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Injury prevention strategies at the FIFA 2014 World Cup: perceptions and practices of the physicians from the 32 participating national teams

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ABSTRACT

Purpose The available scientific research regarding injury prevention practices in international football is sparse. The purpose of this study was to quantify current practice with regard to (1) injury prevention of top-level footballers competing in an international tournament, and (2) determine the main challenges and issues faced by practitioners in these national teams.

Methods A survey was administered to physicians of the 32 competing national teams at the FIFA 2014 World Cup. The survey included 4 sections regarding perceptions and practices concerning non-contact injuries: (1) risk factors, (2) screening tests and monitoring tools, (3) preventative strategies and (4) reflection on their experience at the World Cup.

Results Following responses from all teams (100%), the present study revealed the most important intrinsic (previous injury, accumulated fatigue, agonist:antagonist muscle imbalance) and extrinsic (reduced recovery time, training load prior to and during World Cup, congested fixtures) risk factors during the FIFA 2014 World Cup. The 5 most commonly used tests for risk factors were: flexibility, fitness, joint mobility, balance and strength; monitoring tools commonly used were: medical screen, minutes/matches played, subjective and objective wellness, heart rate and biochemical markers. The 5 most important preventative exercises were: flexibility, core, combined contractions, balance and eccentric.

Conclusions The present study showed that many of the National football (soccer) teams' injury prevention perceptions and practices follow a coherent approach. There remains, however, a lack of consistent research findings to support some of these perceptions and practices.

practices in professional club settings. The first⁵ surveyed the perceptions and practices of premier league clubs worldwide and revealed the most important perceived risk factors (previous injury, fatigue, muscle imbalance), alongside the most commonly used screening tests (functional movement screen, questionnaires, isokinetic muscle testing) and preventative exercises (eccentric, specific hamstring eccentric focused, balance/proprioception) included in their injury prevention programmes. The second study⁶ systematically reviewed the scientific evidence underpinning these most important perceptions and practices. The authors showed that the majority of these perceptions and practices did not possess a strong level of scientific evidence or graded recommendation for use in the practical setting. Regardless, these studies represent football in the specific context of professional clubs where the training programmes, logistical demands and available facilities differ from those in competitions involving national teams, such as at the FIFA World Cup. While injury rates in the FIFA World Cups have significantly declined in each subsequent tournament since 1998,⁷ the time-loss match injury rates remain higher in comparison to those reported as per professional club standards (40.0/1000 h vs 26.7/1000 h, respectively).^{7,8} The differences in injury rates could be explained by several factors; accumulated fatigue as the World Cups are contested following a full competitive club season, changes in training style and the high level of player competitiveness at the most important tournament worldwide.

Therefore, the purpose of the present study was to quantify current practice with regard to (1) injury prevention of top-level footballers competing in the FIFA 2014 World Cup, and (2) determine the challenges faced by practitioners in implementing their injury prevention programmes.

METHODS

Participants

National team physicians of the 32 teams competing at the FIFA 2014 World Cup in Brazil were invited to participate in this structured survey. An invitation was emailed to the physicians of all 32 national team federations on 20 December 2014 introducing the concept and objectives of the survey, and provided a web link to access the survey.

Physicians were asked to submit their response online. If a question was unanswered, it was excluded from the analysis. Data were collected

INTRODUCTION

Injury prevention in top-level football is of utmost importance given the negative outcomes borne out in reduced performance,^{1,2} financial impact³ and long-term health of players.⁴ To overcome the significant cost due to injuries as well as reduce the early onset of degenerative changes, sports medicine and science should ideally assist practitioners in the identification of important risk factors for injury occurrence and aid in the provision of evidence-based preventative recommendations. However, scientific investigations and information from the elite echelons of world football are sparse and much remains unknown in this domain.^{5,6}

Two studies^{5,6} have started the process of quantifying the actual practices of top-level football organisations in order to provide recommendations on how to align injury risk factors with preventative



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retrospectively between 20 December 2014 and 1 February 2015. All physicians 'consented to participate'. The list of participating national teams is presented in [table 1](#). When there was more than one physician in a team, both physicians were asked to complete one survey with collaborative input.

