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Do Niggles Matter? - Increased injury risk following physical complaints in football (soccer)

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ABSTRACT

Objective: To determine the prevalence and impact of non-time loss injuries in semi-professional football.

Methods: 218 players completed the Oslo Sports Trauma Research Centre (OSTRC) Questionnaire on Health Problems weekly during the 2016 season (35 weeks), recording the prevalence and impact of time loss (TL) and non-time loss (non-TL) injuries. TL injury and exposure were also collected by a third party as per the Football Consensus statement. The relative risk (RR) of a TL injury within 7 days of a self-reported non-TL injury was determined, with associated predictive power calculated.

Results: The risk of TL injury was 3.6 to 6.9 × higher when preceded by 'minor' and 'moderate' non-TL complaints, respectively, and good predictive power (22.0–41.8%) was observed (AUC range = 0.73 to 0.83). Compliant responders (80% of completed OSTRC questionnaires) showed a mean self-reported weekly injury prevalence (TL and non-TL combined) of 33% (95% CI – 31.4% to 34.6%) with 28% (CI – 26.4% to 29.6%) attributed to non-TL injury.

Conclusion: Over a quarter of players on average, report a physical complaint each week that does not prevent them from participating in training or match play. A non-TL injury was shown to be useful in identifying individual players at an increased risk of a TL injury.

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KEYWORDS
Time loss; non-time loss; prevention; injury surveillance

Introduction

Accurate injury surveillance underpins effective injury prevention programs (Van Mechelen and Hlobil 1992). However, in football injury research, whilst an injury is defined as 'any physical complaint' (Fuller et al. 2006), only time loss (TL) injuries resulting in a failure to fully participate in training or matches are used to determine injury incidence and severity (Ekstrand et al. 2011). It is acknowledged that excluding physical complaints that do not result in a TL injury may underestimate the true injury profile in football (Clarsen 2017). The complex nature of injury suggests that as many contributing factors as possible should be considered during surveillance to improve the effectiveness of injury risk reduction strategies (Bolling et al. 2018). Notably, in overuse injuries, tissue failure may already be present before the development of pain and performance deficits, with dysfunction in a local area potentially impacting on pathology in neighbouring regions (Wilke et al. 2019). As such, injury surveillance methods that capture all 'physical complaints' may improve the sensitivity of injury surveillance (Clarsen and Bahr 2014) and allow practitioners to consider the magnitude of the symptoms suffered alongside the burden associated with time loss injury (Bahr et al. 2018).

Such methods may be achieved in an elite setting where clubs have access to full-time medical staff and resources that allow thorough player monitoring and accurate injury surveillance. In the sub-elite setting, however, there is often a lack of medical staff and recording protocols may need to be more adaptable (Finch 2017). Self-reported data collection methods can improve injury data collection (Gallagher et al. 2017), increasing capture of physical complaints that do not result in training or match play absences (a non-TL injury), versus more commonly used TL only methods (Clarsen et al. 2013; Ekegren et al. 2015; Møller et al. 2017; Langhout et al. 2018). However, little is known about the prevalence and impact that non-TL injuries in football may have on more serious TL injury risk. This information may have particular importance in semi-professional environments, where the players' primary source of income may be from non-football occupations, and the long-term cost of injury can effect both the player's health (Hainline et al. 2017a) and financial status (Lee and Garraway 1996). Indeed, injuries in non-professional settings; such as a college, high school or university, are associated with significant financial cost (Fair and Champa 2018). The increasing costs associated with sporting injury has led to suggestions that the risk of injury, may negate the positive health benefits associated with physical activity (Conn et al. 2003). It is therefore of paramount importance that practitioners continue to search for effective and easily implementable methods to reduce injury incidence (Marshall and Guskiewicz 2003).

The current study will therefore compare the prevalence and impact of 'all physical complaints' in semi-professional football

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between self-reported and third party injury surveillance recording methods and further aims to; 1) determine the relative risk of sustaining a TL injury within 7 days of reporting the presence (vs absence) of a reported non-TL injury; 2) examine whether the presence of a non-TL injury, in isolation, is linked injury occurrence.

Methods

Participants

Twenty-five teams from 10 semi-professional football clubs, volunteered to participate in the study during the 2016 season. Clubs were recruited from the NSW National Premier League and Illawarra Premier League in Australia (2nd and 3rd tiers of participation, respectively). All players participated in a minimum of three football-based sessions per week (training and match). Prior to data collection, all players were informed of the study and provided written informed consent. All procedures were approved by the University of Wollongong's Ethics Committee (reference number: 15/340).

