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SPORTS MEDICINE

The awareness of injury prevention programmes is insufficient among French- and German-speaking sports medicine communities in Europe

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Abstract

Purpose Evaluate the current state of sports injury prevention perception, knowledge and practice among sports medicine professionals located in Western Europe and involved in injury prevention.

Methods Members of two different sports medicine organizations (GOTS and ReFORM) were invited to complete a web-based questionnaire (in German and in French, respectively) addressing perception, knowledge and implementation of sports injury prevention through 22 questions.

Results 766 participants from a dozen of countries completed the survey. Among them, 43% were surgeons, 23% sport physicians and 18% physiotherapists working mainly in France (38%), Germany (23%) and Belgium (10%). The sample rated the importance of injury prevention as "high" or "very high" in a majority of cases (91%), but only 54% reported to be aware of specific injury prevention programmes. The French-speaking world was characterized by lower levels of reported knowledge, unfamiliarity with existing prevention programmes and less weekly time spent on prevention as compared to their German-speaking counterparts. Injury prevention barriers reported by the respondents included mainly insufficient expertise, absence of staff support from sports organizations and lack of time.

Conclusion There is a lack of awareness regarding injury prevention concepts among sports medicine professionals of the European French- and German-speaking world. This gap varied according to the professional occupation and working country. Relevant future paths for improvement include specific efforts to build awareness around sports injury prevention.

Level of evidence Level IV.

Keywords Sports-related injuries · Injury prevention · Professional practice

Introduction

Sports-related injuries cause a partial loss of the important benefits of physical activity. Their health-related and social consequences also raise concern [6, 28]. Therefore, measures of primary sports injury prevention are highly important to mitigate the injury risk. Recent scientific research has identified their effectiveness in up to 50% of sports injuries [3, 12, 16, 22, 23]. They can consist of exercise-based programmes such as the widely disseminated FIFA-11 + [38], the Nordic Hamstring Exercise program [16, 30], or the OSTRC neuromuscular training programme to prevent anterior cruciate ligament injuries in handball [32]. Additional preventive efforts also include adjustments to the rules and regulations of the respective sport (e.g. body checking in ice hockey), optimization of sports equipment (e.g. helmets in football) and educational work for both athletes and coaches [21, 27, 44].

However, implementing these preventive measures remains challenging [43], which is notably caused by poor adherence of sports participants to prevention programmes[2, 36], and by problems such as lack of knowledge, resources and time of the individual stakeholders who are

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involved in the protection of the athletes' health [24]. While building awareness around preventive measures is a necessary step, little is known about the current perception of the role and importance of sports injury prevention by the athletes' (para)medical staff. Likewise, the required knowledge transfer to improve its implementation as well as possible geographical and cultural specificities are unknown [25].

Therefore, this study aimed to explore injury prevention approaches of two geographically and culturally different large sports medicine communities in Western Europe. The hypothesis was that the perception of the importance of sports injury prevention, the awareness of existing programmes and the amount of time spent on prevention would be at a comparable high level in the two groups. The second hypothesis was that the perception and knowledge of sports injury prevention may vary between different healthcare professions.

Materials and methods

Study design and overall procedure

A cross-sectional study was conducted through an online survey and disseminated in two phases to a population of sports medicine professionals. It assessed the current perception, practice and state of knowledge regarding sports injury prevention. Since this was a health professional's anonymous survey, no ethics committee reviewed the protocol.

Population

The target population comprised the members of the German Speaking Society for Orthopedic and Traumatological Sports Medicine (GOTS) and the members and extended professional networks of The Réseau Francophone Olympique de la Recherche en Médecine du sport (ReFORM). The GOTS is a scientific, individual member society of approximately 1500 interdisciplinary healthcare professionals including a majority of orthopaedic consultants as well as medical students and residents, but also physical therapists and sports scientists [45]. ReFORM is a consortium of five French-speaking leading interdisciplinary sports medicine institutions in France (Paris), Luxembourg (Luxembourg), Switzerland (Geneva), Belgium (Liège) and Canada (Montréal) which is recognized by the International Olympic Committee (IOC) as a research centre for the prevention of injury and illness in athletes [25]. The ReFORM population thereby encompassed the members of the group (circa 20 persons) and their respective institutional and professional networks (including orthopaedic surgeons, sports medicine physicians and physiotherapists).

Data collection

A German web-based questionnaire was designed by three of the authors (CL, RS, TT) and tested by fourteen members of the sports injury prevention committee of GOTS. From August 21st to November 21st, 2019, all members of the GOTS (~ 1500) were invited by email to participate. The subgroup results of GOTS have been previously published [24]. In accordance with international guidelines [4], this original German questionnaire underwent a translation, back-translation, as well as an experts' validation process to provide a French version that was disseminated from September 16th to December 23, 2020, to the ReFORM consortium. Each institution of the consortium disseminated it locally by email, newsletters, websites and social media. It was thereby not possible to estimate the number of potential participants reached.

