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Return to Sport or Military Duty After Lower Extremity Open Fracture: Systematic Review of Athletes and Active Military

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Abstract

Background: Open fractures are complex injuries with high complication rates and infection risks, often resulting in prolonged recovery and limited return to physical activities. Despite this, data on return to sport (RTS) or return to military duty (RTD) are limited. This study evaluates RTS or RTD in individuals with lower extremity open fractures, hypothesizing extended recovery times and limited return rates, particularly for amateur athletes and military personnel compared with professional athletes.

Methods: A systematic review of studies from 1990 to 2024 was conducted using Embase, Ovid MEDLINE, Clinicaltrials.gov, Cochrane databases, SPORTDiscus, and Scopus. Studies investigating lower extremity open fractures with RTS or RTD outcomes were included. Data extracted included patient demographics, Gustilo-Anderson classifications, recovery timelines, and return rates.

Results: Eleven studies were included, with 10 involving adults and 1 including pediatric patients. The analysis covered 722 open fractures. Two studies reported an average return to sport time of 44.0 weeks (17 individuals) in amateur athletes, whereas 3 studies reported an average return to sport time of 61.8 weeks (26 individuals) in professional athletes. Five studies reported 27.3% of amateur athletes had returned to sports at final follow-up (mean = 19.5 months), and 1 study reported that 18.3% of military members returned to full duty at final follow-up. In the 3 studies reporting on professional athletes, 80.8% returned to playing at the professional level.

Conclusions: Lower extremity open fractures often result in prolonged recovery times and significantly limit RTS or RTD. Although professional athletes demonstrated higher return rates, the outcomes for the general amateur athlete and military populations were substantially poorer. Further research with discrete fracture and treatment details is needed to better understand recovery trajectories for open fractures, disparity in outcomes between professional and amateur athletes, and the influence of resources and motivation on returning to activity.

Keywords: Open fracture, sports, military duty

Introduction

Open fractures are relatively common traumatic injuries, accounting for 0.7% of pediatric fractures and 3.1% of adult fractures, with a reported incidence of 30.7 per 100 000 per year.[6,21] They most commonly affect the tibia and fibula, and often result from high-energy trauma such as motor vehicle collisions, falls, sports injuries, or ballistic etiologies.[6,20-22,29] Compared with closed fractures, open fractures have higher

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complication rates, longer hospital stays, and increased readmissions.[3,4,10,25] They have a significantly higher infection rate (15% vs 1%) than closed fractures, with risks compounded by patient factors, fracture location, wound contamination, and soft tissue damage, making early prophylactic antibiotic use essential.[3,4,10,18,25] After initial treatment, postoperative complications are commonly observed, including nonunion, malunion, delayed union, and fracture-related infection.[3,4,10,25]

Return-to-sport (RTS) timelines are well-documented for closed fractures, but less is known about recovery and return to play after open fractures. Two recent studies on National Football League (NFL) athletes reported high return rates, suggesting favorable outcomes.[5,20] However, these findings reflect a high-resource setting with highly motivated patients, which may not be generalizable to other populations.

Therefore, this systematic review sought to characterize return-to-activity rates after open fractures of the lower extremity, comparing professional athletes, amateur athletes, and military personnel to clarify expected outcomes and determine whether return rates or timelines differ amongst them. We hypothesized that the return rates would differ among professional athletes, amateur athletes, and military personnel, with professional athletes having the greatest return rates.

Methods

This systematic review was conducted following PRISMA (Preferred Reporting Items for Systematic reviews and Meta-Analyses) guidelines. An institutional medical librarian was consulted to search for records that included open fractures and return to sport or military duty. Embase, Ovid MEDLINE, Clinicaltrials.gov, Cochrane Database of Systematic Reviews, Cochrane Central Register of Controlled Trials, SPORTDiscus, and Scopus databases were queried from database inception to 2024. The initial search strategy was date-limited to 1990-2024 and resulted in a total of 525 results identified. Among those, 255 duplicate records were deleted, resulting in a total of 270 unique citations included in the project library (Figure 1). Additional details about the search strategies for each database can be found in the supplemental materials.

