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Sprint Acceleration Mechanical Outputs and Lower Limb Injuries: A Follow-Up of Sprint, Jumps and Combined Events Athletes during an Athletics Season

Mechanische Leistung bei der Sprintbeschleunigung und Verletzungen der unteren Extremitäten: Eine Nachuntersuchung von Sprint-, Sprung- und Mehrkampfsportlern während einer Leichtathletiksaison

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Summary

› **Problem:** We aimed to explore the potential association between sprint running horizontal force production capacities (the theoretical maximum horizontal force that the lower limbs can produce at zero velocity: F_{H0}, and the theoretical maximum velocity until which they can produce force (velocity at zero force): v_0) and occurrence of lower limb injuries (LLI) in athletics (track and field) athletes through a season.

› **Methods:** We performed a prospective cohort study with data collection of F_{H0} and v_0 and their week-to-week changes (dF_{H0} and dv_0, respectively) and LLI in 16 athletes practicing sprints, jumps or combined events in the same training group during the 2021/2022 season (37 weeks). We performed a multivariable binomial logistic regression with LLI (yes/no) as the dependent variable, and F_{H0} and v_0, dF_{H0} and dv_0 as explanatory variables, adjusted for individual athletes and LLI during the previous week (yes/no). Risk indicators were presented as odd ratios (OR) and 95% confidence intervals (95% CI).

› **Results:** The multivariable binomial logistic regression showed that a higher F_{H0} was associated with lower LLI risk (OR=0.12 (95%CI: 0.00-0.89).

› **Conclusion:** Lower F_{H0} was associated with higher risk of sustaining a new lower limb injury during the next week. Although caution should be taken on these preliminary results (e.g., small athletes' sample, missing measurements, few confounding factors included), monitoring the F_{H0} could be one additional relevant approach to detect LLI in athletics.

KEY WORDS:
Injury Prevention, Sprinting, Biomechanics, Field Testing, Screening

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Introduction

In athletics (track and field), performance serves as the cornerstone of an athlete's career, with performance appraisal typically based on competition results. Performance success involves numerous factors, and the best athletes in youth categories are rarely the best at the adult level, and vice-versa (1, 2). Sports injury is one reported factor that could explain the athletics performance failure (3, 4, 5, 6) and youth elite athletes' career failure (7, 8). The relationships between injuries and performance have thus been explored in team sports (e.g., football, basketball, and rugby) (9), as well as in athletics (3, 4, 5, 6). Raysmith and Drew (3) demonstrated that injuries during the preparation of international athletics events adversely affected international-level athletes' subsequent performances. Edouard et al. (4) reported a correlation between lower injury rates per team and higher medal counts during international athletics championships. In international athletics championships of combined events, injuries were associated with reduced chances of winning a medal (5). Chapon et al. (6) described the injuries and performances of 8 national-level athletes and reported that higher injuries were associated with lower odds of international championships participation. There is thus evidence in athletics of the negative impact of injuries on athletics performance in competition (3, 4, 5, 6).

However, using only in-competition performance as an indicator of an athlete's performance can be a limitation (6). Indeed, various factors influence the performances in competition (e.g., physical, psychological, and environmental factors) (6). Furthermore, the number of in-competition performances is limited, by nature, to the number of competitions performed by an athlete. Since competitions can be rare, collected over a short period in the season, and with long periods without any performances, there could be long periods without in-competition performances limiting the longitudinal follow-up of athletes' performance using these values (6). Regular monitoring of physical performances using simple physical field tests instead of in-competition performances only could be an appropriate approach to analyse more in-depth the relationships between injuries and performances (6). ›

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Table 1

Characteristics of the 16 included athletes, as well as overall results regarding performances and lower limb injuries. M=man; W=woman; m=meter; s=second: kg: kilogramme; SD: standard deviation; max: maximum; min=minimum; pts=points; PB=Personal Best.

