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Abstract

Introduction: Considerable media attention has recently focused on an increased number of professional athletes that experience forced retirement due to severe injuries. Despite the highly completive, physical nature and tolerance of risk in contact sports, no Occupational Safety and Health (OSH) awareness-related measurement instrument exists in professional sports. As part of a wider project, this study aimed to develop a survey instrument to evaluate risk and safety awareness in sports, taking elite rugby (union) as an example. Methods: Based on the identified conceptual framework incorporating theories from the OSH discipline, the survey has been updated for three rounds according to the feedback from a multidisciplinary team of experts before the pilot test. The pilot test data (n=46, response rate 76.7%) were imported to SPSS for analysis and validation. The survey's key themes included health outlook, tackle behavior, awareness of risk acceptance, reasons for risk-taking, and safety consideration for other players. Results: Overall, the survey has a high internal consistency (Cronbach's α= 0.742). Some sections of the survey require a further factor analysis, such as awareness of risk acceptance during the competition (Kaiser-Meyer-Olkin Measure of Sampling Adequacy - KMO <0.767, p<0.001) and reasons for risk-taking (KMO<0.604, p=0.003). Some sections require a larger sample size for further validation, such as safety consideration for other players (KMO<0.481, p<0.001). Conclusion: This is the first survey that evaluates players' safety and risk awareness in rugby drawing upon OSH concepts. Such a survey has the potential to improve athletes' health and wellbeing by customized educational intervention, which could point the way forward for its application in a wider range of sport settings internationally.

1. INTRODUCTION

Professional sport can be considered a unique workplace with its own culture that substantially influences whether players prioritize performance over their health and safety, often resulting in long-term health and wellbeing impacts for their post-sport lives (Haslam et al., 2016). Utilizing or applying occupational safety and health (OSH) management concepts in sport is promising. It may lead to a greater understanding of why some players accept risky and aggressive behaviors. While OSH management practices are embedded into organizational management internationally, they have yet to be utilized to their fullest extent in professional sports.

Considerable media attention has recently focused on an increased number of elite athletes' long-term health consequences, especially in contact team sports, such as rugby union (hereafter referred to as rugby). For example, many former players, who are all under 45, have been diagnosed with the early signs of dementia (Aylwin & Rees,

2020). The prevailing culture of risk tolerance in elite sports (Schnell et al., 2014) raises significant concern about how contact team sports can keep their athletes safe and healthy (Buggy et al., 2020). Understanding elite sports players' level of safety and risk awareness is thus paramount for cultivating safety culture in their sport organization and their long-term health and wellbeing.

However, considering sports contextual features, risk awareness and perceptual instruments validated for other occupations cannot be directly adopted in professional sports such as rugby. When compared to the array of safety culture/climate frameworks reviewed, a well-established and leading quantitative research instrument within the field of OSH climate/culture evaluation – the NOSACQ-50 safety-climate questionnaire, was identified with potential to be applied in professional sports (EU-OSHA, 2011; Kines et al., 2011). Based on its validated theoretical framework, the NOSACQ-50 has been widely applied in various occupational settings internationally and externally validated in over 40 languages (Marín et al., 2019; Susanto et al., 2019; Yunita et al., 2018). However, even the widely used quantitative survey instrument such as the NOSACQ-50 questionnaire has not yet been applied to professional sports. Due to the substantial variation in socio-demographic characteristics of participants and the cultures between individual sports, this research concentrates on the sport of rugby, as it has a relatively unified global approach to management and rules.

Professional rugby as an occupation undoubtedly has a high injury risk. In senior male professional rugby, the overall injury incidences approximately 81/1,000 player hours (Williams et al., 2013). However, rugby players may also be exposed to a high injury risk even in less competitive playing levels. Previous research in rugby emphasized the importance of a safe tackle attitude as most severe injuries are caused by tackling (Chalmers et al., 2004; Noakes & Draper, 2007; Quarrie et al., 2002, 2007). Like other contact sports, the culture in rugby is often reflected in players' brutal" performances against each other, which has been accepted as an element of voluntary assumption of risk among the players since rugby's professionalization (Davies et al., 2017). Furthermore, players denoted that they were often "marked" by their opponents who were trying to "take them out" during the competition (Badenhorst et al., 2019) – this is not conducive to OSH management in a teamwork environment.

Recently, rugby was reported to be facing lawsuits on a similar scale to the NFL (National Football League), which has been paying out over one billion dollars to retired players who have sustained head trauma (Ingle, 2020). In such a background, this research exploring OSH awareness in elite Irish rugby contributes to improving elite athletes' health and wellbeing, which, if successful, could point the way forward for application in a wider range of sports internationally.

