Are Internal Load Measures Associated with Injuries in Male Adolescent Gaelic Football Players?

Abstract

This study aimed to examine internal loads in male adolescent Gaelic footballers and their association with musculoskeletal injury over one season. Written training diaries were completed by 97 male adolescent Gaelic footballers weekly and injuries sustained during the season were assessed by a Certified Athletic Therapist. Injuries were defined as any injury sustained during training or competition causing restricted performance or time lost from play. Daily load was determined for each player (session rating of perceived exertion by session duration) and summed to give weekly load. Univariate and multiple logistic regressions were conducted to determine the association with injury. Twenty-two injuries were recorded with match injuries significantly more common than training injuries. Periodic variations in weekly load and injuries were evident throughout the season. Univariate analysis identified weekly load (OR=2.75; 95%CI=1.00-7.59), monotony (OR=4.17; 95%CI=1.48-11.72) and absolute change in load (OR=3.27; 95%CI=1.15-9.32) greater than the team average were significant injury risk factors. Multiple logistic regression with 2-weekly and 3-weekly cumulative loads, absolute change, monotony, strain, ACWR and age as independent variables identified internal load measures (monotony, strain and absolute change) were associated with injury with high specificity (96.0%) but low sensitivity (25.0%). The findings highlight the need to monitor team and individual loads to avoid sudden week-to-week changes or excessive weekly loads. Open communication between players, parents, coaches and sports medicine clinicians enables effective load monitoring that can reduce injury risk and may subsequently minimise dropout, improve team success and overall sport enjoyment and promote life-long sports participation.

Introduction

Gaelic football is one of the most popular spectator and participatory sports in Ireland (Reilly, Akubat, Lyons & Collins, 2015) and is regarded as the most popular club sport played by male adolescents (Murphy, Rowe & Woods, 2017). Gaelic football requires repeated, short-duration, high-intensity anaerobic exercise combined with light-to-moderate aerobic activity (Cullen et al., 2013), while incorporating skilful hand and foot passing (Malone, Roe, Doran, Gabbett & Collins, 2017a). The primary aim of the game is to outscore the opposition by winning possession of the ball, evading opponents and breaking tackles (Cullen et al., 2013). To prepare a player for the physical demands of Gaelic football, coaching staff must efficiently control, alter and monitor loads (Henderson, Cook, Kidgell & Gastin, 2015) to assess if an athlete is optimally adapting to their applied load while also minimising injury (Malone et al., 2017b). Load can be measured via internal (physiological and psychological stress imposed by applied load) and external measures (work done independent of the athlete's internal characteristics) (Halson, 2014). Recent technological advances have allowed the development of wearable internal and external load monitoring tools such as heart-rate monitors, global positioning systems (GPS), time-motion analysis and accelerometers (Haddad, Stylianides, Djaoui, Dellal & Chamari, 2017). However, despite their ability to track precise player data in training and match environments and offer extensive information on the training stimulus (Haddad et al., 2017; Comyns & Flanagan, 2013), there are associated limitations. The considerable expense, time-consuming data analysis, requirement for high technical proficiency and danger of losing data due to technical error (Haddad et al., 2017; Comyns & Flanagan, 2013) limits their practicality in amateur and community sport environments. Alternatively, an easily administered, non-invasive, feasible and well-accepted method for monitoring load is session rating of perceived exertion (sRPE) (Foster et al., 2001; Comyns & Flanagan, 2013). The cost-effectiveness, simplicity and within-player validity of sRPE (Malone, Hughes, Mangan, Roe

& Collins, 2017c; Malone et al., 2017a) along with its ability to quantify load regardless of mode or location (Bourdon et al., 2017) highlights its use in amateur sport environments. sRPE is a subjective load monitoring measure deemed more sensitive and consistent than objective measures in assessing acute and chronic changes in an athlete's response to imposed loads (Saw, Main & Gastin, 2016). sRPE has been shown as a valid measure of quantifying load in rugby (Gabbett & Domrow, 2007) and Australian Rules football (Scott, Black, Quinn & Coutts, 2013), sports which possess similar characteristics to Gaelic football.

