AI-01899 Paper Resistance Training Safety and Injury Trends

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Below is a detailed briefing document based on the provided source.

Briefing Document: Safety and Injury Trends in Resistance Training

Source: Serafim, T. T., de Oliveira, E. S., Maffulli, N., Migliorini, F., & Okubo, R. (2023). Which resistance training is safest to practice? A systematic review. *Journal of Orthopaedic Surgery and Research, 18*(296). https://rdcu.be/ex8kL

Date of Review: October 26, 2023

Executive Summary

This systematic review, published in the *Journal of Orthopaedic Surgery and Research* in 2023, aimed to identify the safest resistance training (RT) methods in terms of injury prevalence and incidence, characterize injured individuals and injury severity, and analyze injury definitions across studies. The review analyzed 28 articles, finding that **traditional strength training is the safest RT method**, exhibiting the lowest injury rates. Conversely, **Strongman training was identified as the least safe**, although this conclusion is limited by the small number of studies on this modality. The most common injury sites across various RT methods are the **shoulders and back**. A significant challenge identified by the review is the **lack of standardized injury definitions** across studies, which hinders the generalization and comparison of results.

Key Findings and Themes

1. **Safety of Resistance Training Methods:**

- **Traditional Strength Training (ST) is the safest.** It showed the lowest prevalence of injuries, averaging 13%, and a low incidence (< 1/1000 hours). The authors attribute this safety to its focus on "specific muscle contraction" compared to other modalities that emphasize complex movements at higher intensities.
- **Strongman training is the least safe.** The single study on Strongman reported the highest injury prevalence (82%) and incidence (5.5/1000 hours). The authors note this sport involves "high loads and varied movements."
- **High-Intensity Functional Training (HIFT)/CrossFit** showed a mean injury incidence of 4.2/1000 hours and a prevalence of 52.5%. Some studies within this category reported significantly higher incidences (e.g., 18.9/1000 hours), potentially due to varying injury definitions.
- **Powerlifting** had a mean injury prevalence of 56.6% and an incidence of 4/1000 hours. The authors suggest that "using high loads requires excellent technique and reduces the chances of injuries."
- **Weightlifting** had an injury incidence of 3.2/1000 hours and a prevalence of 46.2%, similar to HIFT/CrossFit. However, fewer studies were available for weightlifting, impacting the robustness of this finding.

1. **Common Injury Locations:**

- The **shoulders** were the most frequently injured anatomical site across all RT methods.
- The **back (lumbar region)** was the second most common injury location.
- These findings are consistent with previous research and are attributed to "high loads and large ranges of motion" involved in these training modalities.
- Knees, wrists, hips, and lower extremities were also reported as injury sites, though less frequently overall.

1. **Injury Severity and Associated Factors:**

- Most injuries were classified as **moderate**, but the small number of studies reporting severity limited generalization.
- **Previous untreated injuries** are a significant predisposing factor for new injuries. Individuals starting HIFT/CrossFit were 3.75 times more likely to get injured if they had prior injuries, and athletes with previous shoulder injuries were 8 times more likely to injure the same area.
- Other factors explored included sex (generally no association found with injury occurrence), age, BMI, training experience (e.g., <6 months experience in HIFT/CrossFit increased injury risk), training frequency, supervision, and movement quality.

1. **Challenges in Standardizing Injury Definitions:**

- A critical issue highlighted by the review is the **lack of a consistent "injury" definition** across the included studies.
- Definitions ranged from "any pain or change in performance" that altered training, to only considering injuries that necessitated medical treatment or caused absence from training/competition for a specific period (e.g., >1 week, >2 weeks).
- This non-standardization significantly impacts reported incidence and prevalence rates, making direct comparisons between studies and modalities difficult and increasing "the subjectivity of the interpretation."
- The authors emphasize that a standardized definition "must include within its definition the inability to perform the sport."

1. **Quality of Research:**

- The review assessed the quality of included studies using the STROBE checklist.
- Out of 28 studies, only five were classified as "level A" (high quality), 21 as "level B," and two as "level C." This indicates that a majority of the existing research has limitations in reporting observational studies, affecting the generalizability of their findings.
- The review also noted that "few studies have been published on some RT methods," further contributing to the difficulty in drawing broad conclusions.

