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REVIEW ARTICLE

Analyzing Handball Techniques Using A Biomechanical Approach: A Systematic Literature Review

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Authors' Contribution: A – Study design; B – Data collection; C – Statistical analysis; D – Manuscript Preparation; E – Funds Collection

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Abstract

Objectives. The study aimed to examine the use of biomechanical analysis in handball technique.

Materials and methods. This review study followed the PRISMA standards for systematic reviews and meta-analyses. The study had to be published within the period of 2018 to 2023. The search procedure involved using the keywords (1) handball and (2) biomechanics. Scopus search engine was used in the study.

Results. The search results on the database yielded 115 articles, which were adjusted according to the criteria into 11 articles.

Conclusion. Biomechanical analysis that can be applied to handball techniques includes such aspects: distance travelled, speed, change of direction, joint angle, postural stability, movement pattern, and injury localization.

Keywords: handball, biomechanics, technique.

Introduction

Handball players have significant asymmetry in body musculature and grip strength, which may impact performance and increase injury risk (Lijewski et al., 2021). Elite and sub-elite performers in beach handball are differentiated by horizontal jump and technical ability via the performance of specific throwing skills, rather than anthropometric or other physical variables (Lemos et al., 2022). The most frequent injuries in handball players are located in the lower limbs (thigh, knee, ankle), and in the shoulder in the upper limbs (Vila et al., 2022).

Systematic literature reviews provide a comprehensive understanding of a business literature topic, guide future research, and help business leaders make better decisions (Clark et al., 2021). Systematic reviews are invaluable for synthesising research findings and help demystify the search process (Foo et al., 2021). A search summary table in systematic reviews improves search results reporting and adds to the evidence base about information retrieval (Bethel et al., 2021).

Sports biomechanics examines athletic movements to enhance performance and reduce injury risk, with motion technologies being used in support of athletes (Aresta et al., 2023). Biomechanics in sports performance involves automating performance analysis and assessment by using motion capture sensors and biomechanical software to extract joint angle curves and summarize them into standard performance curves (Fathalla et al., 2023). Sports biomechanics aims to reduce injury risk and improve sports performance, with the Journal of Sports Sciences combining Sports Medicine and Biomechanics sections to form the current Sports Medicine and Biomechanics section (Wallace et al., 2022).

Different movement profiles of speed, acceleration, and tortuosity were identified across phases of play and in-game win probabilities (Gregory et al., 2022). Linear advancing actions are the most common movements preceding goals, followed by decelerations and turns (Martínez-Hernández et al., 2023). Attacking agility actions, such as side steps, shuffle

steps, crossover cutting, split steps, spins, decelerations, and sharp turns, are important maneuvers in invasion team sports to evade, create separation, generate high exit velocities, and facilitate sharp redirections (Dos'Santos et al., 2022).

There has been a long history of research on handball related to education (Arias et al., 2021), physicological (Muntianu et al., 2022), body composition (Martínez-Rodríguez et al., 2021). Some sports place great importance on biomechanics as an instrument of achievement. Biomechanics is considered a determining factor in athlete performance (Aresta et al., 2023; Wallace et al., 2022). Some of the previous studies that examined handball (Hidayat & Permana, 2023; Nurhadi et al., 2023) require updates regarding the importance of training techniques and biomechanics in this sport. This research can help in creating a training plan that suits the requirements of the sport. Therefore, this research is very important. The researchers hope that the findings from this study will provide recommendations for readers.

Materials and Methods

The research method used is a systematic literature review (SLR) for studying and interpreting biomechanical analysis on handball.

Study Participants

The population of this study were articles published in international journals indexed by a highly reputable database, namely Scopus, which is equivalent to the role of weight training in gymnastics athletes. The sample selected was articles with H-Index and articles published in international journals with Elsevier homepage from 2018-2023. This study has two types of research data sources, namely primary and secondary data sources. The instrument used in this research is a data coding sheet. This data not only serves as an internal audit, but is also useful in answering why certain studies are not included in the synthesis.

Data Collection Techniques and Instruments

a. Planning

The initial stage to start the systematic review process is planning by forming a review panel of experts and practitioners to develop a review question. Review questions will result in data analysis and synthesis. Review questions have been discussed in the problem formulation chapter.

b. Data Collection

The data collected in this study are secondary data obtained from the results of research that has been carried out by previous researchers and published in international journals indexed by a highly reputable database Scopus.

The article search used the keywords "biomechanical" AND "handball". In addition, the authors also checked the references of the articles searched to increase the number of article searches.

c. Inclusion and Exclusion Criteria

The inclusion criteria in this study:

1. The data used only relates to keywords.
2. Data is an original article.
3. Only English articles and indexed according to predetermined criteria.
4. Data used in the time span 2018-2023.

While the exclusion criteria are as follows:

1. Data that is not related to biomechanics in handball.
2. Data is not an original article including review articles.
3. Not an English-language article and indexed according to predetermined criteria.
4. Data used in the time range 2018-2023.