Time loss injury data collection

TL injury data and individual exposure minutes (training and match) were collected in accordance with the Fuller et al. (2006) consensus statement on injury definitions and data collection procedures in football, with injury defined as 'any physical complaint', and TL injury defined as an 'inability to fully participate in football training or matches' (Fuller et al. 2006). To comply with the Consensus methods, each club was assigned a Primary Data Collector (PDC) holding a minimum medical qualification (Sports Trainer Level 1), a method that has been previously shown to be a valid and reliable means of collecting injury data (Ekegren et al. 2015; McCunn et al. 2017). The PDC attended all training and match sessions to record injury and exposure via standardised data collection forms and were provided with additional tuition by a qualified physiotherapist detailing injury description, definitions, and recording exposure to comply with the Fuller et al. (2006) Consensus statement (Whalan et al. 2019). No exposure data was recorded for players performing modified training or rehabilitation exercises at training. Players were considered no longer injured on their return to full training and deemed available for match selection.

Non-time loss injury data collection

The presence and impact of physical complaints on training/match participation, performance, volume and severity were assessed weekly (35 weeks) using the OSTRC Questionnaire on Health Problems (Clarsen et al. 2014). The OSTRC Questionnaire was only used to record injury occurrence, an accumulated 'injury score' was not calculated. A survey link was emailed to each player at the start of each week (www.surveymonkey.com) with instructions to complete prior to the first training session of the same week. Due to the 'participation' focus in the Fuller et al. (2006) consensus statement for injury definition, the 'participation' category of the OSTRC Questionnaire was selected to be the primary category for analysis. A TL injury was recorded via the OSTRC Questionnaire when a report of 'Cannot participate due to injury' was recorded. A non-TL injury was recorded when a player self-reported 'full participation but with health problems' (minor) or 'reduced participation due to health problems' (moderate). The impact of any non-TL injury reported was further assessed by its affect (minor or moderate) on performance, volume of training and perceived severity. Players reporting the presence of any injury (TL or non-TL) were required to record the location as per the Fuller et al. (2006) football consensus statement. Illnesses were also recorded by the OSTRC Questionnaire but were not included in the analysis for this study. All PDC's, clubs and coaches were blinded to self-report responses.

To facilitate compliance, the questionnaire reminder was emailed the day after each weekly game and resent daily up until the first training session of the following week to any players that had not yet completed the questionnaire. The primary investigator then sent each PDC a list of players who had not yet completed the questionnaire and they were asked to encourage players to complete the questionnaire online prior to the start of training.

Statistical analysis

During analysis, PDC reported TL injuries were compared with self-reported questionnaire responses. Weekly non-TL or self-reported 'complaints' from players fully participating in the training were included in the analysis. Self-reports submitted by players engaged in modified training or rehabilitation were excluded from the relative risk (RR) analysis but retained within prevalence calculations. In these cases, the player would be considered to be 'injured' under the TL injury definition as they have an 'inability to fully participate in football training or matches' (Fuller et al. 2006), and the self-reported injury would relate to a pre-existing TL injury. Similarly, if a PDC TL injury report was present in the absence of a player self-report in the preceding week, the TL injury was excluded from the relative risk (RR) analysis but included in the overall seasonal total for prevalence calculations.

The 'normal' risk of injury was determined by calculating the risk of a TL injury within 7 days of a self-report indicating 'no physical complaints'. The RR of a TL injury occurring within 7 days of a non-TL 'minor' or 'moderate' complaint was calculated relative to the 'normal' injury risk. The risk of sustaining a TL injury at a specific location was also determined relative to the specific location of the self-reported non-TL complaint. To account for within-subject variance due to the repeated measures and potential unbalanced nature of the data set (differences in number of survey responses by players), a generalized estimating equation (GEE) analysis (SPSS v24, IBM, USA) was used to examine associations between OSTRC questionnaire injury reports for each category and occurrence of time loss injury within 7-days. Specifically, a binary logistic regression model (link function) was used, including a robust estimator with an autoregressive working correlations matrix and an independent model category. The predictor variable was the OSTRC value for that week, which was coded as an ordinal variable and included in the model as a Factor. That is, for the participation category, full training with no health problems = 1, full training but with health problems = 2; reduced participation due to health problems = 3; Cannot participate due to health problems = 4. '1 – Full training with no health problems' was used as the reference category. The response/dependent variable was the injury indicator represented ordinally (0 = no TL injury within 7 days/1 = TL within 7 days), modelled as a Binary logistic. Exponential parameter estimates were included to calculate odds ratio values to determine the relative effects of reporting a 2 or 3 (compared to reporting a 1) on the OSTRC health questionnaire on the risk of sustaining a subsequent time-loss injury (within 7 days). In the event of a missing questionnaire response, this week was excluded from analysis regardless of whether or not a TL injury was recorded in the following 7 day period. Where significance was observed, sub-category analysis with RR (95% CI) was calculated and resultant *p* values used to calculate the likelihood of a harmful effect statistic, accompanied by relevant probabilistic terms to describe the clinical inference ranging from *'most unlikely to be harmful <0.5%'* to *'most likely to be harmful >99.5%'* (Hopkins 2007). The predictive power of a non-TL complaint on the occurrence of a TL injury was examined using receiver operating characteristic (ROC) curves. The area under the curve (AUC) was used to determine discriminatory power, with values <0.5, >0.7, and 1.0 considered as poor, good, and perfect, respectively (Crowcroft et al. 2016). Diagnostic accuracy and predictive power (95% CI) were also determined via sensitivity and specificity analysis of minor and moderate complaint sub-categories of the OSTRC Questionnaire.

