

## Preventing sports injuries during the physical education teacher curriculum, students' perspectives and recommendations on prevention

S. (SANDER) BLIEKENDAAL<sup>1</sup>, M. (MAARTEN) BARENDRECHT<sup>2</sup>, J. (JANINE) H. STUBBE<sup>3</sup>, C. (CAROLINE) BOLLING<sup>4</sup>, E. (EVERT) VERHAGEN<sup>5</sup>

<sup>1,4,5</sup>Amsterdam Collaboration on Health and Safety in Sports, Department of Public and Occupational Health, Amsterdam Movement Science, Amsterdam UMC, Amsterdam, THE NETHERLANDS

<sup>1</sup>Aeres University of Applied Sciences, Almere, THE NETHERLANDS

<sup>2,3</sup>Mijn Fysio en Adviespunt, Den Haag, THE NETHERLANDS

<sup>2,4</sup>Avans+, Breda, The Netherlands

<sup>3</sup>Codarts University of the Arts, Rotterdam, THE NETHERLANDS

<sup>3</sup>Performing artist and Athlete Research Lab (PEARL), Rotterdam, THE NETHERLANDS

<sup>3</sup>Rotterdam Arts and Science Lab (RASL), Rotterdam, The Netherlands

<sup>3</sup>Department of General Practice, Erasmus MC University Medical Centre, Rotterdam, THE NETHERLANDS.

Published online: September 30, 2022

(Accepted for publication September 15, 2022)

DOI:10.7752/jpes.2022.09276

### Abstract

The objective of this study was to describe, from the Physical Education Teacher Education (PETE) students' perspective, sports injury prevention practices and map their suggestions for its improvement. In this qualitative study, we conducted 21 semi-structured interviews with PETE students from four different PETE schools in the Netherlands, which were transcribed verbatim and analysed these using the thematic analysis method. Four main themes were extracted from the data, which described the applied preventive strategies, the critical factors for successful injury prevention, motives for injury prevention, and recommendations on prevention. All the participants described using various preventive measures. They described injury prevention as a standard part of daily life and approached it in a multi-faceted and dynamic way. Maintaining a healthy lifestyle and balancing load and recovery were consistently described as essential injury prevention strategies. According to the participants, the critical factors to successfully apply injury prevention were: communication, learning what works, self-management, shared responsibilities, and social support. The main motives for injury prevention were to care for the body and perform well (e.g., academic success; sports). Given the participants, injury prevention could be improved, mainly by enhancing the PETE program's load management (e.g., schedules) and offering injury prevention education (e.g., theory; practical skills). This study provided insight into how injury prevention is shaped in practice, identified critical factors for successful injury prevention and motives for injury prevention, and mapped recommendations for its improvement from the target population. These findings support the development of context-driven preventive strategies in the PETE population.

**Key Words: Qualitative research, Health and wellbeing, Injury prevention, Performance**

### Introduction

Physical Education Teacher Education (PETE) students follow a curricular program with various weekly sports classes, and, also, many participate in extra-curricular sports activities (Bliekendaal et al., 2017, 2021; Ehrendorfer, 1998; Goossens et al., 2014; Mukherjee, 2014). This high physical workload puts the PETE students at increased risk for sustaining injuries. Incidence rates range from 1.0 to 2.1 injuries per academic year (Bliekendaal et al., 2017, 2018; Goossens et al., 2014, 2015; van Beijsterveldt et al., 2017). Consequently, injuries can lead to increased medical costs (Dijksma et al., 2019), long term physical complaints (Gribble et al., 2016; Snoeker et al., 2019) and may negatively affect their academic development and future career (e.g., drop-out; delay). Therefore, injury prevention in this population is of paramount importance. Despite the numerous sports injury prevention strategies described in the literature (Mugele et al., 2018; Vriend et al., 2017), only one study on injury prevention includes PETE students as a target population (Goossens et al., 2016). Since this study was limited in reducing injury rates, there remains an ongoing challenge for developing and implementing successful preventive strategies in the PETE population.

The *Translating Research into Injury Prevention Practice* (TRIPP) framework described that it is critical to understand the implementation context (e.g. social factors, personal factors) to work towards successful preventive strategies (Bolling et al., 2018; Finch, 2006; Hanson et al., 2005; Jacobsson et al., 2018; McGlashan & Finch, 2010; Soligard et al., 2010; Steffen et al., 2013; Verhagen et al., 2011). In this process, qualitative research methods are deemed necessary (Bolling et al., 2018; Verhagen & Bolling, 2018). By gathering information about a population's perspectives, qualitative research methods provide an understanding

of the 'what', 'how' and 'why' of injury prevention (Verhagen & Bolling, 2018). Learning about these aspects supports developing more context-driven preventive strategies and successful implementation and intervention uptake (Verhagen, 2012). However, no previous study explored injury prevention from the PETE population's perspective. Therefore, this qualitative study aimed to describe injury prevention practices from the PETE students' perspective and map their recommendations for improvement.

## Materials & Methods

### Study design

This was an exploratory qualitative study. An analysis of the participants' perspectives provided an understanding of how sports injury prevention is shaped in practice and how this could be improved. An interpretative paradigm underpinned this study. The Ethical Committee of the Amsterdam University Medical Centre (location VUmc, reference number: 2019.317) approved the study procedures.

### Participants

Participant recruitment took place via convenience sampling (Green & Thorogood, 2018) at four different PETE programs at Dutch Universities of Applied Sciences. These four locations represented 67% of the PETE programs in the Netherlands and were selected because the authors (SB, MB) had collaborations with colleagues from these schools. All the PETE programs have a curriculum designed following national qualification criteria for a Bachelor PETE degree (Koninklijke Vereniging voor Lichamelijke Opvoeding, 2017), but curricular activities may vary in practice.

For privacy reasons, first, students were asked if their contact details could be provided to the researchers by teachers or peer students from the schools. After that, consenting students were informed about the study's goals and procedures and invited to participate by e-mail. Subsequently, those who accepted the invitation completed an informed consent form and a baseline questionnaire. The baseline questionnaire included age (years), sports participation, and injury history. Participants' inclusion criteria were: 1) completed the first three years of the PETE program; 2) understanding of the Dutch language at the native level because of the language used during the interviews. Participants' (N = 21) characteristics (e.g., sex, age, sports, and sports level) are presented at the group level to ensure anonymity in table 1. All participants had experienced one or more injuries while following the PETE program.