Searching for articles in the database using keywords obtained a total of 115 articles. After filtering by determining the publication period (2018-2023), language and type of article, 60 articles were obtained. Furthermore, the articles were selected based on inclusion and exclusion criteria according to relevance and a total of 11 articles were obtained (fig. 1).

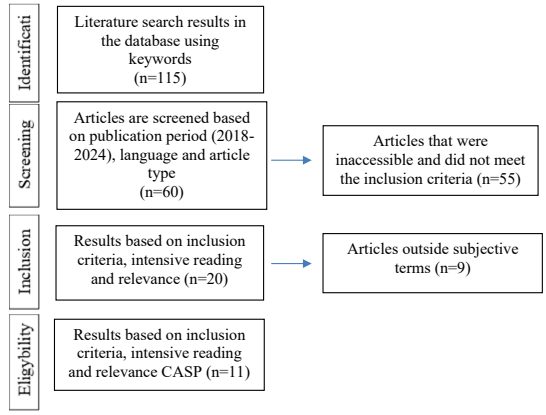

Fig. 1. PRISMA scheme in the literature selection process

Study Instrument

The researcher used annotated bibliography analysis. Several things were considered in analyzing the annotated bibliography, namely:

1. Identity of the referenced source.
2. Qualification and purpose of the author.
3. A simple summary of the content.
4. The importance of the sources referred to in answering the problem that has been formulated.

Results

The table below shows the total number of publications during the selected time period, year of publication.

Table 1. Evolution of the number of publication at year

Year of Publication	Number of article
2023	10
2022	9
2021	8
2020	8
2019	13
2018	12

Based on the articles that met the inclusion criteria, intensive reading and relevance to answer the research questions, 5 studies were eligible to proceed to the next stage. The collected studies were then analyzed using the mixed methods appraisal tool (MMAT) adapted from Hong (2018). The results of the MMAT analysis of the eleven quantitative studies in table 4 show that nine studies used random sampling using a control or comparison group.

Table 2. Source from country

Country	Number of article
Spain	10
Denmark	9
Germany	7
Norway	7
Poland	7
United Kingdom	6
United States	6
Austria	4
Brazil	4
France	4

Discussion

Based on results handball techniques is distance traveled, velocity, changes in direction, joint angle, postural stability, movement pattern, location injury. High levels of physical fitness and motor skill development, including the ability to jump, throw, sprint short distances, move quickly, have both anaerobic and aerobic capacity, and have strong muscles, are hallmarks of the handball sport (Dimkova, 2022). Running, direction changes with and without the ball, opponent interaction, and decision-making in both offensive and defensive activities are all part of the game (Fenici et al., 2022). Due to its comparatively quick mastery

Table 3. Mixed method apparaisal tool (MMAT) version 2018

	Screening Questions		Quantitative randomized controlled trial				
Author, year	Is question research questions clear?	Is collection data collection can answer questions research question?	2.1. Was randomization carried out appropriately?	2.2. Are the groups comparable from the beginning?	2.3. Is there is result data complete?	2.4. What is the intervention given confidentially (blind) to the results assessor?	2.5. Is participant obey intervention which given?
(Fathalla et al., 2023)	Yes	Yes	Yes	Yes	Yes	Yes	Yes
(Müller et al., 2022)	Yes	Yes	Yes	Yes	Yes	Yes	Yes
(Lijewski et al., 2021)	Yes	Yes	Yes	Yes	Yes	Yes	Yes
(Wilczyński et al., 2022)	Yes	Yes	Yes	Yes	Yes	Yes	Yes
(Russomanno et al., 2021)	Yes	Yes	Yes	Yes	Yes	Yes	Yes
(Guignard et al., 2022)	Yes	Yes	Yes	Yes	Yes	Yes	Yes
(van den Tillaar et al., 2021)	Yes	Yes	Yes	Yes	Yes	Yes	Yes
(Sánchez-Sáez et al., 2021)	Yes	Yes	Yes	Yes	Yes	Yes	Yes
(Di Credico et al., 2021)	Yes	Yes	Yes	Yes	Yes	Yes	Yes
(Vila et al., 2022)	Yes	Yes	Yes	Yes	Yes	Yes	Yes
(Wagner & Hinz, 2023)	Yes	Yes	Yes	Yes	Yes	Yes	Yes

