Sports injury prevention programmes from the sports physical therapist's perspective: An international expert Delphi approach.

Luciana De Michelis Mendonça, PT, PhD[1,2,3]; Joke Schuermans, PT, PhD[12]; Sander Denolf, PT, PhD [4]; Christopher Napier, PT, PhD [5]; Natália FN Bittencourt, PT, PhD [6]; Andrés Romanuk, PT[7]; Igor Tak, PT, PhD [8]; Kristian Thorborg, PT, PhD [9]; Mario Bizzini, PT, PhD [10]; Carlo Ramponi, PT, MSc [11]; Colin Paterson, PT, MSc[12]; Martin Hagglund, PT, PhD [13]; Laurent Malisoux, PT, PhD [14]; Wesam Saleh A. Al Attar, PT, PhD [15]; Mina Samukawa, PT, PhD [16]; Ernest Esteve, PT, PhD [17]; Ummkulthoum Bakare, PT, MSc[18]; Maria Constantinou, PT, PhD [19]; Anthony Schneiders, PT, PhD [20]; Alexandre Cavallieri Gomes, PT, MSc [21]; Didier Florentz, PT, MSc[22]; Derya Ozer Kaya, PT, PhD [23]; Syahmirza Indra Lesmana, PT, MSc [24]; Joar Harøy, PT, PhD [25]; Vesa Kuparinen, PT[26]; Nicola Philips, PT, PhD [27]; Walter Jenkins, PT, PhD [28]; Evi Wezenbeek, PT, PhD [2]; Erik Witvrouw, PT, PhD [29]

[1]*Graduate Program in Rehabilitation and Functional Performance, Universidade Federal dos Vales do Jequitinhonha e Mucuri (UFVJM), Diamantina, Minas Gerais, Brazil.*

[2]*Postdoctoral researcher at Department of Physical Therapy and Motor Rehabilitation, Faculty of Medicine and Health Sciences, Ghent University, Ghent, Belgium.*

[3]*CAPES Foundation, Ministry of Education of Brazil, Brasília, Distrito Federal, Brazil.*

[4]*Researcher at Department of Physical Therapy and Motor Rehabilitation, Faculty of Medicine and Health Sciences, Ghent University, Ghent, Belgium.*

[5]*Department of Physical Therapy, University of British Columbia, Vancouver, British Columbia, Canada.*

[6]*Postdoctoral researcher at Department of Public and Occupational Health, Amsterdam UMC, Vrije Universiteit Amsterdam, Amsterdam, The Netherlands*

[7]*Consulting Physical Therapy in Sports and Clinical Director at Recovery Sports Clinic, Buenos Aires Argentina and Coordinator Physical Therapy ARTRO trauma and sports center, San Isidro, Buenos Aires, Argentina*

[8]*Post-Doctoral Researcher at Amsterdam Collaboration on Health and Safety in Sports, Department of Public and Occupational Health, Amsterdam UMC, Vrije Universiteit Amsterdam, Amsterdam Movement Sciences, Amsterdam, The Netherlands*

[9]*Sports Orthopaedic Research Center-Copenhagen (SORC-C), Arthroscopic Center, Department of Orthopedic Surgery, Copenhagen University Hospital, Amager-Hvidovre, Denmark, Amager-Hvidovre Hospital, Hvidovre, Copenhagen, Denmark*

[10]*Schulthess Clinic Human Performance Lab, Zurich, Switzerland.*

[11]*Kinè rehabilitative and orthopaedic center,Treviso ,Italy*

[12]*School of Sport and Health Sciences. University of Brighton, Eastbourne, UK*

[13]*Department of Health, Medicine and Caring Sciences - Division of Prevention, Rehabilitation and Community Medicine - Unit of Physiotherapy, Linköping University, Linköping, Sweden*

[14]*Department of Population Health, Luxembourg Institute of Health, Luxembourg, Luxembourg*

[15]*Department of Physical Therapy, College of Applied Medical Sciences, Umm Al Qura University, Makkah, Saudi Arabia*

[16]*Faculty of Health Sciences, Hokkaido University, Sapporo, Japan*

[17]*University School of Health and Sport (EUSES), University of Girona, Girona, Spain*

[18]*Physiotherapy Department, Faculty of Health Sciences, University of the Witwatersrand, Johannesburg, South Africa.*

[19]*School of Allied Health, Australian Catholic University, Brisbane, Australia*

[20]*School of Health, Medical and Applied Sciences, Central Queensland University, Rockhampton, Australia.*

[21]*Physical Therapy Department at Escola Superior de Saúde de Santa Maria, Porto - Portugal.*

[22]*Sport physiotherapist at sportclinic CHR Hautesenne, pole of the neuro-musculoskeletal system, Belgium*

[23]*Izmir Katip Celebi University, Faculty of Health Sciences, Department of Physiotherapy and Rehabilitation, Izmir, TURKEY*

[24]*School of Physiotherapy Esa Unggul University, Jakarta Indonesia*

[25]*Department of Sports Medicine, Norwegian School of Sport Sciences, Oslo Sports Trauma Research Center, Oslo, Norway.*

[26]*Head physiotherapists of Finnish Olympic Committee and Chairman of Finnish Sportsphysiotherapists Association*

[27]*School of Healthcare Sciences, Cardiff University, Cardiff, UK*

[28]*Department of Rehabilitation Sciences, Waters College of Health Professions, Georgia Southern University, Savannah, GA, 31419 USA*

[29]*Department of Physical Therapy and Motor Rehabilitation, Faculty of Medicine and Health Sciences, Ghent University, Ghent, Belgium.*

Financial disclosure: This work has been partially supported by grants from the *Coordenação de Aperfeiçoamento de Pessoal de Nível Superior* (CAPES - Brazil; finance code 0001).

Conflict of interest: LDM, CR, CN, UB are on the IFSPT executive board. The other co-authors have none declared.

Ethics Committee approval: This study was approved by the Ethics Committee of the Ghent University Hospital (Ghent, Belgium) (#B6702020000151).

Corresponding author:
Luciana De Michelis Mendonça
Physical Therapy Department – School of Biologic and Health Sciences
Universidade Federal dos Vales do Jequitinhonha e do Mucuri
Rodovia MGT 367 - Km 583, no 5000 Alto da Jacuba
CEP 39100-000 - Diamantina - Minas Gerais
Brazil
lucianademichelis@yahoo.com.br

Abstract

Objective: To provide consensus on how to plan, organize and implement exercise-based injury prevention program (IPP) in sports. **Design**: Delphi. **Setting**: *LimeSurvey* platform. **Participants:** Experienced sports physical therapists from the International Federation of Sports Physical Therapy member countries. **Main outcome measures**: Factors related to sports IPP planning, organization and implementation. **Results:** We included 305 participants from 32 countries. IPP planning should be based on an athlete's injury history, on pre-season screening results, and on injury rates (respectively, 98%, 92%, 89% agreement). In total 97% participants agreed that IPP organization should depend on the athlete's age, 93% on the competition level, and 93% on the availability of low-cost materials. It was agreed that IPP should mainly be implemented in warm-up sessions delivered by the head or strength/conditioning coach, with physical training sessions and individual physical therapy sessions (respectively, 94%, 92%, 90% agreement). **Conclusion:** Strong consensus was reached on (1) IPP based on the athlete's injury history, pre-season screening and evidence-based sports-specific injury rates; (2) IPP organization based on the athlete's age, competition level, and the availability of low-cost materials and (3) IPP implementation focussing on warm-up sessions implemented by the strength/conditioning coach, and/or individual prevention sessions by the physical therapist.

Keywords(MeSH): consensus, athletic injuries, physical therapy

Introduction

The risk of injury is part of sports participation, and injury is recognized as a significant problem due to the consequences on athletic performance and related costs for the sport team and athlete's family[27]. Due to its nature and surveillance, it is difficult to guarantee pure primary or secondary prevention approaches for sports injuries in elite athletes[22,47]. Therefore, usually sport injury prevention is delivered combining primary, secondary and tertiary approaches. Sports related musculoskeletal injuries are a complex phenomenon, arising from multiple interactions between underlying factors[4,8,20], making injury prevention challenging[4,20]. Thus, to be effective, sports injury prevention programmes (IPPs) would need to incorporate different components specific to the individual high performance athlete[10,49].

Contemporary research has built solid evidence on the effectiveness of exercise-based IPPs to reduce injury rates and severity[23,56] and, consequently, an athlete's absence from training and competition[56]. However, this evidence commonly involves young sub-elite athletes[23], while strong evidence on IPP strategies and their effectiveness in adult elite athletes is still lacking[21,31]. More so, for specific injuries such as hamstring strain[21] and patellar tendinopathy[31], the incidence/prevalence rates are still high and even tend to increase over the past years, despite prevention efforts[21]. To date, we have not succeeded in preventing certain sports injuries from occurring during the competition season. This could be attributed to a limited understanding of the injury aetiology[8] and context[18] behind those injuries, the lack of structured individualised prevention strategies[19], implementation barriers[19,50], and the lack of communication between peers[18,19,50].

