EPIDEMIOLOGY OF INJURY IN OLYMPIC SPORTS

VOLUME XVI OF THE ENCYCLOPEDIA OF SPORTS MEDICINE
AN IOC MEDICAL COMMISSION PUBLICATION

EDITED BY
DENNIS J. CAINE, PhD
PETER A. HARMER, PhD, MPH, ATC
and
MELISSA A. SCHIFF, MD, MPH
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Foreword

Throughout periods of conditioning and training by athletes and during actual competition, the potential for injury exists as a threat to successful performance. The study of injury mechanisms and the prevention of injuries rely on a comprehensive knowledge base of injury statistics for each particular sport and sports event.

For each Olympic sport and event, the injury statistics have been studied and analyzed by the co-editors and contributing authors of this volume in terms of types of injuries, time and location, risk factors, and inciting conditions. With the overall goal of decreasing the incidence of injuries for athletes in the future, careful consideration has been given to the issues of the prevention of these injuries and the presentation of guidelines for future research.

This volume of the Encyclopaedia of Sports Medicine makes an important contribution to the total understanding of Olympic sports and it is this understanding that exists as the major objective of the Encyclopaedia series. Professors Caine, Harmer, and Schiff, together with all of the contributing authors, are to be congratulated on the quality of the comprehensive coverage that they have provided regarding the epidemiology of sport injuries. We welcome this important addition to the Encyclopaedia of Sports Medicine series.

Dr Jacques Rogge
IOC President
Preface

DENNIS J. CAINE,¹ PETER A. HARMER² AND MELISSA A. SCHIFF³

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In this age of highly specialized training and intense competition, injuries are common and may sometimes prevent top performers from competing in national and international competitions. Younger athletes who aspire to Olympic participation may also find progress towards top-level competition compromised as a result of injury. Sport injuries may also significantly impact quality of life. There is epidemiological evidence that level of physical fitness is a significant predictor of all-cause mortality, morbidity, and disease-specific morbidity and that physical activity patterns track from early to later life. Injury or incomplete recovery from injury affects the ability to participate in those sport and recreational activities that would be beneficial to health. Injuries may also contribute to the development of osteoarthritis. There is a significant public health cost associated with these injuries, the future development of osteoarthritis, and other diseases associated with decreased levels of physical activity.

We wish to congratulate the Medical Commission of the International Olympic Committee (IOC) on their decision to dedicate an entire encyclopedia volume to the topic of Epidemiology of Injury in Olympic Sports. This choice no doubt reflects the growing importance of injury prevention and protecting the health of athletes to support the IOC mission. The purpose of Epidemiology of Injury in Olympic Sports is to comprehensively review what is known about the distribution and determinants of injury and injury rates as reported in the literature, and further to evaluate the current research on injury prevention strategies and suggest directions for further research. This book provides a state-of-the-art account of the epidemiology of injury across a broad spectrum of Olympic sports. All sports and events within sports, where there were a sufficient number of studies published to warrant a chapter, are included in this book.

Epidemiology of Injury in Olympic Sports is subdivided into four parts: Summer Sports, Winter Sports, Paralympic Sports, and Injury Prevention and Further Research. Whereas we have included as many summer and winter sports as possible in the first two parts, only one part covering all paralympic sports has been presented, given the paucity of epidemiological studies in these events.

A common, uniform strategy and evidence-based approach to organizing and interpreting the literature is used in this book and applied across all sport-specific chapters, each with the same basic headings so that the reader can easily find common information across chapters:

- Introduction
- Who is affected by injury?
- Where does injury occur?
- When does injury occur?
- What is the outcome?
• What are the risk factors?
• What are the inciting events?
• Injury prevention
• Further research

Each chapter is amply illustrated with tables to make it easy to examine injury factors between studies within a sport and between sports. Most significantly, this book has limited the discussion of risk factors and preventive measures to those which have actually been scientifically tested.

The information in this book will benefit physicians, physical therapists, athletic trainers, sport scientists, sports governing bodies, coaches, parents and reference librarians. Physicians, physical therapists and athletic trainers will find *Epidemiology of Injury in Olympic Sports* helpful in identifying problem areas in which appropriate preventive measures can be tested and ultimately implemented to reduce the incidence and severity of injuries. Some sports scientists as well as healthcare professionals will find the information in this book useful as a basis for continued epidemiological study of injuries in various sports, while others may find it beneficial as a course or reference text. We are optimistic that sports governing bodies and coaches will use this information as an informed basis for the development of injury prevention programs related to such factors as exposure, training techniques, equipment modifications, and rules.