Survey

The survey was constructed in English, French and Spanish and administered via an online survey software (Survey Monkey, <http://www.surveymonkey.net>) and consisted of 27 questions (17 closed ended and 10 open ended; see online supplementary appendix A) with four sections: (1) perceived risk factors for non-contact injuries, (2) screening tests and monitoring tools used to identify non-contact injury risk, (3) non-contact injury prevention strategies used, perceived effectiveness and implementation strategies, and (4) reflection on the effectiveness of injury prevention strategies, challenges faced and future directions for research. The questions were designed by six experts—three sport scientists, two physicians and a sports medicine specialist. The design of questions took into consideration their combined knowledge and experience of sports medicine, and the science in professional and international football, in addition to their work in peer-reviewed research and implementing survey-based research. The survey was pilot tested with two national team physicians before the official invitations were sent. Following the pilot survey, four questions pertaining to 'psychological strategies' were added.

Survey analysis

The raw data was exported from Survey Monkey to Microsoft excel and analysed independently by the research team. To calculate the overall importance of risk factors, points were awarded based on a scale developed for previous survey research.⁵ Each time a physician rated a risk factor 'very important', it was awarded 3 points; 'important'—2 points; 'somewhat important'—1 point; 'not sure'—0.5 points and 'not important'—0 point. Points were then summed up and risk factors ranked in order of highest summed points to the lowest. A similar method was used to determine the '5 most important preventative exercises'. Physicians were asked to rank in order of importance (1st to 5th) the preventative exercises they

considered the most important in their injury prevention programme. Points were awarded based on a scale developed for the previous survey research:⁵ exercises rated in first position were given 5 points, second—4 points, third—3 points, fourth—2 points; and fifth—1 point. Points for each exercise were summed and ranked in order, from highest to lowest. Regarding open-ended questions, individual responses were subjectively analysed for similarities and were grouped by the lead author (AM) into the appropriate overall category.

RESULTS

Survey

Background information

All (100%) physicians submitted survey responses. Thirty-two surveys based on the perceptions and practices of 37 physicians were included for analysis (5 teams with 2 physicians).

Perceived non-contact injury risk factors

As based on national team physicians' perceived rating of importance, the five most important 'intrinsic' and 'extrinsic' risk factors for non-contact injury are presented in [table 2](#).

Assessment and monitoring of injury risk

All 32 teams confirmed undertaking testing and monitoring of their players during both the pre-training camp and World Cup tournament. A total of 30 (94%) teams confirmed that they assessed and determined injury risk based on an 'individual player risk profile'. The five most commonly used injury-screening tests and monitoring tools are presented in [figures 1](#) and [2](#) (respectively).

Injury prevention strategies

Twenty-nine (91%) teams implemented an exercise-based injury prevention programme. Twenty-eight (97%) of these teams individualised the exercise programme according to players' individual injury risk profile determined from testing conducted prior to their World Cup camp. Of the teams implementing an exercise prevention programme, 24 (83%) did so in both the

Table 1 The 32 national teams competing at the FIFA 2014 World Cup (according to FIFA confederation)

AFC	CAF	CONCACAF	CONMEBOL	UEFA
Australia	Algeria	Costa Rica	Argentina	Belgium
Iran	Cameroon	Honduras	Brazil	Bosnia-Herzegovina
Japan	Ghana	Mexico	Chile	Croatia
South Korea	Ivory Coast	USA	Colombia	England
	Nigeria		Ecuador	France
			Uruguay	Germany
				Greece
				Italy
				Netherlands
				Portugal
				Russia
				Spain
				Switzerland

AFC, Asian Football Confederation; CAF, Confederation Africaine de Football; CONCACAF, Confederation of North, Central American and Caribbean Association Football; CONMEBOL, Confederación Sudamericana de Fútbol, UEFA, Union of European Football Associations.