Different concepts regarding injury risk (e.g. prediction or probability, risk profile or risk factor)[4,8] and diversity in methodologies on sports IPPs could contribute to diverse approaches in clinical practice and conclusions obtained from sport injury prevention research. The development of a consensus on exercise-based sports IPPs could inform 'best practice' injury prevention guidelines and assist sports physical therapists during the associated decision-making processes. Unfortunately, there is no previous consensus published on how to plan, organize and implement an exercise-based IPP in sports, with no evidence to guide the best approach. Therefore, the aim of this study was to use an international Delphi approach to develop a consensus among experienced sports physical

therapists to provide guidelines on how to plan, organize and implement exercise-based IPPs in high performance sports.

Methods

We used a three-round Delphi approach to establish consensus from a panel of experienced sports physical therapists on how to plan, organize and implement IPPs in sports. We used the guidance on conducting and reporting Delphi studies (CREDES) to report this study[39]. We used the International Federation of Sports Physical Therapy (IFSPT) membership database to recruit participants. Our intention was to develop a consensus based on the expertise of international sports physical therapists. Each Delphi round involved the following steps: (1) data collection via an online anonymous survey (using the *LimeSurvey*® platform), (2) analysis of responses and survey modification, and (3) provision of feedback to the panel of sports physical therapists before the subsequent round. The goal of the Delphi process was to achieve an *a priori* defined level of agreement (>70%) between the members of the panel.[17] This study was approved by the Ethics Committee of the Ghent University Hospital (Ghent, Belgium) (#B6702020000151). All participants provided electronic informed consent before agreeing to participate.

Definitions

We defined "athletes" as *"individuals of young and adult age, engaged in exercise training on a regular basis and participating in official sports competition, either amateur or professional*[51]. *"*Official sports competition" (local, regional, national, or international) was defined as *"an organized team or individual sports event, placing a high premium on athletic excellence and achievement, that is organized and scheduled in the agenda of a recognized Athletic Association*"[51]. Sport injury prevention programs (IPP) was defined as exercise-based interventions delivered with the purpose to reduce the probability of an athlete get injured.

Participants

Experienced sports physical therapists from different geographical locations in five continents, working with athletes competing in nationally representative teams were targeted

during the recruitment process. The authors of this present study were from 32 member countries of the IFSPT and assisted in the recruitment of experienced sports physical therapists. These authors were responsible for screening the eligibility of the participants of this study.

Eligibility criteria for participants were: (1) sports physical therapists with recognized expertise in sports injury prevention in their region (2) from an IFSPT country member organization, (3) currently working with athletes[51] competing in nationally representative teams or teams playing national competitions[51], and (4) sufficient proficiency in comprehension and use of the English language.

Sport physical therapists working exclusively with paralympic or athletes with disability, or from other populations such as the military, were excluded, as providing IPPs for these athletes requires specific knowledge and experience, which was not the aim for this consensus. Invited participants had four weeks to respond to the first Delphi round and those who did not answer within the required timeframe were excluded.

Online surveys

The online survey had three sections: 1) plan (information/reasoning to develop the IPP*),* 2) organization (work-environment before implementation), and 3) implementation (barriers and facilitators to IPP compliance and feasibility). The survey was developed by five researchers with extensive experience in planning, organizing and delivering IPPs in high level athletes and also in injury prevention research. The questions were chosen based on clinical reasoning and injury prevention research, since there is no strong evidence on planning, organizing and implementing IPPs.

Prior to sending out the first-round survey, the survey was piloted on five sports physical therapists, from different countries with research background, who were involved in applying IPPs. This step was undertaken to improve clarity of questions and identify and remove possible ambiguities[36]. Two questions were rewritten to improve the survey's clarity. The final version of the survey was reviewed by all authors who were given an opportunity to provide feedback prior to distribution to the participants.

Procedures

For each Delphi round, sports physical therapists received an email invitation with a link to the online survey. Participants were given four weeks to complete each round, with reminders sent weekly. The investigator responsible for data analysis (L.D.M.) was blinded to the participant's identification on the first round. This first round included a combination of structured and open response questions[17]. Questions were posed to enable participants to indicate their level of agreement on each of the items investigated, using the respective statement (e.g.,*" Do you believe that the development of injury prevention programmes should be based on the (highest) injury rates within the particular athletic field, available in scientific evidence?")*[36]. The sports physical therapists were instructed to answer with *"Yes"*, *"No"* or *"Unsure/I do not know"*. Participants were asked to provide additional comments when answering the multiple-choice questions, to specifically explain the rationale behind their responses. At the end of each section, a broader open response question was included (e.g., *"Is there anything else you think should be taken into account to support injury prevention management*?") to maximize the amount of data collected and to prevent the researchers from missing out on acquiring any potentially useful injury-prevention associated detail.[48]

Structured questions for which consensus was reached (more than 70% of the participants agreeing on inclusion or exclusion of the item[56]) were no longer added in the following survey round. Therefore, the second and third Delphi rounds were composed of new questions based on the content analysis, as suggested by the participants. Also, structured questions using a ten-point Likert scale to indicate the level of importance of the underlying IPP were included.

Data analysis

Data collected throughout each Delphi round was exported from *LimeSurvey*® into Excel® (Microsoft Corporation, Washington, USA). Data were analysed for the extent consensus was reached (yes/no) and the associated consensus agreement level (%). Central tendencies (means and medians) and levels of dispersion (standard deviation) were provided for all Likert scale data [32,35], which enabled participants to see where their response was located relative to the group average of responses.

Content analysis was used after the first round to identify themes from open response questions.[13] Respective analysis was performed by two researchers (L.D.M. and S.D.) to

achieve agreement, with disagreement resolved by a third researcher (E.W.). Initially, all responses were read for familiarization, then re-read for identification of themes and finally data were categorized. A list of items on structuring/elaborating, organizing and implementing IPPs in sports was created from the open responses, which was used to develop structured questions for the second Delphi round.

Results

Experienced sports physical therapists panel

We invited 385 sports physical therapists from 34 countries to participate in this Delphi study, of which 305 from 32 countries completed round one (reply rate of 79.2%). We received 272 and 257 complete replies in round two (reply rate of 89.2%) and round three (reply rate of 84.3%), respectively. FIGURE 1 shows the flow diagram of the participants and their contributions throughout the Delphi process. TABLE 1 demonstrates the participants' demographics.

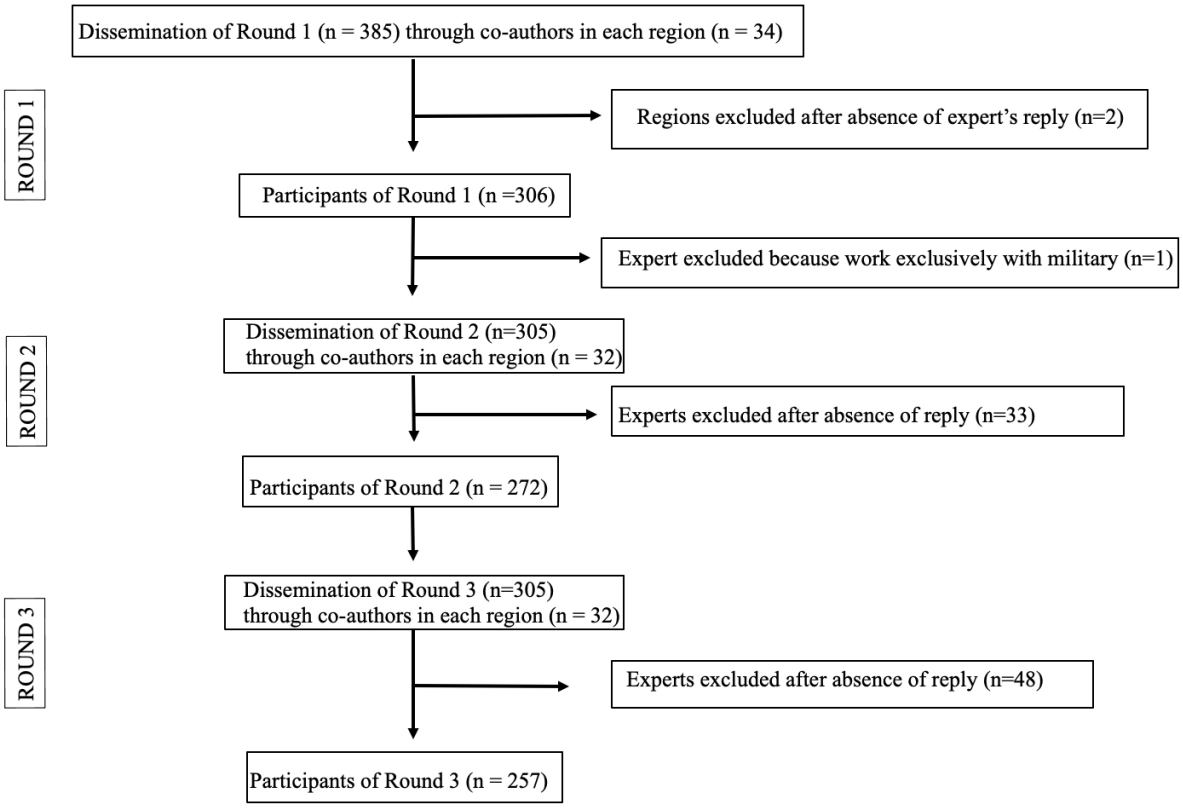


FIGURE 1. Flow chart representing the participation adherence of participants through the three Delphi study rounds (n = sample size)

