



**HAL**  
open science

## Determinants of the adoption of injury risk reduction programmes in athletics (track and field): an online survey of 7715 French athletes

Alexis Ruffault, Marine Sorg, Simon Martin, Christine Hanon, Lison Jacquet, Evert Verhagen, Pascal Edouard

### ► To cite this version:

Alexis Ruffault, Marine Sorg, Simon Martin, Christine Hanon, Lison Jacquet, et al.. Determinants of the adoption of injury risk reduction programmes in athletics (track and field): an online survey of 7715 French athletes. *British Journal of Sports Medicine*, 2021, bjsports-2021-104593. 10.1136/bjsports-2021-104593 . hal-03578632

**HAL Id: hal-03578632**

**<https://insep.hal.science/hal-03578632v1>**

Submitted on 17 Feb 2022

**HAL** is a multi-disciplinary open access archive for the deposit and dissemination of scientific research documents, whether they are published or not. The documents may come from teaching and research institutions in France or abroad, or from public or private research centers.

L'archive ouverte pluridisciplinaire **HAL**, est destinée au dépôt et à la diffusion de documents scientifiques de niveau recherche, publiés ou non, émanant des établissements d'enseignement et de recherche français ou étrangers, des laboratoires publics ou privés.

1 Original article

2

3 **Determinants of the adoption of injury risk reduction programmes in athletics (track**  
4 **and field): an online survey of 7,715 French athletes**

5

6 **Running head:** Determinants of injury risk reduction programmes adoption

7

8 Alexis Ruffault<sup>1,2</sup>, Marine Sorg<sup>3</sup>, Simon Martin<sup>4,5</sup>, Christine Hanon<sup>1,6</sup>, Lison Jacquet<sup>3</sup>, Evert  
9 Verhagen<sup>7</sup>, Pascal Edouard<sup>3,8,9</sup>

10

11 **Affiliations:**

12 <sup>1</sup> Laboratory Sport, Expertise, and Performance (EA 7370), French Institute of Sport (INSEP),  
13 Paris, France

14 <sup>2</sup> Unité de Recherche interfacultaire Santé & Société (URiSS), University of Liège, Liège,  
15 Belgium

16 <sup>3</sup> Department of Clinical and Exercise Physiology, Sports Medicine Unit, University Hospital  
17 of Saint-Etienne, Faculty of Medicine, Saint-Etienne, France

18 <sup>4</sup> Laboratoire Adaptations Physiologiques à l'Exercice et Réadaptation à l'Effort (APERE),  
19 Université Picardie Jules Verne, Amiens, France

20 <sup>5</sup> Center of Research on Welfare Health and Sport, Halmstad University, Halmstad, Sweden

21 <sup>6</sup> French Athletics Federation (FFA), Paris, France

22 <sup>7</sup> Amsterdam Collaboration on Health & Safety in Sports (ACHSS), Department of Public and  
23 Occupational Health, Amsterdam UMC, VU University, Amsterdam Movement Sciences,  
24 Amsterdam, The Netherlands

25 <sup>8</sup> Inter- university Laboratory of Human Movement Science (LIBM EA 7424), University of

1 Lyon, University Jean Monnet, F-42023. Saint Etienne, France

2 <sup>9</sup> European Athletics Medical & Anti Doping Commission, European Athletics Association  
3 (EAA), Lausanne, Switzerland

4

5 **Correspondence to:**

6 Pascal Edouard, MD PhD, Department of Clinical and Exercise Physiology, Sports Medicine  
7 Unit, IRMIS, Campus Santé Innovations, University Hospital of Saint-Etienne, 42 055 Saint-  
8 Etienne cedex 2, France. Tel.: +33 674 574 691; Fax numbers: +33 477 127 229; E-mail:  
9 Pascal.Edouard@univ-st-etienne.fr

10

11 **Funding:** The authors have not declared a specific grant for this research from any funding  
12 agency in public, commercial or not-for-profit sectors. The present study was conducted in the  
13 context of the FULGUR project (ANR-19-STPH-003) funded by the French Research Agency  
14 in the perspective of the Paris 2024 Olympic and Paralympic Games in collaboration with  
15 French Federations of Athletics, Rugby and Ice Sports, Universities of Nantes, Côte d'Azur,  
16 Savoie Mont Blanc, Jean Monnet Saint-Etienne, Saclay, the Mines Saint-Etienne, the CEA  
17 and the CNRS. The University Jean Monnet Saint-Etienne and the French Institute of Sport  
18 (INSEP) are partners of the French-speaking network ReFORM. ReFORM, and the  
19 Amsterdam Collaboration on Health & Safety in Sports (ACHSS) are recognised as Research  
20 Centres for the Prevention of Injury and Illness the Protection of Athletes by the International  
21 Olympic Committee (IOC) and received funding from the IOC to establish a long-term  
22 research program on the prevention of injuries and illnesses in sports to protect athlete health.

23 **Competing Interest:** None declared. EV and PE are Associate Editors for the BJSM. EV is  
24 the Editor in Chief of BMJ Open Sports and Exercise Medicine. PE is Associate Editor for the

1 BMJ Open Sports and Exercise Medicine. PE is the Speciality Chief Editor for the Injury  
2 Prevention and Rehabilitation section of Frontiers in Sports and Active Living.

3 **Ethics approval:** The study was reviewed and approved by the Saint-Etienne University  
4 Hospital Ethical Committee (Institutional Review Board: IORG0007394,  
5 IRBN232020/CHUSTE).

6 **Data availability statement:** Data are available upon reasonable request. Please contact the  
7 corresponding author.

8 **Contributorship statement:** PE, MS, and AR conceived and designed the study and  
9 proposed the study protocol; SM, CH, LJ, and EV provided revisions on the study protocol.  
10 AR performed data analyses and drafted the manuscript. All co-authors contributed  
11 substantially to interpreting the results, provided important revisions, and approved the  
12 manuscript. All authors understand that they are accountable for all aspects of the work and  
13 ensure the accuracy or integrity of this manuscript.

14 **Acknowledgements:** The authors warmly thank the French Federation of Athletics (FFA,  
15 <https://www.athle.fr>) for sharing the questionnaire through their email lists and the athletes  
16 who participated in the study. The authors would like to thank Crane Rogers (Chaire ActiFS,  
17 Univ Lyon, UJM-Saint-Etienne, Laboratoire Interuniversitaire de Biologie de la Motricité, EA  
18 7424, F-42023 Saint-Etienne, France) for his contribution to this project.