OSTRC questionnaire response rates of 80% have previously been observed in athletic groups (Clarsen et al. 2014; Harøy et al. 2017). To accurately assess the effects of minor and moderate injury reports, a sub-group analysis of players with >80% response rates across the season was performed. Initially, the results of the GEE, RR and predictive characteristics of the sub-group and entire cohort were compared. In the event that both groups were statistically similar, an absence of bias was assumed and further analysis of the sub-group performed to assess the frequency of injury and reported weekly injury locations relative to PDC reports. Data are presented as absolute and relative values. Weekly injury prevalence was determined by calculating the percentage of injury reports relative to the total number of players participating that week.

Results

Relative risk and time-loss injury prediction

A total of 218 players (age: 24.1 ± 4.3 years; height: 177.1 ± 5.2 cm; weight: 74.9 ± 6.2 kg) participated in the study. A total of 3430 questionnaires were completed over the 35 week period (45% overall compliance, mean = 98 [95% CI – 88.1 to 110.2] completed questionnaires each week). The risk of sustaining a TL injury within 7-days of self-reported 'no health problems' was 6%. OSTRC Questionnaire perceived minor and moderate effects on participation, performance, volume and severity were each associated ($P< 0.05$) with an increased relative risk of TL injury within 7-days (Table 1). The power of a reported non-TL injury to predict the incidence of a TL injury within 7-days was good across all OSTRC categories (Table 1). Sensitivity, specificity and positive predictive power values are displayed in Table 2. A cohort of 73 (33%) players completed >80% of the weekly questionnaires (mean = 28.5 [CI: 26.2 to 31.3] completed questionnaires each week) to form the sub-group. In this sub-group of players, the risk of TL injury within 7-days of 'no health problems' was 9%. The associated injury risk and prediction results for the sub-group are also reported (Tables 1 and 2).

Sub-group

The magnitude of the increase in risk (RR) and predictive capacity for future TL injury was similar for the sub-group and entire cohort (Table 2). The total number of reported 'physical complaints' was 2.3 times greater when comparing self-reported versus PDC methods (n = 604 vs 265). Within the self-reports, non-TL injuries were 13.2 times (516 vs. 39) higher; however, TL injuries were 2.6 times lower (88 vs. 226) when compared to PDC data (Table 3). The proportion and distribution of injuries were similar between methods, with 87% (PDC) and 83% (self-reported) of all injuries affecting the lower limb. The most common locations were the hamstring (17% – PDC; 16% – self report) and knee (19% – PDC; 17% – self report; Table 3). Overall, 68% of all TL injuries were preceded by a non-TL report, with 94% of knee and 90% of hamstring TL injuries preceded by a non-TL complaint in the same location. The greatest risks were observed in the ankle and lower leg (RR = 6.8 and 6.3, respectively; Table 3). As players were able to report multiple locations per survey, there were more injury locations than injury reports recorded via the OSTRC Questionnaire (Table 3).

Sub-group weekly injury prevalence

Self-reports highlighted 33% (95% CI – 31.4% to 34.6%) of all players recorded an injury (comprising TL and non-TL injuries) each week with non-TL complaints accounting for 28% (95% CI – 26.4% to 29.6%) of all weekly injuries (Figure 1A). Combining self-reported non-TL and PDC recorded TL injury reports indicates that 49% (95% CI – 47.0% to 51.0%) of players were affected by injury each week (Figure 1B).

Discussion

To our knowledge, this is the first study to investigate the impact and prevalence of non-TL injuries in semi-professional men's football. Across the cohort of 218 players, the TL injury risk within 7 days of a self-reported minor or moderate non-TL injury (complaint) effecting performance, participation, volume or perceived severity was three to seven times greater compared to the absence of any complaint. Uniquely, a non-TL report across all four categories presented 'good' injury prediction capacities of sustaining a TL injury within the subsequent 7-days. A comparison of PDC and self-reports in the compliant group indicated a total injury prevalence more than 2 times higher within the self-reports. As similar injury risks and predictive capacities were observed in compliant and non-compliant groups, to facilitate a detailed analysis of the results, the discussion relates to the findings of the compliant sub-group (n = 73).

