

Original Article

Injury prevention in elite soccer: perceptions and strategies of brazilian soccer teams

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Abstract

Background: The injury preventive strategies of Brazilian soccer teams has not been completely established in the literature and few studies have investigated those practices in elite soccer teams around the world. **Objective:** To identify the injury prevention strategies and practices adopted in Brazilian soccer teams. **Methods:** Setting: cross-sectional study. Participants: Seventy-two Brazilian soccer teams. **Main Outcome Measures:** Those responsible for the teams' preventive strategies responded an online form on injuries prevention, injury risk factors, injury assessment and control methods, and injury prevention training exercises. **Results:** Injury prevention programs were being developed in 64 teams (89%), 93.8% of teams in series A and B, 76.9% in C and 88.9% in series D. In this study, 48.4% of preventive measures used by the teams were based on scientific evidence, 48.4% were partially based, and 3.1% were measures established by the teams. In 79.7% teams, the physiotherapist is the most active professional in preventing injuries. The predisposing factors of injury were biomechanical changes, physical conditioning, muscle imbalance, previous injuries, pitch quality, training load and number of matches per season. The athletes' evaluation involved validated functional tests, isokinetic dynamometry, and serum creatine kinase. Preventive activities included proprioceptive exercises, core training, eccentric, plyometric, and stretching exercises. **Conclusion:** Most Brazilian soccer teams develop preventive strategies, but few have bases on scientific evidence. The physiotherapist is the most active professional. Injury risk factors, assessment methods, and preventive training were similar across the teams evaluated.

Keywords: soccer, injury prevention, risk factors, tests, exercises.

Highlights

- There are differences in injury assessment among Brazilian soccer teams.
- The prevention actions are mostly performed by physiotherapists.
- The preventive training was similar across the teams evaluated.
- The preventive strategies are based on some scientific evidence.

Introduction

Soccer is the most popular sport worldwide, with more than 400 million of practitioners(Sadigursky et al., 2017), however it presents a high risk of overload and subsequent traumatic injuries. The total injury incidence was 40.1% during competition and 4.4% during training at every 1000 hours(Mosler et al., 2017). Traumatic injuries in soccer, with a prevalence of 71%(M. Hägglund et al., 2009), and injuries caused by overload can be prevented by monitoring the risk factors and developing specific training programs. It is important to highlight that there are many injury prevention programs in soccer, however their different methodologies contribute to the lack of scientific evidence and point to the need for studies that can contribute to the standardization of preventive strategies in soccer. This highlights the importance of implementing well-designed preventive strategies and programs.

The FIFA Medical Assessment and Research Centre (F-MARC) encourages the implementation of its injury prevention program (IPP) FIFA 11+, comprising warm up exercises(Kirkendall et al., 2010), familiar to many sports elites who have adapted it to apply in their teams(O'Brien et al., 2016). In general, considerable reductions in the number of injured players (with traumatic or by overload injuries), ranging between 30% and 70%, have been observed among teams that implemented the FIFA 11+. In addition, players with high compliance to the FIFA 11+ program presented an estimated risk reduction of all injuries by 35%(Barengo et al., 2014).

For many years, prevention strategies were based on expert opinion and experience of sports elites(Kirkendall et al., 2010), nevertheless, new evidence-based evaluation and exercise protocols have provided advances in injury prevention. Currently, the scientific literature presents the prevention profile of national teams(McCall, Davison, et al., 2015) and teams from various parts of the world(McCall et al., 2014). However, the real situation of Brazilian soccer has only been described by a single study with teams from the top division (A), which present higher technical level and financial capacity(Meurer et al., 2017), which does not characterize the present state of soccer in the country. Therefore, the purpose of the present study was to determine the practices and perceptions of elites from the different series of the Brazilian soccer championship, with a focus on injury prevention, risk factors, assessment methods and preventive training.

Methods

Characteristics of the study

This is a cross-sectional study, developed through an online questionnaire. The study was approved by the ethics committee of the institution (Protocol N. 1.648.200), and participants signed the online consent form.