In the course of each survey, monthly reminders followed via email to increase participation.

The online platforms SurveyMonkey® (SurveyMonkey, San Mateo—CA, United States, GOTS survey) and SondageOnline (enuvo GmbH, Zurich—Switzerland, ReFORM survey) were used to prepare the survey. It included twenty-two questions in five sections. The estimated completion time was about 5 min. The first part consisted in an assessment of prevention importance ($n = 4$ questions). It included an assessment of the knowledge of existing prevention concepts such as injury prevention programmes and of the ability to cite some, which we then defined as injury prevention awareness. The second part ($n = 3$ questions) of the survey focused on general information regarding specifications of the study population (e.g. participant's country of professional activity). The third part consisted of eight questions on the current implementation of prevention in daily practice. In section four ($n = 4$ questions), underlying problems and difficulties of prevention work were addressed and possibilities for improved implementation and application of prevention concepts were assessed. The last part ($n = 3$ questions) investigated possible future topics in the field of prevention research. Questions thereby mainly consisted of single ($n = 14$) or multiple-choice ($n = 4$) questions; four questions were open-ended (full questionnaires available in supplementary material).

Statistical analysis

Microsoft Excel (Microsoft, Redmond, Washington, USA) was used for data curation; statistical analyses were performed using SigmaStat software (Systat Software Inc., San Jose, USA) and R (R Foundation for Statistical

Computing, Vienna, Austria). All the collected available data were used for the analyses. Descriptive analyses were performed using counts and proportions (%). Between-group comparisons were performed using chi-square tests. *P* values < 0.05 were considered statistically significant. The post hoc pairwise chi-square comparisons applied a Bonferroni correction for multiple comparisons. For free-text responses, two independent authors (GM and TT) coded the responses with pre-determined keywords.

Results

Population

A total of 766 participants completed the survey (GOTS: *n* = 272 [35%], ReFORM network: *n* = 494 [65%]; Table 1). Some surveys were partially filled; at the single-question level, the rate of complete responses varied between 78 and 99% with an average of 90%. The respondents were mainly working as surgeons (*n* = 330; 43%), sport physicians (*n* = 176; 23%) and physiotherapists (*n* = 138; 18%). Most of them reported being active in supervision of athletes, caring for ambitious amateurs (*n* = 526; 69%), recreational athletes (*n* = 471; 62%), professional athletes (*n* = 369; 48%) and school sport (*n* = 224; 29%).

The perceived importance of injury prevention, comprehension of its concept and awareness of existing programmes

In the whole sample, the importance of sports injury prevention was rated as "very high" by 426 respondents (55%), "high" by 269 (35%), "medium" by 53 (7%), "small" by 14 (2%) and "not important" by two (< 1%). The concept of sports injury prevention appeared to be clearly understandable but difficult to implement for 393 respondents (51%) and as a generic concept unclear and difficult to implement for another 105 (14%). It was perceived to be clearly defined, easy to understand and achievable for only 188 (25%) respondents. Only 415 respondents (54%) reported being aware of existing prevention programmes. The FIFA-11 + was by far the most known programme (cited by 241 [32%]), followed by Stop-X (cited by 56 [7%]) (Table 2). Figure 1 shows the reported knowledge of existing programmes according to the rating of importance. In the group considering the importance of injury prevention as "very high", the awareness of existing prevention programmes was significantly higher ($Chi^2 = 49.1$; $p < 0.001$).

Reported implementation of prevention

A vast majority of the sample reported working with preventive measures in the care of athletes on a routine (*n* = 296; 39%) or occasional (*n* = 291; 38%) basis, whereas 283 (37%) reported using existing prevention concepts such as Stop-X or FIFA-11 + . The weekly reported time spent on prevention when working with athletes was about 1 h, 5 h and more than 5 h for 346 (45%), 155 (20%) and 38 (5%) respondents, respectively.

The main implementation barriers reported in the single questions were lack of experience with preventive measures (*n* = 401; 52%), insufficient or missing financial incentive (*n* = 328; 43%) and lack of understanding from coaches (*n* = 365; 48%) or athletes (*n* = 295; 39%). When investigating the free-text reports related to other barriers for implementation, lack of time was the most frequent argument (*n* = 159; 33% of respondents to this question).