Table 1: Participant characteristics.

Location #	N	Gender (N)		Age (mean, range)	Year		Main sport (N)	Sports level (N)
		M	F		3	4		
1	11	9	2	22 (19-25)	7	4	soccer (4), skateboarding (1), korfbal (1), skiing (1), gymnastics (1), fitness (2), trail running (1)	elite (1), club (6), recreational (3)
2	5	1	4	21 (19-25)	5	-	handball (1), swimming (1), athletics (1), judo (2)	elite (4), club (1)
3	4	1	3	21 (19-23)	3	1	hockey (1), soccer (3)	elite (2), club (2)
4	1	1	-	21	1	-	judo (1)	club (1)

M, Male. F, Female.

### Data collection

Semi-structured interviews were conducted using an interview guide based on a topic list. The interview guide covered the following topics: experiences with combining extra-curricular sports participation and the PETE program; injury definition; experiences with injury; risk factors and injury mechanisms; injury prevention. This paper covers only the data related to the injury prevention topic.

Participants were asked about their perception of how injuries could be prevented. They were also asked which preventive strategies they apply, what motivates them to apply them, and what to consider choosing a strategy. Finally, they were asked about their recommendations for improving injury prevention within the PETE context. The course of the interview did not necessarily follow a particular order. Follow-up questions were added to enhance clarity and deeper understanding. Nevertheless, all interviews covered the same topics.

Interviews were conducted in Dutch by telephone (without video) by one of the researchers (MB [N = 9], SB [N = 12]) between March and May 2020. The researchers prepared the interviews together to make sure the interviews were conducted similarly. Interviews lasted between 28 and 49 minutes (mean: 36 min., SD: 6 min.), were audio-recorded (Olympus VN-541PC) and transcribed verbatim (in Dutch) by the researchers to ensure accuracy in the data. After 17 interviews, the information in the interviews repeated itself. To ensure data saturation, four additional interviews were conducted, in which no new information was obtained.

### Analysis

Data were analysed using the six-staged thematic analysis approach (Braun & Clarke, 2006) because of the potential to deliver complex and rich understanding and its flexibility. After conducting the first five

interviews, the researcher (SB, MB) familiarised with the data through transcription and reading, coded the data, and generated preliminary themes and codes. Alongside conducting the following interviews, the researchers had regular meetings and moved back and forth between the stages refining the themes and codes. To support the neutrality of the findings, a third researcher (CB) was involved in refining the themes and codes. A final code-list was created after reaching a consensus between the researchers (SB, MB, CB). ATLAS.ti was used to organise and code the transcripts' data. The most suitable quotes were selected to illustrate the results. Only the presented quotes were translated into English.

## Results

Four main themes were extracted from the data: 1) applied preventive strategies, 2) critical factors for successful injury prevention, 3) motives for injury prevention, 4) recommendations for improvement. Figure 1 summarises these themes and the related main codes, elaborated in the following paragraphs.

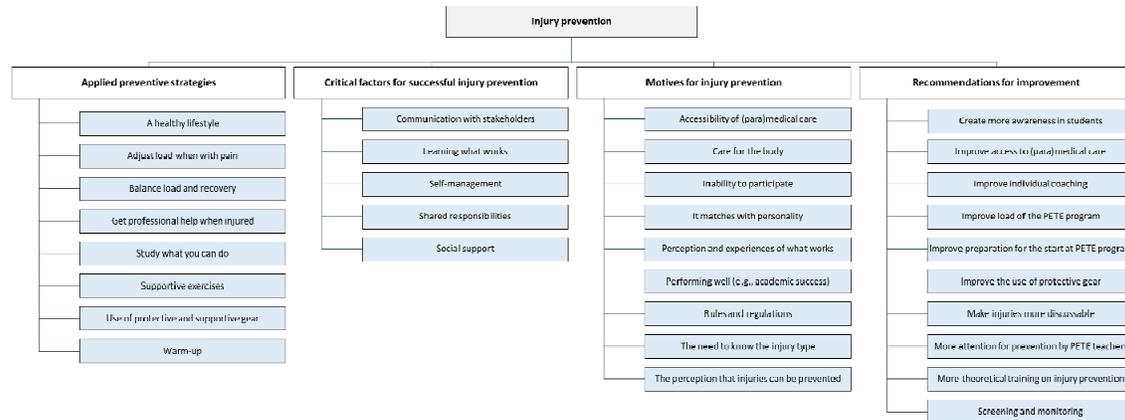


Figure 1: Main codes related to the 'injury prevention' theme.

### Theme: Applied preventive strategies

All participants mentioned having applied various preventive strategies (table 2). They described focussing on preventing recurrence or worsening of injuries. Using protective and supportive gear (e.g., proper shoes, shin guards, taping) was mentioned as a common preventive strategy. Maintaining a healthy lifestyle (e.g., nutrition; sleep) and balancing load and recovery were consistently described as essential injury prevention strategies. The participants mentioned that they maintained participation as long as possible when tired or having sores. They adjusted physical load (e.g., reduced intensity; changed exercises) and described resting during the weekends to achieve this. Nevertheless, they explained that extra-curricular sports participation limited proper recovery and sometimes skipped extra-curricular training sessions. They also mentioned that elite athletes had flexible schedules to combine their sports careers with the PETE educational program. However, they said that semi-professional athletes, who are not eligible for flexible schedules, faced difficulties balancing load and recovery due to combining the PETE program with sports. Along that line, quitting extra-curricular sports participation was also mentioned several times.

The participants explained, when injured, researching (e.g., internet searches, ask peers) what they could do to resolve the injury. Other frequently mentioned preventive strategies were doing exercises (e.g., strength training) and proper warm-ups. Warm-ups were often given extra attention to reduce physical complaints (e.g., longer warm-ups, specific exercises). When their approach did not resolve the injury, participants described seeking professional help (e.g., physiotherapist).