Monitoring load in adolescents is important as rapid physical, physiological and psychological pubertal changes occur during adolescence (Gabbett, Whyte, Hartwig, Wescombe & Naughton, 2014), which may affect the load response. Young athletes' volume of training is continually increasing (Gould & Whitley, 2009) and in particular, with diverse sports participation, adolescents participate in more frequent training and competitions (Kaleth & Mikesky, 2010) leading to high exposure and sports participation rates. Year-long training patterns, a congested calendar with overlap of match fixtures between sports and the prevalence of Gaelic players playing with club, school and county teams and varying age levels simultaneously increases load, can result in poor recovery between matches and trainings (Malone et al., 2017b) and may increase adolescents' susceptibility to injury (Brenner, 2007).

Research to date has monitored load in elite adult Gaelic footballers, with a clear association between higher loads and increased injury risk evident (Malone et al., 2017a). Similarly, the Acute:Chronic Workload Ratio (ACWR), which describes the acute load (from previous week) in relation to the chronic load (average of previous four weeks) (Blanch & Gabbett, 2016), has been utilised to explain load changes and the association with injury in elite Gaelic footballers. The greatest injury risk is suggested to exist when the ACWR exceeds 2.0, whereas, moderate to high ACWR of ≥1.35 to ≤1.50 protects against injury in the preseason and early in-season but not late in-season (Malone et al., 2017a). Research in Gaelic football has focused on elite adult players. However, findings in adult players may not be applicable to adolescents due to the varying physiological traits and responses to load evident, attributed to maturation (Gabbett et al., 2014).

Research in adolescent Gaelic footballers to date has explored external match and training loads with the focus on examining aerobic capacity using estimated VO_2max (Roe & Malone, 2016) and monitoring heart rate and distance covered via GPS technology (Reilly et al., 2015). While external load monitoring may be useful, internal load measures can provide information on how the individual responds to imposed loads without the need for specialised costly equipment (Haddad et al., 2017). Research in soccer using subjective exposure hours has shown injury incidence to quadruple in adolescents exposed to more than 3 hours of training but more than 5 hours of training may have a protective effect against injury (Schmikli, DeVries, Inklaar & Backx, 2011). sRPE is an additional internal load monitoring tool that incorporates exposure hours with session intensity and can provide comprehensive data for coaches and sports medicine clinicians. Despite the continued growth and popularity of Gaelic football in youth participants (Murphy et al., 2017) and increased pressure on players to be successful and perform to a high standard from parents/coaches (Hughes & Hassan, 2017), the appropriate internal load for adolescents that minimises the risk of injury is under-explored and poorly understood. In particular, the exploration of internal load as measured by sRPE and its relationship with injury has not been examined. Therefore, this study aimed to identify the impact of internal load measures on injury incidence in male adolescent Gaelic footballers.

Methods

Participants

Ninety-seven male adolescents (13.4±1.1 years; 1.6±0.1 m; 59.3±12.5 kg) that played under-14 (n=66) or under-16 (n=31) Gaelic football were recruited from recreational Gaelic football clubs. Parental/guardian written informed consent and participant assent were granted prior to the study beginning following an information session. Ethical approval was granted by the Athlone Institute of Technology Research Ethics Committee (#20180201).

Procedures

Data collection took place for one underage Gaelic football season. Gaelic football teams were tracked for 15.2±8.9 weeks, depending upon success, where teams that were more successful participated for a longer season. All injuries sustained during Gaelic football participation, defined as any injury sustained during training or competition resulting in restricted performance or time lost from play (O'Connor, McCaffrey, Whyte & Moran, 2016a), were assessed by a Certified Athletic Therapist. Injuries were recorded using a standardised injury report form (O'Connor et al., 2016a), detailing the injury onset, occurrence during match or training, location, nature and mechanism. Injury severity was also classified according to days missed from participation; minor (<7 days), moderate (8-21 days) or severe (>21 days) (O'Connor et al., 2016a). Growth-related issues were defined as injuries occurring to the growing skeleton due to the vulnerability of growth cartilage to injury from repetitive loading and increased injury risk associated with the adolescent growth spurt (DiFiori, 2010), such as physeal injury or bony apophysitis.