2. METHODS

In order to sufficiently evaluate elite rugby players' level of risk awareness, a study instrument is needed to achieve three specific objectives:

- Objective 1: To explore the difference between player tackle behavior in training and competition;
- Objective 2: To explore the difference between player risk-acceptance awareness in training and competition; and
- Objective 3: To explore the difference between rugby players' and general occupational employees' risk-acceptance awareness (by benchmarking with the NOSACQ-50 dataset).

As part of a larger research project, this cross-sectional pilot study was thus conducted in three phases: 1) survey development, 2) pilot testing, and 3) psychometric property evaluation. In our previous research phases, an ethnographic inquiry (Chen, Kelly, et al., 2021) in elite Irish rugby has been conducted to understand safety culture in rugby context, followed by an interview-based study (Chen, Buggy, et al., 2021) with safety related rugby personnel such as coaches, physiotherapists and team mangers. This

current phase of the study focuses on opinions and experiences from players' perspective by using a quantitative research method.

2.1 Conceptual framework

The conceptual framework (Figure 1) has been continuously updated as research progressed in which' risk acceptance', 'safety behavior' and 'consideration for other players' have been identified as key constructs for the evaluation. First, the high level of risk acceptance in sports contributes to players' incompliance with risk-taking behaviors which directly impact their physical health condition (Chen et al., 2019). Second, aggressive players who intentionally cause injury to their opponents (co-workers) are common in collision sports (Maxwell & Visek, 2009), so individual's consideration of other players' safety is a critical indicator to evaluate the safety behavior (Hofmann & Stetzer, 1996) in rugby context. Third, as most injuries in rugby are caused by tackling (Pettersen, 2002), players' tackle behavior was thus considered as a key indicator of safety behavior to be evaluated. As rugby injury risk varies between training and competition, the survey questions under the theme of risk acceptance and tackle behavior are designed in both training and competition settings. Based on our previous studies, elite players' reasons for risk-taking mainly include spectators' expectation, pressure from coaches, game excitement, professional career and game rewards (Chen et al., 2019; Chen, Kelly, et al., 2021). In addition, players' health outlook, demographic information such as current age, gender, playing position, age started playing rugby and level of playing experience are also included in the framework as common factors that may influence on overall player safety awareness.

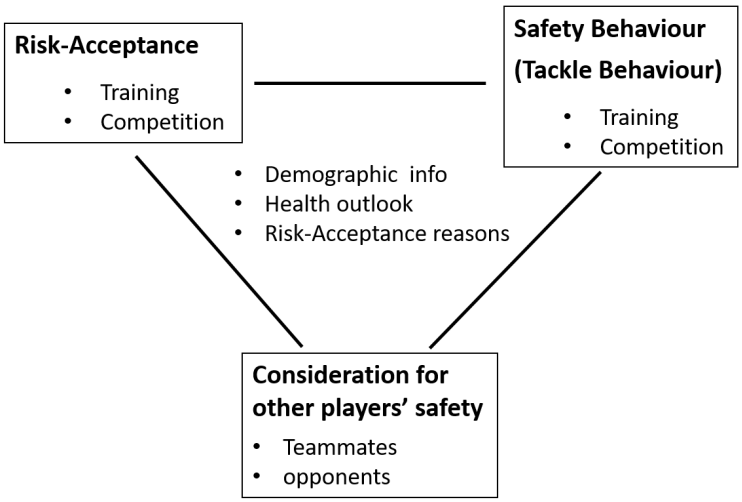

Figure 1. Player safety awareness framework

2.2 Survey development process

Based on the conceptual framework introduced, a survey instrument was designed through an iterative process by adopting questions from existing validated questionnaires (Clarsen et al., 2014; Hendricks et al., 2015; Kines et al., 2011) and designing a series of original questions, involving a team of experts from the following disciplines: Sports Management; Occupational Safety and Health; and Public Health. The key themes in the survey include demographic information, health outlook, tackle behavior, awareness of risk acceptance, consideration for other players, and reasons for risk-taking. After three rounds of revision, the fourth version survey met the content validity criteria of the multidisciplinary experts (e.g. sport management, OSH, rugby performance, statistics), the process of which is further described in the Results section. A series of interviews highlighted specific factors that needed to be focused on, and those factors were extracted from the full NOSACQ-50 survey. Since most injuries (including concussions) in rugby are caused by tackling (Pettersen, 2002), players' tackle attitude/behavior was thus considered as a critical indicator of safety behavior during rugby performance in this specific context. Table 1 exemplifies the sections and items to be investigated in the survey.