19 **Supplementary data:** The supplementary material contains: the material for measuring  
20 socio-cognitive determinants of injury risk reduction programmes adoption (i.e., the survey),  
21 and the tables displaying the means and standard deviations of socio-cognitive determinants  
22 for all categorical variables (i.e., athletes' characteristics).

23

24 **Keywords:** Sports injury prevention; prevention strategy adoption; theory of planned  
25 behaviour; socio-cognitive determinants; track and field; athletes.

1

2 **Number of words (excluding title page, abstract, references, figures and tables): 3445**

3 **words**

4

1 **SUMMARY BOX**

2

3 **What are the new findings?**

- 4 • Competing at the highest level, presenting a larger number of previous injuries, and  
5 sustaining the most-recent injury in the previous or current season increased the odds of  
6 adopting an injury risk reduction programme.
- 7 • Scores of the socio-cognitive determinants (i.e., attitudes, subjective norms, perceived  
8 behavioural control, and intentions) of injury risk reduction programme adoption were  
9 higher in athletes who adopted an injury risk reduction programme in the current season or  
10 sometime in their lifetime than those who didn't.
- 11 • Athletes who competed at the highest level, sustained a larger number of previous injuries,  
12 or the most-recent injury in the previous or current season, had higher scores of socio-  
13 cognitive determinants of injury risk reduction programme adoption.

14

15 **How might it impact clinical practice in the near future?**

16 While athlete characteristics (e.g. athletic discipline, level of competition, history of injuries)  
17 are difficult or even impossible to change, it is possible to influence the socio-cognitive  
18 determinants of their views on injury risk reduction programmes. Thus, a targeted approach  
19 on athletes' beliefs and intentions could increase the adoption of injury risk reduction  
20 programmes. Clinicians could increase the adoption of injury risk reduction programmes by  
21 educating athletes on the benefits of such programmes (i.e., improving attitudes), and how  
22 best to implement them into their daily life (i.e., increasing perceived behavioural control).  
23 The use of social media to visualise elite athletes performing such programmes (i.e.,  
24 increasing subjective norms) could be an effective strategy to increase adoption.

25

1 **ABSTRACT**

2 **Objectives** To identify individual characteristics associated with the adoption of injury risk  
3 reduction programmes (IRRP) and to investigate the variations in socio-cognitive  
4 determinants (i.e., attitudes, subjective norms, perceived behavioural control, and intentions)  
5 of IRRP adoption in athletics (track and field) athletes.

6 **Methods** We conducted a cross-sectional study using an online survey sent to athletes  
7 licensed with the French Federation of Athletics to investigate their habits and socio-cognitive  
8 determinants of IRRP adoption. Sociodemographic characteristics, sports practice, and  
9 history of previous injuries was also recorded. Logistic regression analyses and group  
10 comparisons were performed.

11 **Results** The final sample was composed of 7,715 athletes. From the multivariable analysis,  
12 competing at the highest level was positively associated with IRRP adoption (AOR=1.66;  
13 99.9%CI 1.39-1.99 and AOR=1.48; 99.9%CI 1.22-1.80) and presenting a low number of past  
14 injuries was negatively associated with IRRP adoption (AOR=0.48; 99.9%CI 0.35-0.65 and  
15 AOR=0.61; 99.9%CI 0.44-0.84), both during their lifetime and the current season,  
16 respectively. These results were supported by higher scores of socio-cognitive determinants  
17 among athletes who reported IRRP adoption compared to other athletes.

18 **Conclusion** Some characteristics of athletes seem to be associated with IRRP adoption either  
19 positively (competing at the highest level) or negatively (presenting a lower number of past  
20 injuries), whereas all the socio-cognitive determinants tested appear to be linked to IRRP  
21 adoption. Since many athlete characteristics are difficult or impossible to change, IRRP  
22 promotion may be enhanced by targeting athletes' beliefs and intentions to adopt an IRRP.

23

## 1 INTRODUCTION

2 Like other sports, participation in athletics (track and field) leads to injury risk.<sup>1</sup> Although to  
3 date there is little scientific evidence specifically on risk reduction strategies in athletics,<sup>1-4</sup> it  
4 seems important to implement effective injury risk reduction programmes (IRRP), as seen in  
5 other sports.<sup>5-7</sup> However, in athletics,<sup>2,8</sup> running,<sup>9</sup> and other sports,<sup>10,11</sup> studies investigating  
6 the effects of IRRP tend to show low compliance with suggested risk reduction interventions,  
7 limiting the impact of IRRP to those athletes who choose to adopt an IRRP. Hence, a better  
8 understanding of the beliefs and intentions of athletes who adopt or do not adopt an IRRP is  
9 likely to improve the implementation of IRRP. Specifically targeting athletes' behaviours  
10 may also improve compliance.<sup>12,13</sup>

11

12 The relevance of socio-cognitive theories of behaviour change has been highlighted by the  
13 work of Chan and Hagger.<sup>14</sup> One of the most studied socio-cognitive theories of behaviour  
14 change<sup>15</sup> is the theory of planned behaviour.<sup>16</sup> It posits that behavioural beliefs (attitudes,  
15 subjective norms, and perceived control) predict the intention to perform certain behaviours,  
16 which then predicts a change in these behaviours.<sup>16</sup> In the theory of planned behaviour,  
17 attitudes are defined as overall evaluations of behaviour by an individual; subjective norms as  
18 beliefs about what significant others may think of an individual's behaviour adoption;  
19 perceived behavioural control as the individual's perception of the extent of control over  
20 behaviour adoption, and intentions as conscious plans, decisions or self-instructions to exert  
21 effort towards adopting a behaviour. Such behavioural beliefs and intentions from the theory  
22 of planned behaviour are identified as socio-cognitive determinants of behaviour adoption.  
23 Previous studies on IRRP adoption assumed that the theory of planned behaviour could be  
24 used as part of a framework to better understand the athlete's compliance with their  
25 IRRP.<sup>14,17,18</sup>