Implications

- For individuals considering resistance training, **traditional strength training appears to be the safest entry point** in terms of injury risk.
- Athletes and coaches in more intense RT modalities like HIFT/CrossFit, Powerlifting, Weightlifting, and especially Strongman, should be highly aware of the **elevated risk of shoulder and back injuries**.
- The prevalence of moderate severity injuries suggests that while these sports may not involve constant physical contact, the nature of their movements and loads can still lead to significant musculoskeletal issues.
- The strong association between **previous injuries and new injury risk** underscores the importance of thorough rehabilitation and preventive strategies for athletes returning to or starting RT.
- Future research in RT injury epidemiology critically needs to **standardize injury definitions** to improve the comparability and reliability of findings, thereby enabling more accurate risk assessments and prevention strategies.

Resistance Training and Injury: A Comprehensive Study Guide

This study guide is designed to help you review and consolidate your understanding of the provided research article, "Which resistance training is safest to practice? A systematic review" by Serafim et al. (2023).

Quiz: Short Answer Questions

Answer each question in 2-3 sentences.

1. What was the primary objective of the systematic review conducted by Serafim et al. (2023)?
2. Which electronic databases were searched for this systematic review, and what keywords were used?
3. How many studies were ultimately selected for data extraction, and what types of resistance training (RT) methods did they investigate?

4. According to the results, what was the reported range for the incidence of injuries across all studies included in the review?
5. Based on the conclusions of the systematic review, which resistance training method was identified as the safest, and which was the least safe?
6. What were the two most commonly affected anatomical areas for injuries reported in the studies?
7. Why did the authors highlight the difficulty in standardizing the definition of "injury" across different studies?
8. How did the authors explain the relatively low injury rates observed in traditional strength training compared to other modalities?
9. What associated factors were commonly identified in the studies as potentially increasing the risk of injury, particularly in HIFT/CrossFit?
10. What limitations did the authors identify regarding the generalizability of their findings?

Answer Key: Short Answer Questions

1. The primary objective of the systematic review was to identify which resistance training (RT) method is safest in terms of injury prevalence and incidence. It also aimed to characterize injured subjects, injury severity, and the definitions of injuries used in available studies.
2. The electronic databases searched were PubMed, SPORTDiscuss, and Web of Science. Keywords included "Resistance training," "Strength training," "CrossFit," "Weightlifting," or "Powerlifting" combined with "Injury," "Injuries," "Sprain," "Incidence," "Prevalence," "Epidemiology," or "Epidemiological."
3. Twenty-eight articles were selected for data extraction. These studies investigated injuries in HIFT/CrossFit (17), powerlifting (3), strength training (3), weightlifting (3), and strongman (1), with one study covering both HIFT/CrossFit and weightlifting.
4. The incidence of injuries presented in the selected studies ranged from 0.21/1000 hours to 18.9/1000 hours. The prevalence of injuries ranged from 10% to 82%.

5. The systematic review concluded that traditional strength training is the safest RT method in terms of injuries. Conversely, Strongman was identified as the least safe method, though only one study on strongman was included.
6. The two most commonly affected anatomical areas for injuries were the shoulders, followed by the back. These areas are frequently injured across various resistance training modalities due to high loads and large ranges of motion.
7. The authors highlighted the difficulty in standardizing injury definitions because sports often allow athletes to continue training with pain, making simple absence from training an insufficient criterion. Different studies used varying stringency in their definitions, from any pain/performance change to only considering medical consultation or prolonged absence.
8. The low injury rates in traditional strength training were explained by its focus on specific muscle contraction, unlike other modalities that emphasize complex movements at higher intensities. This different training profile contributes to its safety.
9. Common associated factors identified included previous injuries, lack of supervision, being a competitor, and lower training experience. For HIFT/CrossFit specifically, factors like alternating Rx/scaled workouts and quality of movement also played a role.
10. The authors noted that few studies were rated highly according to STROBE, indicating a lack of high-quality evidence. Furthermore, the limited number of studies available for some RT methods (e.g., Strongman) made it difficult to generalize the results across all modalities.