ATHLETES	SEX	HEIGHT (M)	BODY MASS (KG)	AGE (YE-ARS)	MAIN DISCIPLINE(S)	NUMBER OF ATHLETICS YEARS AT THE START OF FOLLOW UP (YEARS)	NUMBER OF TRAINING TEST PERFORMAN-CES	NUMBER OF LOWER LIMB INJURY BEFORE THE FOLLOW UP	NUMBER OF LOWER LIMB INJURY DURING THE FOLLOW UP
Athlete 1	M	180	66	22	400m (51.31s)	7	13	1	2
Athlete 2	M	168	56	16	200m (31.03s)/60m (9.35s)	0	20	0	1
Athlete 3	W	170	80	20	100m/60m	0	8	0	0
Athlete 4	W	166	53	16	200m (27.00s)/100m (13.23s)/60m (8.49s)	9	13	2	0
Athlete 5	M	170	60	18	100m (11.93s)/60m (7.77s)	9	11	0	0
Athlete 6	W	160	50	16	100m (12.90s)/60m(8.36s)	5	22	0	0
Athlete 7	W	170	62	18	long jump (5.55m)/100m (13.05s)/60m (8.23s)	6	4	4	1
Athlete 8	M	170	60	21	100m (11.61s)/60m (7.53s)	8	18	1	0
Athlete 9	W	160	48	21	long jump (5.48m)/100m (12.63s)/60m (8.14s)	10	7	0	0
Athlete 10	M	184	75	19	100m/60m	0	19	0	0
Athlete 11	M	178	70	19	pole vault (4.76m)	11	12	5	3
Athlete 12	M	170	55	23	400m (55.45s)	5	9	0	0
Athlete 13	M	179	74	25	100m (11.78s)/60m (7.83s)	10	12	1	3
Athlete 14	W	162	51	16	100m (13.32s)/60m (8.41s)	5	13	1	6
Athlete 15	M	183	78	16	Decathlon (4166 pts), Heptathlon (3453 pts)	10	6	2	0
Athlete 16	M	180	64	22	200m (24.77s)/400m (52.54s)	6	20	1	1
TOTAL	-	-	-	-	-	**101**	**207**	**20**	**17**
MEAN	-	**171.9**	**62.6**	**19.2**	-	**6.3**	**12.9**	**1.3**	**1.06**
SD	-	**7.9**	**10.3**	**2.9**	-	**3.7**	**5.5**	**1.6**	**1.69**
MAX	-	**184.0**	**80.0**	**24.8**	-	**11**	**22**	**5**	**6**
MIN	-	**160.0**	**48.0**	**15.8**	-	**0**	**4**	**0**	**0**

Among simple physical field tests, evaluation of the sprint acceleration mechanical outputs could be relevant (10). Such an evaluation could be of interest, because, the ability to produce and apply high levels of force in the horizontal direction over the entire acceleration has been shown to be a strong determinant of sprint acceleration performance (10, 11, 12). This ability is well described by a linear Force-velocity relationship (i.e. F-v profile) (10). The F-v profile is an integrative feature of the athlete's mechanical output during all-out sprinting acceleration efforts (10, 11), and can be summarized by two extreme theoretical values: the theoretical maximum horizontal force that the lower limbs can produce at zero velocity (F_{H0}) and the theoretical maximum velocity until which they can produce force (velocity at zero force) (v_0) (10). In this framework, we will mainly consider the component of the ground reaction force that causes the movement of the athlete's center of mass in the overall running direction, i.e. the step-averaged antero-posterior (horizontal) force. For simplicity and clarity of the narrative, this component will be named "horizontal force" or "FH" in this manuscript. Conceptually, F_{H0} can represent the force production capacity at very low velocity, and v_0 can represent the force production capacity at very high velocity (10). The interest of such physical field tests in clinical field comes from i) the fact that this is a functional evaluation similar to actions performed by athletes in training and competition, and ii) the reported associations between F_{H0} and injuries (13, 14). In football players, Mendiguchia et al. (13) reported a lower F_{H0} at the time of return to sport after a hamstring injury in injured players compared to uninjured players. Edouard et al. (14) extended this result by reporting that low within-season F_{H0} was associated with future hamstring injuries in football players. They thus proposed using sprint acceleration mechanical output measurements to assess the risk of hamstring injuries (14). In this context, we hypothesized that regular monitoring of sprint acceleration mechanical output (F_{H0} and v_0) could be a way to monitor injury risk. A F_{H0} decrease at any time of a season might serve as a pre-injury marker without apparent symptoms.

In this context, the primary aim of this study was to explore the potential association between sprint running horizontal force production capacities (F_{H0} and v_0) and occurrence of lower limb injuries in athletics (track and field) athletes through a season. The secondary aim was to explore the potential consequences of a lower limb injury on sprint running horizontal force production capacities (F_{H0} and v_0).

Table 2

Odd ratio (OR) with 95% confidence interval (95% CI) of the association between FH0 (maximum horizontal force) and V0 (velocity at zero force), dFH0 and dV0 and LLI (lower limb injuries) during the 37 weeks of the study follow-up and adjusted for individual athletes and LLI during the previous week (yes/no).