Table 1. Associated injury risk and injury prediction using the OSTRC Questionnaire on Health Problems (Clarsen et al. 2014) for time loss injury for the entire cohort and sub-group.

Entire Cohort (n = 218)		Association		Prediction
OSTRC Category	*P* level	Relative Risk (RR) [a]	Clinical Inference (Hopkins 2007)	Area Under the Curve Ɨ
Participation	**<0.0001**			0.79 (CI: 0.76 to 0.82)
Full Participation with Problems		3.3 (CI: 2.0 to 5.8)	93.5% – likely harmful	0.75 (CI: 0.70 to 0.80)
Reduced Participation Due to Health Problems		6.5 (CI: 3.7 to 8.9)	100% – most likely harmful	0.79 (CI: 0.74 to 0.84)
Performance	**<0.0001**			0.79 (CI: 0.75 to 0.83)
To a minor extent		4.0 (CI: 1.9 to 9.3)	93.1% – likely harmful	0.77 (CI: 0.72 to 0.83)
To a moderate extent		5.5 (CI: 3.2 to 9.4)	100% – most likely harmful	0.80 (CI: 0.75 to 0.84)
Volume	**<0.0001**			0.77 (CI: 0.74 to 0.80)
To a minor extent		4.4 (CI: 1.9 to 5.7)	100% – very likely harmful	0.75 (CI: 0.71 to 0.79)
To a moderate extent		6.9 (CI: 3.2 to 10.1)	100% – very likely harmful	0.74 (CI: 0.70 to 0.78)
Severity	**<0.0001**			0.73 (CI: 0.69 to 0.76)
To a minor extent		4.7 (CI: 0.01 to 11.7)	63.4% – possibly harmful	0.69 (CI: 0.65 to 0.74)
To a moderate extent		4.8 (CI: 1.1 to 15.0)	99.2% – likely harmful	0.72 (CI: 0.67 to 0.76)
*Sub Group** (n = 73)*				
Participation	**<0.0001**			0.83 (CI: 0.80 to 0.86)
Full Participation with Problems		2.8 (CI: 1.01 to 7.8)	95.2% – likely harmful	0.79 (CI: 0.73 to 0.84)
Reduced Participation Due to Health Problems		5.2 (CI: 2.7 to 9.9)	100% – most likely harmful	0.83 (CI: 0.78 to 0.88)
Performance	**<0.0001**			0.82 (CI: 0.79 to 0.85)
To a minor extent		3.2 (CI: 1.01 to 10.3)	94.6% – likely harmful	0.80 (CI: 0.76 to 0.84)
To a moderate extent		5.4 (CI: 2.78 to 10.4)	100% – most likely harmful	0.83 (CI: 0.79 to 0.87)
Volume	**<0.0001**			0.78 (CI: 0.75 to 0.82)
To a minor extent		3.5 (CI: 1.9 to 6.7)	99.9% – very likely harmful	0.75 (CI: 0.70 to 0.80)
To a moderate extent		5.9 (CI: 3.6 to 9.4)	100% – most likely harmful	0.72 (CI: 0.66 to 0.77)
Severity	**<0.0001**			0.78 (CI: 0.75 to 0.82)
To a minor extent		3.6 (CI: 0.01 to 10.7)	64.3% – possibly harmful	0.68 (CI: 0.62 to 0.75)
To a moderate extent		5.2 (CI: 1.82 to 15.0)	99.5% – very likely harmful	0.77 (CI: 0.73 to 0.81)

[a]RR of a third party reported TL injury within 7-days of the non-TL injury report within each category (95% confidence intervals) **Sub-group inclusion determined by >80% completion of OSTRC Questionnaire surveys during the season. Ɨ Area under the curve based on ROC curve analysis for each category for prediction of a time loss in 7-days following a physical complaint (95% confidence interval).

Importance of non-time loss injuries

In this study, the majority (85%) of recorded OSTRC Questionnaire complaints were non-TL and did not prevent participation. Our results thus highlight that including non-TL injuries substantially increases the prevalence of 'slight' (0–1 day TL) injuries ('physical complaints') in semi-professional football (van Beijsterveldt et al. 2015). Previously, congested match fixtures have been associated with a third of players reporting groin pain on a weekly basis (Harøy et al. 2017). However, to our knowledge, our study is the first prospective study in semi-professional football to be conducted over an entire season and record all injury locations. Therefore, given the duration of the TL and non-TL injury capture, our findings highlight a more comprehensive injury profile in semi-professional football than previously reported.