Essay Format Questions

1. Discuss the methodological challenges faced by systematic reviews attempting to compare injury rates across different resistance training modalities, specifically referencing the issues of injury definition and study quality assessment (STROBE checklist) as highlighted in the article.
2. Compare and contrast the injury profiles (incidence, prevalence, common anatomical sites) of traditional strength training, HIFT/CrossFit, and

powerlifting based on the findings of this systematic review. What factors might explain these observed differences?

3. Analyze the role of "injury definition" in influencing reported injury rates. How did the lack of standardization in injury definitions among the included studies impact the comparability and generalizability of the results? Provide examples from the text.
4. Beyond simply identifying the safest and least safe RT methods, what practical implications can be drawn from this systematic review for practitioners, coaches, and researchers? Consider areas such as injury prevention strategies and future research directions.
5. Evaluate the strengths and limitations of this systematic review. How do these limitations affect the certainty of its conclusions, particularly concerning the safety of less-studied RT methods like Strongman?

Glossary of Key Terms

- **Aerobic Training:** Physical activity that increases heart rate and breathing for a sustained period, improving cardiovascular health. Often combined with resistance training for optimal effects.
- **Creative Commons Attribution 4.0 International License:** A public license that allows others to use, share, adapt, and distribute copyrighted material for any purpose, as long as appropriate credit is given to the original author(s).
- **CrossFit:** A branded fitness regimen involving varied, high-intensity functional movements. It combines elements of weightlifting, gymnastics, metabolic conditioning, and other sports.
- **Epidemiological:** Relating to the branch of medicine that deals with the incidence, distribution, and possible control of diseases and other factors relating to health. In this context, it refers to the study of injury patterns in populations.
- **High-Intensity Functional Training (HIFT):** A broad term encompassing training programs that combine functional movements performed at high intensity. CrossFit is a well-known example of HIFT.

- **Incidence of Injuries:** The rate at which new injuries occur within a specified population over a defined period (e.g., injuries per 1000 hours of training).
- **Injury:** Defined in the context of this review as any physical complaint sustained during training that leads to pain, loss of function, modification of training, or seeking medical attention. The definition varied across included studies.
- **Medical Subject Headings (MeSH):** A comprehensive controlled vocabulary maintained by the National Library of Medicine (NLM) and used for indexing, cataloging, and searching for biomedical and health-related concepts.
- **Powerlifting:** A strength sport that consists of three attempts at maximal weight on three lifts: squat, bench press, and deadlift.
- **Prevalence of Injuries:** The proportion of individuals in a population who have experienced an injury at a specific point in time or over a defined period (e.g., percentage of participants injured).
- **Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA):** An evidence-based minimum set of items for reporting in systematic reviews and meta-analyses. It aims to help authors improve the reporting of their reviews.
- **PROSPERO:** An international prospective register of systematic reviews. Registration helps to avoid duplication and provides transparency in the systematic review process.
- **Resistance Training (RT):** A form of physical activity designed to improve muscle fitness by exercising a muscle or muscle group against external resistance. Also known as strength training.
- **Shoulder Injuries:** Injuries affecting the complex structures of the shoulder joint, including muscles, tendons, ligaments, and bones. Often seen in RT due to overhead movements and high loads.
- **Sprain:** A stretching or tearing of ligaments, the fibrous tissues that connect bones and joints.
- **Strengthening the Reporting of Observational Studies in Epidemiology (STROBE):** A checklist of items that should be addressed in articles reporting

observational studies. It is used to assess the quality of epidemiological research.

- **Strongman:** A strength sport that involves athletes performing feats of strength in various events, often involving heavy, unconventional objects and complex movements.
- **Systematic Review:** A type of literature review that collects and critically appraises all available research evidence relevant to a specific research question, typically using a systematic and explicit methodology.
- **Traditional Strength Training (ST):** Resistance training that typically focuses on specific muscle contraction using equipment like free weights, machines, or bands, often with a focus on hypertrophy or general strength gains rather than complex, high-intensity functional movements.
- **Weightlifting:** An Olympic sport (also known as Olympic weightlifting) consisting of two lifts: the snatch and the clean and jerk. It requires significant strength, technique, and mobility.