Table 2: Main codes and typical quotes related to the theme 'Applied preventive strategies'.

Code	Quote
A healthy lifestyle	"It sounds a bit wishy-washy, but I think to shape your life well, eat healthily, eat well, sleep a lot, anyhow just get enough sleep." (participant 8) "In daily life, consider that if I have to do many physical exercises, I will not make it a late night. Or to pay attention to food or alcohol consumption, which I reduce. To give my body more recovery." (participant 16)
Adjust load when with pain	"So yes, then I just participated in everything. But for example, in a game of basketball, I will put in less energy, and I will be less likely to sprint because I am aware that it can worsen the injury or that I will have extra problems." (participant 15) "I noticed that if I took a little bit of rest or have problems with my knees, I sit down and let them rest for a day, and then it will be fine again. I noticed that I could stay in the running that way." (participant 9)
Balance load and recovery	"And I think if you look for a balance between, okay what can I handle and how far am I already energised." (participant 5)

Get professional help when injured	"The first time, I didn't do anything with it. I took a rest, but I did not go to the doctor or a physiotherapist. The second, third and fourth time, I did go to a physiotherapist to strengthen the muscle and the tendon, which tore repeatedly." (participant 3)
Study what you can do	"I looked up a few things for myself, which in addition to starting slowly, I can incorporate to make it [the hamstrings] stronger. Or so to speak. To prevent it from happening again." (participant 17) "I always try to research a bit myself. Like, what it is, and what can I do about it before I go to a physio?" (participant 7)
Supportive exercises	"I just really got into it, in the gym and at home, with some of the exercises that I had been given." (participant 9) "I think it is mainly about preparation. Rather before that injury occurs again in winter, so before then, extra training." (participant 15)
Use of protective and supportive gear	"Make sure I wear good shoes, instead of flat sneakers with too little cushioning." (participant 16) "From then onwards, I started doing everything with a brace. And because of the brace, my arm did not stretch, so neither did it overstretch, and that makes a big difference" (participant 20)
Warm-up	"Doing a warm-up. Super important to prevent injuries, is to ensure that you are warmed-up" (participant 16) "For example, in athletics, we indicated that he [PETE lecturer] really should not make us run two or 3 kilometres without any warm-up. Eventually, not much had been done with that. So, the next time we came to class earlier to do a warm-up." (participant 20)

### Theme: Critical factors for successful injury prevention

The participants described several critical factors for successful injury prevention (table 3). They considered themselves the main responsible person for injury prevention and consistently explained the importance of self-management accordingly. Nevertheless, they also mentioned responsibilities for PETE teachers (e.g., taking care that students do not exceed their limits, demanding proper shoes), PETE managers (e.g., appropriate schedules), and sports trainers (e.g., adequate training). Therefore, the participants also described the importance of communication. When injured, they mentioned discussing training content and participation level with PETE teachers and sports trainers. Also, they noted that getting social support (e.g., advice) from their stakeholders (e.g., parents, classmates, teammates, PETE lecturers) helped to make decisions regarding injury prevention (e.g., reducing extra-curricular sports, going to the physiotherapist). Furthermore, the participants frequently mentioned that applying preventive strategies was part of the learning process. The participants said they learned from previous injuries and mentioned that theoretical knowledge is essential, which both helped them implement preventive strategies within their daily routines.

Table 3: Main codes and typical quotes related to the theme 'Critical factors for successful injury prevention'.

Code	Quote
Communication with stakeholders	"Mainly because you raise the alarm on time. You do not come to class and ask, like, hi [name] I am injured and what can I do. But send an e-mail in advance like well, this is happening, this is the therapist's advice." (participant 11) "I sent an e-mail to all the relevant sports class teachers, and they were very nice to deal with. And it was very easy for them. Because I could not participate at that time, so for each sports class, we looked at what the easiest option was to conclude the exams as soon as possible." (participant 15) "I did not play in the selection of my club for a while, and that meant that I only trained once a week. So that was a bit more balanced in terms of intensity. In the second year, I combined it [playing in the selection]. I indicated to my trainer; 'I have already had so many lessons today or already did these specific classes. I just participate when I can. When I am tired, I just take it easy', and that worked fine so far" (participant 5)
Learning what works	"I have done a lot of individual sports from an early age. So, because of that, I think I am used to knowing how far I can commit and how far I cannot." (participant 3) "I did learn a lot about that [injury prevention] within the course and during the internship at the physio. You learn a lot about it, which gave me a lot of knowledge. It also gave me the idea to do something with it [the injury]." (participant 10) "Then I kicked and tore it [hamstrings] immediately. Since that moment, I have started to be a bit more careful with jumping right into it." (participant 12) "With the jumpers-knee, I knew that I had to put in a lot of effort at school to stand up for myself, to take good care of myself when we had sports classes. I also really needed some time to warm up. You had to stand up for yourself in class. That is one of those things, and if I want to keep everything going as I do now, I must take the space to take good care of myself in the form of a warm-up. So if that was not possible in class, I noticed that I went all out, and I immediately noticed it in my injuries. It ached extra." (participant 16)
Self-management	"When I did not feel fit enough, I just said, let me put it this way, I just decided for myself I will not participate in this class. I do make those kinds of choices." (participant 9) "Just by having a polite and friendly attitude towards teachers and giving the impression that you need

