all had an effect on overall internal training load with RTT showing no impact on internal load measures across the period ($p = 0.651$, $F_{1,91} = 1.01$). Post hoc analysis showed accumulated training load previous two days and previous 7 days ($p = 0.012$, $F_{1,80} = 6.58$) had an significant impact on internal training load in addition to external load variables of total distance covered ($p \leq 0.001$, $F_{1,276} = 864.51$), high metabolic load distance ($p < 0.001$, $F_{1,234} = 11.66$), accelerations ($p < 0.001$, $F_{1,299} = 13.78$) and dynamic stress load ($p < 0.001$, $F_{1,291} = 15.14$). No other variables were shown to be impacted by internal training load within the model.

RPE intensity

When RPE intensity was controlled for within the model activity type ($p \leq 0.001$, $F_{2,81} = 9.50$), muscle soreness ($p = 0.015$, $F_{1,505} = 5.94$), sleep quality ($p = 0.010$, $F_{1,505} = 15.94$), and sleep duration ($p = 0.045$, $F_{1,515} = 18.90$), all significantly affected the RPE intensity measures provided within training and match-play with RTT showing no impact on RPE intensity measures ($p = 0.961$, $F_{1,91} = 1.32$) within the model. Post hoc analysis showed that RPE was significantly impacted by previous days loading ($p < 0.001$, $F_{1,61} = 26.36$), accumulated training load across the previous

2 ($p = 0.003$, $F_{1,96} = 9.95$), 5 ($p = 0.001$, $F_{1,53} = 12.84$), and 7 days ($p \leq 0.001$, $F_{1,416} = 818.68$) with external loading measures of accelerations ($p \leq 0.001$, $F_{1,276} = 98.32$), decelerations ($p \leq 0.001$, $F_{1,296} = 64.52$), high metabolic load distance ($p \leq 0.001$, $F_{1,276} = 67.54$) and total distance covered ($p \leq 0.001$, $F_{1,416} = 818.68$) also having an impact on the perception of loading within training and match play. No other variables were shown to be impacted by RPE intensity within the model.

Discussion

The current investigation aimed to examine the ecological validity of self-reported wellness questionnaires, specifically RTT as an indicator of pre-training preparedness within elite Gaelic football players. Secondly, we aimed to understand the association between RTT, running performance variables, and RPE training load during a competitive season. From a practitioner perspective, RTT is regularly utilised as a surrogate of player preparedness within Gaelic football cohorts and aims to understand how athletes are coping with the demands of training and match play but also to gauge players' subsequent capacity to perform across training and match play environments. However, to date, the effect of pre-training and pre-competition RTT scores on subsequent training and match running performance has received little attention within Gaelic football cohorts. The relationship between RTT and high-speed running, RPE, and training load (TL) was therefore investigated in the current study to establish the practical relevance of RTT as a measure of athlete preparedness within Gaelic football. We report for the first time within the literature that RTT had no significant effect on high-speed running performance during subsequent training and match play environments. Furthermore, RTT failed to show a significant effect on internal training load and RPE intensity measures across the observation period. Furthermore, it appears that pre-training measures of muscle soreness, sleep duration and sleep quality when taken

in isolation show more practical credence within an athlete monitoring system as they consistently showed a significant effect on players' perception of training load, RPE intensity scores and high-speed running outputs across subsequent training and match-play. Finally, it appears that accumulated training load across the previous days and weeks within elite Gaelic football needs to be monitored closely by practitioners given the significant effect these measures had on players' perception of training load and their ability to perform high-speed running across subsequent training and match-play.