Eligibility Criteria

Studies eligible for inclusion examined open fractures of the lower extremity and return to sport or military duty (RTD). As both RTS and RTD require high levels of physical function, military personnel were included as a comparison group, particularly to add some context in an understudied area, although we recognize there are likely large differences in mechanisms and other factors that limit the comparability. Because of the lack of available literature, both adult and pediatric studies were included. Studies were excluded if they (1) were non-English, abstracts, conference proceedings, letters, perspective pieces, reviews, or editorials or (2) were published before 1990.

Selection Process

Two authors independently screened and reviewed the full texts of returned studies, applying the above inclusion and exclusion criteria. Any disagreements between the 2 authors were to be arbitrated by a third author; however, no such disagreements were encountered. Two authors then worked independently, to group, review, and extract data from each study.

Statistical Analysis

After each article was reviewed, the demographic, injury characteristics, RTS, and RTD data were extracted for the included studies. Data were pooled for each.

Risk of Bias Assessment

The risk of bias for the included studies was assessed using the Methodological Index for Non-Randomized Studies (MINORS) criteria. The maximum score for noncomparative studies is 16, and for comparative studies is 24, with higher scores correlating to a lower risk of bias. All studies included in this analysis were noncomparative.

Results

Study Selection

After reviewing the abstracts of 270 unique manuscripts, 98 full-text reviews were performed with 11 selected for final analysis. Ten studies reported on adult patients and 1 on a pediatric patient population. Three of the studies focused on a professional athlete population: two for the NFL and one case report on a professional English football player. One study reported on open fractures in military personnel (Table 1).

Description of Open Fractures

Seven hundred twenty-two fractures were included: 569 were from amateur athletes, 127 were from military duty, and 26 were from professional athletes. Gustilo Anderson type was available for all 127 military open fractures, with 58.3% type IIIA, 37.0% type IIIB, and 4.7% type IIIC. Seven studies reported Gustilo Anderson type for 483