TABLE 1: Participant's characteristics

Demographics (n=305)					
	Mean	**SD**	**Minimum**	**Maximum**	**Frequency**
Age (years)	41.8	11.4	26	69	305 (100%)
Female	45.7	13.6	28	69	102 (33.4%)
Male	39.1	9.2	26	58	203 (66.6%)
Injury prevention experience					
	Mean	**SD**	**Minimum**	**Maximum**	**Frequency**
Working (years)	16.2	8.7	3	35	-
Expertise (0-10 Likert scale)	7.3	1.3	5	9	-
On-field prevention (hours/week)	3.4	3.1	1	10	-
Academic degree					
	Frequency				
PhD	57 (18.7%)				
Master (r)	47 (15.4%)				
Master (p)	111 (36.7%)				
Bachelor	89 (29.2%)				
Current occupation					
Academic	77 (25.2%)				
Clinical	228 (74.8%)				
Country practice (more than 14 participants)					
Canada	23 (7.5%)				
Switzerland	22 (7.2%)				
Brazil	18 (5.9%)				
Belgium	16 (5.2%)				
United Kingdom	16 (5.2%)				
Italy	15 (4.9%)				
Japan	14 (4.5%)				
United States	14 (4.5%)				

Abbreviations: SD=standard deviation; (r)=research; (p)=professional; PT=physical therapist. Expertise item was self-appointed using a 0-10 Likert scale.

APPENDIX 1 describes all the participants invited per country and APPENDIX 2 describes details about participants' evidence-based, sport and prevention experience.

Consensus about sports injury prevention

After three consecutive Delphi rounds performed between May and November 2020, we achieved consensus on all questions related to IPP planning, organization and implementation. The final consensus is presented in FIGURE 2, indicating a summary of the items to be considered.

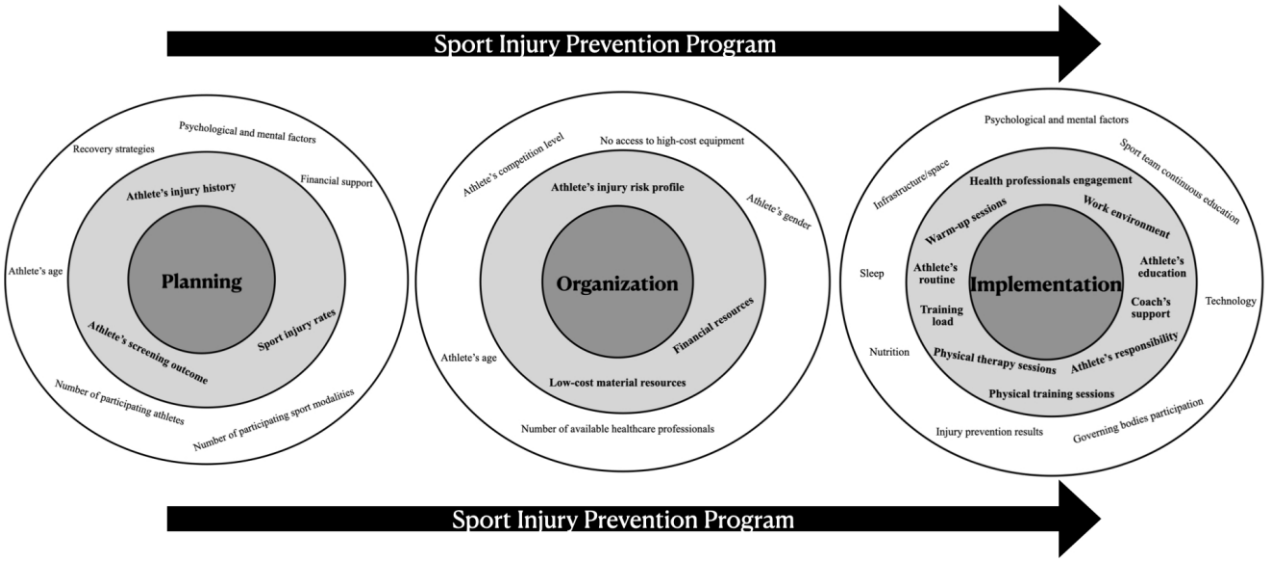


FIGURE 2. Prevention consensus: provides an overview of the items agreed on each phase of sports injury prevention programmes. The level of importance of each item included in the consensus was categorized based on a Likert scale (with scores ranging between 0 to 10). Items in the inner circles had values above the median (9 to 10) and those in the outer circle had values under the median (5 to 8).

All questions reached an agreement level of at least 80% in the first round, except for one question for which only an agreement level of 77% was achieved ("Do you believe the number of available athletes should be taken in to account when developing prevention strategies?"). As some participants indicated the vagueness of this question, the question was rephrased and integrated in the next round, after which an agreement level of 83.45% was achieved.

After content analysis, 27 questions were added to round two. The content of these questions was identified and provided by the participants when they were asked which other factors they considered of importance in IPP planning, organization and implementation.

All questions in round two reached at least 74% of agreement, except for a question regarding the use of high-cost equipment resources which only received an agreement level of 65.8%. This question reached a consensus with an agreement level of 91.1% in round three. The results of each round can be viewed in APPENDIX 3. TABLES 2 and 3 present the final consensus of this Delphi study in comprehensive detail.

TABLE 2: Delphi's study final consensus on factors to be considered for sports injury prevention planning and organization.

Section: Sports injury prevention planning			
Item	**Agreement**	**Score (Mean (SD))**	**Min-Max**
Highest injury rates	89.0%	8.6 (1.3)	1-10
Athlete's injury history	98.0%	9.1 (1.2)	2-10
Athlete's screening outcome	92.5%	8.4 (1.6)	2-10
Athlete's age	93.7%	7.4 (1.8)	1-10
Recovery strategy (physical and mental)	89.7%	7.3 (1.9)	1-10
Psychological and mental factors (coping, stress, anxiety, mindset, etc)	94.4%	7.53 (1.8)	1-10
Number of participating athletes	83.4%	6.55 (2.2)	1-10
Number of participating sport modalities	76.1%	6.51 (1.9)	1-10
Financial support	86.0%	6.78 (2.2)	1-10

Abbreviations: SD= standard deviation; Min-Max = minimum-maximum; IQR = interquartile range

TABLE 3: Delphi's study final consensus on factors to be considered for Sports injury prevention implementation.

Section: Sports injury prevention implementation					
Question	**Agreement**	**Score (Mean (SD))**	**Min-Max**	**Median**	**IQR**
Warm-up sessions provided by the head coach or strength/conditioning coach	93.5%	8.5 (1.5)	3-10	9	2
Physical training sessions provided by the team's strength/conditioning coach	92.0%	8.7 (1.2)	3-10	9	2
Prevention sessions provided by the team's physical therapist	89.5%	8.8 (1.4)	3-10	9	2
Coach's support	98.0%	9.2 (1.0)	3-10	10	1
Health professional's engagement	95.5%	8.9 (1.2)	3-10	9	2
Athlete's routine organization	88.5%	8.7 (1.2)	3-10	9	2
Education	93.0%	9.0 (1.2)	3-10	10	2
Injury prevention results regarding previous seasons (injury risk, time loss, performance, etc) should be disseminated	80.5%	7.4 (1.8)	1-10	8	3
Infrastructure/space	90.0%	7.5 (1.8)	1-10	8	2
Technology	74.2%	3D: 5.4 (2.5)	0-10	5	4
		GPS: 6.1 (2.5)	0-10	7	3.7
		App (assessment): 5.8 (2.5)	1-10	6	4
		App (exercise): 5.9 (2.5)	1-10	6	4
Psychological and mental factors	98.8%	7.8 (1.6)	2-10	8	2
Sleep	97.7%	7.9 (1.7)	1-10	8	2
Nutrition	98.5%	7.6 (1.7)	1-10	8	2
Training load	98.5%	8.4 (1.4)	4-10	9	2
Athlete's responsibility	98.5%	8.7 (1.4)	2-10	9	2
Governing bodies (federations/confederations)	91.5%	7.4 (2.0)	2-10	8	3
Work environment and relationship between the professionals	99.6%	8.7 (1.2)	2-10	9	1
Sport team continuous education and engagement about prevention	98.8%	8.2 (1.4)	1-10	8	3
Sport team continuous education and engagement on injury burden	94.4%	7.7 (1.6)	1-10	8	2

Abbreviations: SD= standard deviation; Min-Max = minimum-maximum; 3D: tridimensional analysis; GPS: global positioning system; App=application; IQR = interquartile range

Discussion

This Delphi study which included 305 international experienced sports physical therapists involved in sport injury prevention reached a consensus on planning, organizing and implementing IPPs in high performance athletes. For sports IPPs planning, the participants agreed that it should be based on the athlete's injury history, psychological and mental factors, age, baseline/preseason screening results, recovery strategies, the highest injury rates of the specific sport, financial support, number of participating athletes and type of sport. This is the first study to show that experienced sports physical therapists believe that the number of participating athletes, sport types and financial support are important considerations in sport IPP development. The planning of prevention programmes may differ when designing them for a group of 10 versus 1000 athletes, or for one versus 10 different sports. Similarly, availability of financial resources to support respective screening procedures is clearly important to enable the use of specific materials, equipment and environmental facilities in sports IPP, and in being able to engage multiple professional health care or technical staff members in the process.