Specificities between German- and French-speaking sports medicine organizations

When comparing the GOTS and the ReFORM network, there were some notable differences. The ratings of importance of injury prevention were significantly higher in the GOTS group (Chi-square = 28.7; $p < 0.001$). Importantly, the reported awareness of existing prevention programmes was also significantly different between the two groups, with higher reported knowledge in the GOTS group (Chi-square = 49.9; $p < 0.001$) (Fig. 2). This difference was further confirmed in the subgroup of participants who reported knowing about existing prevention programmes. When they were asked to cite one or several examples, 130 participants (26%) of the ReFORM group mentioned the FIFA-11 + programme, whereas other programmes were hardly unknown (only 1–2% of citations) (Table 2). On the other hand, 111 (41%) participants of the GOTS group mentioned the FIFA-11 + programme and other existing programmes were also frequently cited, such as the Stop-X (*n* = 54; 20%).

The concept of sports injury prevention did not seem to have the same degree of understanding between both groups. Only 85 (17%) ReFORM respondents stated that this concept was clear and practicable, versus 103 (38%) for the GOTS respondents ($p < 0.001$; Fig. 2).

It should be noted that some of these differences might be due to the different distribution of professional occupations between the two entities. There were indeed significantly more physiotherapists in the ReFORM group than in the GOTS (117 (24%) vs. 21 (8%), respectively; $p < 0.001$) and significantly more surgeons in the GOTS group (147 (54%) vs. 183 (37%); $p < 0.001$).

Table 1 Profession, geographic origin and prevention background of study participants

	Total $n=766$	%	ReFORM $n=494$	%	GOTS $n=272$	%
Occupation						
Surgeon	330	43	183	37	147	54
Sports physician	176	23	114	23	62	23
Physiotherapist	138	18	117	24	21	8
Sport scientist	24	3	13	3	11	4
Other[a]	54	7	26	5	28	10
Not reported	44	6	41	8	3	1
Country						
France	287	38	287	58	0	0
Germany	174	23	1	< 1	173	64
Belgium	80	10	80	16	0	0
Switzerland	63	8	24	5	39	14
Austria	53	7	0	0	53	20
Luxembourg	33	4	32	7	0	0
Other	33	4	29	6	5	2
Not reported	43	6	41	8	2	< 1
Supervised athletes' level[b]						
Ambitious amateur	526	69	342	69	184	68
Recreational	471	61	296	60	175	64
Professional	369	48	225	46	144	53
School sports	224	29	158	32	66	24
None	49	6	30	6	19	7
Other	45	6	45	9	0	0
Not reported	43	6	39	8	3	1
Importance of prevention						
Very high	426	55	240	49	186	68
High	269	35	198	40	71	26
Medium	53	7	40	8	13	5
Small	14	2	12	2	2	< 1
None	2	< 1	2	< 1	0	0
Not reported	2	< 1	2	< 1	0	0
Programmes knowledge						
Yes	415	54	221	45	194	71
No	344	45	268	54	76	28
Not reported	7	1	5	1	2	< 1
Time spent on prevention						
None	136	18	101	20	35	13
1 h/week	346	45	206	42	140	51
5 h/week	155	20	87	18	68	25
5–10 h/week	25	3	14	3	11	4
≥ 10 h/week	13	2	9	2	4	2
Not reported	91	12	77	15	14	5

[a]E.g. student, general practitioner, osteopath, occupational therapist, podiatrist, physical trainer

[b]Multiple answers allowed

Specificities across professional communities

The importance of injury prevention was considered similarly across the different professional occupations ($Chi^2 = 19.6$; n.s.). However, the knowledge about existing programmes was significantly different between occupations ($Chi^2 = 29.4$; $p < 0.001$). Post hoc pairwise comparisons showed a significantly lower level of awareness for

Table 2 List of the prevention concepts most frequently mentioned by respondents (multiple answers allowed); counts and (proportions). Other available concepts were mentioned less frequently (< 1%)

Prevention program	Whole sample	ReFORM	GOTS
FIFA-11 + [38]	241 (31.5%)	130 (26.3%)	111 (40.8%)
Stop-X [33]	56 (7.3%)	2 (< 1%)	54 (19.9%)
VBG [46]	18 (2.3%)	0	18 (6.6%)
Handball injuries prevention programme [35]	18 (2.3%)	4 (1%)	14 (5.2%)
NHS [47]	10 (1.3%)	0	10 (3.7%)
PEP (Prevent injury and Enhance Performance) [37]	15 (2%)	7 (1%)	8 (2.9%)
Get set [42]	11 (1.4%)	4 (1%)	7 (2.6%)
OSTRC [32]	10 (1.3%)	10 (2%)	0
Nordic Hamstring [30]	8 (1%)	8 (2%)	0

surgeons in comparison to physiotherapists. The "other" group (students, general practitioners, etc.) did also reveal a significantly inferior level of awareness of existing injury prevention programmes.