EXPLANATORY VARIABLES	MULTIVARIABLE ANALYSIS (N=16 ATHLETES AND 207 ATHLETES-MEASUREMENTS)	
	OR	(95% CI)
F_{H0} (N.kg^{-1})	0.12	(0.00 to 0.88)
dF_{H0} (%)	1.12	(1.00 to 1.29)
V_0 (m.s^{-1})	0.27	(0.00 to 7.62)
dV_0 (%)	1.08	(0.86 to 3.87)

Materials and Methods

Study Design and Overall Procedure

We performed a prospective cohort study with data collection of physical performances (i.e., sprint running horizontal force production capacities) and lower limb injuries in athletics (track and field) athletes during the 2021/2022 season (37 weeks). The study was conducted in accordance with the Helsinki Declaration and was reviewed and approved by the Saint-Etienne University Hospital Ethical Committee (Institutional Review Board: IORG0007394).

Population

At the start of the season, we contacted a coach (AP) of the Coquelicot 42 Athletics Club (http://coquelicot42.athle.com), we explained to him the study objectives, procedures and risks, via oral communication and a paper information sheet, and asked him about his participation in this study. After his approval, we proceeded with athletes recruitment among athletes of his training group including about 20 athletes. To be included in the present study, athletes had to meet the following inclusion criteria:

- be licensed at the French Federation of Athletics (https://www.athle.fr) for competition;
- be licensed within the Coquelicot 42 Club and trained by the same coach (AP) (we decided to work with this coach because he was already familiar with sprint acceleration mechanical output measurements and was interested by the research topic. Moreover, he coached a large group of athletes);
- train at least 3 times per week in explosive events (sprint, jump, hurdle, combined events);
- be aged between 16 and 25 years old.

A written information letter about the study objectives and procedures and risks was sent to the eligible athletes at the beginning of the study follow-up and their legal guardians when under 18 years old.

Patient Involvement

The athletes were not involved in the design of the study, development and/or selection of outcome measures, recruitment, however a coach considered as a public was involved in the design of the study. The study results will be disseminated to the participants through an infographic, which will also be disseminate to coaches. Participants are acknowledged in the manuscript.

Athlete's Characteristics Data Collection

Athletes' characteristics were collected at the start of the follow-up using an online questionnaire: sex, date of birth, height, body mass, main discipline, and number of years of athletics practice. Date of birth was collected to calculate the age of each included athlete at the start of the follow-up.

Sprint Acceleration Mechanical Output Data Collection

During the 37 weeks of the 2021/2022 season, we performed a weekly follow-up of the sprint acceleration mechanical outputs to determine the two sprint-running horizontal force production capacities: F_{H0} and v_0. The same examiner (AP) performed all the measurements during the 37 weeks of the season. He used an iPad Pro (Apple Inc., California, USA) and My Sprint (15) software version 2.0.1 to measure F_{H0} and v_0. Romero-Franco et al. established the My Sprint software's precision comparable to conventional field methods like a radar gun (F_{H0}: ICC=0.999 (0.999-1.000); v_0: ICC=0.987 (0.979-0.992)) (15). This cost-effective and efficient method facilitated precise data collection, allowing coaches (AP) to integrate it easily and seamlessly into training sessions.

After usual warm-up before a maximal sprint, athletes underwent a maximal 30-m sprint, outdoors on the track with spikes, starting from a crouching position with the right hand on the track, with video recording by AP following always the same procedure and following Romero-Franco et al. (15)'s recommendations despite reducing the distance from 40m to 30m which does not alter the F_{H0} and v_0 measurements. To record the video of each sprint, the iPad Pro was mounted to a tripod (in the frontal plane) in order to film the sprint from the side, at the 20 m marker and at 18 m from the track, in order to register the entire sprint. Since the iPad Pro was in a fixed position, video parallax was corrected to ensure 5-, 10-, 15-, 20-, and 30- m split times were measured properly (15). The video recording was made at 240 per second. All the videos were then processed by the same researcher (JC) using My Sprint software (15), and exported to Excel for statistical analysis.

The determination of F_{H0} and v_0 was thus based on the video recording of the sprint running to capture the velocity (i.e., calculated using the split times and the distance at 5-, 10-, 15-, 20-, and 30- m), as well as body mass, height, and age. The determination of F_{H0} and v_0 was an estimation of these values using an inverse dynamic approach applied to the runner body center of mass, which corresponded to the pelvic of the athletes (10).