Table 1. Survey safety and risk awareness section, facets and exemplifying items

Section	Facets	Example item
1) Demographic information	Players' basic information	Age; Playing position; Level of playing experience
2) Current health outlook	Players' health status and recent injury history	To what extent have injury, illness, or other health problems affecting your performance during the past week?
3) Tackle behavior (training)	Players' attitudes towards the importance of tackle behaviors during a training session	Bringing down the ball-carrier at all costs; Safety of both you and the ball-carrier.
4) Tackle behavior (competition)	Players' attitudes towards the importance of tackle behaviors during a competition	Competition scenarios: Playing to win the league or to prevent relegation
5) Awareness of risk acceptance (training)	Players' awareness of risk acceptance during a training session	We regard risks as unavoidable during training; We consider minor accidents as a regular part of our training routine.
6) Awareness of risk acceptance (competition)	Players' awareness of risk acceptance during a competition	We regard risks as unavoidable during a competition; We consider minor accidents as a regular part of our competition
7) Consideration for other players	Players' safety awareness of their teammates and opposition players	We consider our teammates as co-workers; We are concerned for our teammates' safety during the game.
8) Reasons for risk acceptance	Reasons why players may accept risk when playing rugby	We accept risks in playing rugby to advance our rugby careers
Further comments	Players' further comments on health and safety	Do you think health and safety training would be beneficial to you and your teammates? Please feel free to comment.

2.3 Pilot test

An elite Irish rugby team consented to participate in the advanced pilot test. The ethical approval has been granted by the Human Research Ethics Committee of the authors' university, and the permission for research survey deployment was also approved by the IRFU (Irish Rugby Football Union) Research Committee. As suggested by the club director, the fourth version survey was deployed online by using SurveyMonkey™. The club director sent the message embedded with a survey link to the players' WhatsApp group on behalf of the researcher. The survey was opened for two weeks (from November 4 to November 17, 2020, and a reminder was sent in the middle of the data collection period. Since the total number of participants was known, the following formula was used to calculate the recommended sample size:

$$n = \frac{z^2 \times p \times \frac{(1-p)}{e^2}}{1 + z^2 \times p \times \frac{(1-p)}{(e^2 \times N)}}$$

Where z = 1.96 for a confidence level of 95%, p = proportion (expressed as a decimal), N = population size, e = margin of error.

$$z = 1.96,\ p = 0.5,\ N = 60,\ e = 0.05$$

$$n = \frac{1.96^2 \times 0.05 \times \frac{(1-0.05)}{0.05^2}}{1 + 1.96^2 \times 0.5 \times \frac{(1-0.5)}{(0.05^2 \times 60)}}$$

$$n = \frac{384.16}{7.4027} = 51.895 \approx 52$$

The recommended sample size for a confidence level of 95% and margin of error of ±5% is 52 players. However, in this case, 46 responses returned out of 60 players in the group, representing a 77% response rate. Based on SurveyMonkey's record, players completed the questionnaire in approximately 8 – 18 minutes, depending on the length of responses to the open-ended questions.

2.4 Psychometric properties

Quantitative survey validation followed recommended guidelines for survey reliability and validity testing (Presser et al., 2004). Psychometric properties assessed as part of the study are described as follows:

- Content validity: the survey covers all relevant aspects of safety and risk awareness among rugby players, and no sections or items in the survey are irrelevant to safety and risk awareness in rugby settings
- Construct validity: the degree to which the survey items measure each identified key theme of safety and risk awareness in rugby settings. Principal component analysis (PCA) has been performed to each section. The known-groups technique is applied to the "risk acceptance" section to test the differences between rugby and general, occupational groups.
- Reliability: the survey can reproduce consistent results in time and space. Specifically, the internal consistency scores on similar items in one construct are expected to be related (internally consistent), but for each to contribute some unique information as well (e.g., questions regarding safety consideration for other players can be evaluated from both teammates and opposition player perspective).

Furthermore, this survey can serve the future survey version when assessing criterion validity.

3. RESULTS

All the data downloaded from SurveyMonkey were in the format of Excel. Data were cleaned, coded according to the developed data dictionary, and subsequently imported to SPSS for validity and reliability analysis.

3.1 Participants demographics

All the players who participated in the survey were playing for Men's Rugby. The overall characteristics of the participants are presented as Table 2.