1 The individual perceptions of IRRP and injuries using qualitative research design was  
2 previously investigated in athletes in a study.<sup>19</sup> Although this study included a small number  
3 of participants, the results suggested that athletes emphasise beliefs such as attitudes (e.g.,  
4 injury prevention is less important than performance), subjective norms (e.g., communication  
5 with physiotherapists and coaches is necessary), and perceived control (e.g., injury prevention  
6 is part of training).<sup>19</sup> Additionally, Bolling et al.<sup>19</sup> showed that other factors such as previous  
7 injuries or years of sport experience might determine IRRP adoption. However, studies based  
8 on larger samples and using behaviour change theories as background are very rare in the  
9 context of IRRP adoption. To our knowledge, only Chan and Hagger<sup>17</sup> were able to  
10 investigate the socio-cognitive determinants of IRRP adoption in elite athletes. Their results  
11 were based on the self-determination theory,<sup>20</sup> which is a theory of motivation (i.e., the reason  
12 why adopting an IRRP), and not on the theory of planned behaviour (i.e., the beliefs regarding  
13 IRRP adoption, and intentions to adopt an IRRP).<sup>17</sup>  
14 In this context, the present study aimed to 1) identify individual athletes' characteristics  
15 associated with IRRP adoption and 2) investigate the variations in socio-cognitive  
16 determinants of IRRP adoption among athletics athletes using the theory of planned behaviour  
17 as theoretical background. We hypothesised that some athletes' characteristics and socio-  
18 cognitive determinants are associated with IRRP adoption.

19

## 20 **METHODS**

### 21 **Study design and procedure**

22 We conducted a cross-sectional study through a one-time online survey. We asked athletics  
23 athletes licensed at the French Federation of Athletics (FFA, <http://www.athle.fr>) on their  
24 habits, motives, beliefs, and intentions to adopt an IRRP. There was no athlete, patient and  
25 public involvement in the development of the study questions or conduction of the survey.

1 The study was reviewed and approved by the Saint-Etienne University Hospital Ethical  
2 Committee (Institutional Review Board: (Institutional Review Board: IORG0007394,  
3 IRBN232020/CHUSTE).

4

## 5 **Population**

6 The eligible population was comprised of athletes licensed at the FFA with the following  
7 inclusion criteria: aged 18 years or older, licensed as competing athletes, and legally able to  
8 provide consent to participate in the present study.

9

## 10 **Data collection**

11 The survey was developed by one researcher experienced in sports psychology (AR), two  
12 sports medicine physicians (PE and MS), one researcher experienced in sports scientist (EV),  
13 one athletics coach (SM) and one psychologist (LJ). After two review rounds, all co-authors  
14 approved the survey which was then pilot-tested on three competitive athletes in February  
15 2020. All co-authors performed the final validation of the survey.

16 The online survey was composed of four parts: *i*) information on the athletes (age, sex,  
17 athletics discipline,<sup>21</sup> number years of athletics practice experience, and competition level), *ii*)  
18 adoption of an IRRP during the entire career named “lifetime” and during the current season  
19 (with options: “yes entirely”, “yes partially”, “not at all”), *iii*) information on injuries (lifetime  
20 number, time since the most-recent injury, location (following the classification used by  
21 Edouard et al.<sup>22</sup>) and cause (traumatic or overuse) of the most-recent injury and time loss after  
22 the most-recent injury<sup>21</sup>), and *iv*) socio-cognitive determinants of behaviour adoption from the  
23 theory of planned behaviour for IRRP adoption (attitudes, subjective norms, perceived  
24 behavioural control, and intentions<sup>16</sup>). The survey is presented in supplementary data.

1 An IRRP was defined in the survey as a set of specific exercises related to his/her sport which  
2 aims to reduce the risk of injury, including, for example, muscle strengthening, stretching, or  
3 balance exercises. An injury was defined as pain, discomfort, or damage to the  
4 musculoskeletal system, occurring during sports practice (training or competition), and having  
5 resulted in consequences on sports practice (reduction in practice, adaptation or incomplete  
6 practice, or discontinuation of the practice), regardless of consultation by a health  
7 professional.<sup>2</sup> These definitions were provided to the athletes in the survey (supplementary  
8 data file).

9 Items measuring the socio-cognitive determinants of the theory of planned behaviour were  
10 created following Ajzen's guidelines.<sup>16</sup> The four socio-cognitive determinants (attitudes,  
11 subjective norms, perceived behavioural control, and intentions) were measured with four  
12 items each, rated on 7-point Likert scales.<sup>16</sup> Individual scores ranged from 1 (lowest possible  
13 score) to 7 (highest possible score). The items are available in supplementary data. A  
14 confirmatory factor analysis was performed using the R package *lavaan*<sup>23</sup> to check the factor  
15 structure of the created material. The comparative fit index (CFI), the Tucker–Lewis index  
16 (TLI), and the root-mean-square error of approximation (RMSEA) were used to estimate the  
17 goodness-of-fit statistics<sup>24,25</sup> and revealed an acceptable fit of the factor structure to the data.  
18 The invitation to the survey was distributed via an email sent by the FFA to the registered  
19 email address of licensed competing athletes on April 22<sup>nd</sup> 2020. The survey was closed on  
20 May 7<sup>th</sup> 2020, after 15 days, without any reminder after the initial invitation.

21

## 22 **Statistical analyses**

23 Statistical analyses were conducted using R (version 4.0.2, © Copyright 2020 The Foundation  
24 for Statistical Computing (Comprehensive R Archive Network, <http://www.R-project.org>)). In  
25 order to limit the risk of Type I errors and given the large size of our sample, the  $\alpha$  (i.e.,

1 significance level) was set at 0.001 for statistical analyses;<sup>26</sup> *p*-values were set at 0.001 and  
2 confidence intervals (CI) were set at 99.9%. We first performed a descriptive analysis of the  
3 collected data, using frequency with percentages for categorical variables, and median and  
4 range for continuous variables describing the sample (i.e., age and years of experience in the  
5 athlete's main discipline).