A written self-recall diary, adapted from a validated training diary (O'Connor, McCaffrey, Whyte & Moran, 2016b), was utilised to record sport/physical activity training and matches, recreational activity and physical education completed in the previous week. The diary documented the activity, type of participation, level played at and duration and was completed weekly at one training session, which was agreed upon at the start of the study. Exposure for any player absent from weekly training sessions was not recorded for that week, which occurred in 9.3% of participants. A familiarisation session was held at the beginning of the season to explain the diary in detail. In addition, the intensity of each session was determined using the modified rating of perceived exertion (RPE) scale (Foster et al., 2001). Coaches were present to remind players of the sessions completed in the previous week but each player was instructed to report sRPE individually without consultation with teammates for accuracy and to eliminate the effect of peer-pressure or duplication of teammates' ratings (Malone et al., 2017b).

Statistical Analysis

Data were analysed using Microsoft Excel 2016 (Microsoft Corporation, Redmond, Washington, USA) and IBM SPSS v.24 (IBM, New York, USA). The Gaelic football season was divided into four phases; early (week 2-7), mid (week 8-14), mid-to-late (week 15-21) and late season (week 22-28). sRPE values for week 1 were not collected due to communication issues with coaches during the initial week of data collection. Training load data represents weekly participation in sports (not solely Gaelic football). Missing values were estimated by replacing the missing load values with the mean value of the corresponding week (Brink et al., 2010). Load, measured in arbitrary units (AU), was determined for each player by multiplying the rating of session intensity by session duration (Foster et al., 1995) and daily loads were summed to give weekly load. In addition, cumulative two-, three- and four-weekly loads, acute:chronic workload ratio, absolute load changes from week-to-week, monotony (mean session load divided by standard deviation of load for that week) and strain (weekly load multiplied by monotony) (Foster, 1998) were calculated. Descriptive statistics for load measures and injuries were calculated for the season and each season phase for under-14 and under-16 players. Injury incidence proportion (number of injured participants/number of participants at risk), repeat incidence proportion (number of repeat injured participants/number of injured participants) and incidence rate (number of injuries/total hours playing sport*1000) were calculated. Confidence intervals (95%CI) were determined using Poisson distribution.

Due to the skewed nature of training and match loads, physical education and recreational activity data, as is common with measures of athletic performance (Malone, Hughes, Roe, Collins & Buchheit, 2017d), load measures were log-transformed by taking the natural logarithm (Ln). Independent samples T-tests determined differences in load, strain and monotony between under-14 and under-16 players. One-way repeated measures analysis of variance (ANOVA) with Bonferroni post-hoc analysis compared load across season phases and one-way between groups ANOVA with Tukey post-hoc test analysed differences in load by playing position. Effect sizes were calculated using Eta squared and determined according to Cohens' classification; small=0.01, moderate=0.06 and large=0.14 (Cohen, 1988). Initially, univariate logistic regression was performed to examine whether age and internal load measures were injury risk factors, with odds ratios (ORs) and 95%CI examined. Internal load measures were coded as ≤ or > season average (Table 3). OR greater than one indicated increased injury risk. All variables that were significant at $P \leq 0.20$ (Van Middelkoop, Kolkman, Van Ochten, Bierma-Zeinstra & Koes, 2008) were subsequently analysed in a backward likelihood ratio stepwise multiple logistic regression to identify their ability to predict injury. The sensitivity and specificity of the overall model were reported along with ORs and 95%CI. Multicollinearity in multiple logistic regression was assessed by examining variance inflation factors (VIFs), with a VIF >10 indicating multicollinearity. Multicollinearity was noted for weekly and 4-weekly cumulative loads. Significance of 0.05 was set for all statistical tests ($p \leq 0.05$).