In closing, we would like to thank the authors for their outstanding contributions to this project. The 32 chapters in this book have been written by professionals—including sports medicine physicians, epidemiologists, and exercise scientists—who have expertise in sports injury epidemiology. Researching and writing an epidemiologic overview of the literature in each of the sports areas is a very meticulous and time-consuming endeavor. Increasingly, the professional rewards for chapter contributions are over-shadowed by those received for a successful research grant application or publishing an article in a juried scholarly venue. We therefore view the contributions of the authors to this project as generous donations of their time, effort, and expertise to the IOC specifically and more generally to the field of sports injury epidemiology.

Above all, we would like to thank Dr. Howard Knutgen and the IOC Medical Commission as well as Cathryn Gates of Wiley-Blackwell for their assistance and patience during this challenging endeavor.

**Sport-Specific Chapter Outline**

In the Introduction for each chapter, authors were asked to provide the following information: historical background of the sport in the context of the Olympics, relevant background information to establish the importance and need for the review, a well-defined problem statement (what is being reviewed, the population of interest, and for what purpose), and a succinct comment on the methodological limitations of the literature reviewed.

Search methods employed by the authors involved four broad approaches: (1) academic search engines; (2) World Wide Web and Google Scholar; (3) privately owned and government statistical sites; and (4) hand search of references lists (i.e., ancestry approach).

The most commonly used electronic databases were EMBASE, PubMed, and Sport Discus. Other search engines used included: AARP Ageline, Academic Search Premier, Allied and Complementary Medicine (AMED), Biological Abstracts, Cumulative Index to Nursing and Allied Health Literature (CINAHL), Cochrane Central Register of Controlled Trials, Cochrane Database for Systematic Reviews, Cumulative Index for the Physician and Sportsmedicine, Database of Review of Effects (DARE), Health STAR, NHS Economic Evaluation Database, Physical Education Index, ISI Web of Science, Proquest, Proquest Dissertation and Theses, Psych Info, SafetyLit, Social Science Citation Index, Spotlit Scopus, and the Science Citation Index.

Privately owned and government statistical sites used included: AUSPORT, AUSTROM, the Centers for Disease Control and Prevention (CDC), National Center for Health Statistics (NCHS), the National Safety Council (NSC) Fact Sheets Library, National Collegiate Athletic Association Injury Surveillance System (NCAA ISS), the National Center for Catastrophic Sports Injury
Sports injury epidemiology is concerned with the who, where, when, what, why, and how of injuries. To address the question of who is affected by injury, each author presents a discussion of overall (competition plus practice) rates of injuries and a tabular summary of injury rates by age/participation level, gender, and position played. In many sports, incidence rate data are available (e.g., rate per 1000 hours, snowboard runs, skier days, races, etc.). However, in others, authors had to report clinical incidence (e.g., number of injuries divided by the number of injured participants times some $k$ value).

Each chapter includes a section on where the injury occurred, providing detailed information on anatomic and environmental location. Anatomic information may include a breakdown of injuries by region and/or specific body parts. Environmental location includes whether an injury occurs in practice or competition, indoors or outdoors, by event, or by surface or terrain in which the activity takes place.

The discussion of when injuries occur includes injury onset and chronometry. Injury onset addresses information related to the frequency and distribution of acute and overuse injuries. Chronometry may address such time-related factors as time into practice, time of day, and time of season when injury occurred.

Each chapter addresses the question, “what is the outcome?”, through presentation of data concerning injury type, time loss, clinical outcome, and economic cost. Depending on the research available, the sections on clinical outcome include the following subsections: recurrent injury, catastrophic injury, non-participation, and residual effects of injury.

A discussion of the why and how of injury is presented in sections on risk factors and inciting events. In the section on risk factors, only data on risk factors that have been tested for correlation or for predictive value are included. Analytical data can point toward factors that contribute to the occurrence of injury. Authors classified risk factors in terms of intrinsic and extrinsic. Intrinsic factors are individual biologic or psychosocial characteristics predisposing an athlete to the outcome of injury, such as previous injury or life stress. Extrinsic risk factors are factors that have an impact on the athlete while he or she is participating in sport, such as training methods or coaching qualifications.

In sports where data were available, authors discussed player-related inciting events leading to the injury situation and which are reported across injuries rather than a description of biomechanical aspects of specific injuries. Player-related aspects typically represent the action or activity leading to the injury (e.g., receiving or delivering a roundhouse kick in taekwondo, collisions in snowboarding, falls from a horse in equestrian, tackling in soccer, body checking in ice hockey, etc.).

Each chapter includes a section on injury prevention based on research that has attempted to determine the effectiveness of sport-specific preventive measures. This section might be broken down into randomized and non-randomized studies where preventive measures have been tested and/or implemented. In the latter case, for example, the introduction of mandatory full face shield rules among the pediatric ice hockey population has dramatically reduced the frequency of facial and eye injuries.

Finally, authors provide suggestions for further research which arose from their identification of gaps and weaknesses in the epidemiology literature. In these regards they were asked to consider such factors as research questions arising from the epidemiological review, injury definition most appropriate for the sport, study population and sample size considerations, study design, and statistical approaches.