Table 2. Participants overall characteristics

Demographics	n	(%)	Mean (SD)
Current Age (years)	44		20.6 (2.6)
Age started playing rugby	45		7.4 (2.7)
Playing position	45		
Forwards (No. 1-8)	22	(48.9)	
Backs (No. 9-15)	23	(51.1)	

To strictly follow GDPR regulations and ethical clearance conditions to ensure complete anonymity of the players, the results in relation to Level of Playing Experience (in Section 1), Player Health Outlook (Section 2) and Competition Scenarios (in Section 4) have not been presented in this paper.

3.2 Survey validation results

The content validity was discussed prior to data collection during the survey development phase to validate the survey, while the construct validity and reliability were evaluated after data collection. In terms of content validity, the research team proposed that rugby's safety and risk awareness level should be investigated from both player and management perspectives, referring to the general occupational safety climate framework (Kines et al., 2011). However, as the rugby experts suggested, the content focusing more on the player perspective would be more practical considering the applicability of survey deployment. For example, as players' safety attitudes can differ between training and competition, their risk acceptance level and tackle behavior were suggested to be evaluated using the same items from both scenarios. The result of such a hypothesis has been tested as presented in Table 3 (Objective 1) and Table 4 (Objective 2).

Table 3. Mean ratings of importance for tackle attitudes and behaviors

Tackle behaviors	Training (n)	Mean	95% CI	Competition (n)	Mean	95% CI	df	P-value
Doing what you practiced	37	4.59	4.34-4.85	32	4.38	3.98 - 4.80	31	0.190 (ns)
Proper technique	37	4.65	4.49-4.81	32	4.47	4.11 - 4.79	31	0.388 (ns)
Bring down the ball-carrier	37	4.24	3.93-4.55	32	4.59	4.33 - 4.89	31	0.073 (ns)
Your own safety	37	4.11	3.82-4.40	32	3.88	3.45 - 4.29	31	0.083 (ns)
Safety of the ball-carrier	37	3.70	3.32-4.09	32	3.34	2.90 - 3.81	31	0.092 (ns)
Safety of both you and the ball-carrier	37	4.03	3.74-4.32	31	3.68	3.26 - 4.09	30	0.038*
Putting in a 'Big Hit'	37	3.73	3.34-4.12	32	4.31	3.98 - 4.67	31	0.024*
Going for the ball only	37	2.70	2.35-3.05	32	3.13	2.77 - 3.49	31	0.037*
Staying on your feet	37	2.89	2.48-3.31	32	3.00	2.53 - 3.47	31	0.197 (ns)
Preventing the ball-carrier from retaining position	37	4.08	3.75-4.41	32	4.56	4.40 - 4.76	31	0.018*
Preventing the ball-carrier's team from retaining the ball	37	4.24	3.93-4.55	32	4.50	4.25 - 4.78	31	0.364 (ns)

*Wilcoxon signed-rank test $p<0.05$ indicated the same player's attitude towards that particular tackle behavior significantly differed between training and competition.

As indicated in Table 3, the difference between each item for each training question was respectively tested against each of the 11 items listed for the same question during competition. Players' attitudes towards four items were significantly different between training and competition including "*safety of both you and the ball-carrier*" ($p = 0.038$), "*Putting in a 'Big Hit'*" ($p = 0.024$), "*Going for the ball only*" ($p = 0.037$) and "*Preventing the ball-carrier from retaining position*" ($p = 0.018$). As players ranked, "*safety of both you and the ball-carrier*" was more important in training (mean = 4.03, 3.74 - 4.32 95% CI) than that in competition (mean = 3.68, 3.26 - 4.09 95% CI); "*Putting in a 'Big Hit'*" was more important in competition (mean = 4.31, 3.98 - 4.67) than that in training (mean = 3.73, 3.34 - 4.12 95% CI); "*Going for the ball only*" was more important in competition (mean = 3.13, 2.77 - 3.49 95% CI) than that in training; and "*Preventing the ball-carrier from retaining position*" was more important in competition (mean = 4.56, 4.40 - 4.76 95% CI) than that in training (mean = 4.08, 3.75-4.41 95% CI).