6 Based on the descriptive analysis, several categorical variables were merged to improve the  
7 power of logistic regression analyses. For IRRP adoption, "yes entirely" and "yes partially"  
8 were combined as "yes", and "not at all" was considered "no"; this choice was made  
9 pragmatically to make "IRRP adoption" become a binary outcome variable for logistic  
10 regression analyses. For discipline practice, we categorized as "explosive" the following  
11 disciplines: "sprints", "jumps", "throws", "hurdles", and "combined events"; and as  
12 "endurance": "middle and long distances", "marathon", "race walking", "road running", and  
13 "trail and mountain running") as previously performed.<sup>27</sup> From the 4 competition level  
14 categories, we combined "international" and "national" as one category and "regional" and  
15 "departmental" as another. For lifetime number of injuries, categories from "none" to "3"  
16 were considered as separate categories, categories of "4" and "5" were combined as "4 or 5",  
17 and categories of "6" to "10 or more" were combined as "more than 5"; for time since the  
18 most-recent injury "current season" and "6 months to 5 years" were considered as separate  
19 categories, and "5 to 10 years" and "more than 10 years" were combined as "more than 5  
20 years". For time loss after the most-recent injury, "1 to 7 days" and "8 to 28 days" were  
21 combined as "minor to moderate", and "29 days to 6 months" and "more than 6 months" were  
22 combined as "severe", this reduced the usual classification of the severity of injuries<sup>21</sup> to two  
23 categories.

24 We used binomial logistic regressions to analyse the potential associations between IRRP  
25 adoption (lifetime and current season) and individual characteristics (sex, age, sport practised,

1 years of discipline practice experience, competition level, lifetime number of injuries, time  
2 since the most-recent injury, and time loss after the most-recent injury), providing odds ratios  
3 (OR) and 99.9% confidence intervals (99.9% CI) in univariate and multivariable models. We  
4 then used multivariable models to calculate adjusted OR (AOR) by including all athletes'  
5 characteristics as covariates. OR above 1 indicates a tendency for the reference group to adopt  
6 IRRP more than the other groups, and OR below 1 indicates a tendency for the reference  
7 group to adopt IRRP less than the other groups.

8 For the comparison of socio-cognitive determinants of IRRP adoption between groups (i.e.,  
9 those who adopted an IRRP *versus* those who did not), based on Shapiro-Wilk and Bartlett  
10 tests of normality and homogeneity in variances, parametric group comparisons were  
11 performed using the Student t-test, as well as analyses of variances (ANOVA) with Tukey  
12 post-hoc tests.

13

## 14 **RESULTS**

### 15 **Population**

16 From a list of 75,575 competitive licensed athletes, a total of 8,809 athletes replied to the  
17 invitation to participate in this study between April 22<sup>nd</sup> 2020 and May 7<sup>th</sup> 2020, among which  
18 7,715 athletes (10.2%) met inclusion criteria, gave their informed consent to participate in the  
19 present study, and were included in the analysis. The characteristics of the final sample are  
20 displayed in table 1.

21

### 22 **IRRP adoption**

23 A total of 5,430 (70.4%) athletes declared they never adopted an IRRP during their entire  
24 athletics career, 1,705 (22.1%) declared having partially adopted an IRRP, and 580 (7.5%)  
25 declared having already performed an IRRP during their lifetime. Additionally, 5,929 (76.9%)

1 athletes were not adopting any IRRP during the current season, 1,282 (16.6%) were partially  
2 adopting an IRRP during the current season, and 504 (6.5%) declared having performed an  
3 IRRP during the current season (table 1).

4

#### 5 **IRRP adoption as a function of athletes' characteristics**

6 Univariate logistic regression models showed that athletes practising endurance disciplines  
7 were less likely to adopt an IRRP during their lifetime (OR = 0.72; 99.9%CI 0.60 to 0.87),  
8 and that athletes competing at a higher level were more likely to adopt an IRRP both during  
9 their lifetime (OR = 1.82; 99.9%CI 1.53 to 2.15) and during the current season (OR = 1.55;  
10 99.9%CI 1.29 to 1.86) (table 2).

11 However, when adjusting the models for all athletes' characteristics (i.e., multivariable  
12 models), the results showed that only the association between IRRP adoption and competition  
13 level remains significant (table 2).

14 Results of the associations between IRRP adoption and history of injuries, both in current  
15 season and during their lifetimes, showed that athletes with no history of an injury were less  
16 likely to adopt an IRRP than those who sustained 3 or more injuries (table 2). These  
17 associations remained significant for athletes who sustained the most injuries (4 or more) in  
18 multivariable models adjusting for all athletes' characteristics (table 2).

19 The results of univariate logistic regression analyses also showed that individuals who  
20 sustained an injury more than five years before their participation in this study were less likely  
21 to adopt an IRRP during the current season (OR = 0.62; 99.9%CI 0.48 to 0.81) than those  
22 who sustained an injury during the current season. However, there seem to be no significant  
23 association between IRRP adoption and the severity or cause (overuse *versus* traumatic) of the  
24 most-recent injury (table 2).

25

## 1 **Socio-cognitive determinants of IRRP adoption**

2 Regarding the socio-cognitive determinants of IRRP adoption, the 7,715 athletes participating  
3 in the present study showed mean scores above the theoretical median of 4 (possible scores  
4 ranged from 1 to 7) for attitudes ( $5.54 \pm 1.21$ ) and perceived behavioural control ( $5.45 \pm$   
5  $1.30$ ), and near the theoretical median for subjective norms ( $4.17 \pm 1.26$ ) and intentions ( $4.69$   
6  $\pm 1.69$ ).

7 The comparisons between athletes who reported having adopted an IRRP during their lifetime  
8 or current season and those who did not showed that for all socio-cognitive determinants (i.e.,  
9 attitudes, subjective norms, perceived behavioural control, and intentions), athletes who  
10 declared they adopted an IRRP scored higher than athletes who declared they didn't (for both  
11 lifetime and current season) (table 3).

12

## 13 **Variations in socio-cognitive determinants across athletes' characteristics**

14 Women displayed significantly higher scores for attitudes and significantly lower scores for  
15 perceived behavioural control than men. Athletes practising disciplines categorised as  
16 "explosive" showed significantly higher scores of attitudes and subjective norms than those  
17 practising "endurance". Athletes competing at the highest levels displayed significantly higher  
18 scores for subjective norms, perceived behavioural control and intentions of IRRP adoption  
19 than those competing at the regional or departmental level. More detailed descriptions of the  
20 socio-cognitive determinant variables can be found in the supplementary data.