Table 2 Top five most importantly perceived intrinsic and extrinsic non-contact injury risk factors according to physicians of 32 national teams

Rank	Intrinsic Risk Factor	Accumulated points of importance
1 st	Previous Injury	85
2 nd	Accumulated fatigue (i.e. throughout season / congested fixtures)	77
3 rd	Muscle imbalance (Agonist:Antagonist)	76
4 th	Physical fitness	70
5 th	Balance / coordination	69

Rank	Extrinsic Risk Factor	Accumulated points of importance
1 st	Reduced recovery time between matches	76
2 nd	Training load in clubs prior to the World Cup	73
Joint 3 rd	Training load during World Cup Congested match schedule	66
Joint 4 th	Number of matches played during club season Poor pitch quality	65
5 th	Recovery facilities	64

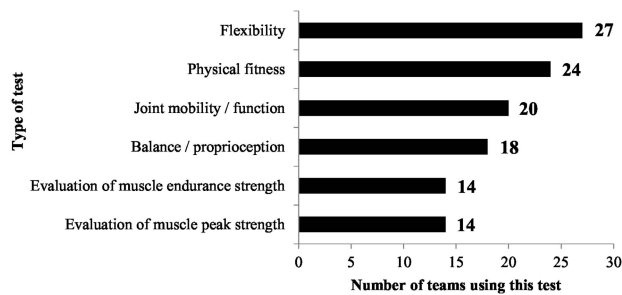


Figure 1 Top five most common injury risk screening tests used by national teams.

training camp leading up to the World Cup and during the World Cup tournament, while only 4 (14%) teams implemented their exercise programme solely during the training camp.

Difference in exercise programming variables between training camp and World Cup tournament

The variables selected by physicians (and % selected) explaining modifications made by teams to their exercise programme during the World Cup tournament were; (1) modifying the exercise type (76%), (2) reducing the external load (76%), (3) reducing the frequency (68%), and (4) reducing the sets and repetitions (60%). In addition to the above exercise prescription adjustments, physicians also listed the five most important injury prevention exercises used (figure 3). Altogether, 14 (44%) teams implemented strategies to reduce injuries by addressing the psychology of the player. Psychologically focused preventative strategies specifically targeted anxiety (93% of teams), motivation (64%), coping (57%), and stress (50%).

Compliance to injury assessment and prevention

Physicians' perceived 'importance' of coach compliance to their injury prevention practices is detailed in table 3. Furthermore, figure 4 shows the level of coach compliance to the individualisation of players' training programme and recommendations for injury prevention as rated by physicians.

Efficacy of and challenges to preventative strategies

Twenty-six (81%) national teams stated that they perceived their injury prevention strategies to be 'effective at reducing/limiting injuries, however, could have been better', while five (16%) stated that they 'could not have done better' and one team was 'not sure'. Thirty (94%) national teams responded to the question 'What were the main challenges faced in preventing injuries?' These responses are grouped into nine main categories and listed in table 4.

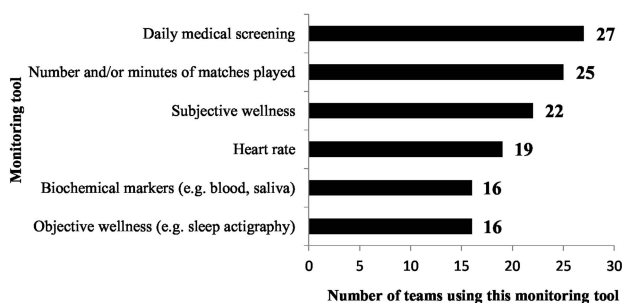


Figure 2 Top five most commonly used monitoring tools for national teams.

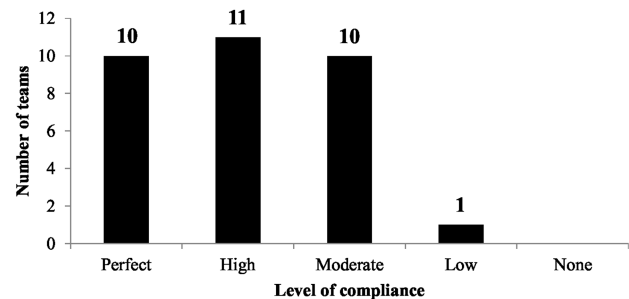


Figure 3 Top five injury prevention exercises used by national teams.