Previously, the need to record non-TL injuries has been questioned due to concerns over obtaining accurate and useful data (Orchard and Hoskins 2007). However, the results of the current study in semi-professional football, show a non-TL physical complaint to be associated with a 2.8–5.9 fold increase in the risk of sustaining a TL injury risk within the subsequent 7-days. Determining why this increased risk exists is likely to be multifactorial and dependent on the origin of the player's pain and physical discomfort (Bittencourt et al. 2016; Hainline et al. 2017a). The presence and perceived impairment (minor or moderate) resulting from a complaint, are likely to reflect the presence of perceived pain. Importantly, the risk of a TL injury within 7-days of a reported complaint increased with elevated perception of 'pain' severity. The presence of pain alters motor patterns and muscle recruitment behaviour (Hodges et al. 2015), which may affect performance capacity and contribute to the more serious injury risk we observed. Pain that leads to a 'physical complaint' may originate from a number of pathological issues (Hainline et al. 2017b) and the high prevalence observed in this study reveals the pain-related issues that players in semi-professional football experience on a weekly basis. Issues associated with pain, long-term medication use, and the development of chronic pain conditions in elite athletes (Hainline et al. 2017a) have been identified, with the long-term health of ex-professional football players impacted by osteoarthritis related pain (Arliani et al. 2016). When interpreting our results it is, however, important to consider that pain is often associated with sporting injury (Meyers et al. 2001), may be present in the absence of physiological or biomechanical pathology, and can continue after damaged tissue has healed (Hainline et al. 2017b). Furthermore, athletes are known to have a greater capacity to perform and participate despite pain compared with non-athletes (Tesarz et al. 2012), and pain may be a by-product of the normal process of a physiological overload stimulus and ensuing fatigue (O'Sullivan et al. 2018). Regardless of the pathology, mechanism, or origin of pain, this study highlights that the presence of a non-TL injury clearly increased the risk of a subsequent TL injury and suggests that reporting non-TL injuries may be an important consideration for coaches, players, medical and performance staff in semi-professional football.

Our findings thus support research that suggests the complexity of injury should be considered when describing the injury 'problem' and the multifactorial aetiology of

Table 2. Diagnostic accuracy assessment for OSTRC Questionnaire on Health Problems (Clarsen et al. 2014) for each sub-category drawn from entire cohort and sub-group.

OSTRC Questionnaire Category	True Positive (n)	False Positive (n)	False Negative (n)	True Negative (n)	Sensitivity (%) with 95% CI	Specificity (%) with 95% CI	Positive Predictive Value (%) with 95% CI
Entire Cohort (n = 218)							
Participation							
Full participation with problems	67	237	0	14	100.0 (100)	5.6 (2.2 to 7.1)	22.0 (19.4 to 24.8)
Reduced participation due to health problems	82	156	0	2	100.0 (100)	1.3 (0.2 to 3.1)	34.5 (31.6 to 39.3)
Performance							
To a minor extent	93	277	0	15	100.0 (100)	5.1 (2.8 to 7.3)	25.1 (21.9 to 30.0)
To a moderate extent	56	102	0	4	100.0 (100)	3.8 (2.1 to 7.9)	35.4 (30.3 to 40.9)
Volume							
To a minor extent	74	203	0	8	100.0 (100)	3.8 (1.9 to 4.9)	26.7 (21.2 to 31.9)
To a moderate extent	48	72	0	10	100.0 (100)	2.9 (1.8 to 4.1)	35.5 (30.2 to 41.8)
Severity							
To a minor extent	101	253	0	15	100.0 (100)	5.6 (2.1 to 7.3)	28.5 (23.7 to 31.5)
To a moderate extent	51	128	0	4	100.0 (100)	3.0 (1.1 to 5.1)	28.5 (25.9 to 30.2)
Sub-Group (n = 73)							
Participation							
Full participation with problems	64	196	0	36	100.0 (100)	15.5 (10.9 to 20.2)	24.6 (19.4 to 29.8)
Reduced participation due to health problems	75	120	0	25	100.0 (100)	17.2 (11.1 to 23.4)	38.5 (31.6 to 45.3)
Performance							
To a minor extent	85	219	1	51	98.8 (96.6 to 100)	18.9 (14.2 to 23.6)	28.0 (22.9 to 33.0)
To a moderate extent	51	81	0	14	100.0 (100)	14.7 (7.6 to 21.9)	38.6 (30.3 to 46.9)
Volume							
To a minor extent	70	163	0	37	100.0 (100)	18.5 (13.1 to 23.9)	30.0 (24.2 to 35.9)
To a moderate extent	48	72	0	10	100.0 (100)	12.2 (5.1 to 19.2)	40.0 (31.2 to 48.8)
Severity							
To a minor extent	92	203	1	54	98.9 (96.8 to 100)	21.0 (16.0 to 26.0)	31.2 (25.9 to 36.5)
To a moderate extent	50	85	0	26	100.0 (100)	23.4 (15.5 to 31.3)	37.0 (28.9 to 45.2)

Table 3. Sub-Group time-loss Injury reports and associated relative risk following a previous physical complaint. Data presented according to location using third party (Football Consensus) (Fuller et al. 2006) and self-reporting method (OSTRC Questionnaire on Health Problems) (Clarsen et al. 2014).