	<i>each other to make things work. I think you can achieve a lot with that. It is not just asking a teacher, and it is also giving and take." (participant 11)</i> <i>"What I did about it was a lot of stretching, a lot of stretching and a lot more focus on the knees within the warming-up. So, making sure that my legs were warm and my ankles and other things were warm. So, the knees would not get a beating, or so they were warmer to endure the beating at least. I bought straps to go around my knee tendon and put pressure on the knee tendon to relieve that nagging pain. And I went to the doctor again. To check what is useful to do because of the physical load I have at the PETE." (participant 21)</i>
Shared responsibilities	<i>"But I still think that in injury prevention there is mainly a responsibility for the student himself." (participant 11)</i> <i>"You also have to be able to protect your students from themselves as a teacher, or as an outside coach." (participant 5)</i> <i>"I think it is important that if, due to the PETE itself or the education itself, many injuries occur. That the school, as it is, because of the school itself. So that the school itself does something about it, they should offer something for it. I think that's important." (participant 19)</i>
Social support	<i>"When you talk about it with your fellow students, well like; 'I don't want to get injured.'. You talk about it a bit with your fellow students and, at least in my class; there arose a bit of an atmosphere, then it stops [extra-curricular sport participation]. But fellow students were also ... entering into a conversation with fellow students were also a reason for me to make that choice easier." (participant 6)</i> <i>"And when injured, they [PETE lecturers] ask about it and whether you do something with it. Or whether they can help. I like that." (participant 13)</i> <i>"I could hardly do anything at school. I could not even open my computer, or I already got a headache. When a ball bounced in the sport classes, the headache started again, so my parents had sent me to the physiotherapist." (participant 20)</i>

#### Theme: Motives for injury prevention

Given the participants, particularly recurrent and muscle injuries could be prevented and, therefore, they applied preventive strategies targeting these injuries. Preventing injury was not their primary goal, but it was considered necessary. Maintaining participation and performing well (e.g., academic success; sports) were mentioned as priorities, so injury prevention was more a mean than a goal. Moreover, the participants considered injuries an inherent part of sports and the PETE program and explained accepting injury risks (e.g., in contact sports). Several students mentioned that specific injuries (e.g., ankle injuries) did not hamper performances and, therefore, were considered trivial. Nevertheless, they consistently described care for the body as a motive for injury prevention. The participants described that they were more likely to apply preventive strategies when injury hampered participation. In contrast, they also expressed the inability to participate as failing or abandoning the class- or teammates, and they maintained participation if possible. When injured, participants mentioned that they were more likely to seek professional help (e.g., physiotherapist, general practitioner) at an early stage of an injury when access was easy or uncertain about the injury diagnosis. The participants also explained that motivation for prevention depended on personality, experiences of benefits (e.g., reduced pain after strengthening exercises) and harms (e.g., decreased ankle strength due to taping), and rules and regulations (table 4).

Table 4: Main codes and typical quotes related to the theme 'Motives for injury prevention'.

Code	Quote
Accessibility of (para)medical care	<i>"I heard from some classmates who went to the, I never went there myself, went to the physiotherapist at the PETE, and he was always difficult to reach." (participant 3)</i> <i>"That was pure because, at the time, I was living in rooms in [name location]. And the other time, I lived an hour away from school, so it was more convenient to go to the physiotherapist at home." (participant 17)</i>
Care for the body	<i>"My body becomes my profession, and I have to look after myself" (participant 6)</i> <i>"But yes, the larger muscle groups are slightly different, for example, when you have back pain. I would take that more seriously and go to a physiotherapist sooner to see if something is really wrong." (participant 20)</i>
Inability to participate	<i>"You are side-lined, but that is difficult. Especially for the average PETE student, they just do not like that at all. I did not like that at all. So, you will still participate wherever you can." (participant 2)</i> <i>"Well, the idea that I could not lean on my arms while I am physically very fit made it clear to me that I had to go there [physio]." (participant 8)</i>
It matches with personality	<i>"That's my character, I think. Now I chose to commit to PETE and even quit elite sports. And then you want to achieve, and I wanted to get my P [propaedeutic diploma] in 1 year. And I just want to graduate in 4 years, so I also want to put in the work." (participant 1)</i> <i>"Because many people are still young, some are 17 years old, under 18. They are still developing themselves very much. They do not yet know what they can and cannot do and what they should be doing." (participant 9)</i>

Perception and experiences of what works	<p>"You constantly get hits on the wrists. Without dealing with it by taking good care of it, it all goes bad at some point. I noticed that at the time, and I noticed it afterwards. I looked at it together with the physiotherapist and did some exercises. I did some stretching and strengthening exercises. It went better afterwards. Suppose I would do it now. I would really need those exercises." (participant 10)</p> <p>"I also work in a sports shop where we get a lot of similar stories. And we know quite a bit about it [hamstring injuries], so I already knew some things about it. So, when I tore mine, I thought, okay, this [compression short] is probably a good option to use." (participant 14)</p> <p>"Because I am afraid that my ankle will become weak, and that it will get used to it [taping]. So, I want to tape as little as possible, so it doesn't get lazy." (participant 21)</p>
Performing well (e.g., academic success)	<p>"The drive to get educational credits and the realisation that I would not pass if I could not pass my sports classes. For me, the idea was to put my studies before my recreational sport, which was an important reason to make a choice very easily. Then I will quit my sports, and then I will prioritise my studies because I just like to, well, my studies have priority over my sport." (participant 6)</p> <p>"I did see in my environment that people, for example, tore their knee ligaments because of soccer and therefore either stopped the PETE completely or were delayed for a year and a half. And I think that fear of such a serious injury also plays a role in the back of your mind." (participant 15)</p>
Rules and regulations	<p>"Because at the beginning of the first year, it is said [by PETE lecturers] that you [when injured] must present some proof, but after the first block, you have realised that it is not taken that seriously at all." (participant 11)</p> <p>"I am missing some guidance. There is no consequence when you do not participate because you do not want to or because you do not participate because of an injury." (participant 9)</p> <p>"Because I think that students don't like it that much [individually performing warming-up]. And if you [PETE lecturer] schedule 10 minutes in class for a warm-up, it will happen" (participant 19)</p>
The need to know the injury type	<p>"Because we had a lot of exercises for a high jump. We were jumping on benches and doing other assignments. And I just noticed that my knees did not work anymore because my knees were hurting. I had many problems with my knees, and I was not quite sure what it was. So, I then asked other people; 'Hey, did you ever suffer from that?'" (participant 4)</p> <p>"Yes, because at the time it [injury] was something I have not had before. So, I should have it looked at to see what it could be." (participant 17)</p>
The perception that injuries can be prevented	<p>"I think it [injuries] is just a bit part of it when I consider my sport, soccer. It is a contact sport." (participant 1)</p> <p>"You can hardly prevent it. It is part of sports. I think that every athlete has experienced running into an injury or that he could not fully participate. So yes, I also think that every athlete already considers risks when he gets on the mat or something" (participant 2)</p> <p>"I think mainly muscle injuries because they are lurking. I have often experienced that when I am not warmed up and start exercising. And overuse injuries. That also comes from my own experience with, well, yes, shin splits. That knee. That is why I pay attention to whether I do a little extra on certain days. To relieve my legs a bit." (participant 16)</p>