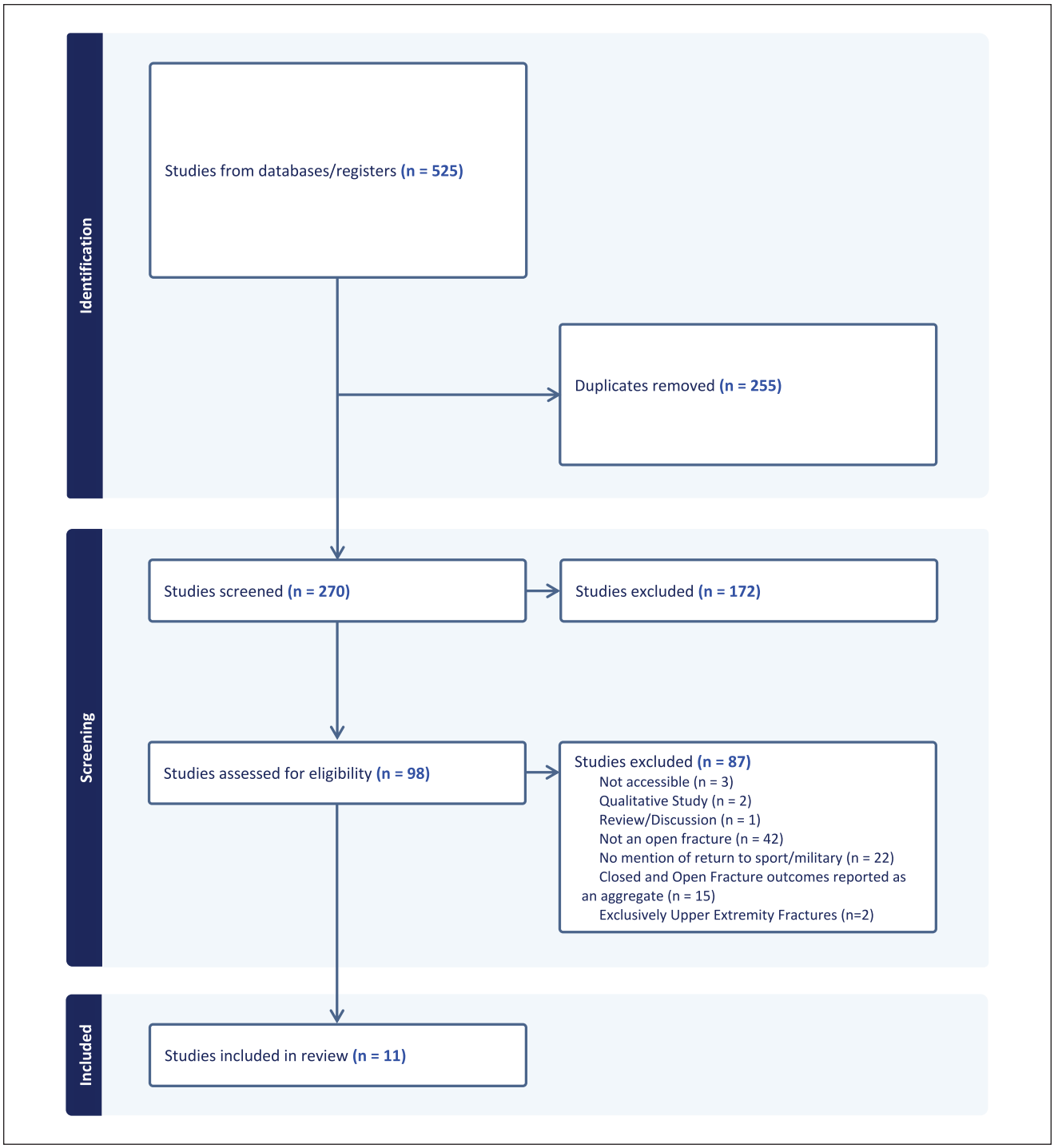

Figure 1. PRISMA diagram depicting the review process to the eventual inclusion of 11 manuscripts. The diagram portrays the flow from identification to screening to inclusion. PRISMA, Preferred Reporting Items for Systematic reviews and Meta-Analyses.

open fractures in amateur athletes with 3.5% type I, 7.0% type II, 65.8% type IIIA, 23.4% type IIIB, and 0.21% type IIIC. The causes of open fractures included motor vehicle accidents (90), explosive devices (81), sport injuries (38), gunshot wounds (8), and a limited number of other mechanisms such as lawn mower accidents, falls, and industrial accidents. The studies reporting on NFL athletes did not include Gustilo Anderson grading.

Table 1. Return to Sport or Military Duty.

Author	Year	Number of Patients	Male, %	Female, %	Pediatric Study?	Sport or Military	Mean %of RTS/RTD	Mean Time to RTS/RTD (wk)	Mean Follow-up Time (wk)
Cross et al	2012	127	94	6	No	Military duty	18.3	57.4	
Bansal et al	2021	1	0	100	No	Amateur sports	100		104
Nudelman et al	2023	9	100	0	No	Professional sports	88.9	63.5	
Bibbo et al	2015	1	100	0	Yes	Amateur sports	100		104
Giordano et al	2021	1	0	100	No	Amateur sports	0		260
Kaeting et al	1997	61			No	Amateur sports	91.8		95.6
METRC	2021	390	68	32	No	Amateur sports	16.7		82.6
Cotton et al	2021	16	100	0	No	Professional sports	75	63.4	
Taberner et al	2019	1	100	0	No	Professional sports	100	39.1	
Shaw et al	1997	4			No	Amateur sports		57.0	
Gaston et al	1999	13			No	Amateur sports		40.0	

Abbreviations: METRC, Major Extremity Trauma Research Consortium; RTD, return to duty; RTS, return to sport.