Results

Twenty-two injuries occurred during Gaelic football participation in 97 male adolescents over one season. Most participants (70.1%) took part in another sport outside Gaelic football. Soccer (46.4%) was the most frequently played other sport, followed by rugby (14.4%), swimming (11.3%), hurling (9.3%), hockey, golf, basketball (5.2%), athletics, sailing (3.1%), gym, badminton (2.1%), cycling and horse-riding (1.0%). Incidence proportion indicated that 20.6% (95%CI=13.4%-31.6%) of male adolescent players became injured, while 4.8% (95%CI=0.7%-34.1%) of those who sustained an injury also suffered a subsequent injury. The incidence of injury was 21.4 injuries/1000h (95%CI=14.1-32.6). Match injuries (44.4/1000h; 95%CI=26.3-74.9) were significantly more common than training injuries (8.4/1000h; 95%CI=3.8-18.8) (Table 1). Injuries that occurred in the lower limb were prevalent (14.6 injuries/1000h; 95%CI=8.8-24.3), particularly in the early (22.0 injuries/1000h; 95%CI=9.2-53.0) and mid-to-late season (20.3 injuries/1000h; 95%CI=9.7-42.6) (Table 1). Sprains (7.8 injuries/1000h; 95%CI=3.9-15.6) and strains (6.8 injuries/1000h; 95%CI=3.3-14.3) were the most commonly reported nature of injury with muscle (8.8 injuries/1000h; 95%CI=4.6-16.9) and ligament (7.8 injuries/1000h; 95%CI=3.9-15.6) injuries predominant (Table 2).

Periodic variations in internal loads were evident throughout the season with spikes in accumulated weekly load (1037-1798AU) and absolute changes in load (65-1571AU) evident (Figure 1). Strain was consistently greater than load throughout the early and mid-season phases but load became greater than strain in the mid-to-late and late season phases of the season (Figure 1). The overall average weekly load for the season was 898±311AU. Weekly loads were not significantly different between under-14s (771±594AU) and under-16s (676±471AU) ($P=0.53$; $\eta^2=0.00$). No significant differences were evident in monotony between under-14 (0.49±0.21) and under-16 players (0.43±0.18) ($P=0.07$; $\eta^2=0.04$). Similarly, strain was not significantly greater in under-14 (649±961AU) compared to under-16 players

(437±378AU) (P=0.59; η^2=0.00). Load was greatest in the early (1219±390AU) and mid-season (979±105AU) compared to mid-to-late (617±104AU) and late season (823±244AU). A significant difference in load between phases was evident (P=0.01; η_p^2=0.98), with early season loads significantly greater than mid-to-late season loads (P=0.01) and mid-season loads significantly greater than mid-to-late season loads (P=0.00). Loads were not significantly greater for backs (795±595AU), forwards (726±568AU), midfielders (553±280AU) or goalkeepers (795±552AU) (P=0.82; η^2=0.01).

The greatest spike in injuries occurred during weeks 14 to 16 (Figure 1) with large variations in absolute change in load prior to this from weeks 8-12 (113-753AU) (Figure 1). A spike in injuries was evident in the late phase of the season in weeks 24 and 26 following consistent increases in load from weeks 20-26 (512-1121AU) (Figure 1). Univariate analysis identified players with weekly loads greater than the average season load of 898AU (OR=2.75; 95%CI=1.00-7.59; P=0.05), monotony greater than 0.53 (OR=4.17; 95% CI=1.48-11.72; P=0.01) and absolute change in load greater than 410AU (OR=3.27; 95%CI=1.15-9.32; P=0.03) were significantly more likely to sustain an injury (Table 3). As multicollinearity was detected for weekly and cumulative 4-weekly loads, they were not included in the multiple logistic regression. The final multiple logistic regression model, which included age (OR=1.46; 95%CI=0.89-2.40), monotony >0.53 (OR=6.16; 95%CI=1.58-24.06), strain >809AU (OR=0.35; 95% CI=0.05-2.32) and absolute change in load >410AU (OR=3.70; 95%CI=0.87-15.75), were significantly associated with injury (Table 3). The overall model explained 13.0%-20.2% of the variance in injury with 25.0% sensitivity and 96.0% specificity (X^2(4)=13.23; P=0.01).