Which resistance training (RT) method is the safest in terms of injury?

- Traditional strength training is identified as the safest resistance training method, demonstrating the lowest prevalence of injuries with an average of approximately 13%. This low injury rate, often less than 1 injury per 1000 hours of practice, is attributed to its focus on specific muscle contraction rather than complex, high-intensity movements.

Which resistance training method carries the highest risk of injury?

- Strongman training is found to be the least safe RT method regarding injuries, reporting the highest prevalence at 82% and an incidence of 5.5 injuries per 1000 hours. The high loads and varied, often complex movements inherent in Strongman training contribute to this elevated risk.

What are the most common anatomical sites for injuries across resistance training methods?

- The most frequently injured anatomical areas across various resistance training methods are the shoulders, followed by the back (lumbar region). This is consistent across High-Intensity Functional Training (HIFT)/CrossFit, weightlifting, and powerlifting, likely due to the high loads and large ranges of motion involved in exercises common to these modalities.

How does the injury rate in High-Intensity Functional Training (HIFT)/CrossFit compare to other RT methods?

- HIFT/CrossFit has an average injury incidence of 4.2 injuries per 1000 hours and a prevalence of 52.5%. While this is higher than traditional strength training, it is similar to weightlifting. However, there is a wide range in reported injury rates within HIFT/CrossFit studies, with some studies showing significantly higher rates (up to 18.9/1000h), often due to inconsistencies in injury definitions.

What factors are associated with an increased risk of injury in resistance training?

- Several factors are associated with an increased risk of injury. These include having previous injuries (which predispose individuals to new injuries, especially in the same area, e.g., shoulder injuries increasing the likelihood of re-injury by eight times), being new to a training method (e.g., individuals starting HIFT/CrossFit are 3.75 times more likely to get injured), lack of supervision, male sex, and engaging in more frequent training sessions (e.g., less than 3 days/week can lead to more injuries, as can more than 9 hours/week). Conversely, coaching exposure, physical activity outside of the specific RT, and regular warm-up/cool-down routines may reduce risk.

Why is it difficult to compare injury rates across different resistance training studies?

- A significant challenge in comparing injury rates across studies is the lack of a standardized definition of "injury." Some studies define an injury broadly as any pain or change in performance that leads to a modification or reduction in training, while others are more stringent, only considering injuries that result in missed training time or require medical attention. This inconsistency leads to highly variable and heterogeneous results, making generalization difficult.

What is the typical severity of injuries sustained during resistance training?

- Most injuries sustained in resistance training are classified as moderate. However, the exact severity can vary widely, and few studies explicitly include injury severity in their results, which limits the ability to generalize findings regarding this variable. The nature of these sports, generally not involving constant changes of direction or physical contact, tends to result in less severe injuries compared to contact sports.

Are there any specific recommendations for safer resistance training based on the review?

- Based on the review, traditional strength training is highlighted as the safest option for resistance training due to its lower injury rates. For all RT methods, proper technique and, in modalities like powerlifting, the use of excellent technique when handling high loads are crucial for reducing injury risk. The importance of standardizing injury definitions in future research is also emphasized to allow for more accurate comparisons and generalizations of safety profiles across different RT methods.

Here is a detailed timeline and cast of characters based on the provided sources:
Detailed Timeline

Pre-2002:

- **Various:** Resistance training (RT) and aerobic training are recognized as beneficial for performance. Different RT methods exist.

2002:

- **American College of Sports Medicine (ACSM):** Publishes a position stand on "Progression models in resistance training for healthy adults," defining resistance training for health and fitness.

2003:

- **Surakka et al.:** Publish a study on the feasibility of power-type strength training for middle-aged men and women, including injury rates.

2004:

- **Kraemer and Ratamess:** Publish "Fundamentals of resistance training: progression and exercise prescription."