21 Scores of socio-cognitive determinants of IRRP adoption significantly increased with the  
22 lifetime number of injuries: the more the injuries, the higher the scores. Additionally, a similar  
23 tendency was observed for the time since the most-recent injury occurred: the more recent the  
24 injury, the higher the scores of socio-cognitive determinants of IRRP adoption. Furthermore,  
25 athletes with the most-recent injury categorised as "severe" showed significantly higher

1 scores of intentions to adopt an IRRP than those with a “minor to moderate” most-recent  
2 injury. However, no difference was found between overuse and traumatic injuries (see  
3 supplementary material).

4

## 5 **DISCUSSION**

6 The main findings of the present study were that competing at the highest level, presenting a  
7 larger number of past injuries, and sustaining a most-recent injury during the last or current  
8 season were positively associated with IRRP adoption. Higher scores of socio-cognitive  
9 determinants supported adopting an IRRP in these categories of athletes. Additionally,  
10 athletes who adopted an IRRP during their career or the current season showed higher scores  
11 of socio-cognitive determinants than those who did not.

12 Another important finding of the present study is that, in our sample of 7,715 adult athletics  
13 athletes, more than two-thirds (70%) had never adopted an IRRP and less than a quarter  
14 (22%) had only partially performed an IRRP during their lifetime. Hence, only 7.5% of the  
15 study athletes had already completely performed an IRRP during their lifetime. These results  
16 suggest that there is a need for further work to increase adoption of injury risk reduction  
17 strategies in athletics.

18

### 19 **Higher level and number of previous injuries associated with higher IRRP adoption**

20 The main characteristics associated with IRRP adoption in multivariable models were a  
21 higher level of competition and a higher number of past injuries. These results are in line with  
22 previous investigations on the perception of injury prevention in elite athletes. Athletes  
23 perceive injury prevention as a learning process that comes with experience, higher training  
24 loads, and past injuries.<sup>19</sup> However, the current challenge in injury prevention may be to  
25 generalise efforts among non-elite athletes who have not sustained more than one or two



1 injuries during their careers. Additionally, the current study showed that elite athletes  
2 presented higher scores of subjective norms, perceived behavioural control, and intention  
3 regarding IRRP adoption, as well as the same tendency for athletes who sustained more  
4 injuries, hence increasing their likelihood to adopt an IRRP. For these athletes, the promotion  
5 and delivery of IRRP may benefit from evidence-based practice in the domain of behaviour  
6 change, such as intervention mapping approaches.<sup>28</sup>

7

### 8 **Taking into account the context to enhance IRRP implementation**

9 Bolling et al.<sup>29</sup> suggested revising the “sequence of prevention” of sports injuries and  
10 highlighted the importance of considering the context to provide better grounds for injury  
11 prevention. What athletes (a) think of IRRP (i.e., attitudes), what they (b) think their coaches,  
12 medical staff, teammates, friends, and family think of IRRP (i.e., subjective norms), (c) how  
13 autonomous they are regarding IRRP adoption (i.e., perceived behavioural control), and (d)  
14 how much they intend to adopt an IRRP (i.e., intentions) are core contextual determinants of  
15 their perceptions of injury and injury prevention. Thus, the methods used to promote injury  
16 prevention, and improve athletes’ adoption of IRRP, should consider socio-cognitive  
17 determinants as levers to help athletes change their behaviours.

18 Kok et al.<sup>28</sup> posited that there are three parameters to consider for improving the effectiveness  
19 of a method that targets a change in behaviours: “(a) it must target a determinant that predicts  
20 behaviour; (b) it must be able to change that determinant; (c) it must be translated into a  
21 practical application in a way that preserves the parameters for effectiveness and fits with the  
22 target population, culture, and context”. Respecting these parameters when promoting IRRP  
23 among athletes may increase the chances of achieving higher adherence and compliance rates,  
24 and thus, the efficacy of IRRP. For example, perceived behavioural control has been shown to  
25 be associated with IRRP adoption in our sample of French athletes. Hence, to increase the

1 perceived behavioural control (i.e., determinant) of athletes who have never adopted an IRRP  
2 because they think they are not in control of such exercises, visualising themselves  
3 successfully performing IRRP exercises may be an effective strategy (see Conroy and  
4 Hagger<sup>30</sup> for an example in health psychology). Most athletes are familiar with using mental  
5 imagery (i.e., visualisation) as a tool for mental skill training, so this could easily translate to  
6 imagining themselves performing exercises from the IRRP.

7

## 8 **Limitations**

9 One limitation of the present study is that we focussed solely on the socio-cognitive  
10 determinants of adopting an IRRP and not the perception of the consequences of adopting an  
11 IRRP. As highlighted in the reasoned action approach,<sup>31</sup> the perceived effects of adopting a  
12 behaviour is an important determinant. Previous qualitative research has shown that the  
13 perception of an injury may impact athletes' decisions on their training content.<sup>32</sup> Hence,  
14 further investigations may be needed and should consider the reasoned action approach (i.e.,  
15 an extended version of the theory of planned behaviour) as a framework for investigating the  
16 determinants of IRRP adoption in athletes. Another limitation could be recruitment bias.  
17 Indeed, it is possible that athletes who agree with or who have performed IRRP responded  
18 preferentially to the survey, and thus could be over-represented compared to the general  
19 population of FFA licensed athletes. In addition, although we defined IRRP, no details  
20 regarding different IRRP practices and experiences were collected from participating athletes.  
21 Among athletes who reported IRRP adoption, understanding and/or experiences of IRRP  
22 could differ and thus influence the results.

23 Additionally, the retrospective design of the present study does not make it possible to  
24 conclude that the differences in socio-cognitive determinants (measured as beliefs regarding  
25 IRRP adoption at the time of the survey) explain the differences in IRRP adoption during

1 previous seasons or throughout athletes' careers. In order to be able to estimate the  
2 associations between socio-cognitive determinants and changes in IRRP adoption, a  
3 prospective study design is recommended. However, estimating the differences in socio-  
4 cognitive determinants across groups of individuals who (1) adopt and (2) do not adopt a  
5 behaviour is the recommended method for identifying the most relevant determinants to target  
6 a behaviour change intervention, as suggested by Crutzen, Peters and Noijen.<sup>33</sup> Finally, it was  
7 not possible to conduct an analysis of non-responders to determine how well the study sample  
8 represented the 75,575 eligible athletes.