We used F_{H0} (N/Kg) and v_0 (m/s) for analysis, as well as the week-to-week changes of the F_{H0} and v_0, dF_{H0} and dv_0, respectively, calculated as the relative variation between the value of week n compared to week n-1: $dF_{H0} = ((F_{H0}$ week n)-(F_{H0} week n-1))/(F_{H0} week n-1); $dv_0 = ((v_0$ week n)-(v_0 week n-1))/(v_0 week n-1). When the values were not measured during a week n or n-1, the related weekly variation were not calculated.

Injury Definition and Data Collection

In the present study, we used the definition of injury used by Edouard et al. (16): "an injury complaint leading to participation restriction" (ICPR) corresponds to a pain, physical complaint or musculoskeletal lesion sustained by an athlete during participation in athletics training or competition that lead to a reduction or full absence in athletics participation.

Table 3

Descriptive analysis of FH0 (maximum horizontal force) and V0 (velocity at zero force) values and injuries. LLI=lower limb injury; SD=standard deviation; max=-maximum; min=minimum.

ATHLETES	NUMBER OF THE LLI OCCUREN-CE	DATE OF LLI	DURATION BETWEEN LLI AND FIRST PRE-INJURY TEST IN DAYS	DURATION BETWEEN LLI AND FIRST POST-INJURY TEST IN DAYS	DIFFERENCE FH0 BETWEEN PRE-POST INJURY TEST	TIME TO RETURN AT PRE-LLI FH0 PERFORMANCE IN DAYS	DIFFERENCE V0 BETWEEN PRE-POST INJURY TEST	TIME TO RETURN AT PRE INJURY V0 IN DAYS
Athlete 1	1	16.01.2022	44	12	-0.07	12	0.35	19
Athlete 1	2	16.03.2022	8	1	-0.90	1	0.85	No recovery pre-injury value at the end of follow-up
Athlete 2	1	10.01.2022	45	8	-1.13	8	-0.05	8
Athlete 7	1	20.11.2021	23	129	1.90	129	-0.46	129
Athlete 11	1	20.11.2021	31		0.36	150	0.38	88
Athlete 11	2	27.11.2021	38	62	0.12	81	0.11	62
Athlete 11	3	18.12.2021	2	4	0.12	60	0.11	41
Athlete 13	1	29.03.2022	1	7	-0.10	No recovery pre-injury value at the end of follow-up	0.46	No recovery pre-injury value at the end of follow-up
Athlete 13	2	31.03.2022	5	5	-0.10	5	0.46	No recovery pre-injury value at the end of follow-up
Athlete 13	3	05.04.2022	7	28	-0.53	28	-0.40	28
Athlete 14	1	20.12.2021	24	71	1.32	155	-0.38	71
Athlete 14	2	08.03.2022	7	42	0.30	56	-0.30	42
Athlete 14	3	19.04.2022	42	14	-1.38	14	0.63	No recovery pre-injury value at the end of follow-up
Athlete 14	4	03.05.2022	14	7	-0.66	7	0.13	37
Athlete 14	5	10.05.2022	7	14	-0.43	14	-0.01	14
Athlete 14	6	24.05.2022	14	16	1.47	No recovery pre-injury value at the end of follow-up	-0.38	16
Athlete 16	1	04.01.2022	32	24	0.19	72	-0.68	24
MEAN	-	-	**22.0**	**28.7**	**0.03**	**52.8**	**0.05**	**44.5**
SD	-	-	**14.2**	**32.9**	**0.89**	**54.3**	**0.43**	**34.8**
MAX	-	-	**45.0**	**129.0**	**1.9**	**155.0**	**0.85**	**129.0**
MIN	-	-	**5.0**	**1.0**	**-1.38**	**1.0**	**-0.68**	**8.0**

The potential athletes' IPCR histories during the lifetime prior to the start of the follow-up were collected at the start of the follow-up during the baseline data collection through the online questionnaire. The IPCR that occurred during the season were collected prospectively by i) the sports physician of the Coquelicot 42 Club (PE) if athletes asked for medical consultations, ii) the coach (AP) or one researcher (JC) in close contact with athletes, and iii) checked at two times during the follow-up (i.e., after 24 weeks and at the end of the follow-up) by a paper survey asking for any injuries during the period of follow-up in order to avoid any missing information. For each IPCR, we recorded: the date of occurrence, location, and type following the consensus statement of epidemiolocal data collection in athletics (17).