The literature indicates that prevention planning is commonly based on the athlete's injury history[28,61], athlete's baseline/preseason injury risk screening results[11,15,65] and the highest injury rates of the sport of interest[29,34,63]. There is sufficient evidence indicating injury rates and injury history to be crucial determinants for prevention organization[28,61]. Moreover, a survey of football players and coaches indicated they understood the importance and accepted the inclusion of preseason screening protocols in the preparation for safe competition[42]. Although the agreement on some topics, such as screening and risk profiling, prevention and risk mitigation, we recognize that it can be controversial. For example, Bahr[4] argues that despite some evidence on statistically significant association of tests with injury risk, such tests do not predict injury with sufficient accuracy. However, the experienced group of sports physical therapists, who participated in this Delphi study (with the main purpose to enhance effective decision-making in health and social care) agreed that preseason assessment and associated delivery of IPPs based on these results should seriously be considered. Moreover, the highest percentage agreement was in issues with sufficient evidence such as athlete's injury history.

The sports physical therapists agreed that the organization of IPP depends on the athlete's age[54,60], competition level[3,6], gender[2,25,33], and risk profile[8,64], which is supported by the literature. Age and gender both essentially influence sport IPP organization as existing scientific evidence indicates that some injuries are more common in female athletes[33,47] and youth athletes[23,52,60]. Due to this relative increment in injury susceptibility seen in some athletic groups, injury risk screening and prevention should be addressed with particular focus for these entities. The participants also agreed that access to low-cost materials, with no need for high-cost equipment, financial resources and the number of available healthcare professionals importantly influence the organization of IPPs, despite the lack of supporting evidence regarding these issues. However, FIFA 11+40 is an excellent example of an effective prevention program that was developed using low-cost materials, it is highly accessible to different contexts, which made it easily implementable[55]. Therefore, being developed by experts in the area and delivered by an important sport organization (FIFA), the FIFA 11+ has had a substantial influence on physical therapists engaged in sports injury prevention throughout the last decade[9]. It was interesting to identify that the sports physical therapists agreed that high-cost equipment such as isokinetic machines was not mandatory to deliver injury prevention programmes. One reason to identify high-cost equipment as non-essential could be due to the lack of the actual application of its associated results in the sports IPP[26,41].

The participants also agreed that strength and conditioning training and prevention sessions delivered by the strength/conditioning coach and the physical therapists are both ideal strategies to implement IPPs into the athlete's/team's weekly training regimen. Read, Jimenez, Oliver & Lloyd (2018) identified that prevention programme delivery was most performed once or twice per week in male youth soccer athletes during warm-up sessions or during individual prevention sessions or a combination of both[52]. Moreover, the gym is the most reported location for injury prevention session organization. Loose, Achenbach & Fellner (2018) identified that players and coaches believe frequent physiotherapy consulting to be the most important step for injury prevention in football[42]. These data support the belief that prevention programmes should be diverse and be delivered to the athletes using different formats (i.e., warm-up and sessions) and locations (i.e., field and gym) within the right context.

The agreement on IPP implementation included, as the most frequent ways to carry out the programme, the use of warm-up sessions delivered by the head coach or strength coach, physical training sessions delivered by the strength coach, and individual prevention sessions delivered by the physical therapist. The previous argument about FIFA 11+ could also support the agreement on warm-up sessions delivered by the head or strength coach[55]. The majority of factors indicated by the participants for prevention implementation is supported by the literature: coach's support[16], health professionals' engagement[14], athletes' routine organization[42], education[42], prevention results dissemination[7,46], infrastructure/space[24,37], technology[1,40], psychological and mental factors[57], sleep quality[12,30], nutrition[43], training load[38,59], athletes' responsibility[42], governing bodies participation[64] and work environment/relationship between professionals[64]. Regarding the dissemination of injury prevention results from previous seasons to the athletes (injury risk, time loss, etc), no strong evidence is available to support the agreement established in the present study. Since gym was cited as the most common location for injury prevention[52], it does make sense that infrastructure/space is an important element to consider in sustainable and manageable organization of prevention implementation. Moreover, according to Loose, Achenbach & Fellner (2018), reasoning about compliance should be considered a key factor in injury prevention[42]. Most probably, communicating injury prevention results, incorporated learning and consequently recommending effective practical guidelines could increase athlete's compliance with injury prevention programmes.

Implementation science, bias toward exercise interventions performed during a warm-up IPP and the range of measures to mitigate injury, such as sleep quality and training monitoring should be considered, preferably individually. These issues should be constantly included in the education process. The sports physical therapists agreed that ongoing sport team education and engagement in prevention could impact on athletic adherence to prevention strategies and lower the injury burden. Increasing athlete knowledge and understanding of the importance of injury prevention should be undertaken on an ongoing basis, utilising training courses and evidence-based practice. Loose, Achenbach & Fellner (2018)[42] indicated that warm-up and training programmes in football are fundamentally based on tradition and are mainly performed in an identical, stereotypical fashion throughout the competitive part of the season, without taking into account the latest evidence-based guidelines. For example, Bahr et al[5] identified a low compliance of evidence-based injury prevention programmes for hamstring injuries by the majority of Champions League or Norwegian Premier League

football teams. McCall et al.,2015[44] showed how most perceptions and practices of injury prevention strategies by professional football teams were of low level of evidence, thus demonstrating the gap between practice and published research. Therefore, transferring knowledge and insights from a theoretical framework towards practical and ready-to-use prevention strategies and routines should be considered crucial in sport injury prevention (research).

Study strengths and limitations

Strengths of this study include the large sample size of participants from 32 different countries, with an achieved high response rate[53,62]. In addition, each round was disseminated to the same initial sample, which increased the statistical power of the associated data analysis. Also, we included experienced sports physical therapists in IPP, with the majority of participants regularly consulting scientific evidence to organize IPPs for their athletes. Moreover, most of the participants were involved in the development or implementation of assessment protocols to identify athletes at increased injury risk and in the development or implementation of injury surveillance within their organization.

Nonetheless, this study has some limitations that should be considered when interpreting the results. Differences in culture, financial resources, experience and context between the participants were not taken into account in the statistical analysis in this study. Moreover, we acknowledge that a separate study could be done related to paralympic or athletes with disability, or military populations. The same methodology has been recently used in two expert surveys[45,58], showing a mix of experience, beliefs and evidence in how IPPs are implemented. It worth to mention that the questions used on the first round were constructed based on injury prevention research and author's clinical experience. However, a chance was given to all participants to add themes which could raise new questions for the second round.

Clinical relevance and future research

This study contributes to the body of evidence on disseminating good clinical practice in injury prevention guidelines and supporting sport physical therapists in their decision-making processes. This consensus will help both clinicians and researchers in performing improved IPP in athletes, especially to those who are not familiar with IPP or need initial guidance. In

order to achieve these goals, the implementation of continuous athlete and staff education and associated strategies to increase overall adherence to evidence based IPPs are needed. If we could make some essential steps in this direction, the global effectiveness of sports IPPs dissemination and implementation would be increased.

It is worth to mention that this agreement involved the participation of experienced sports PTs. Nonetheless, other staff members participate in the development and execution of sport IPP, such as the head coach, strengthening coach, psychologist, physician, etc. Therefore, future studies should approach these professionals and capture their opinions and agreement on sports IPP as well, to better support the athlete's health and well-being.

Conclusion

For injury prevention in high performance sports, strong consensus amongst experienced sports physical therapists was reached on (1) planning being ideally based on athlete's injury history, sports-specific injury rates and baseline screening; (2) organization for which athlete's age, competition level and the availability of low-cost materials should be taken into account and (3) implementation for which integration in warm-up sessions, training sessions with the strength/conditioning coach, and prevention sessions with the physical therapist should be considered. Our results support clinical actions towards sport injury prevention worldwide and guide development of sports IPPs within the context of each country's available resources irrespective of socioeconomic status, in both developing and developed countries.

References

1. Adesida, Y., Papi, E., McGregor, A.H. (2019). Exploring the Role of Wearable Technology in Sport Kinematics and Kinetics: A Systematic Review. *Sensors (Basel),* Apr 2;19(7):1597. doi: 10.3390/s19071597.

2. Arundale, A.J.H., Cummer, K., Capin, J.J., Zarzycki, R., Snyder-Mackler, L. (2017). Report of the Clinical and Functional Primary Outcomes in Men of the ACL-SPORTS Trial: Similar Outcomes in Men Receiving Secondary Prevention With and Without Perturbation Training 1 and 2 Years After ACL Reconstruction. *Clin Orthop Relat Res*, Oct;475(10):2523-2534. doi: 10.1007/s11999-017-5280-2.