	Football Consensus	OSTRC Participation Category				
Injury Location	Time Loss – 3rd Party Method	Total – Self Report	Non-Time Loss – Self Report	Relative Risk (RR)[a]	Clinical Inference (Hopkins 2007)	Factor – Non-Time Loss/Time Loss**
Head/face	6 (3)	4	2	-		
Neck/cervical spine	2	11 (1)	11 (1)	-		
Shoulder/clavicle	3 (1)	18 (2)	14 (2)	-		
Sternum/ribs/upper back	3 (1)	27 (3)	23 (3)	-		
Hand/finger/thumb	4 (2)	16 (2)	15 (2)	-		
Wrist	1	0	0	-		
Low back/ sacrum/pelvis	11 (5)	76 (9)	69 (9)	1.9 (CI: 0.2 to 19.5)	64.8% – possibly harmful	6.3
Hip/groin	26 (12)	138 (16)	128 (17)	3.5 (CI: 2.4 to 5.2)	100% – most likely harmful	4.9
Thigh	64 (28)	189 (22)	163 (21)	5.2 (CI: 2.2 to 12.5)	99.8% – most likely harmful	2.5
Hamstring	39 (17)	136 (16)	116 (15)	4.7 (CI: 2.0 to 11.0)	99.7% – most likely harmful	3.0
Quadriceps	25 (11)	58 (7)	52 (7)	5.8 (CI: 1.4 to 24.9)	96.9% – most likely harmful	2.1
Knee	43 (19)	149 (17)	122 (16)	3.6 (CI: 2 to 6.1)	100% – most likely harmful	2.8
Lower leg/Achilles tendon	28 (12)	89 (10)	78 (10)	6.3 (CI: 0.1 to 375.8)	75.7% – likely harmful	2.8
Ankle	22 (10)	59 (7)	52 (7)	6.8 (CI: 0.1 to 376.0)	77.1% – likely harmful	2.4
Foot/toe	10 (4)	38 (4)	36 (5)	1.3 (CI: 1.1 to 1.5)	96.2% – very likely harmful	3.6
Total Injury Reports	226	604	516			2.3
Total Injury Locations	226	871	771			

[a]RR – of a third party reported time loss injury occurring within 7 days following a self-reported non-time loss injury (determined on injuries with prevalence ≥5%; 95% confidence intervals. Normal risk = 10%) ** Factor = Total Non-time loss injury via OSTRC Questionnaire/Total Time Loss via Football Consensus (only locations with >10 time loss injuries included). Values within brackets show percentage of **total injury locations** (below 1% not shown)

incidence (Bittencourt et al. 2016; Bolling et al. 2018). In this study, self-reports increased the detail of an injury occurrence and encapsulated symptom severity and provided insight into the physical state of a player preceding a more severe injury resulting in TL. Therefore, our findings demonstrate a simple method to enhance the first stage of