In the present study, we only considered in the analyses lower limb injuries (LLI), corresponding to injuries involving the hip/groin, the glutes, the thigh, the knee, the lower leg, the ankle, or the foot), as they are mostly linked to the sprint acceleration mechanical output (13, 14).

Statistical Analysis

We first performed a descriptive analysis of the collected data, using numbers with percentages for categorical variables, and means with standard deviations (±SD) for continuous variables.

For the primary aim of exploring the potential association between sprint running horizontal force production capacities and lower limb injury occurrence, we performed a multivariable binomial logistic regression with LLI (yes/no) as the dependent variable, and F_{H0}, v_0, dF_{H0} and dv_0 as explanatory variables, adjusted for individual athletes and LLI during the previous week (yes/no). Analyses were adjusted to the individual athlete since all athletes completed more than one measurement (14, 18). The unit of analysis was the athlete-measurement. Risk indicators were presented as Odd Ratios (OR) with 95% confidence intervals (95%CI).

For the secondary aim exploring the potential consequences of LLI on the sprint running horizontal force production capacities, we calculated the duration in days between LLI and last pre- and first post- injury tests, the difference for F_{H0} and v_0 between pre- and post-injury tests, and finally the duration to recover the level of pre-test performance for F_{H0} and v_0.

The significance level was initially set at P<0.05. Data analyses were performed using excel (Office, Microsoft®, 2021, Redmond, DC, USA) and R [version 4.0.2, © 2020 The Foundation for Statistical Computing (Comprehensive R Archive Network, http://www.R-project.org)] using R library "questionr".

Results

Population

Sixteen athletes were included in the present study and were followed during 37 weeks from the 14/10/2021 to the 27/06/2022. There were 6 female (37.5%) and 10 male (62.5%) athletes, with a mean (±SD) age of 19.2±2.9 years at their inclusion. The characteristics of these athletes are presented in the table 1.

Sprint Acceleration Mechanical Output

During the 37-week study period, the weekly sprint acceleration mechanical output measurements were performed during 30 weeks. There was a total of 207 individual measurements over the 480 possible measurements. Reasons were not available for all missing measurements, but most of the missing measurements were due to injuries. This thus represented a mean of 12.9±5.5 sprint acceleration mechanical output measurements per athlete (table 1), ranging from 4 to 22 individual measurements, with an adherence to the measurements ranging from 13.3 to 73.3%.

Over the measurements and athletes, the mean values for F_{H0} were 7.58±1.16 N/kg, for v_0: 8.55±0.76 m/s, for dF_{H0}: 1.06±12.28 %, and for dv_0: 0.27±5.37%.

Injuries

Before the follow-up, a total of 20 LLI were reported in 9 athletes (LLI lifetime prevalence of 45%), with a mean number of 1.3±1.6 LLI per athlete (table 1). During the 37-weeks study period, there was a total of 17 LLI in 7 athletes (LLI one-season prevalence of 44%), with an average of 1.1±1.8 LLI per athlete (table 1).

Relationships between Sprint Acceleration Mechanical Output Performances and Injuries

The multivariable binomial logistic regression reported that a higher F_{H0} during a week was associated with lower LLI risk during the next week (OR=0.12 (95%CI: 0.00 to 0.89) (table 2). Every 1 N/kg increase of F_{H0} was associated with 88% lower risk of sustaining a LLI injury during the next week.

Potential Consequences of a Lower Limb Injury on the Sprint Running Horizontal Force Production Capacities

Our descriptive analysis of the potential changes in F_{H0} and v_0 values after LLI showed that on average, injured athletes took 52.8±54.3 days to recover their pre-injury F_{H0} value and 44.5±34.8 days to recover their pre-injury v_0 value (table 3). The mean difference between last pre- and first post-injury measurements were 0.03±0.89 N/kg for F_{H0} and 0.05±0.43 m/s for v_0 (table 3). Two injuries resulted in no return to a pre-injury value for F_{H0} and four injuries resulted in no return to a pre-injury value for v_0.

Discussion

The main findings of the present study were that 1) a higher horizontal force production capacity at low velocity (F_{H0}) was associated with lower risk of sustaining a new lower limb injury during the next week, and 2) after a lower limb injury on average, athlete took about 1.5 months to recover their F_{H0} and v_0 pre-injury values, however this duration varied extremely according to athletes.