2007:

- **Kerr, Collins, and Dawn CR:** Publish an epidemiological study on weight training-related injuries presenting to United States emergency departments between 1990 and 2007.

2009:

- **ACSM:** Updates its position stand on "Progression models in resistance training for healthy adults."
- **Wilk et al.:** Publish a study on shoulder injuries in overhead athletes.
- **Junge et al.:** Report on sports injuries during the Summer Olympic Games 2008 in Beijing.

2010:

- **Cheng et al.:** Publish a study on minimally invasive surgery for total knee arthroplasty.

2012:

- **Westcott WL:** Publishes "Resistance training is medicine: effects of strength training on health."
- **Syed A, Talbot-Smith A, Gemmell I:** Publish on the use of epidemiological

measures for prevention interventions.

2013:

- **Hak, Hodzovic, and Hickey:** Publish on the nature and prevalence of injury during CrossFit training.
- **Clarsen, Myklebust, and Bahr:** Develop and validate a new method for registering overuse injuries in sports.
- **Little et al.:** Report on a 12-month incidence of exercise-related injuries in previously sedentary older adults following an exercise intervention.

2014:

- **Timpka et al.:** Discuss the definition of a sports injury.
- **Winwood et al.:** Publish a retrospective injury epidemiology study of Strongman athletes.
- **Weisenthal et al.:** Publish on injury rate and patterns among CrossFit athletes.
- **Vandenbroucke et al. and von Elm et al.:** Publish the STROBE statement guidelines for reporting observational studies in epidemiology.

2016:

- **Gabbett TJ:** Publishes "The training—injury prevention paradox."
- **Chachula et al.:** Study the association of prior injury with new injuries sustained during CrossFit training.

2017:

- **Keogh and Winwood:** Publish a systematic review on the epidemiology of injuries across weight-training sports.

- **Aune and Powers:** Publish on injuries in an extreme conditioning program.
- **Montalvo et al.:** Conduct a retrospective injury epidemiology and risk factors study for injury in CrossFit.
- **Feito et al.:** Publish on injury incidence and patterns among Dutch CrossFit athletes.
- **Moran et al.:** Publish a prospective cohort study on rates and risk factors of injury in CrossFit™.
- **Aasa, Svartholm, Andersson, and Berglund:** Publish a systematic review on injuries among weightlifters and powerlifters.
- **Escalante et al.:** Conduct a retrospective study on injury patterns and rates of Costa Rican CrossFit® participants.

2018:

- **Feito, Burrows, and Tabb:** Publish a 4-year analysis of injury incidence among CrossFit-trained participants.
- **Strömbäck et al.:** Publish a cross-sectional study on the prevalence and consequences of injuries in powerlifting.
- **Bengtsson, Berglund, and Aasa:** Publish a narrative review of injuries in powerlifting.
- **Kim et al.:** Analyze the characteristics of sports activities and injury experiences of leisure sports participants.
- **Hurley et al.:** Study practices, perceived benefits, and barriers to resistance training among college women.
- **Dominski et al.:** Conduct a systematic review of injury profiles in CrossFit

practitioners.

- **Micheo and Sánchez:** Publish on rehabilitation in musculoskeletal and sports injuries in older adults.

2019:

- **Saeidifard et al.:** Publish a systematic review and meta-analysis on the association of resistance training with mortality.
- **Elkin et al.:** Compare the likelihood of injury and medical care between CrossFit and traditional weightlifting participants.
- **Tafuri et al.:** Conduct an observational retrospective survey on the risk of injuries among CrossFit athletes in Italy.
- **Serner et al.:** Analyze mechanisms of acute adductor longus injuries in male football players using video.
- **Wilk et al.:** Study the influence of grip width on training volume during the bench press.

2020:

- **Hafner et al.:** Estimate the global economic benefits of physically active populations.
- **Szeles et al.:** Publish a prospective 12-week cohort study on CrossFit and musculoskeletal injury epidemiology.
- **Feito et al.:** Publish a cross-sectional analysis of injuries among CrossFit trained participants, titled "Breaking the myths of competition."
- **Teixeira et al.:** Conduct a retrospective study of risk factors and prevalence of injuries in HIFT.
-

Larsen et al.: Conduct a prospective cohort study on injuries in novice participants during an eight-week CrossFit program.