### Theme: Recommendations for improvement

All participants provided recommendations on how PETE students, PETE teachers, or PETE managers could improve injury prevention (table 5). The most consistently mentioned recommendation was to improve the PETE curriculum load. Many participants noted that a proper warm-up at the start of sports classes should be standard, which they missed sometimes. They consistently mentioned that the schedules should be improved, for example, by offering more and longer breaks between sports classes and a better distribution of sports classes during the week. The participants also mentioned missing education on sports injury and injury prevention and recommended implementing such education, preferably at the beginning of the PETE curriculum. Additionally, participants suggested offering more screening and monitoring, for example, by repeating medical examinations at a later stage in the education or monitoring load capacity during the academic year. The participants also recommended improving accessibility (e.g., opening hours, promotion) of the in-house (para)medical consultation hours (e.g., physiotherapist, sports physician).

A few recommendations referred to the role of PETE students. The participants mentioned that increasing PETE students' awareness of sports injuries and injury prevention could be beneficial. For example, by making injuries more discussable among students. They also mentioned that future first-year PETE students could benefit from better preparation. They said that PETE students should be well informed about the PETE program's demands before starting the education to make well-informed decisions about the level of extra-curricular sport participation. Additionally, they said that some students might need to improve their fitness before starting their education.

Several recommendations referred to the role of the PETE teachers. The participants suggested that they should be more open about injuries during sports classes and pay more attention to injury prevention. For example, ensuring that the students do not exceed their limits, providing more individual coaching during sports classes, or discussing injury prevention more frequently during consultations with their study coach. Another suggestion for improvement was making better use of protective and supportive gear. For example, PETE lecturers should demand proper shoes during PETE sports classes.

Table 5: Main codes and typical quotes related to the theme 'Recommendations for improvement'.

Code	Quote
Create more awareness in students	"I think it is very important to see if there is perhaps a little more that can be done to make students a bit more aware of injuries in sport." (participant 4) "I would perhaps give it [information on injury prevention] sooner in the first year because it is about your students and yourself. For example, take a critical look at your shoes, or take a critical look at how much you move and how much energy you spend, how full your agenda is." (participant 5)
Improve access to (para)medical care	"So, I think if it is made clear before the start of education, there is a physio who has a consultation hour, and you can just walk in. I think you can benefit a lot from that." (participant 14)
Improve individual coaching	"Of course, you cannot influence what happens outside the PETE that much, except for having a conversation with students. Like; 'What else do you do besides the PETE and can you handle it all?'" (participant 5) "I would ask for more lifestyle management. So, what can I do best with my life? Literally. Thus management, but also something about having a healthy life or a more vital life. And ask what do I do with sports outside of the PETE?" (participant 9)
Improve load of the PETE program	"Maybe spend a bit more time on doing warm-ups. Because that does not happen enough." (participant 12) "For example, what I might also think is the good idea is to spread it out over 4 years because I noticed in the third and fourth year, I have had very few sports classes." (participant 13) "The divisions during the week. That could certainly be better." (participant 16)
Improve preparation for the start at the PETE program	"I can imagine if you, well, if you are not physically fit, then you'll do some training before you begin." (participant 19) "Perhaps some information would be good. To be aware of it anyway. Like; 'Hey, the first year is pretty tough. Remember, because your health is central of course.'" (participant 21)
Improve the use of protective gear	"You can of course, do a little bit of prevention by demanding good shoes." (participant 11) "Yes, then you should take a preventive measure by taping your ankle or use those new supports that keep your foot firmly in your shoe." (participant 1)
Make injuries more discussable	"For me, a helping hand or even a consultation hour with fellow students in which others tell about what they are doing would help a lot." (participant 9) "I do know that some teachers say beforehand; 'Is anyone suffering from something? Let me know.'. But a lot of teachers do not ask this. And I think that if this is a bit more discussable, then you will go a long way." (participant 14)
More attention to prevention by PETE teachers	"Yes, providing information or teach a course about it. But not only for students but also for teachers. To pay extra attention to it in class." (participant 16)
More theoretical training on injury prevention	"Because now, there is a lot of focus on your way of sports and the techniques of sports and how you can get the children to work with it. But I think that if, for example, a course focuses on sports injuries and sports injury prevention, that could be a very nice addition." (participant 4) "As part of the education, I missed the bit about injury and injury prevention because I didn't hear much about it in my studies." (participant 21)
Screening and monitoring	"A more personal medical examination would be in order. But not quite at the beginning, but just halfway through. At the beginning and halfway through you should say." (participant 9) "There is one more point that I can think of to make students more aware. That could be monitoring students' load capacity. I think that it is also an extra, that it would also make a good point." (participant 16)

## Discussion

This paper focused on sports injury prevention from the PETE students' perspectives by describing the applied preventive strategies, critical factors for successful injury prevention, motives for injury prevention, and recommendations for improvement.

### The multi-faceted and dynamic approach to injury prevention

Consistent with literature in other athletic populations (Bolling, Delfino Barboza, et al., 2019; Bolling, Mellette, et al., 2019; Jelvegård et al., 2016), our findings revealed that PETE students used various preventive strategies and highlighted their multi-faceted and dynamic approach to injury prevention. Similar to results in circus artists and elite athletes (Bolling, Delfino Barboza, et al., 2019; Bolling, Mellette, et al., 2019), PETE students described injury prevention as a standard part of daily life (e.g., healthy lifestyle, balance load and

recovery) and sport participation (e.g., warm-up, protective gear usage). Additionally, they explained that their preventive behaviour is related to their needs at a particular moment. For example, the pacing of activities forms an integral part of their injury prevention approach. They described adjusting physical load (e.g., type, intensity) or skipping training when they were tired or had sores to allow the body to recuperate. This behaviour is labelled as self-monitored activity pacing in the literature and was also described in competitive runners (Jelvegård et al., 2016). However, the participants noted that PETE students with demanding extra-curricular sport participation (e.g., semi-professional athletes) faced difficulties pacing their activities. In that sense, they may need more support in balancing sports and their education.