9

## 10 **Perspectives**

11 As described by Bolling et al.,<sup>29</sup> “the study of any health behaviour in isolation from the  
12 broader social and environmental context is incomplete” and will lead to implementation  
13 issues. Therefore, further research is encouraged to embrace an ecological perspective of  
14 injury prevention by investigating multilevel, contextual, and socioecological factors of IRRP  
15 adoption. A first step in this direction would be to replicate the present study with multiple  
16 stakeholders who are relevant for effective implementation of intervention measures, such as  
17 athletics coaches, as stipulated by O'Brien and Finch.<sup>34</sup>

18 Given the limited number of athletes who have already performed an IRRP during their  
19 lifetime, there is a clear need to improve implementation and adoption of IRRP in order to  
20 improve injury risk reduction in athletics. The results of the present study could serve to  
21 promote IRRP in athletes. In fact, targeting attitudes, subjective norms, and perceived  
22 behavioural control in the material of IRRP promotion campaigns could increase IRRP  
23 adoption. This could also be achieved via education programs for athletes and information  
24 dissemination.

25

1 **CONCLUSIONS**

2 Athletes' characteristics seem to be associated with IRRP adoption and socio-cognitive  
3 determinants of IRRP adoption. As athletes' characteristics are difficult or even impossible to  
4 change, the promotion of IRRP may benefit from targeting athletes' beliefs and intentions to  
5 adopt an IRRP.

6

## 1 REFERENCES

- 2 1. Edouard P, Alonso JM, Jacobsson J, Despiesse F, Branco P, Timpka T. Injury prevention  
3 in athletics: The race has started and we are on track! *IAAF new studies in athletics*.  
4 2015;30(3):69-78.
- 5 2. Edouard P, Cugy E, Dolin R, et al. The Athletics Injury Prevention Programme Can Help  
6 to Reduce the Occurrence at Short Term of Participation Restriction Injury Complaints in  
7 Athletics: A Prospective Cohort Study. *Sports*. 2020;8(6):84. doi:10.3390/sports8060084
- 8 3. Edouard P, Richardson A, Murray A, et al. Ten Tips to Hurdle the Injuries and Illnesses  
9 During Major Athletics Championships: Practical Recommendations and Resources.  
10 *Front Sports Act Living*. 2019;1(12):1-8. doi:10.3389/fspor.2019.00012
- 11 4. Malliaropoulos N, Mendiguchia J, Pehlivanidis H, et al. Hamstring exercises for track and  
12 field athletes: injury and exercise biomechanics, and possible implications for exercise  
13 selection and primary prevention. *Br J Sports Med*. 2012;46(12):846-851.  
14 doi:10.1136/bjsports-2011-090474
- 15 5. Gledhill A, Forsdyke D, Murray E. Psychological interventions used to reduce sports  
16 injuries: a systematic review of real-world effectiveness. *Br J Sports Med*.  
17 2018;52(15):967-971. doi:10.1136/bjsports-2017-097694
- 18 6. Klügl M, Shrier I, McBain K, et al. The Prevention of Sport Injury: An Analysis of 12  
19 000 Published Manuscripts: *Clin J Sport Med*. 2010;20(6):407-412.  
20 doi:10.1097/JSM.0b013e3181f4a99c
- 21 7. Lauersen JB, Bertelsen DM, Andersen LB. The effectiveness of exercise interventions to  
22 prevent sports injuries: a systematic review and meta-analysis of randomised controlled  
23 trials. *Br J Sports Med*. 2014;48(11):871-877. doi:10.1136/bjsports-2013-092538

- 1 8. Edouard P, Steffen K, Navarro L, Mansournia MA, Nielsen RO. Methods matter: dealing  
2 with low compliance in sports injury trials analyses using instrumental variable analysis.  
3 *Br J Sports Med.* 2020;Online First. doi:10.1136/bjsports-2020-102155
- 4 9. Nielsen RO, Bertelsen ML, Ramskov D, et al. Randomised controlled trials (RCTs) in  
5 sports injury research: authors—please report the compliance with the intervention. *Br J*  
6 *Sports Med.* 2020;54(1):51-57. doi:10.1136/bjsports-2019-100858
- 7 10. Bahr R, Thorborg K, Ekstrand J. Evidence-based hamstring injury prevention is not  
8 adopted by the majority of Champions League or Norwegian Premier League football  
9 teams: the Nordic Hamstring survey. *Br J Sports Med.* 2015;49(22):1466-1471.  
10 doi:10.1136/bjsports-2015-094826
- 11 11. Goode AP, Reiman MP, Harris L, et al. Eccentric training for prevention of hamstring  
12 injuries may depend on intervention compliance: a systematic review and meta-analysis.  
13 *Br J Sports Med.* 2015;49(6):349-356. doi:10.1136/bjsports-2014-093466
- 14 12. Finch C. A new framework for research leading to sports injury prevention. *J Sci Med*  
15 *Sport.* 2006;9(1-2):3-9. doi:10.1016/j.jsams.2006.02.009
- 16 13. Donaldson A, Finch C. Planning for implementation and translation: seek first to  
17 understand the end-users' perspectives. *Br J Sports Med.* 2012;46(5):306-307.  
18 doi:10.1136/bjsports-2011-090461
- 19 14. Chan DKC, Hagger MS. Theoretical Integration and the Psychology of Sport Injury  
20 Prevention. *Sports Med.* 2012;42:725-732. doi:10.1007/BF03262291
- 21 15. Kwasnicka D, Dombrowski SU, White M, Sniehotta F. Theoretical explanations for  
22 maintenance of behaviour change: A systematic review of behaviour theories. *Health*  
23 *Psychol Rev.* 2016;10(3):277-296. doi:10.1080/17437199.2016.1151372
- 24 16. Ajzen I. The theory of planned behavior. *Organ Behav Hum Decis Process.*  
25 1991;50(2):179-211. doi:10.1016/0749-5978(91)90020-T