As presented in Table 4, players were more aware of the risk during training (mean = 2.18, 2.07 – 2.31 95% CI) than that in competition (mean = 1.86, 1.68 - 2.03 95% CI). Specifically, players regarded risks were unavoidable during both training (mean = 2.43, 2.18 - 2.69 95% CI) and competition (mean = 1.77, 1.53 - 2.00 95% CI), but risks were considered significantly more unavoidable in competition than that in training (p = 0.001). Players considered minor accidents as a normal part of training (mean = 2.10, 1.90 - 2.30 95% CI) and competition (mean = 1.67, 1.44 - 1.89 95% CI). However, in competition, minor accidents were considered significantly more normal than that in training (p = 0.003). Sometimes, safety rules were reported to be overlooked in order to succeed during training (mean = 2.90, 2.57 - 3.23 95% CI) and competition (mean =2.40, 2.01 - 2.79 95% CI), but this behavior has more significantly prevailed in competition than training (p = 0.003). Most players agreed that rugby required people to have courage, resilience and determination in both training (mean = 1.63, 1.45 - 1.82 95% CI) and competition (mean = 1.43, 1.22 - 1.65 95% CI), which was more significant in competition (p = 0.034).

Table 4. The score of players' awareness of risk acceptance (n=30)

Awareness of Risk Acceptance	Training		Competition		P-value
	Mean	95% CI	Mean	95% CI	
Regard risks as unavoidable	2.43	2.18 - 2.69	1.77	1.53 - 2.00	0.001**
Consider minor accidents as a normal part	2.10	1.90 - 2.30	1.67	1.44 - 1.89	0.003**
Willing to accept risk-taking behavior as long as there are no serious injuries	2.20	1.93 - 2.47	1.93	1.66 - 2.21	0.166 (ns)
Safety rules can sometimes be overlooked in order to succeed	2.90	2.57 - 3.23	2.40	2.01 - 2.79	0.003**
Never accept risk-taking	2.17	1.92 - 2.41	2.13	1.84 - 2.42	0.593 (ns)
Consider that rugby requires people to have courage, resilience and determination	1.63	1.45 - 1.82	1.43	1.22 - 1.65	0.034*
Sometimes accept the need for risk-taking	1.90	1.70 - 2.10	1.67	1.44 - 1.89	0.052 (ns)

*Wilcoxon signed-rank test p<0.05, **p<0.01.

Furthermore, considering the difference between safety and rugby cultures, some questions adopted from the validated OSH questionnaire were modified as rugby experts suggested. For example, the item "*we consider that rugby training/competition is unsuitable for cowards*" adopted (Kines et al., 2011) had been modified to "*we consider that rugby training/competition requires people to have courage, resilience, and determination*." Other aspects of content validity are deemed as satisfactory.

Known-groups technique was also applied for players' risk acceptance awareness in training (Section 5) and competition (Section 6). Using One-sample t-test compared to the same dimension from the existing NOSACQ-50 dataset (n = 59249, mean = 2.98, SD = 0.51) (The National Research Center for Work Environment, 2020). As Table 5 presented, the awareness of risk acceptance score in general occupation provided by NOSACQ-50 dataset was significantly different from that in rugby training or rugby competition, indicating the two sections in this survey successfully captured expected differences (Objective 3).

Table 5. Compared means with the same dimension in NOSACQ-50

Dimension	t	df	P-value	Mean Difference	95% CI
Players' awareness of risk acceptance (training)	-13.50	30	0.000**	-0.80	-0.92 ~ -0.68
Awareness of risk acceptance (competition)	-13.30	29	0.000**	-1.12	-1.30 ~ -0.95

**One-sample t-test p<0.01

In terms of reliability, overall, the survey has a high internal consistency (Cronbach's α= 0.742). Most sections were adopted from the existing validated questionnaire sections, the validity and reliability were analyzed within each section in this stage as an initial step of the survey development.

The principal components analysis has been performed by using SPSS within each section. Specifically, the Kaiser-Meyer-Olkin Measure of Sampling Adequacy (KMO) has been used (Kaiser, 1970, 1974), complemented by Bartlett's test of sphericity tests (Bartlett, 1954). Scree plot inspections and parallel analysis based on minimum rank factor analysis were conducted to determine the advised number of factor dimensions. The orthogonal rotation has been used to aid factor interpretation, with rotated Item loadings above 0.4 being considered for further analysis, while items cross-loading below 0.40 should be deleted (Straub & Gefen, 2004).

As Table 6 presented, section 4, section 5, and section 7 require further exploration with larger sample size.

Table 6. Overall PCA results

Sections	KMO	p-value	Eigen value > 1	Notes
Section 3 Tackle Behavior (Training)	.623	<.001	3	PCA recommended
Section 4 Tackle Behavior (Competition)	.530	<.001	NA	Larger sample required
Section 5 Awareness of Risk Acceptance (Training)	.604	.050	NA	Larger sample required
Section 6 Awareness of Risk Acceptance (Competition)	.767	<.001	2	PCA recommended
Section 7 Consideration for Other Players	.481	<.001	NA	Larger sample required
Section 8 Reasons for Risk Acceptance	.604	.003	2	PCA recommended

For the sections (section 3, section 6, and section 8) qualified for PCA, the scree test (Cattell, 1966) has been used to determine the number of factors that should be reduced to. By reviewing the plot based on Catell criteria, components with an Eigen value larger than 1 are retained to determine how many dimensions should be reduced to.