Return to Sport in Amateur Athletes

Two studies provided the time to RTS for amateur athletes. These studies included a total of 17 patients with open fractures of the lower extremity and reported a pooled mean time for a return to training of 29.6 weeks and a pooled mean time to RTS of 44 weeks.[12,24] Separately, 5 studies reported on the prevalence of RTS results at the time of final follow-up appointment for 454 amateur athletes. The average follow-up period was 19.5 months, at which point 27.3% had returned to sport.[1,2,11,13-16]

Return to Sport in Professional Athletes

Three studies examined patients with open fractures in the NFL and English Football League. Of the 25 patients in the combined NFL cohorts, 20 returned to playing in the NFL with a pooled mean return time of 62.8 weeks.[5,20] No information was given on the Gustilo Anderson type for these fractures. Importantly, the location of the lower extremity fracture impacted the return to NFL timeline. Four patients with an open ankle fracture returned in an average of 47.5 weeks, whereas 4 patients with an open tibia fracture returned in an average of 79.5 weeks.[20] Furthermore, a professional English soccer case study described a Gustilo Anderson IIIb open fracture of the distal tibia and fibula and reported a RTS after 9 months.[26] Overall, 21 of 26 patients (80.8%) returned to playing professional sports at a pooled mean recovery time of 61.8 weeks.

Military Duty

One study provided data on 127 lower extremity open fractures in military members, 70.8% of which were caused by explosions. Twelve patients were polytrauma cases and were excluded from RTD analysis, leaving 115 individuals in the final RTD analysis. Of the 115 individuals, 18.3% successfully returned to active military duty. No timeline for return was given (Figure 2).[7,8]

Risk of Bias Assessment

The risk of bias was assessed using the MINORS criteria. Overall, the mean (SD) MINORS score was 12.8 (2.4). The mean (SD) MINORS score was 12.7 (2.6) for studies evaluating amateur athletes, 13.3 (2.9) for professional athletes, and 12 (0) for studies on military members. A MINORS score of 12.8 falls within the moderate quality range, indicating methodologic limitations typical of small retrospective studies.

Discussion

This systematic review examined the existing literature on return to sport or military duty following lower extremity open fractures. The main findings from this study can be summarized as follows: First, the study revealed poor overall return rates, with only 27.3% of amateur athletes able to return to sports and 18.3% of military personnel successfully resuming full duty. Second, the return rates among professional athletes were notably higher, with 80.8% returning to their professional level of play. Third, we found a protracted time to RTS in both amateur (44 weeks) and professional athletes (61.8 weeks). The benefits of sports and physical activity are well-documented, with studies linking exercise to lower depression risk, and sports to improved mental health, and greater life satisfaction.[9,17]