- 1 17. Chan DKC, Hagger MS. Transcontextual Development of Motivation in Sport Injury  
2 Prevention Among Elite Athletes. *J Sport Exerc Psychol.* 2012;34(5):661-682.  
3 doi:10.1123/jsep.34.5.661
- 4 18. Chan DKC, Lee ASY, Hagger MS, Mok K-M, Yung PS-H. Social psychological aspects  
5 of ACL injury prevention and rehabilitation: An integrated model for behavioral  
6 adherence. *Asia-Pac J Sports Med Arthrosc Rehabil Technol.* 2017;10:17-20.  
7 doi:10.1016/j.asmart.2017.10.001
- 8 19. Bolling C, Delfino Barboza S, van Mechelen W, Pasma HR. Letting the cat out of the  
9 bag: athletes, coaches and physiotherapists share their perspectives on injury prevention  
10 in elite sports. *Br J Sports Med.* 2020;54(14):871-877. doi:10.1136/bjsports-2019-100773
- 11 20. Ryan RM, Deci EL. *Self-Determination Theory: Basic Psychological Needs in*  
12 *Motivation, Development, and Wellness.* Guilford Press; 2017.
- 13 21. Timpka T, Alonso JM, Jacobsson J, et al. Injury and illness definitions and data collection  
14 procedures for use in epidemiological studies in Athletics (track and field): Consensus  
15 statement. *Br J Sports Med.* 2014;48(7):483-490. doi:10.1136/bjsports-2013-093241
- 16 22. Edouard P, Navarro L, Branco P, Gremeaux V, Timpka T, Junge A. Injury frequency and  
17 characteristics (location, type, cause and severity) differed significantly among athletics  
18 ('track and field') disciplines during 14 international championships (2007–2018):  
19 implications for medical service planning. *Br J Sports Med.* 2020;54(3):159-167.  
20 doi:10.1136/bjsports-2019-100717
- 21 23. Roussel Y. lavaan: An R package for structural equation modeling. *J Stat Softw.*  
22 2012;48(2):1-36.
- 23 24. Hu L, Bentler PM. Fit indices in covariance structure modeling: Sensitivity to  
24 underparameterized model misspecification. *Psychol Methods.* 1998;3(4):424-453.  
25 doi:10.1037/1082-989X.3.4.424

- 1 25. Browne MW, Cudeck R. Alternative Ways of Assessing Model Fit. *Sociol Methods Res.*  
2 1992;21(2):230-258. doi:10.1177/0049124192021002005
- 3 26. Kim JH, Choi I. Choosing the Level of Significance: A Decision- theoretic Approach.  
4 *Abacus.* 2021;57(1):27-71. doi:10.1111/abac.12172
- 5 27. Edouard P, Junge A, Sorg M, Timpka T, Branco P. Illnesses during 11 international  
6 athletics championships between 2009 and 2017: incidence, characteristics and sex-  
7 specific and discipline-specific differences. *Br J Sports Med.* 2019;53(18):1174-1182.  
8 doi:10.1136/bjsports-2018-100131
- 9 28. Kok G, Gottlieb NH, Peters GJY, et al. A taxonomy of behaviour change methods: an  
10 Intervention Mapping approach. *Health Psychol Rev.* 2016;10(3):297-312.  
11 doi:10.1080/17437199.2015.1077155
- 12 29. Bolling C, van Mechelen W, Pasman HR, Verhagen E. Context Matters: Revisiting the  
13 First Step of the ‘Sequence of Prevention’ of Sports Injuries. *Sports Med.*  
14 2018;48(10):2227-2234. doi:10.1007/s40279-018-0953-x
- 15 30. Conroy D, Hagger MS. Imagery interventions in health behavior: A meta-analysis. *Health*  
16 *Psychol.* 2018;37(7):668-679. doi:10.1037/hea0000625
- 17 31. Fishbein M, Ajzen I. *Predicting and Changing Behavior: The Reasoned Action Approach.*  
18 Psychology Press; 2010.
- 19 32. Bolling C, Delfino Barboza S, van Mechelen W, Pasman HR. How elite athletes, coaches,  
20 and physiotherapists perceive a sports injury. *Transl Sports Med.* 2019;2(1):17-23.  
21 doi:10.1002/tsm2.53
- 22 33. Crutzen R, Peters GJY, Noijen J. Using Confidence Interval-Based Estimation of  
23 Relevance to select social-cognitive determinants for behaviour change interventions.  
24 *Front Public Health.* 2017;5:165. doi:10.3389/fpubh.2017.00165



1 34. O'Brien J, Finch CF. The implementation of musculoskeletal injury-prevention exercise  
2 programmes in team ball sports: a systematic review employing the RE-AIM framework.  
3 *Sports Med.* 2014;44:1305-1318. doi:10.1007/s40279-014-0208-4

4

5

1 **TABLES**

2 **Table 1** Characteristics of the 7,715 athletics (track and field) athletes included in the  
 3 present study.

<b>Variables</b>	<b>Number (%)</b>	<b>Median (range)</b>
Age (years)		38 (18-87)
Sex		
<i>Men</i>	4,842 (62.8 %)	
<i>Women</i>	2,873 (37.2 %)	
Main sport practice		
<i>Sprints</i>	824 (10.9 %)	
<i>Hurdles</i>	232 (3.0%)	
<i>Jumps</i>	416 (5.4 %)	
<i>Throws</i>	293 (3.8 %)	
<i>Combined events</i>	153 (2.0 %)	
<i>Middle and long distances</i>	1,549 (20.1 %)	
<i>Marathon (incl. semi)</i>	1,069 (14.0 %)	
<i>Race walking</i>	215 (2.8 %)	
<i>Road running</i>	1,871 (24.3 %)	
<i>Trail and mountain running</i>	1,093 (14.2 %)	
Discipline practice experience (years)		7 (1-63)
Competition level		
<i>International</i>	450 (5.8 %)	
<i>National</i>	2,209 (28.6 %)	
<i>Regional</i>	3,136 (40.6 %)	
<i>Departmental</i>	1,920 (24.9 %)	
Lifetime adoption of IRRP		
<i>Yes, entirely</i>	580 (7.5 %)	
<i>Yes, partially</i>	1,705 (22.1 %)	
<i>Not at all</i>	5,430 (70.4 %)	
Current season's adoption of IRRP		
<i>Yes, entirely</i>	504 (6.5 %)	
<i>Yes, partially</i>	1,282 (16.6 %)	
<i>Not at all</i>	5,929 (76.9 %)	
Lifetime number of injuries		
<i>None</i>	772 (10.0 %)	
<i>1</i>	1,436 (18.6 %)	
<i>2</i>	1,672 (21.7 %)	
<i>3</i>	1,246 (16.2 %)	
<i>4</i>	727 (9.4 %)	
<i>5</i>	606 (7.9 %)	
<i>6</i>	275 (3.6 %)	
<i>7</i>	124 (1.6 %)	
<i>8</i>	104 (1.3 %)	
<i>9</i>	41 (0.5 %)	
<i>10 or more</i>	712 (9.2 %)	
Time since most-recent injury (n = 6,943)		
<i>Less than 6 months (current season)</i>	2,603 (37.5 %)	
<i>6 months to 5 years</i>	3,619 (52.1 %)	
<i>5 to 10 years</i>	479 (6.9 %)	