The time spent on working with preventive measures significantly differed among professions as well ($Chi^2 = 99.4$; $p < 0.001$). The differences were significant specifically between surgeons and sports physicians ($p < 0.001$) and surgeons and physiotherapists ($p < 0.001$). Surgeons were more prone to spend less than an hour a week on prevention, while sports medicine physicians and sports physiotherapists seemed to dedicate more time to it, as shown in Fig. 3.

Future research paths

Overall, when asked about necessary priorities that prevention research should cover in the coming years, 43% of the whole sample highlighted the need for development of further sport-specific prevention concepts, while 17% stated that general concepts, independent of specific sports, should be developed. Twenty-four percent of the study group regard

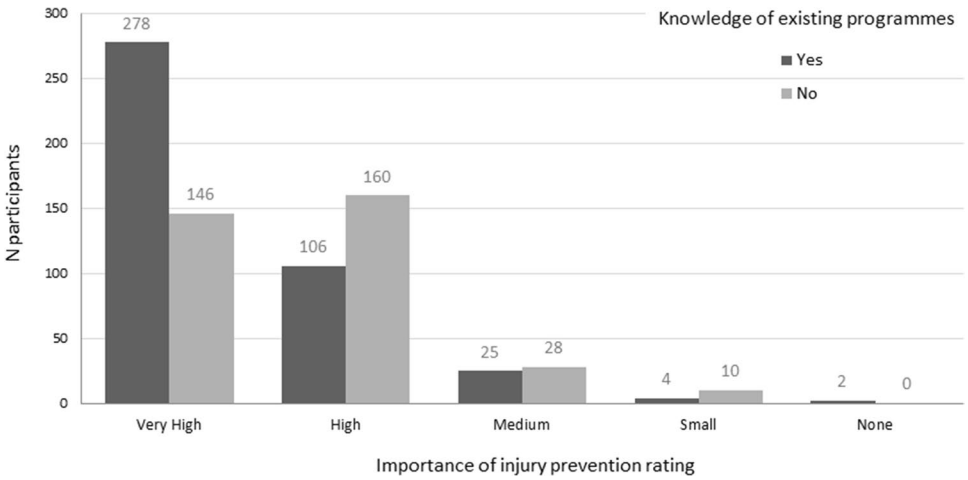

Fig. 1 Study sample reported ratings about the importance of prevention (very high; high; medium; small; none) according to the reported knowledge of existing prevention programmes (yes; no)

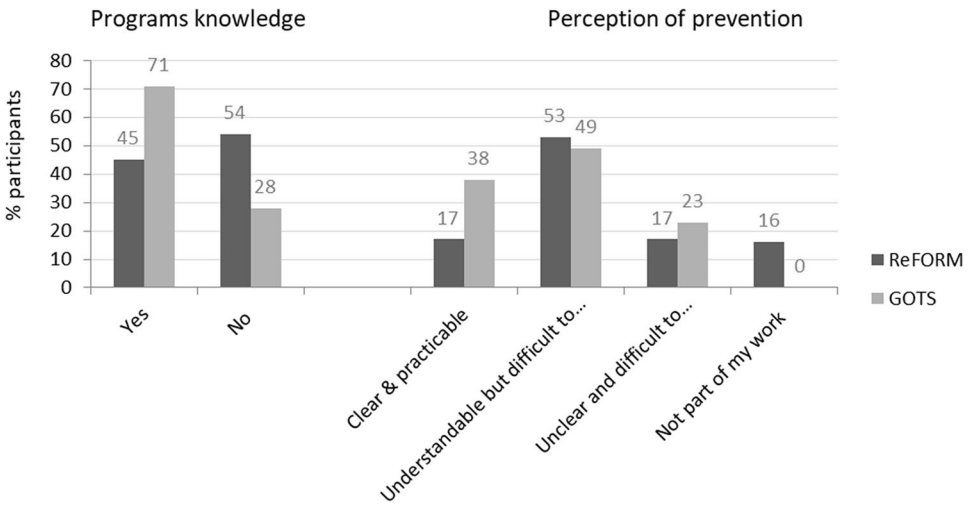

Fig. 2 Differences between the ReFORM and GOTS responses regarding knowledge of existing prevention programmes (Yes; No) and perception of the concept of prevention (Clear and practicable; Understandable but difficult to implement; Unclear and difficult to implement; not part of my work)