Previously, high-speed running has been shown to be an important physical quality within team sport athletes [32, 36, 38] and has shown an association with match-play success within Gaelic football [3, 6]. Furthermore, high-speed running appears to be a discriminating factor across match-play at higher competition levels, with high-speed running shown to increase across the competitive season within elite Gaelic football [36]. Therefore, the development of high-speed running tolerance and capacity appears to be an important consideration for practitioners within Gaelic football in order to increase match-play high-speed running performance while also reducing injury risk [2, 36]. Within the Gaelic football training process high-speed running represents an important external loading metric, the exposure to which should be carefully planned by coaches [2, 11, 13]. Anecdotally, within elite Gaelic football practitioners closely monitor exposure to high-speed running across training days and training weeks, aiming to accrue between 1.5- and 2.5-times match-play running volumes per week depending on the seasonal phase. Knowing the physiological determinants of high-speed running tolerance is important when considering the planning of high-speed running exposure. The known determinants appear to be maximal oxygen consumption (VO_{2max}) and associated velocity (vVO_{2max}) [39]. However, in-season VO_{2max} remains relatively constant within team-sport athletes [40], suggesting that any decrement in high-speed running performance in teams sport athletes is likely transient and attributable to other mechanisms such as maladaptive responses to loading, wellness decay, psychological or environmental factors. As such the application of a composite wellness measure such as RTT as a surrogate measure of athlete preparedness to train or compete within Gaelic football may provide coaches with an indication as to subsequent training and match-play performance. However, we observed across our observational period that RTT had no interaction with subsequent running performance within training and match-play contexts and had no impact on high-speed running within these constructs of the Gaelic football training process. These results together appear to question the applicability of composite wellness scores such as RTT or other surrogate subjective composite readiness scores within team sport populations such as Gaelic football. Mainly, due

to this measure remaining stable despite significant changes in internal and external high-speed running across training weeks. Our findings are similar to those of Gallo et al. [23] where the effect of an overall Z-score of wellness was shown to have trivial effects on subsequent high-speed running outputs within elite Australian rules football cohorts (AFL) corresponding to a 7.8% reduction in high speed running. Furthermore, Buchheit et al. [18] and Malone et al. [38] have reported significant correlations between wellness scores and high-speed running within training camp environments in elite Gaelic football and AFL players. However, it appears that the application of cumulative wellness scores as an indicator of training capacity may be limited to these condensed periods of intensive loading such as training camp environments [29, 38].

The lack of a significant association between RTT and high-speed running in our study may be an unexpected finding, however, this may also be explained by the reduced sensitivity to self-reported questionnaires and the subjective monitoring process. Previously, Saw et al. [21] proposed the concept of 'wellness questionnaire fatigue' where athletes fail to fully engage with the subjective monitoring process. This can result in athletes going through the motions per se with tick the box attitude which over time could negatively impact athlete wellness. It is also possible that pre-training responses were influenced by athlete concerns associated with reduced RTT values. Indeed, within elite cohorts' athletes may manipulate subjective scores to evade modified training and possible deselection from competitive match play. This notion may be associated with the lack of significant interaction between RTT and subsequent running performance within the current investigation. Given the totality of our current findings, it may be suggested that the consolidation of subjective wellness scores to a composite catch-all value may result in reduced sensitivity of these data potentially diluting the data.

Our results support the recommendation to review sub-scales of wellness interpretation on an individualised basis [21]. Sleep duration, muscle soreness, and sleep quality were the only sub-components of RTT that influenced subsequent running performance within elite Gaelic football players. Our findings may add additional clarity to the mixed evidence-based surrounding sleep and performance with many studies indicating that short duration high power activities appear largely unaffected, while endurance performance seems to decrease after sleep deprivation [41]. However, reductions in maximum sprinting and high-intensity intermittent running performance have been reported in team sports athletes following reductions in sleep quality as measured via wellness measures [24]. Although no other component of RTT was found to affect high-speed running, ratings of muscle soreness influenced players' perception of TL in a given session. Research has

already shown that markers of sleep quality and muscle soreness demonstrate increased sensitivity to fluctuations in RPE derived TL's when compared to heart rate-derived indices in elite soccer players [42]. Our findings demonstrate the role markers of sleep and muscle soreness have in guiding adjustments to planned training loads. Coaches should aim to review these individual markers of wellness on a session by session basis to manipulate training loads to ensure that athletes are stressed at the appropriate times of the season while possessing increased global wellness markers for competition.

Appropriate planning of training content represents a key component of the fitness-fatigue paradigm playing a key role in reducing injuries and maximising player availability [11]. High chronic loads have been shown to be necessary with team sport athletes to develop physical qualities and best prepare athletes for the demands of competition [11, 15]. However, a paradox exists between careful planning and progression of loads to evoke physical capacity changes and appropriate recovery to maximise physiological adaptations. Furthermore, the balance between stress and recovery is important to reduce the risk of injury [11]. Although the link between chronic training loads and injury risk in team sports is well established [2, 11–13], our findings suggest that chronic training loads may also have an impact on performance capacity. Indeed, our results have shown the importance of appropriate planning by coaches to best ensure sustained high-speed running and reduced perception of training load by players. We have observed within the current data that accumulated training loads from the previous day up to the previous seven days can still have a significant effect on high-speed running activity in subsequent match and training scenarios.