Participants

A total of 128 soccer teams competing in the 2016 Brazilian Championship, elite male category, from four divisions (A: n = 20; B: n = 20; C: n = 20; D: n = 68) were eligible to participate in the study (Figure 1).

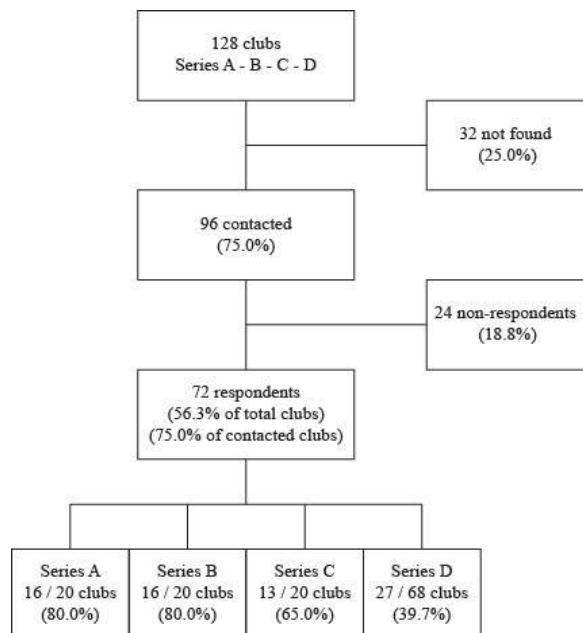


Figure 1 - Flowchart of participants in the study.

One physiotherapist or fitness coach from each team was invited to answer an online survey about their perceptions and practices on injury prevention in their teams, regarding the last season. Participants were able to answer online questionnaires in February, March, April and May, always referring to the previous year's season. They were contacted by phone, social media, text messaging, and e-mail from February to May 2017. After being informed about the study procedures, the elites were given access to the online questions. If a response was not received, the elites were contacted every month.

Survey

An online self-administered survey was applied using Google Forms software. The open and closed questions, in the Portuguese language, were prepared by the authors, based on the study conducted by McCall et al.(McCall et al., 2014). These questions were grouped into four sections: (1) characterization of the elites involved in preventive work, (2) perception on injury risk factors, (3) evaluation methods and (4) injury prevention training exercises. The questions were also reviewed by two physiotherapists specialized in sports physiotherapy (members of the Brazilian Society of Sports Physical Therapy) and an experienced researcher in qualitative studies. For readers' better understanding, the questionnaire is presented as a supplement to this manuscript (Appendice A).

Data analysis

The data were exported to an Excel worksheet (Microsoft Office 365 for Windows), sorted and categorized. The answers to the open questions were analyzed by the responsible researcher using a content analysis approach(Bardin, 1995). Quantitative results were presented as a percentage, and qualitative results were analyzed, grouped and presented descriptively. Doubts were discussed with a second researcher.

Results

Elites and assignments in preventive practices

Among the 128 Brazilian soccer teams, 32 (25.0%) were not found by phone, social media or websites and 96 were contacted (75.0%). Of the 96 teams contacted, 24 (18.8%) chose not to respond to the online questionnaire and did not highlight any reason. At the end of the study 72 responses were tabulated with the participation of physiotherapists (n=69, 95.8%) and fitness coaches (n=3, 4.2%). The questionnaire was answered by 80.0% of teams in series A, 80.0% of teams in series B, 65.0% of series C and 39.7% of teams in series D of the Brazilian soccer championship (Figure 1).

Of the 72 teams that responded to the questionnaire, 64 (88.9%) reported the development of injury prevention activities and 8 (11.1%) presented reasons and difficulties for not doing so (Table 1). The assignments of elites involved in preventive activities in teams and series are presented in Table 2.

Table 1 – Reasons for the absence of preventive practices in soccer teams (n=8).

Team (C)*	Brazilian Championship series	Reasons
C1	A	Lack of interest by the managers Constant change of coaching staff
C2	B	Lack of facilities and equipment
C3	C	Lack of facilities and equipment
C4	C	Lack of communication among coaching staff
C5	C	Lack of interest by the managers Lack of interest by the fitness trainers
C6	D	Lack of interest by the managers
C7	D	Lack of facilities and equipment Lack of elites
C8	D	Lack of interest by the managers Poor financial status

*The teams have been renamed C to protect the privacy of respondents.