#### **Critical factors for successful use of injury prevention**

The findings highlighted that to apply injury prevention successfully, PETE students depend on others but need to do it themselves. The importance of self-management can be explained because PETE students are involved in various sports activities (e.g., curricular sports classes, extra-curricular sport participation). They may be best capable of balancing these activities themselves. Consistent with the literature (Bolling, Mellette, et al., 2019; Gabriel et al., 2019), PETE students considered themselves the main responsible person in injury prevention. They also mentioned sharing responsibilities with other stakeholders (e.g., PETE teachers, PETE managers, sports trainers).

Along those lines, they described the importance of communication and social support. Notably, the PETE context calls for communication with various stakeholders (e.g., sport class teachers; sports trainers). This may be challenging for the less experienced students who may need more guidance.

Another important finding is that PETE students described that successful preventive strategies need to be learned, following results from other athletic populations (Bolling, Delfino Barboza, et al., 2019; Bolling, Mellette, et al., 2019; Gabriel et al., 2019). The participants described developing preventive strategies for themselves according to experiences with injuries and knowledge about injury prevention. In that sense, one might argue that this learning process's guidance is crucial in injury prevention.

#### **Motives for injury prevention**

The findings indicated that participants believed they could prevent specific injuries (e.g., recurrent injuries, muscle injuries). However, more than preventing injuries to happen in the first place, participants described focussing on preventing recurrence or worsening of injuries. Additionally, preventing injuries was not described as their primary goal. Maintaining participation and performing well (e.g., academic success, sports) were mentioned as priorities, and therefore they needed to avoid injury. Such performance-driven motives for injury prevention were also found in other athletic populations (Bolling, Delfino Barboza, et al., 2019; Kristiansen & Larsson, 2017).

When injured, not fully participating was associated with negative emotions such as failing or abandoning the class- or teammates. They wanted to be part of the social process. Therefore, participation is maintained as much as possible, causing participation with pain or injury. This dilemma was also described in other athletic populations (Bahr, 2009; Edouard et al., 2018; Perera et al., 2019) and can be considered a barrier to injury prevention. Promoting that participating with injury or pain should not be considered the norm may help tackle this dilemma in PETE students (Edouard et al., 2018).

In line with Gabriel, Hoch and Cramer (2019), the present study indicated that willingness for injury prevention is related to perceived benefits (Gabriel et al., 2019). For example, participants described implementing specific exercises in their warm-up routines based on their experiences; it reduces soreness during the training. Correspondingly, the participants mentioned care for the body as an essential motive for injury prevention, following findings in elite athletes (Chan & Hagger, 2012), circus artists (Bolling, Mellette, et al., 2019) and secondary school students (Lee et al., 2019). However, injuries were also described as an inherent part of sports and, therefore, injury risks are sometimes accepted. The phenomenon of sports injury risk acceptance has previously been described within the risk management framework (Fuller & Drawer, 2004). The authors stressed that communication about injury risks is helpful in such cases.

Several circumstantial factors, such as adherence to rules and regulations and easy access to (para)medical care, were also mentioned as injury prevention motives. Lee, Standage, Hagger and Chan (2019) described the importance of such circumstantial factors in injury prevention motives in secondary school students (Lee et al., 2019).

#### **Students' recommendations to improve injury prevention**

The present study voiced the target population and mapped their recommendations to improve injury prevention. The participants provided various recommendations, encouraging multi-factorial preventive strategies (Mugele et al., 2018). Many suggestions were process-oriented, highlighting the need for injury prevention as a continuous process. A consistently mentioned recommendation was the improvement of the PETE schedules. For example, more and longer breaks between sports classes on the same day and improving sports class distribution during the week. Such improvements were deemed to support balancing load and recovery, following other athletic populations' findings (Bolling, Delfino Barboza, et al., 2019; Jelvegård et al., 2016; Kristiansen & Larsson, 2017). The participants also suggested a more tailored approach, including more individual coaching, repeated screenings, monitoring, improved preparation, and more attention to injury

prevention by PETE teachers. Furthermore, the participants consistently suggested offering injury prevention education from the beginning of the PETE curriculum. Such education could enable them to become 'better' in applying injury prevention earlier. This result corresponds well with the literature, as education is considered a common part of injury prevention (Vriend et al., 2017). Improving the students' ability to apply preventive strategies may also enable them to multiply this in their future careers as physical education teachers or sports trainers, promoting injury prevention in children and adolescents.

#### **Methodological considerations**

The strengths of this study were as follows. The study had a multi-centre design and obtained a wide range of participants (e.g., sex, age, sport, sport level), strengthening this study's credibility. The three independent researchers' collaborative and reflective analysis process strengthened the findings neutrality. However, this study also had several limitations. First, this study was carried out within the Dutch PETE context. Thus the findings have limited implications for other athletic populations. Second, this study only included third- and fourth-year students and the findings only relate to this sample. Third, the convenience sampling approach may have omitted those with other perspectives on injury prevention. Nevertheless, this study provided novel findings which supports the development of preventive strategies and further research.

#### **Conclusions**

The PETE students described applying various preventive strategies and mentioned many reasons that motivate them to prevent injuries. However, the lack of support and guidance indicated the need for a more comprehensive approach for injury prevention. Given the results, preventive strategies must facilitate students' communication with stakeholders, learning what works, self-management, shared responsibilities, and social support. Injury prevention strategies should also relate to PETE students' motives; caring for the body and performing well (e.g., academic success, sports). Given PETE students, injury prevention can be improved in various ways, mainly by improving load management (e.g., breaks, weekly distribution of sports classes) and injury prevention education (e.g., theory, practical skills).

#### **Acknowledgements**

##### **Ethics approval and consent to participate**

The Amsterdam Academic Medical Centre (location VU Medical Centre, reference number: 2019.317) approved the study procedures, and written consent was obtained from all participants.