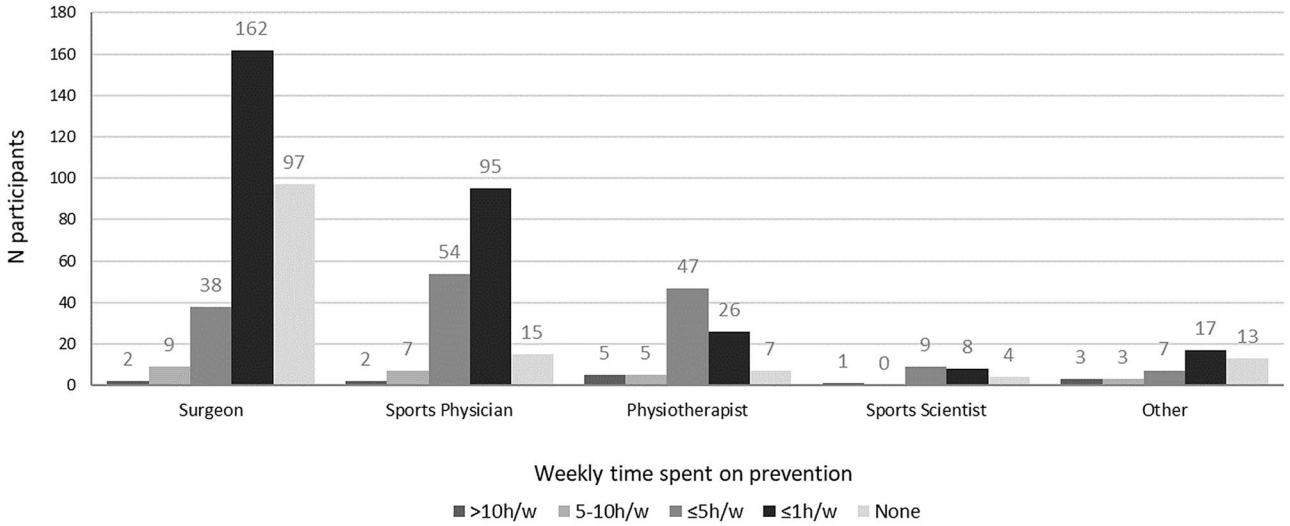

Fig. 3 Study sample reports about the weekly amount of time spent on prevention in the work with athletes (> 10 h/week; between 5 and 10 h/week; 5 h/week or less; 1 h/week or less; none) according to the professional occupation (Surgeon; Sports Physician; Physiotherapist; Sports Scientist; Other, e.g. student, general practitioner, osteopath, occupational therapist…)

implementation research as one of the most important fields of research.

Discussion

The most important finding of this study is the identification of a large gap between the perception of the importance of sports injury prevention (rated as "high" or "very high" by 91% of the participants) and the lack of awareness of existing sports injury prevention programmes (54% informed about specific programmes). The two communities surveyed (i.e. GOTS and ReFORM) demonstrated significant differences both for the aspects of perception and awareness of sports injury prevention. About half (45%) of the participants claimed to spend very little time on prevention and two thirds considered that prevention concepts were difficult to implement. The reported implementation barriers included lack of experience, support, and time in comparable proportions. At the single-occupation level, physiotherapists reported a better awareness of existing programmes. Likewise, physiotherapists and sports medicine physicians reported dedicating more time to injury prevention as compared to surgeons.

While injury prevention implementation challenges are widely known and discussed in the literature [7, 8, 15, 43], the specific aspect of awareness building appears less covered. This aspect should play a crucial role as it represents a preliminary step to bridge the gap between the available evidence, the actual stakeholders' knowledge and, at later stages, their attitudes towards implementation [9–11, 31]. This awareness building step is, however, missing in the current systemic injury prevention models [5, 8, 18, 34]. Healthcare professionals should indeed act as competency drivers in the implementation of injury prevention programmes, in concert with organization drivers and leadership drivers [14]. If healthcare professionals supporting the athlete are not sufficiently aware of existing tools and prevention programmes, it is difficult for them to become active stakeholders of sports injury prevention implementation strategies. Indeed, understanding knowledge and applying it are the most important facilitators of injury prevention implementation [1].

The highly diverse education and practice profiles of healthcare professionals as well as geographical and cultural differences contribute to the heterogeneous awareness building and implementation. While exhaustively addressing these differences was beyond the scope of this study, some interesting features could be revealed. There was an important distinction between the German scientific society and the French-speaking professional network; the importance of prevention was rated at a lower level and less time was reportedly spent on prevention within the latter. This underlines the need for targeted educational efforts regarding injury prevention and its benefits.