[Insert Table 1]

[Insert Table 2]

[Insert Table 3]

[Insert Figure 1]

Discussion

Prescription of adequate workloads are necessary to tolerate load and elicit performance effects (Bourdon et al., 2017). Nonetheless, sudden increases or spikes in load are detrimental to athletes' performance (Malone et al., 2017a), as was evident in the significant association between high absolute week-to-week changes in load and injury. Similarly, this association indicates sudden decreases or undertraining may also have a detrimental effect on Gaelic footballers. High absolute changes in load have also been associated with increased injury risk in rugby (Cross, Williams, Trewartha, Kemp & Stokes, 2016) and Australian football (Rogalski, Dawson, Heasman & Gabbett, 2013) when using session-RPE load measures. The U-shaped relationship between injury and load outlines that both undertraining and overtraining can increase the risk of injury (Bourdon et al., 2017). These findings support the theory that team-sport athletes are better able to sustain small increases or decreases in load rather than larger deviations (Soligard et al., 2016) and avoiding spikes greater than 10% may be successful (Murray, 2017). Therefore, periodic variations in internal load across the season is advised but appropriate monitoring measures must be in place to avoid the application of sudden changes that may increase players' vulnerability to sustaining an injury that can be detrimental to performance.

Male adolescent Gaelic footballers with high weekly cumulative loads had a threefold significantly increased risk of injury. Monotony was also significantly associated with injury, increasing the risk of sustaining an injury fourfold. In addition, the univariate analysis identified those with excessive 2-weekly, 3-weekly and 4-weekly loads have more than doubled their risk of sustaining an injury, however, the associations were not significant. Similar relationships have been shown between load and injury risk in elite adult Gaelic football, where 1-, 2-, 3- and 4-weekly cumulative loads increased the risk of injury in the pre-season and competitive in-season (Malone et al., 2017a). Similarly, research in youth soccer has shown players with high accumulated weekly load >474AU, measured using GPS, have a significantly higher risk of injury (RR=1.65-4.84) (Bowen, Gross, Gimpel & Li, 2017). High monotony (OR=2.59) in youth soccer players has also been shown to significantly increase injury risk (Brink et al., 2010). Therefore, monitoring of weekly load and monotony is required in adolescent Gaelic footballers. Internal load measures (monotony, strain and absolute change) were significantly associated with injury using multivariate analysis but demonstrated low sensitivity and high specificity. Research in elite soccer players also identified sRPE-derived loads poorly associated with injury with low sensitivity and high specificity (Delecroix, McCall, Dawson, Berthoin & Dupont, 2018; Lu, Howle, Waterson, Duncan & Duffield, 2017). These findings indicate internal load measures may be clinically beneficial at ruling out those not at risk of injury where load modifications may not be necessary. Nonetheless, low sensitivity indicates they may be poor predictors of those at increased injury risk and further assessment of these players may be required, which could include additional monitoring with internal or external measures, such as blood lactate or heart rate monitoring, GPS tracking or accelerometry. However, only 13.0-20.2% of the variance in injury is predicted by the model, which may indicate that internal load is not the only predictor of injury and other intrinsic and extrinsic risk factors (Bahr & Holme, 2003), such as previous injury, strength, neuromuscular control, age, equipment or environment (Caine, Maffulli & Caine, 2008) should be considered. The univariate analysis also identified those with ACWR greater than 1.30 had a reduced risk of injury but the association was not significant. There is controversy among research regarding the use of ACWR as a load monitoring tool. Mathematical coupling exists when calculating ACWR, which may lead to a false correlation between acute and chronic load, regardless of the true biological or physiological association between the variables (Lolli et al., 2018; Lolli et al., 2017). Therefore, it is difficult to conceive a causal relationship between changes in load when no true association is evident. Lolli et al. (2018) also found that acute load could be a useful injury predictor when examined in absolute numerical terms without the ratio. However, Gabbett (2018) indicate that both coupled (acute load included in chronic load calculation) and uncoupled (acute load excluded from chronic load calculation) ACWR calculations have been associated with increased injury risk in previous research (Moller et al., 2017; Malisoux, Frisch, Urhausen, Seil & Theisen, 2013). Therefore, due to the lack of research examining the use of ACWR in adolescent Gaelic footballers, both ACWR and absolute loads over 1-, 2-, 3- and 4-weekly periods were included in the current analyses. The lack of significant association between ACWR and injury in the current study suggests it may not be a useful measure of internal load in adolescents.