<i>More than 10 years</i>	242 (3.5 %)	
Location of the most-recent injury (n = 6,943)	8 (0.1 %)	
<i>Head and neck</i>	157 (2.3 %)	
<i>Upper limb</i>	283 (4.1 %)	
<i>Trunk</i>	583 (8.4 %)	
<i>Hip/groin</i>	1,091 (15.7 %)	
<i>Thigh</i>	1,357 (19.5 %)	
<i>Knee</i>	1,158 (16.7 %)	
<i>Lower leg</i>	810 (11.7 %)	
<i>Achilles tendon</i>	806 (11.6 %)	
<i>Ankle</i>	690 (9.9 %)	
<i>Foot</i>		
Time loss after the most-recent injury (n = 6943)	373 (5.4 %)	
<i>Continued to practice as usual</i>	680 (9.8 %)	
<i>1 to 7 days</i>	2,435 (35.1 %)	
<i>8 to 28 days</i>	2,696 (38.8 %)	
<i>29 days to 6 months</i>	759 (10.9 %)	
<i>More than 6 months</i>		
Cause of the most-recent injury (n = 6943)		
<i>Traumatic</i>	3,278 (47.2 %)	
<i>Overuse</i>	3,665 (52.8 %)	

1 IRRP: Injury risk reduction programme.

1 **Table 2** Associations between athletes' characteristics and injury risk reduction programmes (IRRP) adoption during lifetime and during  
 2 the current season using the binomial logistic regression.

	Lifetime IRRP adoption				Current season's IRRP adoption			
	Univariate model		Adjusted for all factors		Univariate model		Adjusted for all factors	
	<i>OR</i>	<i>99.9% CI</i>	<i>AOR</i>	<i>99.9% CI</i>	<i>OR</i>	<i>99.9% CI</i>	<i>AOR</i>	<i>99.9% CI</i>
Sex (reference female athletes)	0.88	0.78-1.10	0.88	0.73-1.07	0.90	0.74-1.08	0.89	0.73-1.09
Age (years)	1.01	1.00-1.02	1.02	1.00-1.02	1.01	1.00-1.01	1.01	1.00-1.02
Main discipline (reference endurance)	<b>0.72</b>	<b>0.60-0.87</b>	0.91	0.73-1.13	0.87	0.71-1.06	1.02	0.81-1.30
Discipline practice experience (years)	0.99	0.98-1.00	0.98	0.97-1.00	0.99	0.98-1.00	0.99	0.98-1.00
Competitive level (reference international or national)	<b>1.82</b>	<b>1.53-2.15</b>	<b>1.66</b>	<b>1.39-1.99</b>	<b>1.55</b>	<b>1.29-1.86</b>	<b>1.48</b>	<b>1.22-1.80</b>
Lifetime number of injuries (reference no injuries)								
1	1.06	0.75-1.50	used as reference		0.84	0.56-1.23	used as reference	
2	0.91	0.65-1.26	0.85	0.72-1.00	0.76	0.52-1.10	0.93	0.69-1.26
3	<b>0.70</b>	<b>0.50-0.99</b>	0.67	0.64-1.12	<b>0.61</b>	<b>0.41-0.89</b>	0.78	0.57-1.07
4 or 5	<b>0.59</b>	<b>0.42-0.82</b>	<b>0.57</b>	<b>0.50-0.91</b>	<b>0.54</b>	<b>0.36-0.78</b>	<b>0.70</b>	<b>0.51-0.95</b>
More than 5	<b>0.49</b>	<b>0.35-0.69</b>	<b>0.48</b>	<b>0.35-0.65</b>	<b>0.45</b>	<b>0.31-0.66</b>	<b>0.61</b>	<b>0.44-0.84</b>
Time since most-recent injury (reference more than 5 years since the most-recent injury)								
Last 5 seasons	0.87	0.69-1.09	1.15	0.85-1.56	<b>0.73</b>	<b>0.57-0.95</b>	0.87	0.61-1.22
Current season	0.92	0.72-1.16	1.40	1.00-1.95	<b>0.62</b>	<b>0.48-0.81</b>	0.80	0.55-1.14
Time loss after most-recent injury (reference minor to moderate (< 28 days))	1.00	0.84-1.19	1.03	0.86-1.23	0.97	0.80-1.16	0.96	0.79-1.16
Cause of most-recent injury (reference traumatic)	1.03	0.87-1.23	0.97	0.81-1.16	0.95	0.79-1.14	0.93	0.77-1.13

- 1 Note: OR: odds ratio. CI: confidence interval. AOR: adjusted odds ratio (adjusted for all variables). Bold values are for significant OR (when 1 is
- 2 not included in the 99.9%CI). OR above 1 means a tendency for the reference group to adopt IRRP more than the other groups, and OR below 1
- 3 means a tendency for the reference group to adopt IRRP less than the other groups.

1 **Table 3** Variations in socio-cognitive determinants by injury risk reduction programmes (IRRP) adoption.

	Lifetime IRRP adoption			Current season IRRP adoption		
	Yes (n = 2,285)	No (n = 5,430)	<i>p</i>	Yes (n = 1,786)	No (n = 5,929)	<i>p</i>
Attitudes	5.88 ± 1.03	5.40 ± 1.25	*	5.97 ± 0.99	5.41 ± 1.24	*
Subjective norms	4.74 ± 1.17	3.93 ± 1.22	*	4.89 ± 1.12	3.95 ± 1.22	*
Perceived behavioural control	5.94 ± 1.07	5.24 ± 1.33	*	6.06 ± 1.00	5.26 ± 1.32	*
Intentions	5.61 ± 1.39	4.30 ± 1.65	*	5.91 ± 1.21	4.32 ± 1.64	*

2 Note: Values are expressed as mean (M) ± standard deviation (SD). \**p* < 0.001.