Future sports medicine and science research to prevent injuries in a national team context?

Twenty-eight (88%) national teams responded to the question "How can future Sports Medicine & Science research help you in terms of preventing injuries in the national team context?". These responses are categorised into six main responses (table 5).

DISCUSSION

The perceptions and practices of the physicians from the 32 national teams competing in the FIFA 2014 World Cup were surveyed with regards to risk factors, screening tests and preventative strategies for non-contact injuries in addition to their main challenges faced in preventing injuries. This study revealed the five most importantly perceived intrinsic and extrinsic risk factors, the five most commonly used tests and monitoring tools, and the five exercises with the greatest perceived importance in the injury prevention programmes.

Non-contact injury risk factors

In sport, the risk of injury experienced by an athlete is affected by a combination of their intrinsic (ie, athlete dependent) factors and the way in which these interact with the sports environment (extrinsic risk factors),^{9–11} some of which are modifiable and others which are non-modifiable.¹¹

Intrinsic risk factors

The first 4 of the 'Top 5' intrinsic risk factors for non-contact injury, identified by the present survey, are reflective (in the same rank order) of those reported in a previous survey of premier league clubs⁵ (1st—previous injury, 2nd—fatigue, 3rd—muscle imbalance and 4th—physical fitness). While fatigue (inter-related with physical fitness) and muscle imbalance have been rated of identical importance in both surveys, the current survey has provided new information by revealing accumulated fatigue (as experienced throughout the course of a season or congested match fixtures) and agonist:antagonist muscle

Table 3 National team physicians' perceptions of the importance of coach compliance in successfully preventing injuries

Importance of 'coach compliance'	Number of teams
Essential (we cannot prevent injuries without it)	15 (47%)
Very important (but we can still prevent some injuries)	17 (53%)
Somewhat important (it can help but it is not essential)	0
Not important (it does not make any difference to preventing injuries)	0

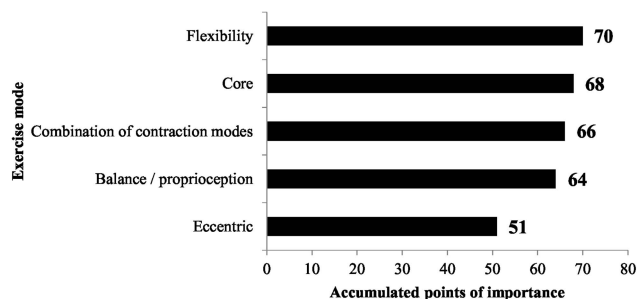


Figure 4 Coaches level of compliance to individualisation of player programmes.

imbalance are deemed of particular importance in the national team context. Currently, previous injury as a risk factor in top-level footballers has a strong level of scientific evidence, whereas fatigue has a low level of evidence and muscle imbalance findings are too inconclusive to assign any specific level of evidence.⁶ Nevertheless, the present findings suggest that future research on national teams should focus efforts on these aforementioned intrinsic risk factors.

Extrinsic risk factors

In line with the perceptions of the physicians in this survey, reduced recovery time (1st) and a congested match schedule (3rd) are supported risk factors for injury in top-level footballers.^{12–13} Three of the other perceived extrinsic risk factors, namely, training load prior to the World Cup (2nd), training load during the World Cup (joint 3rd place) and the number of matches played during the club season (joint 4th place) can be considered specific to national team concerns and are under the umbrella term of ‘workload’ imposed on the player (ie, physical and mental loads from training and matches). Previous research has shown that 60% of players who played in more than one match per week during the 10 weeks prior to the World Cup 2002 incurred injuries or underperformed during that World Cup.¹⁴ Although not currently shown in top-level footballers, workloads from training and matches have been associated with injury in other football codes.^{15–19} Investigations into the association between workload and injury in top-level football players are, therefore, highly pertinent.