3. Asker, M., Brooke, H.L., Waldén, M., Tranaeus, U., Johansson, F., Skillgate, E., Holm, L.W. (2018). Risk factors for, and prevention of, shoulder injuries in overhead sports: a systematic review with best-evidence synthesis. *Br J Sports Med*, Oct;52(20):1312-1319. doi: 10.1136/bjsports-2017-098254.

4. Bahr, R. (2016). Why screening tests to predict injury do not work-and probably never will…: a critical review. *Br J Sports Med*, Jul;50(13):776-80. doi: 10.1136/bjsports-2016-096256.

5. Bahr, R., Thorborg, K., Ekstrand, J. (2015). Evidence-based hamstring injury prevention is not adopted by the majority of Champions League or Norwegian Premier League football teams: the Nordic Hamstring survey. *Br J Sports Med*, 49:1466–7.

6. Barber Foss, K.D., Le Cara, E., McCambridge, T., Hinton, R.Y., Kushner, A., Myer, G.D. (2018). Epidemiology of Injuries in Women's Lacrosse: Implications for Sport-, Level-, and Sex-Specific Injury Prevention Strategies. *Clin J Sport Med*, Jul;28(4):406-413. doi: 10.1097/JSM.0000000000000458.

7. Bekker, S., Paliadelis, P., Finch, C.F. (2017). The translation of sports injury prevention and safety promotion knowledge: insights from key intermediary organisations. *Health Res Policy Syst,* Mar 28;15(1):25. doi: 10.1186/s12961-017-0189-5.

8. Bittencourt, N.F.N., Meeuwisse, W.H., Mendonça, L.D., Nettel-Aguirre, A., Ocarino, J.M., Fonseca, S.T. (2016). Complex systems approach for sports injuries: moving from risk factor identification to injury pattern recognition-narrative review and new concept. *Br J Sports Med*, Nov;50(21):1309-1314. doi: 10.1136/bjsports-2015-095850.

9. Bizzini, M., Junge, A., Dvorak, J. (2013). Implementation of the FIFA 11+ football warm up program: how to approach and convince the Football associations to invest in prevention. *Br J Sports Med*, Aug;47(12):803-6. doi: 10.1136/bjsports-2012-092124.

10. Bolling, C., van Mechelen, W., Pasman, H.R., Verhagen, E. (2018). Context Matters: Revisiting the First Step of the 'Sequence of Prevention' of Sports Injuries. *Sports Med*, Oct;48(10):2227-2234. doi: 10.1007/s40279-018-0953-x.

11. Bonazza, N.A., Smuin, D., Onks, C.A., Silvis, M.L., Dhawan, A. (2017). Reliability, Validity, and Injury Predictive Value of the Functional Movement Screen: A Systematic Review and Meta-analysis. *Am J Sports Med*, Mar;45(3):725-732. doi: 10.1177/0363546516641937.

12. Bonnar, D., Bartel, K., Kakoschke, N., Lang, C. (2018). Sleep Interventions Designed to Improve Athletic Performance and Recovery: A Systematic Review of Current Approaches. *Sports Med*, Mar;48(3):683-703. doi: 10.1007/s40279-017-0832-x.

13. Braun, V., Clarke, V. (2006). Using thematic analysis in psychology. *Qual Res Psychol,* 3:77-101.

14. Breslin, G., Shannon, S., Haughey, T., Donnelly, P., Leavey, G. (2017). A systematic review of interventions to increase awareness of mental health and well-being in athletes, coaches and officials. *Syst Rev*, Aug 31;6(1):177. doi: 10.1186/s13643-017-0568-6.

15. Dallinga, J.M., Benjaminse, A., Lemmink, K.A. (2012). Which screening tools can predict injury to the lower extremities in team sports?: a systematic review. *Sports Med*, Sep 1;42(9):791-815. doi: 10.1007/BF03262295.

16. Dejonghe, L.A.L., Becker, J., Froboese, I., Schaller, A. (2017). Long-term effectiveness of health coaching in rehabilitation and prevention: A systematic review. *Patient Educ Couns,* Sep;100(9):1643-1653. doi: 10.1016/j.pec.2017.04.012.

17. Diamond, I.R., Grant, R.C., Feldman, B.M., et al. (2014). Defining consensus: a systematic review recommends methodologic criteria for reporting of Delphi studies. *J Clin Epidemiol,* 67(4):401-409.

18. Donaldson, A., Finch, C.F. (2013). Applying implementation science to sports injury prevention. *Br J Sports Med,* 47:473–5.

19. Donaldson, A., Lloyd, D.G., Gabbe, B.J., *et al*. (2017). We have the programme, what next? Planning the implementation of an injury prevention programme . *Inj Prev,* 23:273–280.

20. Edouard, P., Branco, P., Alonso, J.M. (2014). Challenges in Athletics injury and illness prevention: implementing prospective studies by standardised surveillance. *Br J Sports Med*, Apr;48(7):481-2. doi: 10.1136/bjsports-2013-093093.

21. Ekstrand, J., Waldén, M., Hägglund, M. (2016). Hamstring injuries have increased by 4% annually in men's professional football, since 2001: a 13-year longitudinal analysis of the UEFA Elite Club injury study. *Br J Sports Med*, Jun;50(12):731-7.

22. Ekegren, C.L., Gabbe, B.J., Finch, C.F. (2016). Sports Injury Surveillance Systems: A Review of Methods and Data Quality. *Sports Med*, Jan;46(1):49-65. doi: 10.1007/s40279-015-0410-z.

23. Emery, C.A., Roy, T-O., Whittaker, J.L., et al. (2015). Neuromuscular training injury prevention strategies in youth sport: a systematic review and meta-analysis. *Br J Sports Med*, 49: 865–870.

24. Finch, C.F., Donaldson, A. (2010). A sports setting matrix for understanding the implementation context for community sport. *Br J Sports Med*, Oct;44(13):973-8. doi: 10.1136/bjsm.2008.056069.

25. Fokkema, T., de Vos, R.J., Bierma-Zeinstra, S.M.A., van Middelkoop, M. (2019). Opinions, Barriers, and Facilitators of Injury Prevention in Recreational Runners. *J Orthop Sports Phys Ther*, Oct;49(10):736-742. doi: 10.2519/jospt.2019.9029.

26. Forthomme, B., Croisier, J.L., Delvaux, F., Kaux, J.F., Crielaard, J.M., Gleizes-Cervera, S. (2018). Preseason Strength Assessment of the Rotator Muscles and Shoulder Injury in Handball Players. *J Athl Train*, Feb;53(2):174-180. doi: 10.4085/1062-6050-216-16.

27. Gosselin, V., Boccanfuso, D., Laberge, S. (2020). Social return on investment (SROI) method to evaluate physical activity and sport interventions: a systematic review. *Int J Behav Nutr Phys Act*, Feb 27;17(1):26. doi: 10.1186/s12966-020-00931-w.

28. Green, B., Bourne, M.N., van Dyk, N., Pizzari, T. (2020). Recalibrating the risk of hamstring strain injury (HSI): A 2020 systematic review and meta-analysis of risk factors for index and recurrent hamstring strain injury in sport. *Br J Sports Med*, Sep;54(18):1081-1088. doi: 10.1136/bjsports-2019-100983.

29. Green, B., Pizzari, T. (2017). Calf muscle strain injuries in sport: a systematic review of risk factors for injury. *Br J Sports Med*, Aug;51(16):1189-1194. doi: 10.1136/bjsports-2016-097177.

30. Gupta, L., Morgan, K., Gilchrist, S. (2017). Does Elite Sport Degrade Sleep Quality? A Systematic Review. *Sports Med*, Jul;47(7):1317-1333. doi: 10.1007/s40279-016-0650-6.

31. Hannington, M., Docking, S., Cook, J., Edwards, S., Rio, E. (2020). Self-reported jumpers' knee is common in elite basketball athletes - But is it all patellar tendinopathy*? Phys Ther Sport,* Jan 23;43:58-64. doi: 10.1016/j.ptsp.2020.01.012.

32. Hasson, F., Keeney, S., McKenna, H. (2000). Research guidelines for the Delphi survey technique. *J Adv Nurs,* 32(4):1008-1015.

33. Hilibrand, M.J., Hammoud, S., Bishop, M., Woods, D., Fredrick, R.W., Dodson, C.C. (2015). Common injuries and ailments of the female athlete; pathophysiology, treatment and prevention. *Phys Sportsmed*, Nov;43(4):403-11. doi: 10.1080/00913847.2015.1092856.

34. Hill, L., Collins, M., Posthumus, M. (2015). Risk factors for shoulder pain and injury in swimmers: A critical systematic review. *Phys Sportsmed*, Nov;43(4):412-20. doi: 10.1080/00913847.2015.1077097.

35. Hsu, C.C., Sandford, B.A. (2007). The Delphi Technique: Making Sense Of Consensus. *Practical Assessment, Research & Evaluation,* 12(10):1-8.

36. Jairath, N., Weinstein, J. (1994). The Delphi methodology (Part one): A useful administrative approach. *Can J Nurs Adm,* 7(3):29-42

37. Johansen, H.D., Johansen, D., Kupka, T., Riegler, M.A., Halvorsen, P. (2020). Scalable Infrastructure for Efficient Real-Time Sports Analytics. *Companion Publication of the 2020 International Conference on Multimodal Interaction*, 230-234.