Table 2 – Elite assignments in the team IPP.

Elite	Evaluation (%)	Design (%)	Application (%)	Monitoring (%)
Doctor	14.1	1.6	1.6	3.1
Physiotherapist	75.0	73.4	57.8	64.1
Sport scientists	3.1	3.1	1.6	14.1
Fitness coach	4.7	20.3	37.5	14.1

In 79.7% (n=51) of the teams, the physiotherapist performed two or more activities related to the injury prevention program (Evaluation, Design, Application and Monitoring) and was responsible for all of them in 37.5% (n=24). With regards to the Brazilian Championship series, the physiotherapists accounted for half or more of the preventive activities in 75.0% of the teams in series A (n=12) and B (n=12), 61.5% in series C (n=8), and 70.4% in series D (n=19). The fitness coach is the second most active elite in soccer teams and is responsible for half or more of the preventive activities in 12.5% of teams in series A (n=2) and B (n=2), 23.1% in series C (n=3), and 25.9% in series D (n=7).

Risk factors for non-contact injuries or by overload

The perception of risk factors for non-contact or by overload injuries was analyzed by an open question, where the elites were able to freely express their knowledge. The top five intrinsic and extrinsic factors are presented in Table 3.

Table 3 – Perception of intrinsic and extrinsic injury risk factors (ranked by order of citation).

Ranking	Intrinsic risk factor	Citations and % of teams	Extrinsic risk factors	Citations and % of teams
1 st	Muscle imbalance	41 (56.9%)	Pitch quality	40 (55.6%)
2 nd	Physical fitness	24 (33.3%)	Training intensity	32 (44.4%)
3 rd	Biomechanical change	23 (31.9%)	Number of matches per season	27 (37.5%)
4 th	Previous injury	17 (23.6%)	Facilities and equipment	16 (22.2%)
5 th	Motor control	16 (22.2%)	Soccer boots	14 (19.4%)

Evaluation methods in preventive programs

The results established different evaluation methods applied by the teams that participated in the preventive programs. Of the 72 teams that responded the questionnaire, 87.5% teams (n=15 series A, n=15 series B, n=9 series C, n=24 series D) evaluated the risk factors in the preseason, 62.5% (n=13 series A, n=9 series B, n=4 series C, n=14 series D) reevaluated their athletes during the season, and only 15.6% (n=3 series A, n=4 series B, n=0 series C, n=3 series D) reevaluated their athletes after the end of the season. The evaluation methods employed by the teams are presented in Figure 2.

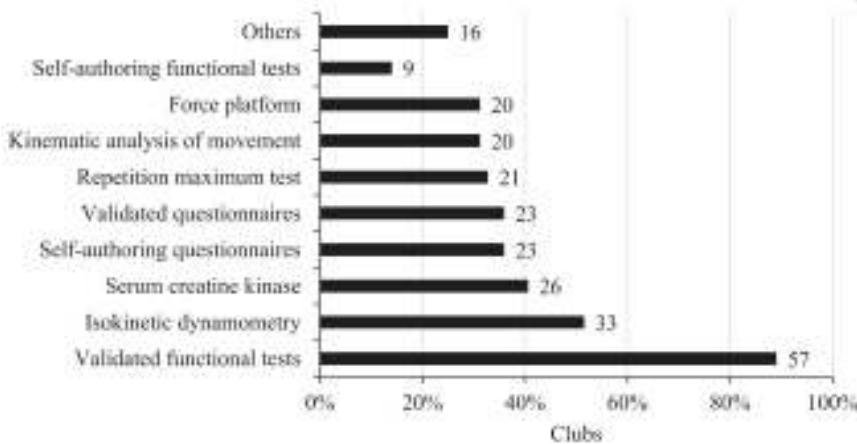


Figure 2 – Evaluation methods used for the identification of intrinsic risk factors (numbers on the bars correspond to the number of teams/Clubs).