To overcome these challenges, structured professional and scientific societies may have a key role to play. Their stated purpose is to bridge the gap between scientific research and clinical practice, by communicating, educating and exchanging between peers; beyond position statements or clinical recommendations [20, 41]. Professional societies may be incremental in implementing sports injury prevention through their capacities of knowledge dissemination to their extended community of peers, as well as their unique

position between the academic and professional environments [39]. A scientific society like the GOTS, by dedicating specific efforts towards injury prevention (e.g. dedicated working committee, educational programmes, congresses, consensus meeting and book publication [40]) paved the way for the crucial awareness building step for professionals, as suggested by the present data, and follows other leading examples such as the European Society of Sports Traumatology, Knee Surgery and Arthroscopy (ESSKA) [39]. The ReFORM network started similar initiatives, but is younger (2018) and its courses and knowledge transfer activities for the sports medicine community have started only recently [25, 26]. These two entities also represent two different types of approaches: on the one hand (GOTS), a traditional professional and scientific society and on the other one (ReFORM) a consortium of five individual sports medicine centres which is part of the largest global network of sports injury prevention [17]. These different approaches may have to play distinct but complementary roles to build awareness around injury prevention and pave the way for a better implementation. The role of such societies and networks for injury prevention awareness building definitely deserve to be further investigated in dedicated well-designed studies.

Regarding implementation, the present study identified previously known barriers such as lack of experience or education among stakeholders (healthcare practitioners, coaches and athletes) and lack of time [13]. Some specific models have been developed and updated to tackle the implementation component [18, 29, 34]. It includes, among others, the intervention context and the appropriate training of users. Again, a preliminary step to these types of models should be identifying the awareness gap and set up awareness building strategies accordingly. In this respect, a major challenge remains the access to practical resource materials for potential stakeholders at all levels. Both general and sport-specific prevention programmes, along with their associated evidence, should be made available using adapted communication supports and translated into the target group's language [26]. Organizations such as the GOTS and ReFORM should make a significant contribution to these efforts in the future due to their special positions and structures.

This study is not without limitations. Web-based surveys are increasingly used for data acquisition. Despite limitations such as sampling bias or self-selection bias, they represent a fast, flexible, and far-reaching tool for data collection and analysis [19]. Furthermore, due to the organization of ReFORM as a network and not a scientific society, the target population was less well delineated as for the GOTS survey which included exclusively affiliated members. The final sample might therefore not have been representative of the target population. There was also an uneven distribution among the professional groups as well as the country affiliations. This, however, reflects country sizes and membership figures of the society and as such cannot be avoided. Nevertheless, 766 participants from different professional groups represent a big collective. To the best of the authors' knowledge, to date it represents the largest and most widespread survey about sports injury prevention.

Clinicians working with athletes of all levels need to account for the current awareness gaps, both at the community and individual levels. They should become active stakeholders of injury prevention knowledge dissemination in their daily practice.

Conclusion

This survey provides a state of current practice and perceptions for preventive measures in a large interdisciplinary sample of two Western European sports medicine communities. Clear discrepancies between professions as well as an important need for awareness building regarding existing injury prevention concepts have been identified. A strong divergence between the perception of the importance of sports injury prevention and its state of implementation were recognized. Specific education and training programmes for all stakeholders who are involved in athletes' health protection need to be developed.

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Data availability Data will made available by the corresponding author upon reasonable request.

Declarations

Conflict of interest Authors do not have any potential conflicts of interest to disclose. GM, JC, PTh, PTs, PE, SL, FD, JLC, JFK, DH and RS are part of the French-speaking IOC Research Centre ReFORM. TT, CL and RS serve on the GOTS board. PE is Associate Editor for the Br J Sports Med and for the BMJ Open Sport & Exercise Medicine.

Ethical approval No approval needed for this study.

Informed consent Collected as part of the online survey.

