

Review

A Systematic Review of the Biomechanical Studies on Shoulder Kinematics in Overhead Sporting Motions: Types of Analysis and Approaches

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Abstract: The shoulder is a unique and complex joint in the human body with three bones and four joints, which makes it the most unstable joint in the body due to the amount of motion. To improve approaches toward understanding the performance of overhead throwing movements, this systematic review summarizes the type of analysis related to shoulder biomechanics involving overhead sporting motions. A search of seven databases identified 33 eligible studies, which were subsequently scored using the Modified Coleman Methodology Score scale. A total of nine articles from badminton, seven from baseball, five from volleyball, five from tennis, three from cricket, and one from softball were reviewed. All 33 studies evaluated shoulder kinematics and 12 of them also investigated the forces and torques (kinetics). The most common methods used were 3D motion analysis (76%), digital video cameras (15%), electromagnetic tracking system (6%), and finally 3% used IMU sensors. Overall, shoulder external rotation during the back swing, internal rotation, and elbow extension during the forward acceleration phase were the strongest predictors of high velocity overhead throwing movement. The findings provide some useful insights and guidance to researchers in their future contribution to the existing body of literature on shoulder overhead throwing movement biomechanics.

Keywords: overhead throw; shoulder; biomechanics; kinematics; kinetics



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1. Introduction

Overhead sporting motions can be defined as any motion in which the upper arm and shoulder are over the athlete's head to hit or propel an object towards the opponent [1]. This includes motions such as the badminton smash, tennis serve, cricket bowling, and the baseball pitch. According to Guinness World Records [2], the fastest projectile speeds in overhead sports recorded include 118.3 m·s⁻¹ in the badminton post impact shuttlecock speed in a competition, 73.1 m·s⁻¹ in the tennis serve, 44.8 m·s⁻¹ in the cricket fast bowl, 44.7 m·s⁻¹ in the baseball pitch, and 36.1 m·s⁻¹ in the volleyball jump spike. Overhead motions in sport have both a speed and control/accuracy component to achieve success, both of which are reliant on appropriate shoulder movements. Unsurprisingly, shoulder injury rates are high in athletic populations with 18–61% of shoulder injury rates reported among the overhead throwing athletes [1,3], accounting for 12.0% and 13.1% of all high school and college sports injuries in the National Collegiate Athletic Association injury surveillance program [4].

Biomechanical Studies Of The Musculo Ske

**Ravindra S. Goonetilleke • Shuping
Xiong**



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Biomechanical Studies of the Musculo-skeletal System Francis Gaynor Evans,1961

Human Musculoskeletal

Biomechanics Tarun Goswami,2012-01-05 This book covers many aspects of human musculoskeletal biomechanics As the title represents aspects of forces motion kinetics kinematics deformation stress and strain are examined for a range of topics such as human muscles skeleton and vascular biomechanics independently or in the presence of devices Topics range from image processing to interpret range of motion and or diseases to subject specific temporomandibular joint spinal units braces to control scoliosis hand functions spine anthropometric analyses along with finite element analyses Therefore this book will be valuable to students at introductory level to researchers at MS and PhD level searching for science of specific muscle vascular to skeletal biomechanics This book will be an ideal text to keep for graduate students in biomedical engineering since it is available for free students may want to make use of this opportunity Those that are interested to participate in the future edition of this book on the same topic as a contributor please feel free to contact the author

Biomechanics in Ergonomics Shrawan Kumar,2007-12-07 Safety or comfort Can you truly have one without the other Is it feasible to have both Although by no means the only factor a deep understanding of biomechanics plays a leading role in the design of work and workplaces that are both pain and injury free Standing firmly on the foundation built by the previous edition the second edition of Biom

Research Awards Index ,1989

Advanced Computational Methods in Life System Modeling and

Simulation Minrui Fei,Shiwei Ma,Xin Li,Xin Sun,Li Jia,Zhou Su,2017-09-01 The three volume set CCIS 761 CCIS 762 and CCIS 763 constitutes the thoroughly refereed proceedings of the International Conference on Life System Modeling and Simulation LSMS 2017 and of the International Conference on Intelligent Computing for Sustainable Energy and Environment ICSEE 2017 held in Nanjing China in September 2017 The 208 revised full papers presented were carefully reviewed and selected from over 625 submissions The papers of this volume are organized in topical sections on Biomedical Signal Processing Computational Methods in Organism Modeling Medical Apparatus and Clinical Applications Bionics Control Methods Algorithms and Apparatus Modeling and Simulation of Life Systems Data Driven Analysis Image and Video Processing Advanced Fuzzy and Neural Network Theory and Algorithms Advanced Evolutionary Methods and Applications Advanced Machine Learning Methods and Applications Intelligent Modeling Monitoring and Control of Complex Nonlinear Systems Advanced Methods for Networked Systems Control and Analysis of Transportation Systems Advanced Sliding Mode Control and Applications Advanced Analysis of New Materials and Devices Computational Intelligence in Utilization of Clean and Renewable Energy Resources Intelligent Methods for Energy Saving and Pollution Reduction Intelligent Methods in Developing Electric Vehicles Engines and Equipment Intelligent Computing and Control in Power Systems Modeling Simulation and Control in Smart Grid and Microgrid Optimization Methods Computational Methods for Sustainable Environment