Preventive training exercises

The elites interviewed believed in the preventive program benefits. Of these, 48.4% (n=7 series A, n=6 series B, n=6 series C, n=12 series D) elites reported the development of activities based on scientific evidence (scientific articles published in journals in the area), 48.4% (n=8 series A, n=9 series B, n=3 series C, n=11 series D) developed the activities partially based on scientific evidence, and 3.2% (n=1 series C, n=1 series D) did not base their work on scientific evidence.

The preventive activities employed by the teams are presented in Figure 3. Preventive exercises were carried out collectively in 32.8% (n=21) of the teams, 10.9% (n=7) with individual and collective activities, 39.1% (n=25) in pre-selected groups, according to the risk factors, and only 17.2% (n=11) with individual activities.

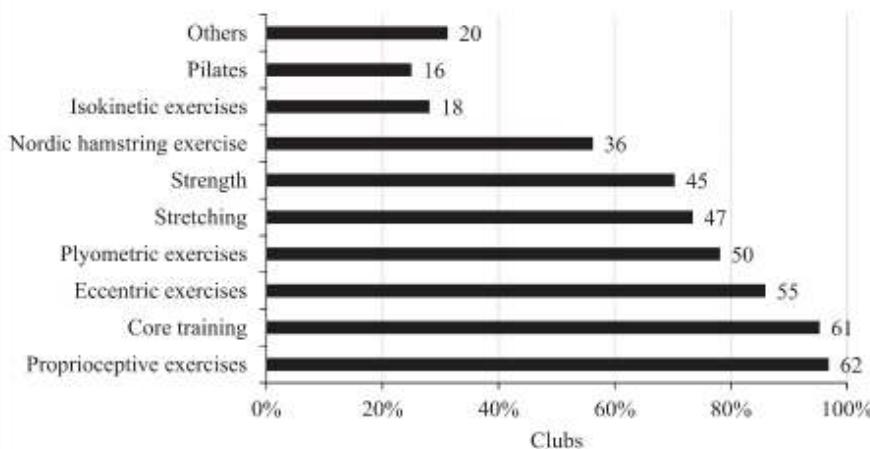


Figure 3 – Injury prevention training exercises (numbers on the bars correspond to the number of teams).

Frequency of activities and recovery time

During the preseason, the preventive training program was carried out twice a week in 46.9% (n=7 series A, n=8 series B, n=5 series C, n=10 series D) of the teams and once a week in 21.9% (n=3 series A, n=4 series B, n=7 series D), which frequency was not used by any team of series C. At the beginning of the season,

30.5% (n=3 series A, n=4 series B, n=4 series C, n=7 series D) of teams continued with the injury prevention training program twice a week and 40.7% (n=7 series A, n=7 series B, n=1 series C, n=9 series D) only once. The main reasons for discontinuation of the preventive program included the number of matches per season (54.7%), team schedule (17.2%), and injury incidence (12.5%). In general, there was no recovery time between the injury prevention training program and the next activity in 21.9% (n=14) of teams, 25.0% (n=16) had a recovery time ranging from 10 to 45 minutes, 9.4% (n=6) from 1 to 4 hours, and 18.8% (n=12) from 12 to 24 hours.

Discussion

The Brazilian soccer championship is composed of four divisions, namely series A, which is considered the most important, followed by series B, C, and D. The highly competitive level and relative balance among the series A teams eventually generate situations where elite teams (regarding the financial capacity, quality, and quantity of staff) finish the championship in the bottom positions and are relegated to series B. In the present study, this variable was considered in the selection of all teams. Thus, it was possible to take a broader view of the actual situation of the Brazilian soccer teams.

The first question in the survey (*Is there an injury prevention program in your team?*) revealed that the Injury Prevention Programs (IPP) had not been implemented in the soccer teams due to numerous challenges and lack of interest. The majority of challenges included poor quality facilities, lack of equipment, no qualified elites, and financial support. These aspects are not directly related to any Brazilian championship series, since the absence of preventive work was found in all of them. It is of utmost importance to recognize the numerous challenges in a team and therefore be able to focus on the implementation of an IPP(O'Brien et al., 2016), with low-cost equipment and using the existing soccer team facilities(Heleno et al., 2016).