- **Mack et al.:** Report on the incidence of lower extremity injury in the National Football League from 2015 to 2018.
- **Alekseyev et al.:** Identify the most common CrossFit injuries in various athletes.
- **Tooth et al.:** Publish a systematic review on risk factors of overuse shoulder injuries in overhead athletes.
- **Frandsen et al.:** Study the use of the PICO model as a search tool for systematic reviews.
- **Cheng et al.:** Study injury incidence, patterns, and risk factors in functional training athletes in an Asian population.
- **Dominski et al.:** Publish a narrative review on motivation for CrossFit training.

2021:

- **Tawfik et al.:** Study the incidence of hand or wrist injuries in CrossFit athletes.
- **Toledo et al.:** Study joint and muscle injuries in men and women CrossFit® training participants.
- **Dominski et al.:** Publish an updated systematic review on injuries in functional fitness.

May 29, 2022:

- **Serafim et al.:** Submit "Which resistance training is safest to practice? A systematic review" for publication.

March 2023:

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Serafim et al.: Conduct their last update of the database search for their systematic review.

April 4, 2023:

- **Serafim et al.:** The manuscript for "Which resistance training is safest to practice? A systematic review" is accepted.

April 12, 2023:

- **Serafim et al.:** "Which resistance training is safest to practice? A systematic review" is published online in the Journal of Orthopaedic Surgery and Research.

Cast of Characters

This list focuses on the principal authors of the systematic review and key researchers cited for their direct contributions to the findings and methodology.

- **Thiago Teixeira Serafim:** One of the primary authors of the systematic review "Which resistance training is safest to practice? A systematic review." He, along with Eliton Stanley de Oliveira, performed the data extraction and contributed to the writing of the manuscript. He is affiliated with the Physiotherapy Nucleus Orthopedic Trauma of Health and Sports Science of the Santa Catarina State (UDESC), Florianópolis, Brazil.
- **Eliton Stanley de Oliveira:** Another primary author of the systematic review. He, along with Thiago Teixeira Serafim, performed the data extraction and contributed to the writing of the manuscript. He is affiliated with the Physiotherapy Nucleus Orthopedic Trauma of Health and Sports Science of the Santa Catarina State (UDESC), Florianópolis, Brazil.
- **Nicola Maffulli:** An author of the systematic review who contributed to the writing of the manuscript and the refinement of data interpretation. He holds affiliations with the Department of Medicine, Surgery and Dentistry, University of Salerno, Italy; School of Pharmacy and Bioengineering, Keele University Faculty of Medicine, England; and Queen Mary University of London, Centre for Sports and Exercise Medicine, England.

- **Filippo Migliorini:** The corresponding author of the systematic review, indicating a significant role in the research and publication. He contributed to the writing of the manuscript and the refinement of data interpretation. He is affiliated with the Department of Orthopaedic, Trauma, and Reconstructive Surgery, RWTH University Hospital, Aachen, Germany.
- **Rodrigo Okubo:** An author of the systematic review who contributed to the writing of the manuscript and the refinement of data interpretation. He also served as the third senior reviewer to resolve disagreements during the study selection process. He is affiliated with the Physiotherapy Nucleus Orthopedic Trauma of Health and Sports Science of the Santa Catarina State (UDESC), Florianópolis, Brazil.

Key Researchers Mentioned in the Context of Their Work:

- **Y. Feito:** A frequently cited researcher, particularly for studies on injury incidence and patterns in CrossFit. His work contributed to the data analyzed in the systematic review regarding HIFT/CrossFit injuries.
- **P. T. Hak:** Cited for one of the first epidemiological studies on injury during CrossFit training conducted online.
- **J.W.L. Keogh:** A prolific researcher cited for work on the epidemiology of injuries across weight-training sports and in competitive Oceania powerlifters.
- **P. W. Winwood:** Cited for contributions to the epidemiology of injuries across weight-training sports and specifically for strongman athletes.
- **E. Strömbäck:** Cited for research on the prevalence and consequences of injuries in powerlifting.
- **P. R. D. Q. Szeles:** Cited for a study that evidenced a particularly high rate of injury incidence in HIFT/CrossFit.
- **R. T. Larsen:** Cited for research on injuries in novice participants during CrossFit programs.

