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Protocol for a Scoping Review: Sensor Implementation for Monitoring and Analyzing Biomechanical Performance in Rowing and Canoeing Athletes

Cruz, M[1]; Sarmento, H[2]; Amaro, A[3]; Roseiro, L[4]; Gomes, B[5].

Corresponding author:
Maria Cruz

ines.p.cruz.98@gmail.com

Author Affiliation:
CIDAF, Faculty of Sport Sciences and Physical Education, University of Coimbra, Portugal.

ADMINISTRATIVE INFORMATION

Support - FCT - UI/BD/153693/2022.

Review Stage at time of this submission - Data analysis.

Conflicts of interest - None declared.

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Amendments - This protocol was registered with the International Platform of Registered Systematic Review and Meta-Analysis Protocols (INPLASY) on 13 September 2023 and was last updated on 13 September 2023.

INTRODUCTION

Review question / Objective What is the best practice framework for selecting and implementing inertial and other sensors to monitor the biomechanical performance of rowing and kayaking athletes?
The objective of this scoping review is to identify and summarize the current state of knowledge regarding the selection and implementation of sensors for monitoring the biomechanical performance of rowing and canoeing athletes. This review aims to provide insights into the types of sensors used, the variables collected, and the validity of their use in the context of outdoor measurements during rowing and canoeing.

Background Performance analysis in sports, which emerged in 2001 through the fusion of biomechanics and notational analysis, has grown alongside the commercialization and popularity of sports in the 20th century. Scientific advancements in anatomy, physiology, mechanics, and engineering have contributed valuable insights into human movement.
The history of performance analysis encompasses biomechanical and notational analysis. Biomechanics gained traction in 1968 with competitive sports data collection, evolving through technological advancements like high-speed cameras and computer software. Notational analysis, employed for centuries in various fields, was revolutionized by technology, enabling sophisticated data collection.
Advancements in technology have made feedback in sports crucial for performance improvement. Traditional athlete performance assessment primarily occurred in controlled laboratory environments, limiting the replication of real sports conditions. However, advances in microelectronics

have facilitated testing and monitoring elite athletes during regular exercise.

Recent years have witnessed significant developments in inertial sensors, which measure acceleration and angular velocity along three axes. These sensors, incorporated into inertial measurement units (IMUs), indirectly measure specific forces based on the laws of motion. IMUs, when combined with other sensors like strain gauges, GPS, or potentiometers, can monitor athlete biomechanics and equipment interaction in diverse settings, including laboratories, training environments, or competitions.

While previous studies have utilized sensors in various sports, applying sensor technology in water sports like canoeing and rowing presents unique challenges due to the aquatic environment. Waterproofing mechanisms and specialized sensor designs are essential for accurate data collection in these conditions. Utilizing multiple sensors and correlating variables during aquatic training offers a comprehensive assessment of performance and technique. This approach provides insights into stroke mechanics, power generation, movement patterns, and course optimization, facilitating targeted training improvements.

Despite systematic reviews highlighting the reliability, validity, and utility of inertial sensors in sports, a specific overview of their implementation in rowing and canoeing is needed. Previous reviews focused on ergometer performance, injuries, and metabolism. Therefore, this scoping review aims to provide an overview of sensor combinations for performance analysis in rowing and canoeing. Its goal is to enhance the objectivity of coaches' evaluations and impact on performance improvement.

Rationale This scoping review is essential to advance our understanding of how sensor technology can enhance the evaluation of athlete biomechanics in water sports. While existing systematic reviews have explored sensor applications in various sports, there is a need for a specific overview of their implementation in rowing and canoeing. This review will help bridge the gap in knowledge and provide guidance for future research in this area.

METHODS

Strategy of data synthesis Electronic databases (Web of Science (core collection), Scopus, Science Direct, and Sage Journals) were searched for relevant publications from inception until August 2023.

Keywords and synonyms were entered in various combinations in all fields: ("athlete$ row*" OR "athletes canoe*" OR canoeing OR rowing) AND ("inertial sensor$" OR sensor$ OR gyroscope OR meter OR "strain gauge$" OR GPS OR "Global Position System" OR GNSS OR "Global Navigation Satellite System") AND (kine OR velocity OR power OR tim* OR force$ OR angle$ OR *feedback).

Eligibility criteria Inclusion criteria were: 1) written in English, 2) refer to the sensor(s) used, 3) use sensors to measure variables in the paddle or oar, and 4) are only used for outdoor measurements. Articles were only excluded if they were 1) not published in scientific journals, 2) did not show a relationship and 3) relevance to the question posed, and 4) were published before 2008.

Source of evidence screening and selection The main findings of the scoping review are divided into two groups: one group is variables and sensors, and another is data collection, processing, and interface. Variable and sensors included provide an overview of the variables collected and the sensors utilized for data collection. Data collection, processing, and interface refer to the sampling frequency, how data is collected and analyzed, and the type of interface used to show the variables to the user.

In this scoping review, the methodological quality of the included studies will be assessed using the National Heart, Lung, and Blood Institute (NHLBI) Quality Assessment Tools. These tools are designed to systematically evaluate the quality and risk of bias in various study designs, ensuring the reliability of the evidence included in our review.

The NHLBI Quality Assessment Tools consist of specific criteria tailored to different study types, such as randomized controlled trials, cohort studies, case-control studies, and cross-sectional studies. Each tool assesses key aspects of study design, conduct, and reporting to gauge the overall quality of the research.

For quality assessment, two independent authors (MC and BG) will use the NHLBI Quality Assessment Tools to individually evaluate the included studies. Disagreements between the two authors will be resolved through consensus discussions. The goal is to assess the overall methodological quality and risk of bias in each study, enhancing the reliability of our scoping review.

This systematic approach to quality assessment ensures that our scoping review maintains rigorous standards in evaluating the methodological quality of the studies included, ultimately enhancing the reliability and trustworthiness of the evidence synthesized.

Data management A scoping review was conducted following the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) criteria, using the extension for scoping reviews (PRISMA-ScR) for completing and reporting the findings of systematic reviews.

Language restriction English.

Country(ies) involved Portugal.

Keywords Biomechanics; Data collection; Oar and paddle sports; Optimization.

Contributions of each author

Author 1 - Maria Cruz.
Email: ines.p.cruz.98@gmail.com
Author 2 - Hugo Sarmento.
Email: hgsarmento@gmail.com
Author 3 - Ana Amaro.
Email: ana.amaro@dem.uc.pt
Author 4 - Luis Roseiro.
Email: lroseiro@isec.pt
Author 5 - Beatriz Gomes.
Email: beatrizgomes@fcdef.uc.pt