The lack of interest in injury prevention among the team managers and coaching staff may be explained by their unawareness of the outcomes or the idea of additional costs to the team associated with the implementation of an IPP. It is believed that the coaches have a key role in the viability of injury prevention; yet, some may consider it inefficient or a waste of time(O'Brien et al., 2014). Managers should consider the financial loss due to injuries. For example, in the elite English soccer leagues during the 1999/2000 season this loss was estimated at approximately £74.7 million(Woods et al., 2002). However, the teams that implemented an IPP reduced their costs from injured athletes(Krist et al., 2013). Thus, the prevention of injuries optimizes the athletes availability to train and compete and, consequently, the teams reduce their costs(Jan Ekstrand, 2013).

Elites and assignments

Meurer et al.(Meurer et al., 2017) reported that Brazilian physiotherapists in all national championship series had the most meaningful participation at all stages of the IPP. This finding is consistent with that obtained in our study. However, a difference was found in the total responsibility of the work in each series: in series A and B, the physiotherapist was primarily responsible for injury prevention; conversely, in series C and D, the fitness coach was in charge of injury prevention. This is probably the result of the lower financial capability and availability of elites in soccer teams, considering that in series C and D the fitness coach probably accumulates functions. The situation in Brazil is similar to that of other countries(McCall et al., 2014), which reinforces the importance of the physiotherapist in prevention strategies, besides the rehabilitation work. Fitness coaches and physiotherapists have the knowledge to perform injury prevention, however the accumulation of functions and the insufficient staff may hinder implementation of IPP(O'Brien et al., 2016).

Injury risk factors

The identification of injury risk factors is essential for planning preventive practices and optimizing time and costs. In the present study, the results indicated by the elites who answered the online interview are in agreement with those presented in the literature. The quality of the grass pitch has been cited as an extrinsic risk factor in this study, as well as by the national team physicians who participated in the 2014 FIFA World Cup(McCall, Davison, et al., 2015). It is believed that a harder or softer surface is related to the ground reaction force that has a major impact on the kinematic chain in determining the movement pattern, with positive or negative adjustments, which can cause overuse injuries(Hardin et al., 2004). However, evidence on the fact that the condition and type of pitch surface influence the risk of sports injury is inconclusive(Rennie et al., 2016).

Other extrinsic risk factors reported were the number of games played in the season and training load activities, which probably increase the exposure of athletes to other risk factors(Windt et al., 2017) and may adversely influence the physical fitness, fatigue, and performance level if there is no appropriate recovery(Carling et al., 2015).

Of the top five intrinsic risk factors identified (Table 3), four have been cited in other studies(McCall et al., 2014; McCall, Davison, et al., 2015; Meurer et al., 2017). The one that stood out was imbalance in the antagonist muscles, particularly the hamstrings and quadriceps. However, there is no conclusive evidence as to whether it is indeed a risk factor and what the minimum difference is that could be tolerable(McCall, Carling, et al., 2015). There is also no conclusive evidence as to whether physical fitness is an injury risk factor. There is a

tendency for injuries to occur at the end of the match(J. Ekstrand et al., 2011), probably due to muscle fatigue, although this has yet to be confirmed(McCall, Carling, et al., 2015). Biomechanical alterations, on the other hand, are well described as an injury risk factor, such as a limited range of motion and ligament laxity in ankle sprains(De Noronha et al., 2006) and excessive valgus knee loads in anterior cruciate ligament injuries(Thompson et al., 2017). Finally, any previous injuries may increase the chances of recurrence(Green et al., 2017), probably due to morphological tissue changes(Martin Hägglund et al., 2013), neurofunctional impairment(Zouita Ben Moussa et al., 2009), or inadequate rehabilitation and return to play criteria.

Assessment of athletes

Evaluation of the risk factors in the preseason was unanimous among the Brazilian teams, as well as described by McCall et al.(McCall et al., 2014) for international teams. Knowing the characteristics of the athletes makes it possible to plan personal and collective injury intervention programs. The percentage of Brazilian teams that maintained the monitoring of risk factors during the season (62.5%) was less than that presented by international teams (81.2%). However, 86.7% teams from series A maintained the evaluation of their athletes throughout the season and this was above the international teams average(McCall, Davison, et al., 2015). This probably reflects the reality of more resources and personal staff that these teams have in relation to those from other series. Continuous assessments of risk factors throughout the season can be a means of optimizing the performance of athletes, and therefore, minimize persisting risk factors.