References

1. Ageberg E, Bunke S, Lucander K, Nilsen P, Donaldson A (2019) Facilitators to support the implementation of injury prevention training in youth handball: a concept mapping approach. Scand J Med Sci Sports 29:275–285
2. 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 49:1466–1471
3. Barden C, Hancock MV, Stokes KA, Roberts SP, McKay CD (2022) Effectiveness of the activate injury prevention exercise programme to prevent injury in schoolboy rugby union. Br J Sports Med 56:812–817
4. Beaton DE, Bombardier C, Guillemin F, Ferraz MB (2000) Guidelines for the process of cross-cultural adaptation of self-report measures. Spine 25:3186–3191
5. Bittencourt NFN, Meeuwisse WH, Mendonça LD, Nettel-Aguirre A, Ocarino JM, Fonseca ST (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 50:1309–1314
6. Black AM, Meeuwisse DW, Eliason PH, Hagel BE, Emery CA (2021) Sport participation and injury rates in high school students: a Canadian survey of 2029 adolescents. J Safety Res Pergamon 78:314–321
7. Bolling C, Barboza SD, Van Mechelen W, Roeline Pasman H (2020) Letting the cat out of the bag: athletes, coaches and physiotherapists share their perspectives on injury prevention in elite sports. Br J Sports Med 54:871–877
8. Bolling C, van Mechelen W, Pasman HR, Verhagen E (2018) Context matters: revisiting the first step of the 'sequence of prevention' of sports injuries. Sport Med 48:2227–2234
9. Caron JG, Bloom GA, Falcão WR, Sweet SN (2015) An examination of concussion education programmes: a scoping review methodology. Inj Prev 21:301–308
10. Caron JG, Rathwell S, Delaney JS, Johnston KM, Ptito A, Bloom GA (2018) Development, implementation and assessment of a concussion education programme for high school student-athletes. J Sports Sci 36:48–55
11. Conaghan C, Daly E, Pearce AJ, King DA, Ryan L (2020) A systematic review of the effects of educational interventions on knowledge and attitudes towards concussion for people involved in sport – optimising concussion education based on current literature. J Sports Sci 39:552–567
12. Crossley KM, Patterson BE, Culvenor AG, Bruder AM, Mosler AB, Mentiplay BF (2020) Making football safer for women: a systematic review and meta-analysis of injury prevention programmes in 11 773 female football (soccer) players. Br J Sports Med 54:1089–1098
13. Donaldson A, Callaghan A, Bizzini M, Jowett A, Keyzer P, Nicholson M (2019) A concept mapping approach to identifying the barriers to implementing an evidence-based sports injury prevention programme. Inj Prev 25:244–251
14. Donaldson A, Finch CF (2013) Applying implementation science to sports injury prevention. Br J Sports Med 47:473–475
15. Donaldson A, Lloyd DG, Gabbe BJ, Cook J, Finch CF (2017) We have the programme, what next? Planning the implementation of an injury prevention programme. Inj Prev 23:273–280
16. Van Dyk N, Behan FP, Whiteley R (2019) Including the Nordic hamstring exercise in injury prevention programmes halves the rate of hamstring injuries: a systematic review and meta-analysis of 8459 athletes. Br J Sports Med 53:1362–1370
17. Engebretsen L, Bahr R, Cook JL, Derman W, Emery CA, Finch CF, Meeuwisse WH, Schwellnus M, Steffen K (2014) The IOC centres of excellence bring prevention to sports medicine. Br J Sports Med 48:1270–1275
18. Finch C (2006) A new framework for research leading to sports injury prevention. J Sci Med Sport 9:3–9
19. Van Gelder MMHJ, Bretveld RW, Roeleveld N (2010) Web-based Questionnaires: the future in epidemiology? Am J Epidemiol 172:1292–1298
20. de Girolamo L, Dejour D, Lind M, Karlsson J, Seil R (2020) Surgical competence, research and evidence-based medicine (EBM) in orthopaedic surgery: what the ESSKA is doing to bring it all together. Knee Surg Sports Traumatol Arthrosc 28:335–338
21. Kolstad AT, Eliason PH, Galarneau J-M, Black AM, Hagel BE, Emery CA (2023) Protective equipment in youth ice hockey: are mouthguards and helmet age relevant to concussion risk? Br J Sports Med. https://doi.org/10.1136/bjsports-2022-105585
22. Lauersen JB, Bertelsen DM, Andersen LB (2014) The effectiveness of exercise interventions to prevent sports injuries: a systematic review and meta-analysis of randomised controlled trials. Br J Sports Med 48:871–877
23. Lemes IR, Pinto RZ, Lage VN, Roch BAB, Verhagen E, Bolling C, Aquino CF, Fonseca ST, Souza TR (2021) Do exercise-based prevention programmes reduce non-contact musculoskeletal injuries in football (soccer)? A systematic review and meta-analysis with 13 355 athletes and more than 1 million exposure hours. Br J Sports Med 55:1170–1178
24. Lutter C, Seil R, Best R, Gokeler A, Patt T, Krutsch W, Grim C, Tischer T (2021) Results of a tri-national online survey on the current status of sports injury prevention among members of the German-Speaking Orthopaedic Sports Medicine Society (GOTS). Sportverletz Sportschaden 35:80–87
25. Martens G, Edouard P, Tscholl P, Bieuzen F, Winkler L, Cabri J, Urhausen A, Guilhem G, Croisier JL, Thoreux P, Leclerc S, Hannouche D, Kaux JF, Le Garrec S, Seil R (2021) Document, create and translate knowledge: the mission of ReFORM, the Francophone IOC Research Centre for Prevention of Injury and Protection of Athlete Health. Br J Sports Med 55:187
26. Martens G, Edouard P, Tscholl PM, Bieuzen F, Winkler L, Cabri J, Urhausen A, Guilhem G, Croiser JL, Thoreux P, Leclerc S, Hannouche D, Kaux JF, Le Garrec S, Seil R (2021) Translation and synthesis of the IOC consensus statements: the first mission of ReFORM for a better knowledge dissemination to the Francophonie. Sci Sport 36:323–324
27. McBain K, Shrier I, Shultz R, Meeuwisse WH, Klügl M, Garza D, Matheson GO (2012) Prevention of sport injury II: a systematic review of clinical science research. Br J Sports Med 46:174–179
28. Van Mechelen W (1997) The severity of sports injuries. Sport Med 24:176–180
29. van Mechelen W, Hlobil H, Kemper HCG (1992) Incidence, severity, aetiology and prevention of sports injuries: a review of concepts. Sport Med 14:82–99
30. Mjølsnes R, Arnason A, Østhagen T, Raastad T, Bahr R (2004) A 10-week randomized trial comparing eccentric vs. concentric hamstring strength training in well-trained soccer players. Scand J Med Sci Sports 14:311–317
31. Mrazik M, Dennison CR, Brooks BL, Yeates KO, Babul S, Naidu D (2015) A qualitative review of sports concussion education: prime time for evidence-based knowledge translation. Br J Sports Med 49:1548–1553
32. Myklebust G, Engebretsen L, Brækken IH, Skjølberg A, Olsen O-E, Bahr R (2003) Prevention of anterior cruciate ligament injuries in female team handball players: a prospective intervention study over three seasons. Clin J Sport Med 13:71–78