Table 4. Review of research results

Title	Finding	Method
(Fathalla et al., 2023)	Observasional Study	Joint Angle
(Müller et al., 2022)	Observasional Study	Distance traveled, velocity, and changes in direction.
(Lijewski et al., 2021)	Observasional Study	Segmental bioelectrical impedance analysis (SBIA)/Angle
(Wilczyński et al., 2022)	Non RCT Trial	Postural stability and angle
(Russomanno et al., 2021)	Observasional Study	Movement
(Guignard et al., 2022)	Observasional Study	Movement
(van den Tillaar et al., 2021)	Non RCT Trial	Handball throws and predict ball velocity, offering a practical and automated method for quantifying throw counts and classifying approach and throw types.
(Sánchez-Sáez et al., 2021)	Observasional Study	Movement patterns and physical demands during an official competition.
(Di Credico et al., 2021)	Observasional Study	Bioelectrical characteristics in young male and female elite handball players.
(Vila et al., 2022)	Sistematic Literature Review	The most frequent injuries in handball players are located in the lower limbs (thigh, knee, ankle), and in the shoulder in the upper limbs.
(Wagner & Hinz, 2023)	Observasional Study	Specific game-based movements and general physical performance tests.

based on natural human movements, handball has become very popular very quickly (Śliż et al., 2022). In order to enhance technical processes during games and minimise injuries, the sport mandates that players follow particular physical training regimens depending on their position and level on the pitch (Russomanno et al., 2021). Handball is a dynamic and difficult sport that integrates motor skills, physical conditioning, and strategic decision-making.

Handball players experience frequent injuries in lower limbs (thigh, knee, ankle), upper limbs (shoulder), and playing positions (over the 6-m line, women), with most occurring during competition (Vila et al., 2022). Handball players cover more total distance in offense (1217.48 ± 699.33 m) and in all locomotion categories ($p < 0.001$) than in defense (900.96 ± 538.95 m), with a similar average total time on court (Manchado et al., 2021). Co-education in school handball leads to significant improvements in skills, effort, enjoyment, participation, and social climate, promoting social and civic skills (Arias et al., 2021).

The results of biomechanical evaluations are crucial for assessing athletic performance because they offer a more thorough understanding of a person's neuromuscular capabilities, which traditional testing may miss (Pleša et al., 2022). Understanding the mechanics of any sport is essential for improving performance and avoiding injuries, and biomechanics can help with this (Kumaran et al., 2022). Accurate performance data is provided by biomechanics-based performance analysis, which aids coaches and athletes in achieving optimal athletic performance (Teferi & Endalew, 2020). In order to determine the biological components that absorb shock and safeguard living systems, as well as to comprehend the stresses and strains that various body parts generate, biomechanics is used in the analysis of sports performance (Bandeiras, 2019). A thorough examination of the motions and coordination involved in sports like cycling can be obtained by biomechanical evaluation, which enables the accurate measurement of kinematic, kinetic, motor, and physiological traits (Turpin & Watier, 2020).

Absence of biomechanical analysis in training can result in a higher risk of injury and less than ideal performance (Bathe et al., 2023). Athlete movement patterns and mechanics can be better understood by biomechanical analysis, which also helps identify potential risk factors and opportunities for improvement (Chenaut et al., 2019; Yin et al., 2022). Coaches and athletes can lower the risk of injury and improve performance by implementing focused training interventions by being aware of and addressing these biomechanical risk factors (Jones et al., 2022). One prevalent risk factor for lower extremities landing injuries is knee flexion angle, which can be reduced to a medium extent by technique training and dynamic strengthening, as demonstrated by previous research (Naichun, 2018). Furthermore, in order to ensure the safety and effectiveness of exoskeletons for people with lower limb limitations, biomechanical analysis can aid in their design and optimisation. Thus, in order to reduce the chance of injury and optimise performance, athletes must integrate biomechanical analysis into their training regimens.

Conclusion

Based on the results of using techniques for analyzing handball biomechanics by searching related literature, it can be concluded that the biomechanical analysis that can be applied to handball techniques is distance traveled, velocity, changes in direction, joint angle, postural stability, movement pattern, location injury.

Conflict of Interest

The authors guarantee that no conflicts of interest exist.

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Аналіз технічних прийомів у гандболі з застосуванням біомеханічного методу: систематичний огляд літератури

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Авторський вклад: A – дизайн дослідження; B – збір даних; C – статаналіз; D – підготовка рукопису; E – збір коштів

Реферат. Стаття: 6 с., 4 табл., 1 рис., 39 джерел.

Мета дослідження. Дослідження мало на меті вивчити питання застосування біомеханічного аналізу в техніці гандболу.

Матеріали та методи. Дане оглядове дослідження проводилося відповідно до стандартів PRISMA для систематичних оглядів та мета-аналізів. Дослідження мали бути опубліковані в період з 2018 по 2023 рік. Процедура пошуку включала використання ключових слів (1) гандбол і (2) біомеханіка. У дослідженні було використано пошукову систему Scopus.

Результати. За результатами пошуку в базі даних було знайдено 115 статей, які були відібрані відповідно до критеріїв у кількості 11 статей.

Висновок. Біомеханічний аналіз, який можна застосувати до техніки гандболу, включає такі аспекти: пройдену відстань, швидкість, зміну напрямку, кут нахилу суглоба, постуральну стійкість, схему рухів і локалізацію травми.

Ключові слова: гандбол, біомеханіка, техніка.

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