Clinical evaluations using isokinetic dynamometry were reported by 51.6% of Brazilian teams, similar to those performed by international teams(McCall et al., 2014). Ideally, it is expected that the majority of teams use gold standard instruments, however this measurement may not be feasible for many teams, mainly because of the high cost(Hewett et al., 2017). This explains the use of functional tests in evaluations, as well as the questionnaires presented in this study.

Functional tests and questionnaires are viable and accessible alternatives due to their easy application and low cost(Chimera et al., 2016). It is important to pay attention to their validity, reliability, sensitivity, and target population(Paul et al., 2015). Moreover, before starting any evaluation, the elites should be familiar with the specific methodologies used in the application of instruments.

Generally, there is consistency between the aforementioned risk factors and the evaluation methods employed. However, the use of self-authoring questionnaires presented by the participants of the present study for the evaluation draws attention, since there is no evidence of their results. Nilsagrd and Lohse(Nilsagrd et al., 2010) showed that more than half of the physiotherapists interviewed in their study knew about the Evidence-Based Practice, however, only 12 to 36% were able to correctly identify all components of this methodology. Meurer et al.(Meurer et al., 2017) described that, similar to international soccer teams, there are few elites in Brazilian teams with master or doctoral degrees, which reveals a gap between the areas of science and soccer practice.

Preventive training

In the preseason, fitness coaches work intensively to improve the strength, speed, and power of athletes. During this period, the highest levels of physical load are imposed on the athletes when compared to the entire season, aiming at the development of adequate adaptations to high-level sport practice(Loturco et al., 2015). Similarly, the preventive training exercises during this period aim to solve problems found in the assessment of risk factors to reduce the occurrence of injuries. The majority of Brazilian teams have reduced the frequency of preventive training from twice a week in the preseason to only once during the season. This can be explained by the same modifying frequency factors cited by the elites, such as the number of games played and the need to adapt the activities (training, travel, and rest) to a week which usually includes two matches.

The most commonly used injury prevention training exercises were consistent with the evaluated risk factors. The use of eccentric, proprioceptive exercises and core training presented in the results are also part of the preventive strategy adopted by international teams and national teams(McCall et al., 2014; McCall, Davison, et al., 2015) and are recommended by FIFA 11+(Kirkendall et al., 2010).

The proprioceptive exercises are used to prevent joint injuries, for example to the ankles and knees(Mohammadi, 2007). The need to improve neuromuscular control makes this type of exercise a unanimous consensus in injury prevention programs, however, evidence of their effectiveness for soccer injuries is weak(McCall, Carling, et al., 2015). Core training stability exercises are used to control the position of the trunk for optimal production, transfer, and control of forces to lower and upper extremities during functional activities(Hill et al., 2011). Iacono et al.(Dello Iacono et al., 2016) conducted a randomized controlled trial with young soccer players, and they reported that 6-weeks of core training exercises were able to significantly improve the lower limb asymmetry and muscle imbalance evaluated by isokinetic dynamometry.

The results presented and discussed in this study may contribute to the prevention of injury in soccer teams and constitute scientific evidence for the practices found. Some relevant information was presented to the teams that do not adopt any type of IPP. In addition, the participation of 72 teams from the four National Championship series allowed a broad analysis of the situation in Brazil.

There are some limitations to this study. The self-administered questionnaire could be misunderstood and the lower participation of teams from series C and D. Further studies could describe the practices in soccer teams in other countries, also including those from lower divisions. Additional research on the injury risk factors in soccer and the theoretical basis for preventive strategies are also necessary.