For Section 3, the questions can be divided into three dimensions (Table 7).

Table 7. Section 3 Rotated Component Matrix

Tackle Behavior (Training)	Component		
	1	2	3
Doing what you practiced			0.820
Proper technique			0.667
Bring down the ball-carrier		0.796	
Your own safety	0.858		
Safety of the ball-carrier	0.837		
Safety of both you and the ball-carrier	0.947		
Putting in a 'Big Hit'		0.640	
Going for the ball only		0.541	
Staying on your feet*	0.469		0.456
Preventing the ball-carrier from retaining position		0.595	0.504
Preventing the ball-carrier's team from retaining the ball		0.776	0.411

*Item deletion suggested
Factors presented of item loadings greater than 0.4

Thus, factor extraction and rotation methods have been adopted for this section to establish a succinct subset of questions suitable for final use, as presented in Table 6. Aligned with the previous study (Hendricks et al., 2012), those tackle behavior items can be divided into safety-based behaviors, including Q16 "*Your safety"* (0.858), Q17 "*Safety of the ball-carrier"* (0.837), and Q18 "*Safety of both you and the ball-carrier"*

(0.947); performance-based behaviors including Q15 "*Bring down the ball-carrier*" (0.796), Q19 "*Putting in a 'Big Hit'*" (0.640), Q20 "*Going for the ball only*" (0.541), and Q22 "*Preventing the ball-carrier from retaining position*" (0.595) and Q23 "*Preventing the ball-carrier's team from retaining the ball*" (0.776). Another type is between safety-based and performance-based behaviors, including Q13 "*Doing what you practiced*" (0.820) and Q14 "*Proper technique*" (0.667). The item Q21 "*Staying on your feet*" has a similar loading score for two dimensions. As both loadings are relatively low, this item can be deleted.

Section 6 can potentially be divided into 2 dimensions (Table 8). One dimension reflects the inherent risk nature of rugby competition, including Q47 "*Regard risks as unavoidable during the competition*" (0.871), Q48 "*Consider minor accidents as a normal part of the competition*" (0.730), and Q52 "*Consider that rugby competition requires people to have courage, resilience, and determination*" (0.840). The other dimension is the risk-taking factor, which is potentially manageable, including Q49 "*Accept risk-taking as long as no serious injuries*" (0.556). Q50 "*Safety rules can sometimes be overlooked to succeed*" (0.816), Q51 "*Never accept risk-taking during the competition*" (0.758), and Q53 "*Accept the need for risk-taking during the competition*" (0.738).

Table 8. Section 6 Rotated Component Matrix

Awareness of Risk Acceptance (Competition)	**Component**	
	1	2
Regard risks as unavoidable during competition		0.871
Consider minor accidents as a normal part of the competition	0.419	0.730
Accept risk-taking as long as no serious injuries	0.556	
Safety rules can sometimes be overlooked to succeed	0.816	
Never accept risk-taking during competition	0.758	
We consider that rugby competition requires people to have courage, resilience, and determination		0.840
Accept the need for risk-taking during competition	0.738	

Factors presented of item loadings greater than 0.4

Similarly, as Table 9 indicates, Section 8 can be divided into two key dimensions, in which Q63 "*Accept risks because of its excitement*" (0.828) and Q64. "*The rewards of rugby outweigh the risks*" (0.881) measure the direct/internal reason for risk-taking (excitement and rewards); Q65 "*Accept risks to advance rugby careers*" (0.669), Q66 "*Accept risks to gain spectators' approval*" (0.632) and Q67 "*Accept risks to meet coaches' expectations*" (0.898) measure the external reasons for risk-taking in rugby.

Table 9. Section 8 Rotated Component Matrix

Reasons for Risk Acceptance	**Component**	
	1	2
Accept risks because of its excitement		0.828
The rewards of rugby outweigh the risks		0.881
Accept risks to advance rugby careers	0.669	
Accept risks to gain spectators' approval	0.632	
Accept risks to meet coaches' expectations	0.898	

Factors presented of item loadings greater than 0.4

Internal reliability was tested within each of those sections as Table 10 indicated. Most of those sections have an acceptable internal consistency (Cronbach's alpha > 0.6) (Streiner et al., 2015). However, Section 5 has a relatively low Cronbach's alpha value, which indicates that the questions adopted from occupational settings may not be suitable for rugby player training settings to evaluate the awareness of risk acceptance. Another section with a relatively low Cronbach's alpha value was Section 7, in which the research team developed the questions. As the value 0.597 was nearly close to the acceptance standard, further analysis has been performed to improve the reliability of this section.