33. Niederer D, Keller M, Achtnich A, Akoto R, Ateschrang A, Banzer W, Barié A, Best R, Ellermann A, Fischer A, Guenther D, Herbort M, Höher J, Janko M, Jung TM, Krause M, Petersen W, Stoffels T, Stöhr A, Welsch F, Stein T (2019) Effectiveness of a home-based re-injury prevention program on motor control, return to sport and recurrence rates after anterior cruciate ligament reconstruction: Study protocol for a multicenter, single-blind, randomized controlled trial (PReP). Trials 20:1–10
34. Padua DA, Frank B, Donaldson A, de la Motte S, Cameron KL, Beutler AI, DiStefano LJ, Marshall SW (2014) Seven steps for developing and implementing a preventive training program: lessons learned from JUMP-ACL and beyond. Clin Sports Med 33:615–632
35. Petersen W, Zantop T, Steensen M, Hypa A, Wessolowski T, Hassenpflug J (2002) Prevention of lower extremity injuries in handball: initial results of the handball injuries prevention programme. Sportverletz Sportschaden 16:122–126
36. van Reijen M, Vriend I, van Mechelen W, Finch CF, Verhagen EA (2016) Compliance with sport injury prevention interventions in randomised controlled trials: a systematic review. Sport Med 46:1125–1139
37. Rodríguez C, Echegoyen S, Aoyama T (2018) The effects of "prevent injury and enhance performance program" in a female soccer team. J Sports Med Phys Fitness 58:659–663
38. Sadigursky D, Braid JA, De Lira DNL, Machado BAB, Carneiro RJF (2017) Colavolpe PO (2017) The FIFA 11+ injury prevention program for soccer players: a systematic review. BMC Sport Sci Med Rehabil 91(9):1–8
39. Seil R (2019) Why ESSKA? On what it takes for orthopaedic surgeons and their scientific societies to adapt to societal changes in 2018. Knee Surgery, Sport Traumatol Arthrosc 27:665–672
40. Seil R, Tischer T (2020) Primärprävention von Sportverletzungen.
41. Shapiro SA, Finnoff JT, Awan TM, Borg-Stein JP, Harmon KG, Herman DC, Malanga G, Master Z, Mautner K (2022) Highlights from the American Medical Society for Sports Medicine position statement on responsible use of regenerative medicine and orthobiologics in sports medicine. Br J Sports Med 56:121–122
42. Verhagen E (2015) Get Set: prevent sports injuries with exercise! Br J Sports Med 49:762–762
43. Verhagen E, van Nassau F (2019) Implementation science to reduce the prevalence and burden of MSK disorders following sport and exercise-related injury. Best Pract Res Clin Rheumatol 33:188–201
44. Vriend I, Gouttebarge V, Finch CF, Van Mechelen W, Verhagen EALM (2017) Intervention strategies used in sport injury prevention studies: a systematic review identifying studies applying the Haddon matrix key points. Sport Med 47:2027–2043
45. German Society for Orthopaedic Traumatologic Sports Medicine (GOTS). https://www.gots.org/en/
46. VBG - Training & Regeneration. https://www.vbg.de/DE/3_Praevention_und_Arbeitshil
47. How to warm up before exercising - NHS. https://www.nhs.uk/live-well/exercise/how-to-warm-

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