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S. Moran: Cited for a prospective cohort study on rates and risk factors of injury in CrossFit.

•

J. S. Kim: Cited for research on sports activities and injury experiences of leisure sports participants.

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A. Junge: Cited for reporting on sports injuries during the Summer Olympic Games.

- • **Various:** Resistance training (RT) and aerobic training are recognized as beneficial for performance. Different RT methods exist.
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- • **Serafim et al.:** Conduct their last update of the database search for their systematic review.
- • **Serafim et al.:** The manuscript for "Which resistance training is safest to practice? A systematic review" is accepted.

- • **Serafim et al.:** "Which resistance training is safest to practice? A systematic review" is published online in the Journal of Orthopaedic Surgery and Research.
- • **Thiago Teixeira Serafim:** One of the primary authors of the systematic review "Which resistance training is safest to practice? A systematic review." He, along with Eliton Stanley de Oliveira, performed the data extraction and contributed to the writing of the manuscript. He is affiliated with the Physiotherapy Nucleus Orthopedic Trauma of Health and Sports Science of the Santa Catarina State (UDESC), Florianópolis, Brazil.
- • **Eliton Stanley de Oliveira:** Another primary author of the systematic review. He, along with Thiago Teixeira Serafim, performed the data extraction and contributed to the writing of the manuscript. He is affiliated with the Physiotherapy Nucleus Orthopedic Trauma of Health and Sports Science of the Santa Catarina State (UDESC), Florianópolis, Brazil.
- • **Nicola Maffulli:** An author of the systematic review who contributed to the writing of the manuscript and the refinement of data interpretation. He holds affiliations with the Department of Medicine, Surgery and Dentistry, University of Salerno, Italy; School of Pharmacy and Bioengineering, Keele University Faculty of Medicine, England; and Queen Mary University of London, Centre for Sports and Exercise Medicine, England.
- • **Filippo Migliorini:** The corresponding author of the systematic review, indicating a significant role in the research and publication. He contributed to the writing of the manuscript and the refinement of data interpretation. He is affiliated with the Department of Orthopaedic, Trauma, and Reconstructive Surgery, RWTH University Hospital, Aachen, Germany.
- • **Rodrigo Okubo:** An author of the systematic review who contributed to the writing of the manuscript and the refinement of data interpretation. He also served as the third senior reviewer to resolve disagreements during the study selection process. He is affiliated with the Physiotherapy Nucleus Orthopedic Trauma of Health and Sports Science of the Santa Catarina State (UDESC), Florianópolis, Brazil.
- • **Y. Feito:** A frequently cited researcher, particularly for studies on injury incidence and patterns in CrossFit. His work contributed to the data analyzed

in the systematic review regarding HIFT/CrossFit injuries.

- • **P. T. Hak:** Cited for one of the first epidemiological studies on injury during CrossFit training conducted online.
- • **J.W.L. Keogh:** A prolific researcher cited for work on the epidemiology of injuries across weight-training sports and in competitive Oceania powerlifters.
- • **P. W. Winwood:** Cited for contributions to the epidemiology of injuries across weight-training sports and specifically for strongman athletes.
- • **E. Strömbäck:** Cited for research on the prevalence and consequences of injuries in powerlifting.
- • **P. R. D. Q. Szeles:** Cited for a study that evidenced a particularly high rate of injury incidence in HIFT/CrossFit.
- • **R. T. Larsen:** Cited for research on injuries in novice participants during CrossFit programs.
- • **S. Moran:** Cited for a prospective cohort study on rates and risk factors of injury in CrossFit.
- • **J. S. Kim:** Cited for research on sports activities and injury experiences of leisure sports participants.
- • **A. Junge:** Cited for reporting on sports injuries during the Summer Olympic Games.