The above findings have several important implications from a planning and periodisation perspective and highlight the potential adverse effects of poorly designed loading structures on players' ability to repeatedly produce high-speed running in addition to players potentially overestimating the RPE for a given session. Currently, within Gaelic football, the application of the majority of weekly training load is completed by skills and football coaches. These often lack experience in the subtle nuances of the workload-performance paradigm as such these coaches tend to prefer increased loading structures that often change depending on results or team tactical performances within a given match-play scenario. As such we suggest that sports science staff within Gaelic football engage in coaching education sessions with skills and football coaches with respect to the workload-performance paradigm. Additionally, it is recommended that sports science staff and Gaelic football coaches actively plan specific training content and review wellness data together, to ensure that the most appropriate training dose is applied.

While several practical applications arise out of the current investigation these findings must be considered with respect to some important limitations. Firstly, the current study represents a case-study of one cohort of Gaelic football players. Therefore, the reported responses across wellness and RTT are reflective of the training methodologies employed across the season analysed. Secondly, the practitioners working with the current cohort of players were well-educated professionals and were aware of the potential effects of loading on wellness measures as such athletes were modified when any "red flags" were observed within their data as per standard training load practices. Unfortunately, inconsistencies between questionnaires make it difficult to compare the current studies results to previous wellness studies within team sports cohorts. The analysis of running performance within the current study utilised an absolute threshold as such these running performances will not be reflective of the individual physiological capacities. Furthermore, while an important training load metric within Gaelic football practitioners must be aware that high-speed running only represents a low percentage of the overall training process within Gaelic football and additional measures such as global running and objective internal training load may offer a more rounded understanding of player performance. The contribution of high-speed running to a training session or match may also be largely influenced by the tactical and positional demands of Gaelic football. Finally, the analysis failed to account for the potential impact of physical qualities on fluctuations in high-speed running or wellness with increased physical qualities shown to impact these measures post-training and match-play.

Conclusion

The purpose of the current investigation was to examine the ecological validity of self-reported wellness questionnaires, specifically readiness to train (RTT) as an indicator of pre-training preparedness within male Gaelic footballers. Our findings have shown that RTT had no significant effect on players running performance within subsequent training and match play environments. Furthermore, it appears that pre-training measures of muscle soreness, sleep duration, and sleep quality when taken in isolation offer an increased understanding of the subsequent perception of training load and running performance within training and match-play constructs. Finally, it appears that accumulated training loads across one through seven-day periods have a significant effect on Gaelic football players' perception of training load and subsequent running performance. We suggest that practitioners avoid the utilisation of composite wellness scores such as RTT within any team sports training process given the lack of an impact of this measure on subsequent

markers of running performance and training load. As such we recommend that the individual sub-scales of wellness questionnaires such as sleep quality, sleep duration, and muscle soreness be monitored closely by practitioners as these may provide better surrogates of athlete preparedness. Additionally, given the association of muscle soreness, sleep quality, and sleep duration on subsequent high-speed running capacity within elite Gaelic football, we suggest that practitioners actively employ recovery and nutritional interventions to ensure optimal recovery between match and training sessions. Given that accumulated training loads impacted player preparedness and the fact that the majority of training load completed by players is prescribed by skills and football coaches we suggest that sport science practitioners improve coaches' understanding as to the workload-performance paradigm. Therefore, Gaelic football practitioners should systematically plan training content so that the training response may be modelled and potentially predicted over time thus avoiding sudden increases in loading that may impact subsequent training content quality.

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Compliance with Ethical Standards

Conflict of interest The authors declare that they have no conflicts of interest.

Ethical Approval All procedures performed in the study involving human participants were in accordance with the ethical standards of the Trust and with the 1964 Helsinki declaration and its later amendments or comparable ethical standards.

Informed Consent Informed consent was obtained from all individual participants included in the study.

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