Table 10. Internal Consistency

Sections adopted from validated surveys	Number of items	Cronbach's alpha
Section 3 Tackle Behavior (Training)		
Dimension 1 (Q16, 17,18)	3	0.869
Dimension 2 (Q15, 19, 20, 22 23)	5	0.709
Dimension 3 (Q24, 25)	2	0.926
Section 4 Tackle Behavior (Competition)	11	0.773
Section 5 Awareness of Risk Acceptance (Training)	7	0.508
Section 6 Awareness of Risk Acceptance (Competition)	7	0.758
Dimension 1 (Q49, 50, 51, 53)	4	0.712
Dimension 2 (Q47, 48, 52)	3	0.781
Section 7 Consideration for Other Players	9	0.597
Section 8 Reasons for Risk Acceptance	5	0.674
Dimension 1 (Q65, 66, 67)	3	0.596
Dimension 2 (Q63, 64)	2	0.704

As Table 11 illustrated, Cronbach's alpha value can be increased in Section 7 if four items were deleted. However, the deletion is not suggested in this case, and the details are further discussed in the following section.

Table 11. Section 7 Internal consistency

Consideration for Other Players	Corrected Item-Total Correlation	Cronbach's Alpha if Item Deleted
Consider teammates as co-workers	0.181	0.628
Consider opposition players as co-workers	0.532	0.494
Aware of teammates' safety during the game	0.540	0.526
Concerned for teammates' safety during the game	0.427	0.531
Aware of opposition players' safety during the game	0.328	0.557
Concerned for opposition players' safety	0.408	0.534
Trust in opposition players' capability to ensure safety	0.088	0.612
Have responsibility for opposition players' safety	0.135	0.603
Opposition players are also responsible for our safety	0.102	0.609

In addition, to explore players' demographic influence on each section, the one-way analysis of variance (ANOVA) has been performed by using the overall mean score calculated by section. Players' *current age* has been divided into two groups (age group one <20, and age group two >=20), and there was no significant difference found between the groups in any of the dimensions. Players' *age started playing rugby* has also been divided into two categories (age group one <7, and age group two >=7) and

there was a statistically significant difference found between the two groups of players' age started playing rugby in Section 7 regarding safety consideration for other players. For the first dimension of Section 8, any of the items deleted will not be able to improve the Cronbach's alpha value. Thus, more questions could be added in this section as there should be more variables to be evaluated in this dimension for a more comprehensive interpretation.

In addition, four participants provided their comments on the questionnaire, among which two comments are related to the understanding of 'risk,' despite the use of terminology such as "safety" and "risk" having been prudently discussed by the research team during the survey development process. For the comment that suggests the use of 'sometimes' disagree' instead of 'neither agree nor disagree' in the scale, the modification of which is not necessary, as most of the players who participated in the pilot test can understand the current terms used in the scale with no confusion.

4. DISCUSSION

Overall, most sections in the current questionnaire have acceptable validity and reliability according to the results and feedback. Based on the statistical analysis, several points are to be improved in the final questionnaire version. However, what is more important is safety awareness education in a rugby context.

For the open-ended comments, although the concept of the term "risk" prevailed in academic sports background (Otago & Brown, 2003), the actual use of the term was not popular among rugby players, as the comments in Table 12 imply.

Table 12. Participants' comments on the questionnaire

	Q70 Comments on the questionnaire
1	I'm not sure what it meant by "Taking Risks" I presumed it meant in terms of risking injury for other players and myself but wasn't sure.
2	What do you [mean] by "risk."
3	All questions were clear.
4	The questionnaire was very very good. There was a couple of questions I would have liked to say 'sometimes' disagree' instead of 'neither agree nor disagree' but that is probably the same thing.

This can be explained by players' acceptance of the inherent risk within the rugby, aligned with previous research findings (Chen et al., 2019). Although this pilot test involved a limited number of rugby players in Ireland, the results still indicate that this cohort has a significantly higher risk acceptance level compared to employees in other occupational settings. While many studies have focused on specific injury prevention in sports, most players are not aware that sporting injuries are occupational injuries requiring responses that could be influenced by OSH practices (Buggy et al., 2020). Therefore, instead of refining the survey term, an intervention program on risk awareness should be designed and deployed among the players, especially those who participate in contact team sports.