Table 4 Main challenges faced in regards to preventing injuries at the FIFA 2014 World Cup

Main challenges faced in preventing injuries	Percentage of responding national teams stating this as a main challenge (%)
Optimising the individualisation of player programmes	47
Compliance of and between staff	35
Limited time to obtain adaptation from a prevention programme	29
Frequent travel	24
Frequent climate change and acclimatisation	18
Congested match fixtures and limited recovery time	12
Acceptance of players to use different methods	12
Coach realisation that he is integral to preventing injuries	6
Psychological repercussions of poor results	6

Assessment and monitoring of injury risk

In sport, each athlete has a unique risk value⁹ and it is important to examine those intrinsic and extrinsic risk factors that interact to make an athlete susceptible to injury, ideally before the injury inciting event occurs.¹⁰ Ninety-four per cent of teams at the FIFA 2014 World Cup assessed their players’ individual injury risk profiles with the common tests and monitoring tools outlined below.

The ‘5’ most commonly used injury risk screening tests

The ‘5’ most commonly used screening tests used by national teams were flexibility (dynamic and static), physical fitness, joint mobility, balance/proprioception and evaluation of both muscle endurance and peak strength.

Tests of physical fitness, balance/proprioception and muscle strength are in line with their similarly ranked importance as risk factors outlined earlier. Accordingly, there appears to be a coherent approach of practitioners in terms of implementing screening tests that potentially identify what they consider to be among the most important intrinsic risk factors for their players. In contrast, as risk factors, joint mobility/function and flexibility were ranked as 11th (58/96 points) and 12th (56/96 points) out of 18 ranks, respectively. Despite this lower ranking and conflicting research about these as risk factors for professional footballers,^{20–23} 91% of physicians rated joint mobility/function and flexibility as having at least some importance. The fact that these tests are generally easy to implement may explain why these are among the most widely used by national teams.

The ‘5’ most commonly used monitoring tools

The ‘5’ most commonly used monitoring tools were daily medical screens, tracking of number of matches/minutes played, subjective and objective wellness, heart rate and biochemical markers (biochemical and objective wellness jointly share 5th rank). These monitoring tools are consistent with national team physicians’ perceptions of injury risk factors in that they can provide a range of outcome measures of how the player is ‘coping with the workload’, whether physically (medical screen, heart rate, biochemical and objective markers of physical state) or mentally (subjective scales). Interestingly, recovery of muscle force was monitored in only nine (28%) teams. This may be due to lack of valid, reliable and sensitive monitoring tools that are easy to implement and require little equipment in such logistically demanding settings.

Exercise-based injury prevention strategies

Top five exercises

The key preventative exercises used by national teams were similar to those reported for premier league clubs,⁵ albeit in a slightly different order of importance. For example, core, balance/proprioception and eccentric exercise also feature in the ‘Top 5’ of national teams’ exercises. At the time of the present survey there is still no direct scientific evidence that core exercises can reduce injury risk in top-level footballers, although evidence from other top-level football codes suggest some preventative capacity.^{24–25} Similarly, there remains a lack of scientific evidence for balance/proprioception exercise with only a single study in top-level football²⁶ suggesting reduced ankle injury occurrence. Despite some studies suggesting support for eccentric exercise, it too has a weak level of evidence in the scientific literature⁶ as it cannot be ascertained that the beneficial effects on injury are specifically from the eccentric component.^{27–29} Interestingly, in the present survey a ‘combination’ of

Table 5 Responses of national team physicians' on where future sports medicine and science research should be targeted to provide meaningful applications to practitioners

Area of research	Percentage of responding national teams stating this as an area for future research (%)	Specific comments
Intervention studies on preventative strategies	35	Specifically at the elite football level Randomised controlled trials
Develop tests that identify significant risk factors	25	At the elite level. That are simple and quick That require little equipment/facilities
Identify significant risk factors	18	Specifically at the elite football level
Provide educational resources for national teams on injury prevention	11	Congress, conference, seminars Traditional format, web based, videos Workshops Roundtables of national teams to share experiences
Determine the optimal recovery strategies	7	Must be applicable to International tournament context Easy and practical to implement in national team context
Investigations on how to maximise compliance and awareness in coaches and players	7	Specifically how to educate coaches, staff and players