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Research Grants Subject Number Investigator & Contracts National Institute of Neurological and Communicative Disorders and Stroke, **Rechnergestützte Verfahren in Orthopädie und Unfallchirurgie** Jörg Jerosch,Klaus

Nicol,Klaus Peikenkamp,2013-03-07 Die Einsatzgebiete neuer rechnergestützter Technologien im Bereich der Haltungs- und Bewegungsorgane werden aus unterschiedlichen Blickwinkeln besprochen Im Bereich Lehre und Ausbildung werden neue Wege unter Ausnutzung multimedialer Techniken diskutiert Die Vereinfachung von Schnittstellen zwischen vorklinischer und klinischer Ausbildung sowie die Möglichkeiten des Internet werden dargelegt In der Forschung erlauben neue Verfahren die Datenakquisition am Probanden oder Patienten und lassen so Rückschlüsse auf in vivo auftretende Belastungen zu Bei der Patientenversorgung sind intraoperative Navigationssysteme und Operationsroboter in ein Stadium der klinischen Routineanwendbarkeit übergegangen Datenarchivierung und -transfer werden sich revolutionieren Diese Systeme erlauben eine standardisierte Datenerhebung und Dokumentation die im Rahmen der Qualitätssicherung immer wichtiger wird

Acta Physiologica Scandinavica ,1996 **Advances in Therapeutic Engineering** Wenwei Yu,Subhagata

Chattopadhyay,Teik-Cheng Lim,U. Rajendra Acharya,2012-12-03 Therapeutic Engineering TE is a cutting edge domain in today's era of medical technology research Through engineering algorithms that provide technological solutions it aims to elevate the quality of life of disabled individuals Advances in Therapeutic Engineering describes various therapeutic processes and mechanisms currently applied to the field of healthcare in a range of areas including mobility communications hearing vision and mental health and cognition The book explores research and advances in the areas of hand-eye coordination motor function the biomechanics of lower limbs and treatment of spinal diseases and neural plasticity It discusses electrical stimulation methodologies for improving human gait It also examines prosthetic devices and assistive technology induction heater based treatment and inclusive user modelling and simulation Additional chapters cover automated asthma detection using clinico-spirometric information computer aided diagnostic modules for malaria screening and various data mining techniques that have been developed and successfully implemented in healthcare management The contributors also examine semantic interoperability issues in e-health systems and clinical decision support systems CDSSs Ranging from prosthetics to sensory substitution and medical robotics the book will prove enlightening to researchers and practitioners in a host of disciplines who want to understand the recent advances achieved globally in the field of therapeutic engineering **Biomechanics, Aging, Exercise and Other Interventions** Rafael Reimann Baptista,Marcus Fraga

Vieira,Chiarella Sforza,Rezaul Begg,2022-12-01 **Biomechanical Studies of the Musculoskeletal System** Francis G.

Evans,1961 **Congressional Record** United States. Congress,1984 The Congressional Record is the official record of the proceedings and debates of the United States Congress It is published daily when Congress is in session The Congressional

Record began publication in 1873 Debates for sessions prior to 1873 are recorded in The Debates and Proceedings in the Congress of the United States 1789 1824 the Register of Debates in Congress 1824 1837 and the Congressional Globe 1833 1873

A Treatise on the Functional Pathology of the Musculoskeletal System William James Brooks, DO, 2022-10-31

In this Treatise on the Functional Pathology of the Musculoskeletal System FPMSS Dr Brooks presents a new paradigm for understanding the musculoskeletal system and a scientifically valid reliable semiquantifiable and consistently interpretable method for examining dysfunction thereof This first volume presents the fundamentals of the paradigm and is designed for use by a primary care audience While the paradigm is applicable to the wide variety of clinical conditions potentially amenable to manual medicine and related rehabilitative techniques this first volume takes chronic nonspecific musculoskeletal pain syndromes as its focus for application The FPMSS paradigm complements orthopedic rheumatologic and neurologic understandings of the musculoskeletal system and contrasts with current models of manual medicine in several important respects Understands the musculoskeletal system MSS as an integrated organ system Discriminates questions about physiology from questions about anatomy Discriminates questions about pathology from questions about physiology Differentiates functional pathology from structural pathology Appreciates principles of scientifically valid nomenclature for function and dysfunction of musculoskeletal structures as components of an integrated system Recognizes dysfunction of the musculoskeletal system as inefficient function Shifts the emphasis of examination for dysfunction from malalignment of structure posture to disturbance of systemic movement Discriminates control of posture and movement from imbalance of available motion Grades available motion deficits using the criterion of proportionality not merely symmetry thus revealing otherwise unappreciated dysfunction and allowing for prioritization and profiling Prioritizes mobilization interventions according to specified ranked criteria Profiles an individual's motion phenotype based upon patterns of available motion deficits thus providing precision biomechanical medicine Use of the FPMSS paradigm examination will reduce the incidence of false negative and false positive findings for MSS dysfunction thus improving the effectiveness safety and efficiency of caring for those suffering from chronic musculoskeletal pain

Temporal Study of Psychosocial Work Factors, Stress, and Musculoskeletal Discomfort Among Computer Users Adsada Sae-Ngow, 2001 *Physical Ergonomics and Human Factors* Ravindra S. Goonetilleke • Shuping Xiong, 2022-07-24 *Physical Ergonomics and Human Factors* Proceedings of the 13th International Conference on Applied Human Factors and Ergonomics AHFE 2022 July 24 28 2022 New York USA

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