For other sections which may need improvement, as indicated in Results section, items in Section 5 regarding awareness of risk acceptance during training did not have high internal reliability, meaning that players had not provided similar consistent responses. This factor could be because players had different priorities depending on the importance of their training sessions. If the training was conducted as a mimic match, it could be as formal as a competition in which players may outweigh their team's performance (Chen et al., 2021). In order to improve, this section could be omitted by future researchers to shorten the survey as the risk acceptance awareness level can also be acquired during the competition (current Section 6).

As tested, the internal reliability in Section 7 can be improved by deleting four items: Q54 (We consider our teammates as co-workers), Q60 (We trust in the opposition players' capability to ensure safety of the game), Q61 (We have some responsibility for our opposition players' safety), and Q62 (Opposition players are also responsible for our safety). The problem with those items may be because players in sports settings rarely

consider other players as co-workers, and thus do not expect they should be responsible for other players safety or wellbeing, including teammates and in particular opposition players, just as they would not expect those other players to consider their safety and wellbeing. From an OSH perspective, in general occupational settings, the workers in the same team at the workplace are considered co-workers. Whether co-workers' are willing to approach a workgroup engaged in (un)safe behavior is a critical indicator to predict the workgroup safety behavior (Hofmann & Stetzer, 1996). It may take a long time for players to accept that their opposition players are also their co-workers. However, once players accept that they need their opposition players' cooperation to complete the match with all players' injury free, the established concept will facilitate a safer game by mutual protection from both teams on the pitch. The four items should thus be retained, and such education programs can be considered to improve players' safety responsibilities during the game.

Section 8 explores reasons for player's risk-taking, which can be divided into internal and external reasons, as the PCA results indicated. Internally, rugby players may take risks for excitement and rewards directly from the game. Unlike general occupations, rugby players' performances need to be exposed to stakeholders in their organization (e.g. teammates, coaches, and managers), and the performances during the game need to be open to the public. The external reasons evaluated in this survey are advancing career, meeting coaches' expectations, and gaining spectators' approval. Those results aligned with the existing sports literature. Pressure from coaches can significantly impact players' behavior, which also relate to players' sports career (Anshel & Eom, 2003). Meanwhile, players may prioritize their performance rather than health-and-safety in order to fulfill spectators' expectation, as the ideal image of a rugby player should be masculine, muscular, agile, tough, fearless of pain, persistent, never give-up, striving for excellence, winning, individual and team competition, and materialism. (Fenton & Pitter, 2010; Harris & Clayton, 2007; Pringle & Markula, 2005). Nevertheless, the Cronbach's alpha value 0.596 in this dimension indicates that more external reasons should be evaluated in the survey. Thus, an open-ended question can be added to ask other reasons that may stimulate players' risk-taking.

Furthermore, for the age started playing rugby, the original age range (from <5 to >20) has been refined as (from <4 to >15) according to the pilot test result. As all players reported they are playing rugby before (including) 15-years-old, the upper age given has been updated to 15-year-old and above. Meanwhile, 24.4% of the players began to play rugby younger than 5-years-old, so the lower age given in the option has been updated to 4-year-old. The revision of this question can potentially find a more specific relationship between players' age in starting rugby and their safety consideration for other players, which will be crucial for developing an effective safety education program in rugby from an early age. Based on the findings discussed, the final version of the survey has been generated.

5. CONCLUSIONS

This is the first survey that attempts to evaluate players' safety and risk awareness in an elite sport (rugby), drawing upon OSH concepts. The limitation of this research is the relatively small sample size in one rugby club for the pilot test. Some sections still need further testing with a larger sample to ensure reliability and validity, such as section 4, section 5, and section 7. A larger population should test those sections in the future survey deployment. However, in addition to the circumstance of Covid-19 during the research deployment, this phase has optimally researched what it aimed to explore. Another limitation of the survey, as discussed, is the lack of management perspective, including coaches, medics and managers who are key stakeholders in "sportsnet" (Nixon, 2016). When introducing safety concepts via such a survey in sports settings, their applicability to the specific sport should be prioritized to ensure that it is deployed with the full support of the 'gatekeepers' i.e. the survey is fully approved and supported by the teams management. In this manner any such survey's findings can be utilized for the improvement of player safety and wellbeing by management and can advance the usage of OSH management, supports and practices within sports. After the

validation of this instrument by a wider population in the future, such a survey could also point the way forward for application in a wider range of sports internationally.

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CONFLICT OF INTEREST

The authors report no conflict of interest.

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