contraction types was rated the third most important exercise type. Using a combination of contraction types is more reflective of the multidimensional approach to injury prevention programmes in the practical setting. However, in top-level football there is only one study to our knowledge that has investigated the effects of such a programme³⁰ and it reports a reduction in muscle injuries. A limiting factor for extrapolating the findings of this aforementioned study to the national team setting is that the programme was conducted over the period of one season. It is not known if a short duration multidimensional programme can significantly reduce injuries during the constrained timetable of a major international football tournament, particularly given the unknown time course required to achieve reductions in injury risk from such programmes. Finally, while flexibility (2nd) is an important exercise for practitioners, two systematic reviews^{31 32} have shown that there is no conclusive evidence to support stretching to prevent injuries. Both reviews, however, also highlight that there is no sufficient reason to discontinue using flexibility exercises in the training programme.

Efficacy of and challenges to implementing injury prevention strategies

The majority (81%) of teams that suggested their overall preventative strategies were effective in reducing/limiting non-contact injuries also conceded that these could be improved. This finding is encouraging as it demonstrates that there is a belief among practitioners that there is scope for further significant reductions of non-contact injuries in top-level footballers competing in postseason international tournaments. The challenge now is to find the effective methods and strategies to help national teams to achieve this.

Obtaining compliance from the coaching staff was viewed as one of the main challenges rated by physicians to prevent injuries. While 31% of teams reported perfect compliance from their coaches, there appears to remain room for improving compliance and in turn, further reducing/limiting non-contact injuries. Investigations into coach compliance is a relatively new area of research; however, it appears essential that future studies focus efforts on how to maximise coach integration into the injury prevention programme if such strategies are to be optimised. One suggestion has been to 'capture the attention of coaches' by transforming medical statistics into a meaningful context for the coaches; for example, give them specific instances of the

negative effect of injury on team selection, performance and results.³ It would be interesting, therefore, to determine what 'details' are important to coaches and how these can be implemented in practice to improve coaches' acceptance of individual injury risk recommendations.

Further, nine specific categories pertaining to 'challenges faced' (table 4) in preventing injuries were highlighted in addition to the six areas where practitioners suggest further research (table 5) is necessary to provide meaningful solutions in the practical setting. One overwhelmingly consistent response pertained to the need for research on top-level players. This is qualitatively evidenced by one statement that suggested; "as long as clubs (top level) do not provide access to scientific studies, we will remain in this unsatisfactory status", that is, where there is little information on preventing injuries at the top level.

A limitation to be recognised is the retrospective nature of the present survey (ie, physicians were surveyed 5 months after the World Cup), and it is acknowledged that such a study design could increase the risk of reporting bias. However, this is a supposition as it is known that a well-designed and conducted retrospective study can be an effective method to guide future prospective work;³³ for example, to focus on research questions, clarify hypotheses and identify feasibility issues for the prospective study.

CONCLUSION

In conclusion, the present study has highlighted the most importantly perceived intrinsic and extrinsic risk factors for non-contact injury in the highest level of international players competing at the FIFA 2014 World Cup. The most commonly used tests and monitoring tools have been identified in addition to the five most important exercises that were incorporated into the injury prevention programme. In a first, the perceived effectiveness of and main challenges faced in the practical setting with regard to preventing non-contact injuries in a major international tournament have been revealed.

Future directions

Future research should concentrate on what is important to practitioners for identifying injury risk (eg, significant risk factors, valid and reliable tests) and the effects of preventative strategies. Also of importance is that future research should

investigate aspects related to maximising coach compliance. Practitioners operating at the top level are strongly encouraged to share knowledge, experiences and data (eg, player match and training loads, injury information, individual characteristics) with researchers. The present authors, therefore, respectfully suggest these respective challenges: one to the researchers and one to the practitioners in top-level football. To researchers—carefully consider the perceptions and practices that are important to practitioners (eg, as shown in this study) and focus future investigations to provide the appropriate solutions. To practitioners—form collaborative relationships with applied researchers and/or academic institutions to ensure that future research is directly applicable.

What are the new findings?