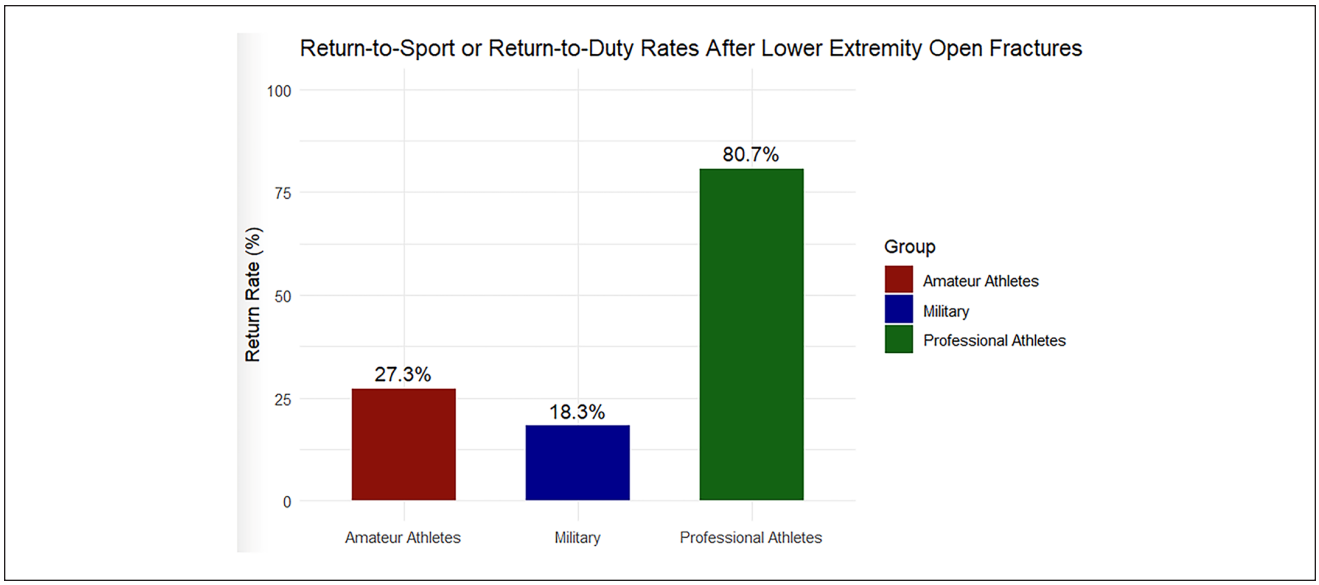

Figure 2. Bar chart depicting the RTS/RTD rates for amateur athletes, professional athletes, and military members. RTD, return to military duty; RTS, return to sport.

Encouraging return to these activities, where possible, is important for physical and mental health. Our findings show that most amateur athletes never return to sports after open fractures, which may impact their overall well-being. However, further research is needed to assess how RTS outcomes influence health and wellness. Nevertheless, these results may aid the practicing surgeon with patient education and expectation setting.

The poor return rates among amateur athletes and military personnel may be explained by the physical demands inherent in both sports and military duties. Both activities necessitate a high level of physical fitness and functionality, qualities that can be compromised by open fractures. Conversely, the high return rates among professional athletes may be explained by several factors, including access to high-quality health care resources with the ability for nearly daily evaluation and therapy, including specialized surgical teams and robust rehabilitation programs often sponsored by their employers.[19] Additionally, the presence of financial incentives for professional athletes to expedite recovery and optimize outcomes may further contribute to their higher return rates. These reasons may explain a sizable portion of the 53.5% difference in return rates. However, further research is needed to identify any possible rehabilitation protocols used by professional athletes that may benefit amateur athlete recovery.

Notably, amateur athletes had a pooled mean RTS time of 44 weeks, much shorter than the 61.8 weeks for professionals. However, these data are limited, encompassing only 2 studies with 17 open fractures in amateur athletes and 3 studies with 26 lower extremity open fractures in professional athletes. One study on NFL athletes highlighted the differences in RTS time between upper and lower extremity fractures, finding that upper extremity fractures had a significantly shorter RTS time as well as a greater percentage RTS.[5] These extended RTS timelines are comparable to recovery periods following anterior cruciate ligament reconstruction or Achilles tendon repair, which typically range from 5 to 13 months.[27,30] In contrast, RTS timelines after closed fractures are generally shorter, with median RTS rates for unimalleolar fractures being 4 months, bimalleolar fractures being 6 months, and tibial plateau fractures 6.9 months.[23,28]

We also included one military study in this systematic review. The RTD rate of 18.3% was low, indicating the substantial impact open fractures can have on soldiers and their ability to continue with military duty. It is important to note that 70.8% of the 127 military open fractures resulted from high-energy explosions. Although we did not feel that a direct comparison between an open fracture resulting from a military injury to that of athletes was possible, we decided to include the one study on military open fractures because of the lack of existing literature on the topic. By broadening the scope of our analysis, we aim to provide physicians treating military members with valuable insights into the challenges of returning to duty after such injuries. Understanding these RTD rates can help guide patient education and set realistic expectations for recovery.

A major limitation of this study is the high percentage of type III Gustilo-Anderson open fractures, comprising 91.6% of cases (100% military, 89.4% nonmilitary). This imbalance limits analysis across severity levels, as type I and II fractures were underrepresented, and available studies lacked stratified return rates. As a result, our findings may not reflect return potential for less severe fractures. Future

research should stratify return rates by severity and injury mechanism. The use of facture classification also varied widely, making comparisons difficult. Inconsistent outcome reporting also complicated comparisons, as some studies used exact RTS timelines whereas others relied on final follow-up assessments. Additionally, no studies examined changes in sport participation, such as frequency, duration, or sport type, after an open fracture. Furthermore, information about whether participants were able to return to any activity if not returning to sport was often unclear. Details on postoperative rehabilitation and complications were also not available. Addressing these gaps will improve understanding of return outcomes and guide rehabilitation strategies.