Monitoring load in adolescents is particularly important to reduce missed training or competition time due to injury (Bourdon et al., 2017). Missed days may have a long-term impact on performance, as youth player's need exposure to master the inherent skills of the sport and consistent absences from training may result in underperformance (Murray, 2017). In addition, there is a significant relationship between high volumes of training, injury and early dropout and retirement from sport, with 17.3% of youth athletes forced to retire because of injury (Huxley, O'Connor & Healey, 2014). Given this potential negative impact, the prescription of appropriate loads should be central to every training plan to increase competitiveness and team success (Malone et al., 2017a) and facilitate a long sporting career with minimal injuries as players progress to adult sports participation (Murray, 2017). The findings also suggest that despite the benefits of load monitoring for a team, injury risk should not solely be considered for a team as one unit. Load should also be assessed individually as a player may have greater exposure to maximal loads and thus report markedly higher or lower scores compared to teammates (Malone et al., 2017c). Players with average weekly load, monotony or strain greater than the weekly team average may be identified as being at increased injury risk and subsequent loads can be altered. This is especially critical in the adolescent population, as over 70% of adolescents participated in more than one sport resulting in substantial variation in training frequency between players. In order for load monitoring to be successful, open communication between players, parents, coaches and sports medicine clinicians is essential and monitoring across all sports needs to take priority. Prioritising monitoring and identifying which stakeholder is responsible for identifying when decreases in load are necessary is essential. Appropriate load management may subsequently be beneficial in fulfilling adolescent athletic potential, reducing burnout and injury, and promoting longevity of life-long sports participation (Burgess & Naughton, 2010). However, with many players, a lack of clarity exists into who assumes this responsibility and a priority system for teams and sports may need to be developed for each individual athlete to decide that when load needs to be reduced, where does this occur. These changes can in turn create a safe sporting environment for adolescents that epitomises success (Murray, 2017).

The average weekly load identified in this study was lower than weekly training loads (1217±364AU) (Phibbs et al., 2018a) and training and match loads (1425±545AU) (Phibbs et al., 2018b) inclusive of all rugby and non-rugby activities in elite adolescent rugby players. Similarly, the average weekly load was lower than early (2740±610AU) and late in-season loads (2560±603AU) previously reported in elite adult Gaelic footballers (Malone et al., 2017a), as would be expected in younger players. Adolescents should ideally be subjected to lower training and match loads compared to adults as they may have increased propensity for injury due to anatomical developmental differences (Malanga & Ramirez-Del Toro, 2008), particularly, the lack of collagen/calcified tissue during growth periods makes physes, apophyses and articular surfaces less resistant to tensile, shear and compressive forces (DiFiori et al., 2014). Exposure to high levels of training during periods of rapid growth and major physiological change when these structures are vulnerable to injury can increase injury risk

(Van der Sluis et al., 2014). Therefore, anatomical and physiological differences need to be accounted for when designing a training regime.

No significant differences in load, monotony or strain were evident between under-14 and under-16 players. Therefore, load monitoring is important across all male adolescent Gaelic footballers, regardless of age, where priority should be placed on avoiding excessive weekly loads or highly monotonous training, as identified in this study. Alternating week-to-week sessions to include a variety of drills and activities that prepare a player for match play demands reduces monotony and allows for more athlete enjoyment, a balanced approach to load management and reduction of illness and overtraining risk (Foster, 1998). By reducing monotony and ensuring load is appropriately planned and managed in younger players, the stress on adolescent Gaelic footballers imposed by training, matches, physical education and recreational activities, as measured by strain, may be reduced and the risk of injury may decrease. In addition, the enjoyment of the game may increase and participation as players' progress to adult level will be maintained.

Match injuries were greater than training injuries, as also identified in previous research examining male adolescent Gaelic footballers (O'Connor et al., 2016a). This is suggested to be attributed to the greater intensity and physicality, increased levels of physical contact and competiveness indicative to match play (Murphy, O'Malley, Gissane & Blake, 2012; Wilson, Caffrey, King, Casey & Gissane, 2007). Similar to previous research (O'Connor et al., 2016a), muscle strains and ligament sprains were common, particularly in the lower extremity. Sprinting, change of direction, jumping, catching, landing, kicking, passing and scoring along with high levels of physical contact are all key elements of the game (O'Connor et al., 2016a; Murphy et al., 2012) and these components combined with the high-intensity, high-velocity nature of the game (Murphy et al., 2012) may explain the frequent occurrence of muscle strains, and ligament strains. The current research suggests internal load monitoring is important but the prevention of injuries with appropriate and well-designed injury prevention strategies cannot be ignored.