- We have revealed the most common perceptions and practices of physicians practicing at the FIFA 2014 World Cup regarding:
 - Risk factors for non-contact injuries
 - Screening tests and monitoring tools used to develop a players' individual risk profile
 - Preventative strategies used
 - Challenges to implementation
- We have also provided new information to guide researchers and practitioners to collaboratively contribute to the advancement of injury prevention in elite footballers.

How might it impact clinical practice in the near future?

- The information revealed in this survey may allow a more coherent approach for practitioners in:
 - Determining risk factors
 - Choosing appropriate tests and monitoring tools
 - Implementing prevention strategies
 - Exercise based
 - Psychology based

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Introduction to the Survey

PURPOSE: The purpose of this survey is to determine the perceptions of and practices put in place by the Medical & Sports Science Department of the referees who competed in the Brazil 2014 World Cup regarding injury prevention.

THE FINDINGS: A report of the overall findings will be sent to each participant. The survey is voluntary and there is no obligation to participate. Completed individual responses will remain anonymous. Any publications and presentations concerning this survey will consist of overall results only and no identifying information will be shown.

The overall findings of this survey could be published in congress, courses and scientific articles.

SPECIFIC OBJECTIVES:

- 1) To establish the most important perceived risk factors for non-contact injuries in referees at a major international tournament.
- 2) To identify the assessment methods employed to determine non-contact injury risk in referees competing in an international tournament
- 3) To determine the preventative based strategies implemented to reduce / limit non-contact injury occurrence during an international tournament.

The survey contains 4 sections with 30 questions in total and should take approximately 15 to 20 minutes to complete

1. Please select one of the following

- ☐ I consent to participate
- ☐ i do not consent to participate

Personal details

2. To be completed by the person responsible for the injury prevention of the referees

Name

Email

Phone

3. Could you please highlight in your experience, in order, the most common non-contact injuries affecting referees

1st

2nd

3rd

4th

5th

Section 1: Non-contact injury risk factors

In this section we aim to discover your perceptions regarding risk factors for non-contact injuries in referees competing in an international tournament

4. Can you please specify your perceived importance of the following as INTRINSIC risk factors for non-contact injury in referees competing in an international tournament

	Very important	Important	Somewhat important	Not important	Not sure
Previous injury	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Age	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Maximal muscle strength	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Strength endurance (i.e. resistance to fatigue)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Muscle imbalance (side to side difference)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Muscle imbalance (Agonist:Antagonist)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Balance / coordination	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Acute fatigue (e.g . following intense actions in a match)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Accumulated fatigue (i.e. towards end of halves)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Accumulated fatigue (i.e. throughout a season / congested match periods)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Joint mobility and function	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Flexibility	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Movement efficiency	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Sleep	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Wellness (mood, fatigue, muscle soreness)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Psychological factors (e.g. stress, anxiety)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Physical fitness	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Biochemical markers (i.e. blood, saliva)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

5. Can you please specify your perceived importance of the following as EXTRINSIC risk factors for non-contact injury in referees competing in an international tournament

	Very important	Important	Somewhat important	Not important	Not sure
Congested match schedule	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Reduced recovery time between matches	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Number of matches played during club playing season	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Training load prior to World Cup	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Training load during World Cup period	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Footwear	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Poor pitch quality	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Change in grass type (even if pitch quality good)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Hot climate	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Frequent Travel	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Training facilities	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Recovery facilities	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Importance of tournament	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

6. Are there any other risk factors that you considered in your referees? Please state and specify the level of importance

Section 2: Assessing Non-contact injury risk: Testing & Monitoring

In this section we aim to determine your perceptions and practices concerning testing and monitoring of non-contact injury risk in your referees

7. Did you assess referees individual injury risk profile?

8. If yes, did you provide specific training recommendations/modifications to referees identified with high risk for non-contact injuries?