Our primary aim was to to explore the potential association between sprint running horizontal force production capacities (F_{H0} and v_0) and occurrence of lower limb injuries in athletics (track and field) athletes through a season. As Edouard et al. (14) showed for hamstring injuries, we showed that higher F_{H0} at any time of a season was associated with lower risk of sustaining a new lower limb injury during the following week: every 1 N/kg increase of F_{H0} was associated with 88% lower risk of sustaining a LLI injury during the next week. The present study thus represents an additional argument supporting the interest of regular monitoring of sprint acceleration mechanical output (F_{H0} and v_0) to monitor injury risk. It seems that as suggested by Edouard et al. (14), a F_{H0} decrease at any time of a season might serve as a pre-injury marker without apparent symptoms in the specific context of athletics.

The secondary aim was to explore the potential consequences of a lower limb injury on the sprint running horizontal force production capacities at low (F_{H0}) and high (v_0) velocities. Our results showed that after LLI there is a decrease in F_{H0}. This reveals the negative consequences of LLI on lower limb performance, which is consistent with results from Mendiguchia et al. (13), and indicates that it is important to monitor the return of F_{H0} performance prior to a return to full practice to all full sprinting horizontal force production capability, and limit the risk of re-injuries. One may also recommend carrying out regular sprint acceleration mechanical output (F_{H0} and v_0) measurements to obtain precise values that are representative of the athlete's condition prior to injury.

Among the limitations of this study, the number of athletes included can be considered as small and the recruitment pool consisted of only one training group. No a priori sample size calculation was performed. Furthermore, the prospective injury data collection used several different channels (i) the sports physician during for medical consultations, ii) the coach (AP) or one researcher (JC), and iii) paper survey two times during the follow-up). However, these multiple approaches were used to limit missing information. Only the sprint mechanical output and lower limb injuries were collected during this study, yet training load and other parameters (e.g., age, sex, muscular strength, flexibility, fatigue) can also play a role on the injury risk. The sprint mechanical output measurements were not performed each week of the follow-up (i.e., during 30 weeks over the 37-weeks follow-up). In addition, some measurements could not be performed for unforeseen reasons: injured athletes, or athletes not attending the training session, weather conditions making the sprint test impossible, training session cancelled. The COVID-19 pandemic did not impact the present study.

As practical implications, since we reported that an increase in F_{H0} at any time of a season was associated with lower LLI risk (we can thus hypothesis that a decrease in F_{H0} at any time of a season was associated with higher LLI risk), it could be considered as a pre-injury biomarker without apparent symptoms. Injuries are of multifactorial nature (19). Among the different approaches and factors that can help to screen the injury screen, the use of sprint acceleration mechanical output › measurement seems an interesting one to objectify injury risk. Indeed, a F_{H0} decrease could be a marker of athlete fatigue or a lack of specific training that would expose the athlete to too little mechanical stress on the lower limb. So, we suggest that regular monitoring of sprint acceleration mechanical output could be a potential opportunity to help detecting injury risk in future research. As a prevention strategy, in order to develop physical qualities, and especially F_{H0}, with the overall goal to reduce the risk of lower limb injuries, regular athletes' exposition to high sprint running (20, 21, 22) and heavy resistance sprint training (23) could represent opportunities. Screening force production capacity at high (v_0) and low (F_{H0}) speeds could therefore be an important tool for both performance and health evaluation. We can hypothesize that the better an athlete is prepared for the demands of his/her discipline the better will perform and be less prone to injury.

Conclusions

The main findings of this study were that 1) a higher horizontal force production capacity at low velocity (F_{H0}) was associated with lower risk of sustaining a new lower limb injury during the following week, and 2) after a lower limb injury recovery of force production capacity take about 1.5 months, however this duration varied extremely according to athletes. Although caution should be taken on these preliminary results, monitoring the F_{H0} could be one relevant approach to detect LLI in athletics.

Conflict of Interest
The authors have no conflict of interest.

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Ethical Approval
The study was reviewed and approved by the Saint-Etienne University Hospital Ethical Committee (Institutional Review Board: IORG0007394).

Data Sharing
Data are available upon reasonable request. Requests for data sharing from appropriate researchers and entities will be considered on a case-by-case basis. Interested parties should contact the corresponding author Pascal Edouard (pascal.edouard@univ-st-etienne.fr).

Summary Box

- Higher horizontal force production capacity at low velocity (FH_0) was associated with lower risk of sustaining a new lower limb injury during the next week.
- After a lower limb injury on average, athlete took about 1.5 months to recover their FH_0 and v_0 pre-injury values, however this duration varied extremely according to athletes.
- Regular monitoring of sprint acceleration mechanical output could be a potential opportunity to help detecting injury risk in future research.

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