##### **Availability of data and materials - No**

##### **Competing interests**

The authors declare that they have no competing interests relevant to this manuscript's content.

##### **Funding**

This study's preparation was supported by NWO-NRO funding (reference number: 40518865231).

##### **Authors' contributions**

MB, SB and EV designed the study. MB and SB conducted the study. SB, MB, and CB analysed the data. SB drafted the manuscript. MB, CB, JS and EV provided feedback on draft versions of the manuscript and edited later versions. All authors approved the final manuscript.

##### **Acknowledgements**

We would like to thank the participants for their participation in this study. We would also like to thank the colleagues from the involved universities for supporting the acquisition of participants. Finally, we would like to thank Lukas Blienkendaal for supporting the quotes' translation.

#### **References**

- Bahr, R. (2009). No injuries, but plenty of pain? On the methodology for recording overuse symptoms in sports. *British Journal of Sports Medicine*, 43(13), 966–972. <https://doi.org/10.1136/bjsm.2009.066936> [doi]
- Blienkendaal, S., Barendrecht, M., Stubbe, J., & Verhagen, E. (2021). Mechanisms of sport-related injuries in physical education teacher education students: A descriptive analysis of 896 injuries. In *Translational Sports Medicine* (Vol. 00, p. 1). Wiley. <https://doi.org/10.1002/tsm2.225>
- Blienkendaal, S., Goossens, L., & Stubbe, J. H. (2017). Incidence and risk factors of injuries and their impact on academic success: A prospective study in PETE students. *Scandinavian Journal of Medicine & Science in Sports*. <https://doi.org/10.1111/sms.12838>
- Blienkendaal, S., Moen, M., Fokker, Y., Stubbe, J. H., Twisk, J., & Verhagen, E. (2018). Incidence and risk factors of medial tibial stress syndrome: a prospective study in Physical Education Teacher Education students. *BMJ Open Sport & Exercise Medicine*, 4(1), e000421. <https://doi.org/10.1136/bmjsem-2018-000421> [doi]
- Bolling, C., Delfino Barboza, S., van Mechelen, W., & Pasman, H. R. (2019). *Letting the cat out of the bag: Athletes, coaches and physiotherapists share their perspectives on injury prevention in elite sports*. <https://doi.org/10.1136/bjsports-2019-100773>

- Bolling, C., Mellette, J., Pasman, H. R., van Mechelen, W., & Verhagen, E. (2019). From the safety net to the injury prevention web: applying systems thinking to unravel injury prevention challenges and opportunities in Cirque du Soleil. *BMJ Open Sport & Exercise Medicine*, 5(1), e000492. <https://doi.org/10.1136/bmjsem-2018-000492> [doi]
- 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 Medicine (Auckland, N.Z.)*, 48(10), 2227–2234. <https://doi.org/10.1007/s40279-018-0953-x> [doi]
- Braun, V., & Clarke, V. (2006). Using thematic analysis in psychology. *Qualitative Research in Psychology*, 3(2), 77–101. <https://doi.org/10.1191/1478088706qp063oa>
- Chan, D. K. C., & Hagger, M. S. (2012). Self-determined forms of motivation predict sport injury prevention and rehabilitation intentions. *Journal of Science and Medicine in Sport*, 15(5), 398–406. <https://doi.org/10.1016/j.jsams.2012.03.016>
- Dijkzma, I., Bekkers, M., Spek, B., Lucas, C., & Stuiver, M. (2019). Epidemiology and Financial Burden of Musculoskeletal Injuries as the Leading Health Problem in the Military. *Military Medicine*, 185(3–4), e480–e486. <https://doi.org/usz328> [pii]
- Edouard, P., Alonso, J.-M., & Branco, P. (2018). New insights into preventing injuries and illnesses among elite athletics athletes. *British Journal of Sports Medicine*, 52(1), 4–5. <https://doi.org/10.1136/bjsports-2016-097369>
- Ehrendorfer, S. (1998). Survey of sport injuries in physical education students participating in 13 sports. *Wiener Klinische Wochenschrift*, 110(11), 397–400.
- Finch, C. (2006). A new framework for research leading to sports injury prevention. *Journal of Science and Medicine in Sport / Sports Medicine Australia*, 9(1–2), 3–9; discussion 10. [https://doi.org/S1440-2440\(06\)00023-5](https://doi.org/S1440-2440(06)00023-5) [pii]
- Fuller, C., & Drawer, S. (2004). The Application of Risk Management in Sport. *Sports Medicine (Auckland)*, 34(6), 349–356. <https://doi.org/10.2165/00007256-200434060-00001>
- Gabriel, E. H., Hoch, M. C., & Cramer, R. J. (2019). Health Belief Model Scale and Theory of Planned Behavior Scale to assess attitudes and perceptions of injury prevention program participation: An exploratory factor analysis. *Journal of Science and Medicine in Sport*, 22(5), 544–549. <https://doi.org/10.1016/j.jsams.2018.11.004>
- Goossens, L., Cardon, G., Witvrouw, E., Steyaert, A., & de Clercq, D. (2016). A multifactorial injury prevention intervention reduces injury incidence in Physical Education Teacher Education students. *European Journal of Sport Science*, 16(3), 365–373. <https://doi.org/10.1080/17461391.2015.1015619> [doi]
- Goossens, L., Verrelst, R., Cardon, G., & de Clercq, D. (2014). Sports injuries in physical education teacher education students. *Scandinavian Journal of Medicine & Science in Sports*, 24(4), 683–691. <https://doi.org/10.1111/sms.12054> [doi]
- Goossens, L., Witvrouw, E., vanden Bossche, L., & de Clercq, D. (2015). Lower eccentric hamstring strength and single leg hop for distance predict hamstring injury in PETE students. *European Journal of Sport Science*, 15(5), 436–442. <https://doi.org/10.1080/17461391.2014.955127> [doi]
- Green, J., & Thorogood, N. (2018). *Qualitative methods for health research*. Sage.
- Gribble, P. A., Bleakley, C. M., Caulfield, B. M., Docherty, C. L., Fourchet, F., Fong, D. T., Hertel, J., Hiller, C. E., Kaminski, T. W., McKeon, P. O., Refshauge, K. M., Verhagen, E. A., Vicenzino, B. T., Wikstrom, E. A., & Delahunt, E. (2016). Evidence review for the 2016 International Ankle Consortium consensus statement on the prevalence, impact and long-term consequences of lateral ankle sprains. *British Journal of Sports Medicine*, 50(24), 1496–1505. <https://doi.org/10.1136/bjsports-2016-096189> [doi]
- Hanson, D., Hanson, J., Vardon, P., McFarlane, K., Lloyd, J., Muller, R., & Durrheim, D. (2005). The injury iceberg: an ecological approach to planning sustainable community safety interventions. *Health Promotion Journal of Australia: Official Journal of Australian Association of Health Promotion Professionals*, 16(1), 5–10.
- Jacobsson, J., Bergin, D., Timpka, T., Nyce, J. M., & Dahlstrom, O. (2018). Injuries in youth track and field are perceived to have multiple-level causes that call for ecological (holistic-developmental) interventions: A national sporting community perceptions and experiences. *Scandinavian Journal of Medicine & Science in Sports*, 28(1), 348–355. <https://doi.org/10.1111/sms.12929> [doi]
- Jelvegård, S., Timpka, T., Bargoria, V., Gauffin, H., & Jacobsson, J. (2016). Perception of Health Problems Among Competitive Runners. *Orthopaedic Journal of Sports Medicine*, 4(12), 2325967116673972. <https://doi.org/10.1177/2325967116673972>
- Koninklijke Vereniging voor Lichamelijke Opvoeding. (2017). *Beroepsprofiel*. KVLO.
- Kristiansen, J. B., & Larsson, I. (2017). Elite professional soccer players’ experience of injury prevention. *Cogent Medicine*, 4(1). <https://doi.org/10.1080/2331205X.2017.1389257>
- Lee, A. S. Y., Standage, M., Hagger, M. S., & Chan, D. K. C. (2019). Sport injury prevention in-school and out-of-school? A qualitative investigation of the trans-contextual model. *PloS One*, 14(9), e0222015. <https://doi.org/10.1371/journal.pone.0222015>