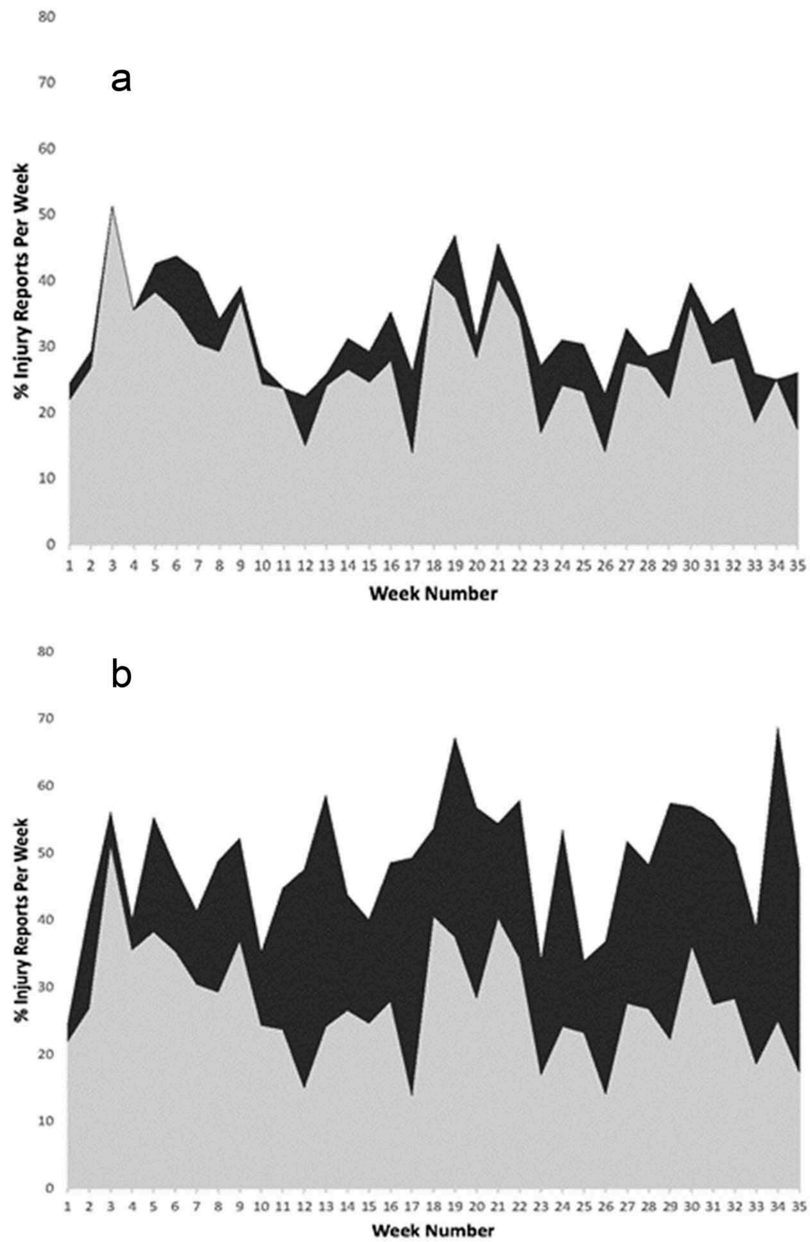

Figure 1. Prevalence of all injuries (dark grey) and non-TL only injuries (light grey) recorded by the weekly self-reported injury OSTRC Questionnaire on Health Problems (A); Combining both injury surveillance methods – Self-reported and Third Party (B).

the injury prevention cycle illustrated by Van Mechelen (Van Mechelen and Hlobil 1992).

Another tool in the injury risk reduction tool box?

The complex and multifactorial nature of injury (Bittencourt et al. 2016) challenge practitioners and researchers to search for tools that identify players at increased risk of injury, and to implement methods to mitigate this risk (Windt and Gabbett 2017). The results of this study suggest that the OSTRC Questionnaire may assist in identifying high-risk players in semi-professional football. Indeed, improving communication between key stakeholders within a club can reduce injury incidence and sustain player availability (Ekstrand et al. 2019).

Uniquely, the presence of a non-TL injury in this study displayed 'good' predictive power for future injury, suggesting that non-TL injuries or 'complaints' can classify 'high risk' players who may require an injury risk reduction intervention (McCall et al. 2017). The strong associations observed between non-TL reports preceding a TL injury in the same location (Table 3), suggest it may also be possible to identify location-specific injury risks. However, the current research does not allow us to accurately determine whether the TL injury suffered was a direct result of a worsening of an issue in the same location or related to a separate issue in a different location. Notably, all OSTRC questions were associated with identifying at risk players to similar degrees, suggesting that a single question could be equally effective. Reducing questionnaire burden may also facilitate compliance. The positive predictive values of 24.6% to 40%

(increasing as reported symptom severity increased) associated with the risk of injury were substantially greater than the 1.8% to 3.8% workload-related risks observed in professional football (McCall et al. 2018). However, whilst good at capturing players at increased risk (high sensitivity), considering the presence of non-TL injury for the prediction of a TL injury resulted in a high number of false positive results (low specificity). Considering non-TL injury reports in isolation to predict injury is not recommended, however using the OSTRC Questionnaire as an early identification tool to prevent minor injuries progressing to more significant ones, i.e. a secondary prevention tool, may be beneficial. As such, a non-TL complaint may be considered as a 'flag' to open player-coach/medical staff communication and assist in injury risk reduction.

Football consensus method vs OSTRC Questionnaire on Health Problems

Despite the lower capture of TL injury data, 2.3 times more total physical complaints were captured using the OSTRC Questionnaire, with a third of players reporting a physical complaint of varying severity each week. Our findings thus suggest that the Football Consensus method of injury surveillance underestimates the number of 'slight' (0–1 day TL) injuries sustained in semi-professional football and is consistent with previous research (Harøy et al. 2017). This result is likely a consequence of methods that rely on players reporting injuries to a medical staff member (Fuller et al. 2006). In professional sport, reporting medical complaints is perceived to be an issue (Bjørneboe et al. 2011), and is likely exacerbated in semi-professional sport due to decreased medical access (van Beijsterveldt et al. 2015). The increased prevalence of self-reported non-TL injuries observed in this study was thus a likely consequence of providing the opportunity to report complaints indirectly (Møller et al. 2017).