Limitations

Training diaries were completed by players present at Gaelic football training sessions. For participants who missed a Gaelic football training session and thus, did not complete a weekly diary, the mean load from the corresponding week (Brink et al., 2010) was used to represent the missing value which likely resulted in over and under-estimation of participation hours. Missing values could have been minimised by requiring the coach to register individual training duration or absences (Brink et al., 2010), which should be considered in future research. The accuracy of sRPE is a suggested limitation of the current study. sRPE is recommended to be measured within 30 minutes post-session for greater accuracy (Comyns & Flanagan, 2013). Retrospective sRPE collection has been shown to remain consistent up to 48 hours (Fanchini et al., 2017), however, beyond that its reliability is questioned (Scantlebury, Till, Sawczuk, Phibbs & Jones, 2018; Phibbs et al., 2017). Thus, future research in adolescent Gaelic football should consider utilising daily training diaries. Previous research utilised prompts about significant days to help recall activities from the past week (Hartwig, Naughton & Searl, 2008) and in this study, coaches were on hand to remind players of each session but did not guide players' ratings. The presence of the coach likely only affected reporting accuracy of Gaelic football hours but additional activities were completed outside of these hours in club, school and county teams at various age groups and in recreational activity and physical education in which the coach could not affect reporting accuracy. In addition, use of self-reporting of training information is associated with high typical error in adolescents and younger athletes may have difficulty understanding sRPE (Phibbs et al., 2017). With adequate familiarisation, difficulties with sRPE may be reduced (Phibbs et al., 2017) and efficiency and accuracy of the measure potentially increased. Therefore, a familiarisation session was completed at the beginning of the season to explain the diary in detail to participants.

Despite its benefits, sRPE is a single measure of load. In order to get a more complete and accurate picture of load in adolescent Gaelic footballers, a combination of subjective, objective, internal and external measures should be utilised to give a true insight into training stress and provide a balance between athlete cognitions and quantifiable practice (Bourdon et al., 2017). In addition, internal loads were categorised according to ≤ or > season average, which results in the discretization of continuous data and assumes that each participant has equal risk of sustaining an injury (Carey et al., 2018). However, this approach allows comparison with previous research in adult Gaelic footballers (Malone et al., 2017b) and other studies examining adolescents (Bowen et al., 2017; Brink et al., 2010). Measuring load using sRPE is beginning the process of examining load in adolescent Gaelic footballers but future research should utilise further measures and examine factors that can moderate sRPE ratings.

Conclusion

Coaches and sports medicine clinicians may effectively minimise injury risk by monitoring applied loads across all adolescent sports participation and avoiding excessive weekly loads or sudden periodic variations that elicit rapid changes in absolute load from week to week. Internal load measures may be associated with those not at risk of injury but further analysis of those who have increased injury risk may be necessary with additional monitoring tools. Load monitoring on a player-to-player basis may also be beneficial in identifying individuals experiencing high weekly sRPE loads, high monotony or excessive absolute changes week-to-week and at increased risk of injury. Adolescent Gaelic footballers ideally should be subjected to lower loads than their adult counterparts as they transition through rapid growth periods and increased training variability in youth players may be beneficial in avoiding monotony and excessive strain. Nonetheless, high variability in absolute load can be harmful highlighting the importance of avoiding sudden changes in load from week-to-week. However, load monitoring alone cannot be effective in reducing injury risk unless there is open communication between players, coaches, parents and sports medicine clinicians across all sports. Effective monitoring and communication to reduce load when required could minimise the risk of injury, which may subsequently minimise dropout, improve team success and overall sport enjoyment and promote life-long sport participation.

Acknowledgements

We would like to thank the players, parents and coaches for their support of this study.

Declaration of Interest Statement

No potential conflict of interest was reported by the authors.

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