38. Jones, C.M., Griffiths, P.C., Mellalieu, S.D. (2017). Training Load and Fatigue Marker Associations with Injury and Illness: A Systematic Review of Longitudinal Studies. *Sports Med,* May;47(5):943-974. doi: 10.1007/s40279-016-0619-5.

39. Jünger, S., Payne, S.A., Brine, J., Radbruch, L., Brearley, S.G. (2017). Guidance on Conducting and REporting DElphi Studies (CREDES) in palliative care: Recommendations based on a methodological systematic review. Palliat Med, Sep;31(8):684-706. doi: 10.1177/0269216317690685.

40. Li, R.T., Kling, S.R., Salata, M.J., Cupp, S.A., Sheehan, J., Voos, J.E. (2016). Wearable Performance Devices in Sports Medicine. *Sports Health*, Jan-Feb;8(1):74-8. doi: 10.1177/1941738115616917.

41. Liporaci, R.F., Saad, M., Grossi, D.B., Riberto, M. (2019). Clinical Features and isokinetic Parameters in Assessing Injury Risk in elite Football Players. *Int J Sports Med*, Dec;40(14):903-908. doi: 10.1055/a-1014-2911.

42. Loose, O., Achenbach, L., Fellner, B., et al. (2018). Injury prevention and return to play strategies in elite football: no consent between players and team coaches. *Arch Orthop Trauma Surg,* Jul;138(7):985-992. doi: 10.1007/s00402-018-2937-6.

43. Maughan, R.J., Burke, L.M., Dvorak, J., et al. (2018). IOC consensus statement: dietary supplements and the high-performance athlete. *Br J Sports Med*, Apr;52(7):439-455. doi: 10.1136/bjsports-2018-099027.

44. McCall, A., Carling, C., Davison, M., et al. (2015). Injury risk factors, screening tests and preventative strategies: a systematic review of the evidence that underpins the perceptions and practices of 44 football (soccer) teams from various premier leagues. *Br J Sports Med,* May;49(9):583-9. doi: 10.1136/bjsports-2014-094104.

45. McCall, A., Pruna, R., Van der Horst, N., et al. (2020). Exercise-Based Strategies to Prevent Muscle Injury in Male Elite Footballers: An Expert-Led Delphi Survey of 21 Practitioners Belonging to 18 Teams from the Big-5 European Leagues. *Sports Med,* Sep;50(9):1667-1681. doi: 10.1007/s40279-020-01315-7.

46. McGlashan, A., Verrinder, G., Verhagen, E. (2018). Working towards More Effective Implementation, Dissemination and Scale-Up of Lower-Limb Injury-Prevention Programs: Insights from Community Australian Football Coaches. *Int J Environ Res Public Health,* Feb 16;15(2):351. doi: 10.3390/ijerph15020351.

47. Michaelidis, M., Koumantakis, G.A. (2014). Effects of knee injury primary prevention programs on anterior cruciate ligament injury rates in female athletes in different sports: a systematic review. *Phys Ther Sport*, Aug;15(3):200-10. doi: 10.1016/j.ptsp.2013.12.002. Epub 2013 Dec 19.

48. Murphy, M.K., Black, N.A., Lamping, D.L., et al. (1998). Consensus development methods, and their use in clinical guideline development. *Health Technol Assess,* 2(3):i-iv, 1-88.

49. No authors listed. (2018). Exercise for Knee Injury Prevention: A Summary of Clinical Practice Guideline Recommendations-Using the Evidence to Guide Physical Therapist Practice. *J Orthop Sports Phys Ther*, Sep;48(9):732-733. doi: 10.2519/jospt.2018.0508.

50. O'Brien, J., Finch, C.F. (2014). A systematic review of core implementation components in team ball sport injury prevention trials. *Inj Prev*, 20:357–62.

51. Pelliccia, et al. (2005). Recommendations for competitive sports participation in athletes with cardiovascular disease: a consensus document from the Study Group of Sports Cardiology of the Working Group of Cardiac Rehabilitation and Exercise Physiology and the Working Group of Myocardial and Pericardial Diseases of the European Society of Cardiology. *Eur Heart J*, 26:1422-45.

52. Read, P.J., Jimenez, P., Oliver, J.L., Lloyd, R.S. (2018). Injury prevention in male youth soccer: Current practices and perceptions of practitioners working at elite English academies. *J Sports Sci*, Jun;36(12):1423-1431. doi: 10.1080/02640414.2017.1389515.

53. Robertson, S., Kremer, P., Aisbett, B., Tran, J., Cerin, E. (2017). Consensus on measurement properties and feasibility of performance tests for the exercise and sport sciences: a Delphi study. *Sports Med Open*, Dec;3(1):2. doi: 10.1186/s40798-016-0071-y.

54. Rössler, R., Verhagen, E., Rommers, N., et al. (2019). Comparison of the '11+ Kids' injury prevention programme and a regular warmup in children's football (soccer): a cost effectiveness analysis. *Br J Sports Med*, Mar;53(5):309-314. doi: 10.1136/bjsports-2018-099395.

55. Sadigursky, D., Braid, J.A., De Lira, D.N.L. *et al.* (2017). The FIFA 11+ injury prevention program for soccer players: a systematic review. *BMC Sports Sci Med Rehabil*, 28(9):18. doi.org/10.1186/s13102-017-0083-z

56. Silvers-Granelli, H., Mandelbaum, B., Adeniji, O., *et al*. (2015). Efficacy of the FIFA 11+ injury prevention program in the collegiate male soccer player. *Am J Sports Med,* 43:2628–37.

57. Slimani, M., Bragazzi, N.L., Znazen, H., Paravlic, A., Azaiez, F., Tod, D. (2018). Psychosocial predictors and psychological prevention of soccer injuries: A systematic review and meta-analysis of the literature. *Phys Ther Sport*, Jul;32:293-300. doi: 10.1016/j.ptsp.2018.05.006.

58. Smith, M.D., Vicenzino, B., Bahr, R., et al. (2021). Return to sport decisions after an acute lateral ankle sprain injury: introducing the PAASS framework-an international multidisciplinary consensus. *Br J Sports Med*, Jun 22:bjsports-2021-104087. doi: 10.1136/bjsports-2021-104087.

59. Soligard, T., Schwellnus, M., Alonso, J.M., et al. (2016). How much is too much? (Part 1) International Olympic Committee consensus statement on load in sport and risk of injury. *Br J Sports Med*, Sep;50(17):1030-41. doi: 10.1136/bjsports-2016-096581.

60. Stracciolini, A., Sugimoto, D., Howell, D.R. (2017). Injury Prevention in Youth Sports. *Pediatr Ann,* Mar 1;46(3):e99-e105. doi: 10.3928/19382359-20170223-01.

61. Toohey, L.A., Drew, M.K., Cook, J.L., Finch, C.F., Gaida, J.E. (2017). Is subsequent lower limb injury associated with previous injury? A systematic review and meta-analysis. *Br J Sports Med,* Dec;51(23):1670-1678. doi: 10.1136/bjsports-2017-097500.

62. van der Horst, N., Backx, F., Goedhart, E.A., Huisstede, B.M., HIPS-Delphi Group. (2017). Return to play after hamstring injuries in football (soccer): a worldwide Delphi procedure regarding definition, medical criteria and decision-making. *Br J Sports Med*, Nov;51(22):1583-1591. doi: 10.1136/bjsports-2016-097206.

63. van der Worp, M.P., ten Haaf, D.S., van Cingel, R., de Wijer, A., Nijhuis-van der Sanden, M.W., Staal, J.B. (2015). Injuries in runners; a systematic review on risk factors and sex differences. *PLoS One*, Feb 23;10(2):e0114937. doi: 10.1371/journal.pone.0114937.

64. Webborn, N. (2012). Lifetime injury prevention: the sport profile model. *Br J Sports Med*, Mar;46(3):193-7. doi: 10.1136/bjsports-2011-090417.

65. Whittaker, J.L., Booysen, N., de la Motte, S., et al. (2017). Predicting sport and occupational lower extremity injury risk through movement quality screening: a systematic review. *Br J Sports Med*, Apr;51(7):580-585. doi: 10.1136.

Figure Captions

FIGURE 1. Flow chart representing the participation adherence of participants through the three Delphi study rounds (n = sample size)

FIGURE 2. Prevention consensus: provides an overview of the items agreed on each phase of sports injury prevention programmes. The level of importance of each item included in the consensus was categorized based on a Likert scale (with scores ranging between 0 to 10). Items in the inner circles had values above the median (9 to 10) and those in the outer circle had values under the median (5 to 8).