- McGlashan, A. J., & Finch, C. F. (2010). The extent to which behavioural and social sciences theories and models are used in sport injury prevention research. *Sports Medicine (Auckland, N.Z.)*, 40(10), 841–858. <https://doi.org/10.2165/11534960-000000000-00000> [doi]
- Mugele, H., Plummer, A., Steffen, K., Stoll, J., Mayer, F., & Muller, J. (2018). General versus sports-specific injury prevention programs in athletes: A systematic review on the effect on injury rates. *PloS One*, 13(10), e0205635. <https://doi.org/10.1371/journal.pone.0205635> [doi]
- Mukherjee, S. (2014). Sports Injuries in University Physical Education Teacher Education Students: A Prospective Epidemiological Investigation. *J J Sport Med*, 1(2), 1–9.
- Perera, N., Åkerlund, I., & Hägglund, M. (2019). Motivation for sports participation, injury prevention expectations, injury risk perceptions and health problems in youth floorball players. In *Knee Surgery, Sports Traumatology, Arthroscopy* (Vol. 27, Issue 11, p. 3722). <http://urn.kb.se/resolve?urn=urn:nbn:se:liu:diva-161596>
- Snoeker, B., Turkiewicz, A., Magnusson, K., Frobell, R., Yu, D., Peat, G., & Englund, M. (2019). Risk of knee osteoarthritis after different types of knee injuries in young adults: a population-based cohort study. *British Journal of Sports Medicine*, 54(12). <https://doi.org/bjsports-2019-100959> [pii]
- Soligard, T., Nilstad, A., Steffen, K., Myklebust, G., Holme, I., Dvorak, J., Bahr, R., & Andersen, T. E. (2010). Compliance with a comprehensive warm-up programme to prevent injuries in youth football. *British Journal of Sports Medicine*, 44(11), 787–793. <https://doi.org/10.1136/bjsem.2009.070672> [doi]
- Steffen, K., Emery, C. A., Romiti, M., Kang, J., Bizzini, M., Dvorak, J., Finch, C. F., & Meeuwisse, W. H. (2013). High adherence to a neuromuscular injury prevention programme (FIFA 11+) improves functional balance and reduces injury risk in Canadian youth female football players: a cluster randomised trial. *British Journal of Sports Medicine*, 47(12), 794–802. <https://doi.org/10.1136/bjsports-2012-091886> [doi]
- van Beijsterveldt, A.-M., Richardson, A., Clarsen, B., & Stubbe, J. (2017). Sports injuries and illnesses in first-year physical education teacher education students. *BMJ Open Sport & Exercise Medicine*, 3(1). <https://doi.org/10.1136/bmjsem-2016-000189>
- Verhagen, E. (2012). If Athletes Will Not Adopt Preventive Measures, Effective Measures Must Adopt Athletes. *Current Sports Medicine Reports*, 11(1), 7–8. <https://doi.org/10.1249/JSR.0b013e318240dabd>
- Verhagen, E., & Bolling, C. (2018). We dare to ask new questions. Are we also brave enough to change our approaches? *Translational Sports Medicine*, 1(1), 54–55. <https://doi.org/10.1002/tsm2.8>
- Verhagen, E., Hupperets, M., Finch, C., & van Mechelen, W. (2011). The impact of adherence on sports injury prevention effect estimates in randomised controlled trials: looking beyond the CONSORT statement. *Journal of Science and Medicine in Sport*, 14(4), 287–292. <https://doi.org/10.1016/j.jsams.2011.02.007> [doi]
- Vriend, I., Gouttebauge, V., Finch, C., van Mechelen, W., & Verhagen, E. (2017). Intervention Strategies Used in Sport Injury Prevention Studies: A Systematic Review Identifying Studies Applying the Haddon Matrix. *Sports Medicine*, 47(10), 2027–2043. <https://doi.org/10.1007/s40279-017-0718-y>