Conclusion

The present study showed that the most Brazilian soccer teams develop injury prevention programs, with preventive strategies based on some scientific evidence. The practices adopted are often developed by the physiotherapists and are similar to those of international elite teams, with little differences in the strategies employed. Despite the disparity in financial condition and facilities at the series C and D soccer teams, there is a certain uniformity of prevention strategies compared to series A and B. However, some challenges were identified, such as the lack of financial conditions and interest of the team managers and fitness coaches for the implementation of injury prevention programs.

Conflicts Of Interest: The authors declare that they have no conflict of interest.

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Appendice A - Online self-administered survey

Introduction to the survey

The purpose of the present study is to determine the practices and perceptions of professionals from the different series of the Brazilian soccer championship, with a focus on injury prevention, risk factors, assessment methods and preventive training.

This survey is self-administered and there is no obligation to participate. Each individual response will remain anonymous and any publications or presentations will consist of overall results only and no identifying information will be shown.

Before proceeding with the research, it is necessary to point out that you are aware and agree to the following terms:

- There is no reward or benefit to be received for participation;
- You may request to withdraw your answers at any time and not to be part of the study, without this leading to any penalty;
- Researchers ensure complete privacy of professionals and clubs identity involved. The information collected will be used exclusively for teaching, research and scientific dissemination purposes.

If you have questions or need more clarification you can contact us.

The survey should take approximately 8 to 10 minutes to complete.

1. Please select one of the following: I agree I do not agree

Section 1 – Personal details

2. Name: _____

3. E-mail: _____

4. Profession: _____

5. Graduation year: _____

6. Educational level: Bachelor Postgraduate (specialization) Master Doctoral Post-doctoral

7. Club: _____

8. Your club belongs to which series of the Brazilian Championship: A B C D

9. Year you joined the club: _____

10. Is there an injury prevention program in your club? Yes No

(Sections 2 to 6 are for those who answered YES at question 10.)

(Sections 5 and 7 are for those who answered NO at question 10.)

Section 2 – Professionals and assignments

11. How many people are involved in the preventive work in your club?

1 2 3 4 5 6 7 8 9 10 More than 10

12. Which professionals are involved? More than one option can be checked.

Doctor Physiotherapist Sport scientist Fitness coach Others

13. Among these professionals, who is responsible for:

	Doctor	Physiotherapist	Sport scientist	Fitness coach	Others
Assessment	<input type="checkbox"/>				
Design	<input type="checkbox"/>				
Application	<input type="checkbox"/>				
Monitoring	<input type="checkbox"/>				

Section 3 – Injury risk factors

14. Based on your experience, could you list, in order of relevance, the most important INTRINSIC risk factors for non-contact injuries (write at least three factors):

15. Based on your experience, could you list, in order of relevance, the most important EXTRINSIC risk factors for non-contact injuries (write at least three factors):

Section 4 – Assessment of athletes

16. In what season period are athletes assessed for intrinsic risk factors? More than one option can be checked.

Pre-season During the season Post season Others

17. Which are the assessment tools? More than one option can be checked.

Validated questionnaires Self-authoring questionnaires Validated functional tests

Self-authoring functional tests Electromyography Isokinetic Force platform

Maximum workload tests Serum creatine kinase levels Kinematic analysis of movement

Others

18. Do you use any other assessment tools? Please specify.

Section 5 – Prevention training

19. Is the program based on any literature reference? Yes No Somehow

10. What is the training frequency?

	1x month	2x month	1x week	2x week	Others
On pre-season	<input type="checkbox"/>				
During the season	<input type="checkbox"/>				

21. Is there any factor that changes the scheduled frequency of prevention training? If yes, please describe. Yes No

22. The prevention training is performed:

individualized by athlete with the whole group in predefined groups

23. Check the activities that are part of your prevention training? More than one option can be checked.

Stretching Resistance Proprioceptive Isokinetic Eccentric Nordic Hamstring exercise Pilates Core training Vertimax® Others

24. Do you use any other activity? Please specify.

25. Based on your experience, which are the most effective exercises in your program (write in order of relevance):

26. How long is the recovery time between the prevention training and the next activity?

Section 7 – Absence of injury prevention program

(Section restricted for those who answered NO at the question 10.)

27. You answered that in your club there is no injury prevention program, could you share with the researchers why? Which factors make it difficult to implement this kind of work?