Tables

TABLE 1: Participant's characteristics

Demographics (n=305)					
	Mean	**SD**	**Minimum**	**Maximum**	**Frequency**
Age (years)	41.8	11.4	26	69	305 (100%)
Female	45.7	13.6	28	69	102 (33.4%)
Male	39.1	9.2	26	58	203 (66.6%)
Injury prevention experience					
	Mean	**SD**	**Minimum**	**Maximum**	**Frequency**
Working (years)	16.2	8.7	3	35	-
Expertise (0-10 Likert scale)	7.3	1.3	5	9	-
On-field prevention (hours/week)	3.4	3.1	1	10	-
Academic degree					
	Frequency				
PhD	57 (18.7%)				
Master (r)	47 (15.4%)				
Master (p)	111 (36.7%)				
Bachelor	89 (29.2%)				
Current occupation					
Academic	77 (25.2%)				
Clinical	228 (74.8%)				
Country practice (more than 14 participants)					
Canada	23 (7.5%)				
Switzerland	22 (7.2%)				
Brazil	18 (5.9%)				
Belgium	16 (5.2%)				
United Kingdom	16 (5.2%)				
Italy	15 (4.9%)				
Japan	14 (4.5%)				
United States	14 (4.5%)				

Abbreviations: SD=standard deviation; (r)=research; (p)=professional; PT=physical therapist.

Expertise item was self-appointed using a 0-10 Likert scale.

TABLE 2: Delphi's study final consensus on factors to be considered for sports injury prevention planning and organization.

Section: Sports injury prevention planning					
Item	**Agreement**	**Score (Mean (SD))**	**Min-Max**	**Median**	**IQR**
Highest injury rates	89.0%	8.6 (1.3)	1-10	9	2
Athlete's injury history	98.0%	9.1 (1.2)	2-10	10	1
Athlete's screening outcome	92.5%	8.4 (1.6)	2-10	9	2
Athlete's age	93.7%	7.4 (1.8)	1-10	8	2
Recovery strategy (physical and mental)	89.7%	7.3 (1.9)	1-10	8	1
Psychological and mental factors (coping, stress, anxiety, mindset, etc)	94.4%	7.53 (1.8)	1-10	8	2
Number of participating athletes	83.4%	6.55 (2.2)	1-10	7	3
Number of participating sport modalities	76.1%	6.51 (1.9)	1-10	7	3
Financial support	86.0%	6.78 (2.2)	1-10	7	3
Section: Sports injury prevention organization					
Item	**Agreement**	**Score (Mean (SD))**	**Min-Max**	**Median**	**IQR**
Athlete's gender	92.50%	7.60 (2.10)	1-10	8	2
Athlete's age (e.g., child, adolescent, adult)	97.00%	8.27 (1.63)	1-10	8	1
Athlete's competition level	93.00%	7.93 (1.64)	2-10	8	2
Athlete's injury risk profile (based on the results a standardized and validated screening procedure)	92.50%	8.47 (1.52)	2-10	9	2
Number of available healthcare professionals	84.50%	7.24 (1.88)	2-10	8	3
Financial resources	88.97%	Professionals: 8.62 (1.60)	1-10	9	2
		Quality, brand: 5.96 (2.14)	1-10	6	3
Low-cost material resources (strengthening bands, weights, balls, etc)	93.01%	7.61 (1.87)	1-10	8	2
No high-cost equipment (strengthening machines, isokinetic, etc)	91.10%	5.02 (2.14)	1-10	5	3

Abbreviations: SD= standard deviation; Min-Max = minimum-maximum; IQR = interquartile range

TABLE 3: Delphi's study final consensus on factors to be considered for Sports injury prevention implementation.

Section: Sports injury prevention implementation					
Question	**Agreement**	**Score (Mean (SD))**	**Min-Max**	**Median**	**IQR**
Warm-up sessions provided by the head coach or strength/conditioning coach	93.5%	8.5 (1.5)	3-10	9	2
Physical training sessions provided by the team's strength/conditioning coach	92.0%	8.7 (1.2)	3-10	9	2
Prevention sessions provided by the team's physical therapist	89.5%	8.8 (1.4)	3-10	9	2
Coach's support	98.0%	9.2 (1.0)	3-10	10	1
Health professional's engagement	95.5%	8.9 (1.2)	3-10	9	2
Athlete's routine organization	88.5%	8.7 (1.2)	3-10	9	2
Education	93.0%	9.0 (1.2)	3-10	10	2
Injury prevention results regarding previous seasons (injury risk, time loss, performance, etc) should be disseminated	80.5%	7.4 (1.8)	1-10	8	3
Infrastructure/space	90.0%	7.5 (1.8)	1-10	8	2
Technology	74.2%	3D: 5.4 (2.5)	0-10	5	4
		GPS: 6.1 (2.5)	0-10	7	3.7
		App (assessment): 5.8 (2.5)	1-10	6	4
		App (exercise): 5.9 (2.5)	1-10	6	4
Psychological and mental factors	98.8%	7.8 (1.6)	2-10	8	2
Sleep	97.7%	7.9 (1.7)	1-10	8	2
Nutrition	98.5%	7.6 (1.7)	1-10	8	2
Training load	98.5%	8.4 (1.4)	4-10	9	2
Athlete's responsibility	98.5%	8.7 (1.4)	2-10	9	2
Governing bodies (federations/confederations)	91.5%	7.4 (2.0)	2-10	8	3
Work environment and relationship between the professionals	99.6%	8.7 (1.2)	2-10	9	1
Sport team continuous education and engagement about prevention	98.8%	8.2 (1.4)	1-10	8	3
Sport team continuous education and engagement on injury burden	94.4%	7.7 (1.6)	1-10	8	2

Abbreviations: SD= standard deviation; Min-Max = minimum-maximum; 3D: tridimensional analysis; GPS: global positioning system; App=application; IQR = interquartile range

Figure 1

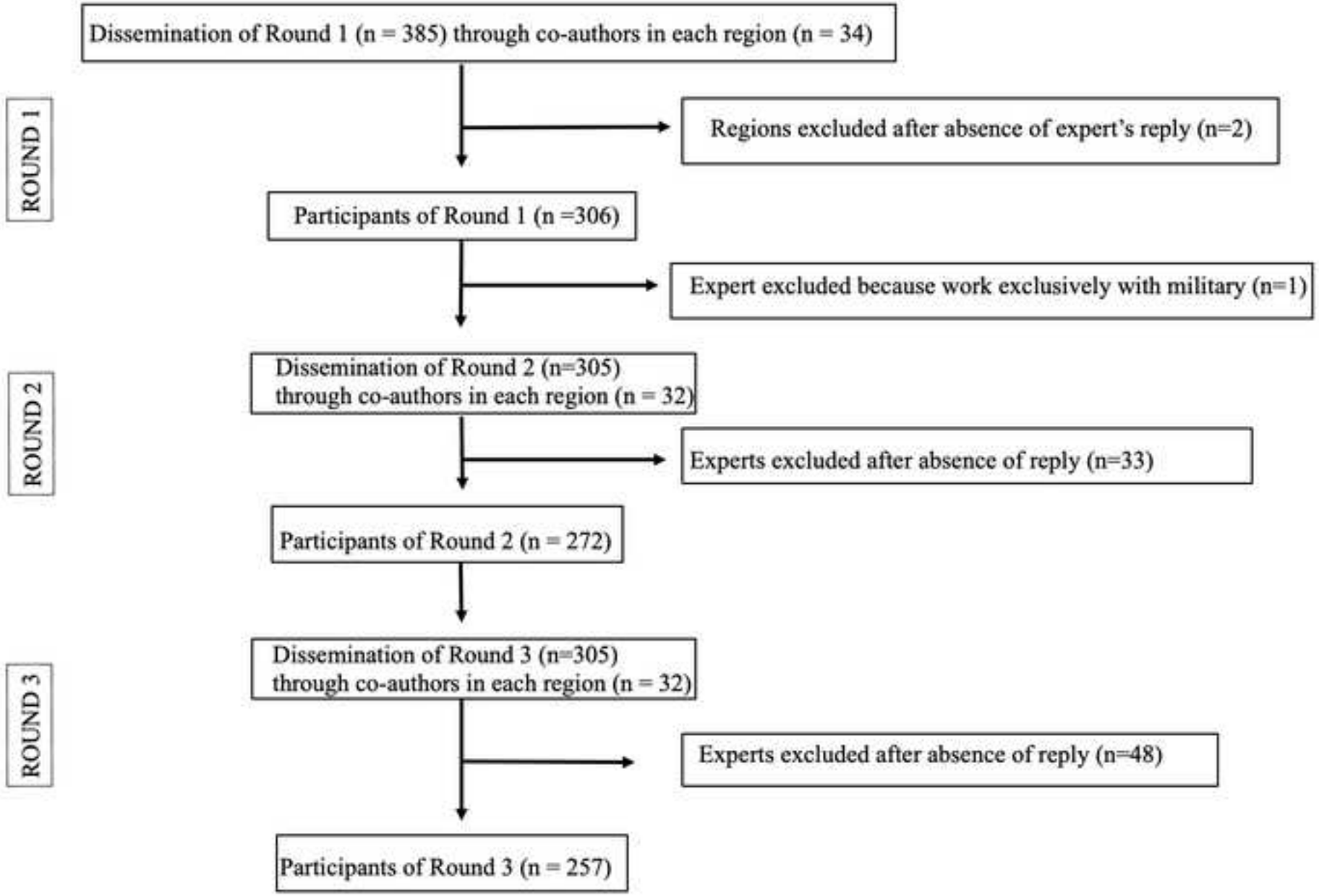
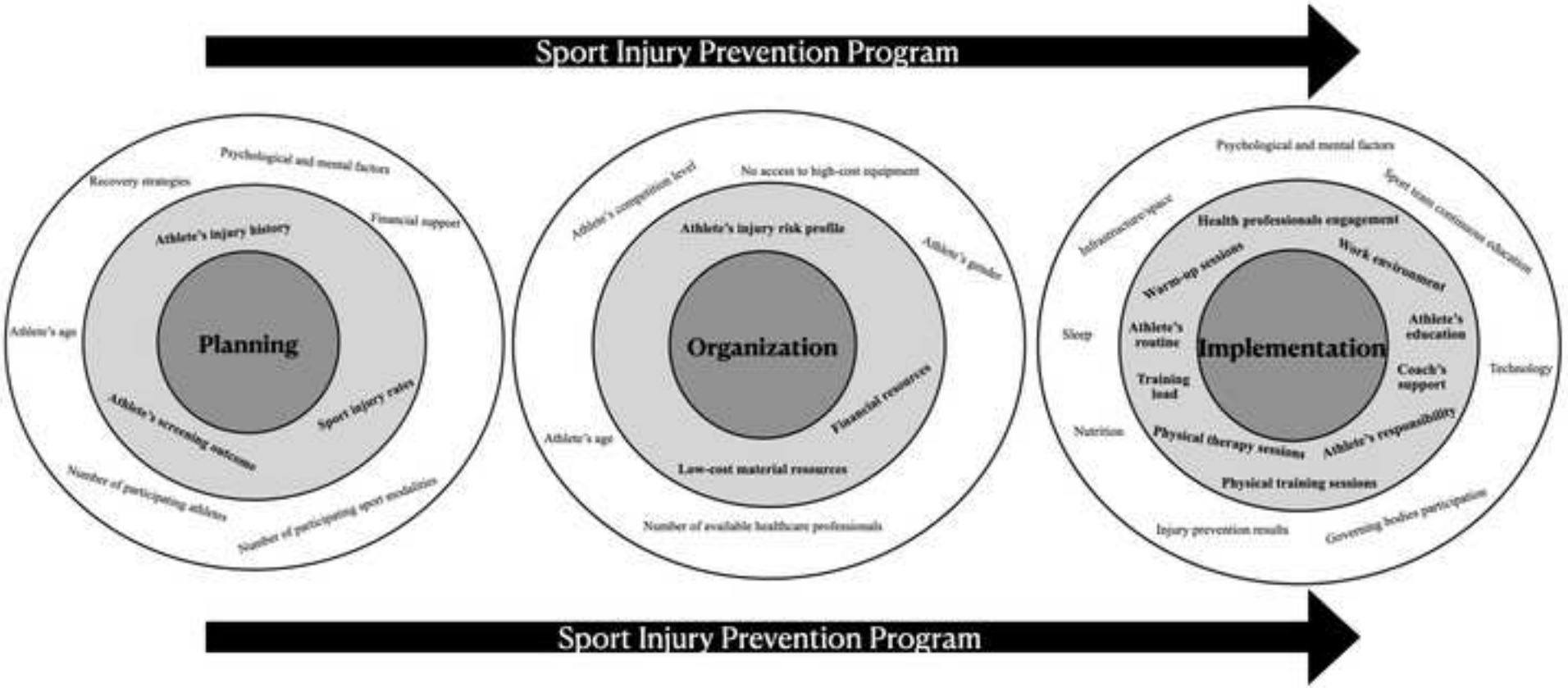