☐ Yes

☐ No

9. Please state the overall compliance from referees with these recommendations

- ☐ Perfect
- ☐ High
- ☐ Moderate
- ☐ Low
- ☐ None

10. In your opinion, how important is compliance from referees in reducing / controlling non-contact injuries?

- ☐ Essential (we cannot prevent injuries without it)
- ☐ Very important (but we can still prevent some injuries)
- ☐ Somewhat important (It can help but it is not essential)
- ☐ Not important (It doesn't make any difference to preventing injuries)

11. What were the biggest challenges to getting compliance from your referees?

12. Please select which of the following tests you implemented to identify non-contact injury risk in your referees

- ☐ Functional Movement Screen
- ☐ Adapted 'in-house' functional movement screen
- ☐ Evaluation of muscle peak strength
- ☐ Evaluation of muscle endurance strength
- ☐ Evaluation of muscle activation / patterns
- ☐ Physical fitness
- ☐ Balance / proprioception
- ☐ Flexibility
- ☐ Joint mobility / function
- ☐ Psychological evaluation
- ☐ Other: please specify in the box below

13. Did you use any other tests? Please specify

14. Please outline the 5 most important tests you used in the development of your referees' non-contact injury risk profile

Test 1	<input type="text"/>
Test 2	<input type="text"/>
Test 3	<input type="text"/>
Test 4	<input type="text"/>
Test 5	<input type="text"/>

15. Which of the following monitoring tools did you employ to assess non-contact injury risk in your referees throughout the World Cup period?

- ☐ Rating of perceived exertion (RPE)
- ☐ Heart rate
- ☐ Subjective wellness (sleep, fatigue, stress, muscle soreness)
- ☐ Objective wellness (e.g. sleep actigraphy)
- ☐ Recovery of muscle force
- ☐ Biochemical markers (e.g. blood, saliva)
- ☐ Daily medical screening
- ☐ Number and/or minutes of matches played

16. Did you use any other monitoring tools? please specify

Section 3: Injury prevention strategies (Non-contact injuries)

Throughout this section we aim to discover your perceptions concerning preventative strategies for non-contact injuries and gain an insight into the implementation of these strategies in an international tournament context

17. Did you implement an exercise based injury prevention program for your referees during the World Cup?

- ☐ Yes
- ☐ No

18. Please select when you implemented exercise based injury prevention strategies?

- ☐ During World Cup training camp only
- ☐ During World Cup tournament only
- ☐ Both

19. Did you individualise the program according to individual risks?

- ☐ Yes
- ☐ No

20. If you performed the exercise based injury prevention program during the World Cup tournament, please specify the variables you modified?

- ☐ Reduced frequency
- ☐ Reduced load
- ☐ Reduced sets & repetitions
- ☐ Exercise type

21. Please specify the exercise mode/s you implemented in your referees to prevent an injury to the corresponding body part

	Eccentric	Isometric	Concentric	Combination of contraction types	Balance / Proprioception	Core	Muscle control & activation	Static flexibility	Dynamic flexibility
Hamstring	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Adductor	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Knee	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Ankle	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Calf	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Quadricep	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Achilles tendon	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Patellar tendon	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>

22. List in order of importance, the 5 most effective exercises in your injury prevention exercise program?

1st	<input type="text"/>
2nd	<input type="text"/>
3rd	<input type="text"/>
4th	<input type="text"/>
5th	<input type="text"/>

23. Did you use any other exercises in your preventative program? please specify

<input type="text"/>	<input type="text"/>
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24. Did you implement any preventative strategies aimed at the psychology of the referee?

- ☐ Yes
- ☐ No

25. If yes, can you please specify the most common psychological stressors that you targeted?

- ☐ Anxiety
- ☐ Stress
- ☐ Motivation
- ☐ Depression
- ☐ Coping

26. Other most common psychological stressors targeted

27. Can you specify the specific strategies that you implemented for psychological stressors?

Section 4: Personal Reflection

In this final section, we ask you to reflect on your World Cup experience and your injury prevention practices, challenges and future perspectives

28. Do you believe that your injury prevention practices were successful at reducing / limiting non-contact injury occurrence?

- ☐ Yes, could not have been better
- ☐ Yes, but could have been better
- ☐ No
- ☐ Not sure

29. What were the main challenges you faced during the preparation for and competing of the World Cup in Brazil in regards to injury prevention?

30. How can future Sports Medicine and Sports Science research help you in terms of injury prevention for referees competing in an international tournament format