Conclusion

Open fractures of the lower extremity often result in prolonged recovery times and significantly limit ability to return to sports or military duties. Although professional athletes demonstrated higher return rates, the outcomes for the general amateur athlete and military populations were substantially lower. Further research with more fracture and treatment details are needed to better understand recovery trajectories for patients with open fractures. Moreover, additional investigations are needed to understand the disparity in outcomes between professional and amateur athletes and determine any relation to access to resources or motivation to resume activity.

Ethical Approval

Ethical approval was not sought for the present study.

Declaration of Conflicting Interests

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Supplemental

Full Search Strategies

Embase

Date Searched: 5/2/2024
Applied Database Supplied Limits: 1990-2024
Number of Results: 181. Full Search Strategy: ('open fracture'/exp OR ((compound OR open) NEAR/3 fracture*)) AND ('return to sport'/exp OR (((return to' OR resumption) NEAR/5 (sport* OR activit* OR participation OR 'pre-injur*' OR play* OR duty)):ti,ab,kw) OR 'return-to-sport*':ti,ab,kw OR 'return-to-activit*':ti,ab,kw) AND [1990-2024]/py

Ovid MEDLINE

Date Searched: 5/2/2024
Applied Database Supplied Limits: limit to yr="1990 - 2024"
Number of Results: 82. Full Search Strategy: (exp Fractures, Open/ OR ((compound OR open) ADJ3 fracture*).ti,ab,kf.) AND (exp Return to Sport/ OR ((return to OR resumption) ADJ5 (sport* OR activit* OR participation OR pre-injur* OR play* OR duty)).ti,ab,kf. OR (return-to-sport* OR return-to-activit*).ti,ab,kf.)

Scopus

Date Searched: 5/2/2024
Applied Database Supplied Limits: 1990-2024
Number of Results: 218. Full Search Strategy: ((TITLE-ABS-KEY((compound OR open) W/3 fracture*))) AND ((TITLE-ABS-KEY((''return to'' OR resumption) W/5 (sport* OR activit* OR participation OR ''pre-injur*'' OR play* OR duty))) OR (TITLE-ABS-KEY(''return-to-sport*'' OR ''return-to-activit*''))) AND PUBYEAR > 1989 AND PUBYEAR < 2025

The Cochrane Library

Date Searched: 5/2/2024
Applied Database Supplied Limits: with Publication Year from 1990 to 2024, in Trials
Number of Results CENTRAL: 24 CDSR: 0
Full Search Strategy: ([mh ''Fractures, Open''] OR ((compound OR open) NEAR/3 fracture*):ti,ab,kw) AND ([mh ''Return to Sport''] OR ((''return to'' OR resumption)

NEAR/5 (sport* OR activit* OR participation OR "pre injur*" OR play* OR duty)):ti,ab,kw OR ("return to sport*" OR "return to activit*"):ti,ab,kw)

SPORTDiscus

Date Searched: 5/2/2024

Applied Database Supplied Limits: Publication Date: 19900101-20241231

Number of Results: 20

Full Search Strategy: TI ((compound OR open) N3 fracture*) OR AB ((compound OR open) N3 fracture*) AND TI (("return to" OR resumption) N5 (sport* OR activit* OR participation OR "pre-injur*" OR play* OR duty)) OR AB (("return to" OR resumption) N5 (sport* OR activit* OR participation OR "pre-injur*" OR play* OR duty)) OR TI ("return-to-sport*" OR "return-to-activit*") OR AB ("return-to-sport*" OR "return-to-activit*")

ClinicalTrials.gov

Date Searched: 5/2/2024

Number of Results: 18. Full Search Strategy: Condition/disease" "open fracture" Other terms: ("return to sport" OR "return to activity"). Date Range Study Start: 01/01/1990- 05/31/2024