Figure 2



Tables

TABLE 1: Participant's characteristics

Demographics (n=305)					
	Mean	**SD**	**Minimum**	**Maximum**	**Frequency**
Age (years)	41.8	11.4	26	69	305 (100%)
Female	45.7	13.6	28	69	102 (33.4%)
Male	39.1	9.2	26	58	203 (66.6%)
Injury prevention experience					
	Mean	**SD**	**Minimum**	**Maximum**	**Frequency**
Working (years)	16.2	8.7	3	35	-
Expertise (0-10 Likert scale)	7.3	1.3	5	9	-
On-field prevention (hours/week)	3.4	3.1	1	10	-
Academic degree					
	Frequency				
PhD	57 (18.7%)				
Master (r)	47 (15.4%)				
Master (p)	111 (36.7%)				
Bachelor	89 (29.2%)				
Current occupation					
Academic	77 (25.2%)				
Clinical	228 (74.8%)				
Country practice (more than 14 participants)					
Canada	23 (7.5%)				
Switzerland	22 (7.2%)				
Brazil	18 (5.9%)				
Belgium	16 (5.2%)				
United Kingdom	16 (5.2%)				
Italy	15 (4.9%)				
Japan	14 (4.5%)				
United States	14 (4.5%)				

Abbreviations: SD=standard deviation; (r)=research; (p)=professional; PT=physical therapist.

Expertise item was self-appointed using a 0-10 Likert scale.

Tables

TABLE 2: Delphi's study final consensus on factors to be considered for sports injury prevention planning and organization.

Section: Sports injury prevention planning					
Item	**Agreement**	**Score (Mean (SD))**	**Min-Max**	**Median**	**IQR**
Highest injury rates	89.0%	8.6 (1.3)	1-10	9	2
Athlete's injury history	98.0%	9.1 (1.2)	2-10	10	1
Athlete's screening outcome	92.5%	8.4 (1.6)	2-10	9	2
Athlete's age	93.7%	7.4 (1.8)	1-10	8	2
Recovery strategy (physical and mental)	89.7%	7.3 (1.9)	1-10	8	1
Psychological and mental factors (coping, stress, anxiety, mindset, etc)	94.4%	7.53 (1.8)	1-10	8	2
Number of participating athletes	83.4%	6.55 (2.2)	1-10	7	3
Number of participating sport modalities	76.1%	6.51 (1.9)	1-10	7	3
Financial support	86.0%	6.78 (2.2)	1-10	7	3
Section: Sports injury prevention organization					
Item	**Agreement**	**Score (Mean (SD))**	**Min-Max**	**Median**	**IQR**
Athlete's gender	92.5%	7.6 (2.1)	1-10	8	2
Athlete's age (e.g., child, adolescent, adult)	97.0%	8.2 (1.6)	1-10	8	1
Athlete's competition level	93.0%	7.9 (1.6)	2-10	8	2
Athlete's injury risk profile (based on the results a standardized and validated screening procedure)	92.5%	8.4 (1.5)	2-10	9	2
Number of available healthcare professionals	84.5%	7.2 (1.8)	2-10	8	3
Financial resources	88.9%	Professionals: 8.6 (1.6)	1-10	9	2
		Quality, brand: 5.9 (2.1)	1-10	6	3
Low-cost material resources (strengthening bands, weights, balls, etc)	93.0%	7.6 (1.8)	1-10	8	2
No high-cost equipment (strengthening machines, isokinetic, etc)	91.1%	5.0 (2.1)	1-10	5	3

Abbreviations: SD= standard deviation; Min-Max = minimum-maximum; IQR = interquartile range

Tables

TABLE 3: Delphi's study final consensus on factors to be considered for Sports injury prevention implementation.

Section: Sports injury prevention implementation					
Question	**Agreement**	**Score (Mean (SD))**	**Min-Max**	**Median**	**IQR**
Warm-up sessions provided by the head coach or strength/conditioning coach	93.5%	8.5 (1.5)	3-10	9	2
Physical training sessions provided by the team's strength/conditioning coach	92.0%	8.7 (1.2)	3-10	9	2
Prevention sessions provided by the team's physical therapist	89.5%	8.8 (1.4)	3-10	9	2
Coach's support	98.0%	9.2 (1.0)	3-10	10	1
Health professional's engagement	95.5%	8.9 (1.2)	3-10	9	2
Athlete's routine organization	88.5%	8.7 (1.2)	3-10	9	2
Education	93.0%	9.0 (1.2)	3-10	10	2
Injury prevention results regarding previous seasons (injury risk, time loss, performance, etc) should be disseminated	80.5%	7.4 (1.8)	1-10	8	3
Infrastructure/space	90.0%	7.5 (1.8)	1-10	8	2
Technology	74.2%	3D: 5.4 (2.5)	0-10	5	4
		GPS: 6.1 (2.5)	0-10	7	3.7
		App (assessment): 5.8 (2.5)	1-10	6	4
		App (exercise): 5.9 (2.5)	1-10	6	4
Psychological and mental factors	98.8%	7.8 (1.6)	2-10	8	2
Sleep	97.7%	7.9 (1.7)	1-10	8	2
Nutrition	98.5%	7.6 (1.7)	1-10	8	2
Training load	98.5%	8.4 (1.4)	4-10	9	2
Athlete's responsibility	98.5%	8.7 (1.4)	2-10	9	2
Governing bodies (federations/confederations)	91.5%	7.4 (2.0)	2-10	8	3
Work environment and relationship between the professionals	99.6%	8.7 (1.2)	2-10	9	1
Sport team continuous education and engagement about prevention	98.8%	8.2 (1.4)	1-10	8	3
Sport team continuous education and engagement on injury burden	94.4%	7.7 (1.6)	1-10	8	2

Abbreviations: SD= standard deviation; Min-Max = minimum-maximum; 3D: tridimensional analysis; GPS: global positioning system; App=application; IQR = interquartile range