Despite the increased prevalence of non-TL injuries observed within self-reports recorded, PDC's in this study recorded >2.5 times the number of TL injuries compared with self-reports. The consistent capture of this TL injury data is essential to determine severity profiles and burden associated with injury (Bahr et al. 2018) and our results thus also highlight the importance of third-party injury surveillance methods. There are a number of possible explanations for the observed TL report discrepancy, (i) an injured player who did not attend at training that week may have failed to complete the survey; (ii) players may have perceived TL injury disclosure may affect their eligibility for selection (Ekegren et al. 2014), and (iii) player and PDC definitions of time-loss may have differed, e.g., a player in modified training may perceive they have returned to play, yet the PDC worked under a definition of returning to full training (Bjørneboe et al. 2011). The third party method of TL injury recording outlined in the Football Consensus (Fuller et al. 2006) thus better facilitates thorough TL injury recording with a consistent injury definition and addresses the limitations associated with questionnaire compliance.

Limitations

Despite the clear association between non-TL injuries and occurrence of a TL injury in this study, a number limitations should be acknowledged.

The low compliance rate of players (33%) completing the weekly survey in this study highlights a potential barrier for the use of the OSTRC Questionnaire for both injury surveillance and as a potential risk identification tool. This issue has also been observed in other athletes with survey compliance over 12 weeks reported as 52% (24/46 players) (Møller et al. 2017). However, given the similarity of the results we observed between the entire cohort and the sub-group, we do not believe that there is an issue in generalising our results on a larger scale. Methods to improve buy-in to self-reported player monitoring methods are thus required. Adopting smartphone technology may improve compliance (Møller et al. 2017; Harøy et al. 2017) and allow sessional or daily application of the survey.

The delivery design of the OSTRC Questionnaire presents a limitation to the use of the questionnaire for injury 'prediction' with multiple injury locations able to be recorded each week. Whilst 90% of all TL hamstring injuries in this study were preceded by a non-TL hamstring complaint, 33% of these preceding complaints included more than one location, and it has been suggested that pain at locations distal to a TL injury site may impact on future injury risk (Wilke et al. 2019). As such, it is not possible to conclusively determine whether the subsequent TL hamstring injury was always a progression of the reported non-TL hamstring injury, or was related to the non-TL injury in a different location. To further evaluate the efficacy of using the OSTRC Questionnaire for injury prediction, more frequent application is necessary.

We also acknowledge that differences in i) coaching styles (Ekstrand et al. 2018), ii) previous injury history and physical fitness levels (Windt and Gabbett 2017) and iii) workloads preceding a TL injury (McCall et al. 2018) were each uncontrolled extraneous variables that may have impacted TL injury risk and non-TL injury prevalence including that were not considered in the analysis in this study. Additionally, the translation of the findings from this study to the professional setting may be limited. In the professional setting, players are likely to be monitored far more closely than in semi-professional football. However, the results may suggest that the use of changes in pain reports commonly collected in daily monitoring in the professional setting (Thorpe et al. 2017), may have potential in secondary injury prevention strategies and requires further investigation. Finally, the treatment received by players for non-TL injuries or TL injuries was not monitored and it is possible that players may have had access to differing medical provision. Furthermore, players that received treatment may have 'self-reduced' their injury risk by addressing non-TL complaints.

Conclusion

In this study, the OSTRC Questionnaire combined with Football Consensus third party methods substantially improved injury surveillance, which may assist in injury risk reduction program design. Weekly non-time loss physical complaints were high in semi-professional football with 49% of all players affected by a physical complaint of varying severity (TL or non-TL) each week. TL injury risk was 3 to 6 times higher when preceded (<7days) by self-reported non-TL physical complaints that have minor and moderate impacts on participation, performance, training volume or perceived severity. Importantly, the presence of a non-TL injury had good injury prediction capacity for the incidence of a TL injury within the following week.

Practical Implications

The combination of third party and self-report injury reporting methods greatly increases the capture of injury data in semi-professional football. Importantly, the presence of a non-TL injury is associated with an increased risk of a TL injury and good predictive power relative to a future TL injury occurrence. Therefore, it is suggested that the OSTRC Questionnaire, in addition to improving injury surveillance, is a useful tool for secondary injury prevention and can be used to assist in player monitoring. The similar results observed across each of the four OSTRC Questionnaire categories does however suggest that a single question may sufficiently identify high-risk players, a strategy that might facilitate player compliance.

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