



REVIEW ARTICLE

ANALYSIS OF PENCAK SILAT TECHNIQUES USING A BIOMECHANICAL APPROACH: 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

Study purpose. The purpose of this research is to look into the use of biomechanical analysis in pencak silat martial arts techniques.

Materials and methods. The PRISMA standards for systematic reviews and meta-analyses were followed in this review investigation. The study must be published within the prior five years, from January 2019 to July 2023. In the search procedure, the following keywords are used: (1) pencak silat; (2) biomechanical analysis. The search engines SINTA (Science and Technology Index) and Scopus were employed.

Results. This evaluation included the results of 10 articles. Six articles looked at combat tactics, two at students and the art of movement, nine articles looked at kick attacks, and one looked at attitudes. Four articles proposed time and speed. Six articles investigated pencak silat motion angles.

Conclusions. Time, angle, direction, flexion, extension, rotation, adduction, visual focus, force, moment of inertia, rotational kinetic energy, and effort are all inferred factors for pencak silat techniques.

Keywords: biomechanical analysis, technique, pencak silat.

Introduction

Every element of the human body is utilized in the unique movements of pencak silat. Pencak silat training involves physical and mental training, aimed at developing an individual's abilities, strengths, and weaknesses. It also focuses on cultivating noble character and self-reflection through rituals such as breathing exercises and fasting (Ediyono et al., 2023). Additionally, research on the physical demands of pencak silat competition shows that it is characterized by full-body contact combat, indicating the involvement of various parts of the body in the sport (Nurul Khotimah et al., 2022). Furthermore, the development of training models for children in pencak silat emphasizes the importance of adapting movements with biomotor components, indicating the involvement of different body elements in the training

process (Subekti et al., 2021). Therefore, it can be concluded that pencak silat utilizes every element of the human body in its movements.

A systematic literature review is a method used to analyze, synthesize, and summarize existing literature on a particular topic (Dwidienawati et al., 2023). It involves a rigorous and systematic approach to collecting and analyzing data from relevant sources (Moher, Shamseer, et al., 2016). The goal of a systematic literature review is to provide a clear and objective summary of the current state of knowledge on a particular topic, identify gaps in the literature, and suggest areas for future research (Pinto et al., 2023). It is widely used in various fields, including health care, education, psychology, social sciences, and business and management (Amjad et al., 2023).

Biomechanics is a scientific discipline that analyzes movement and studies forms and patterns of movement using mechanical concepts. This is supported by the sciences of anatomy, physiology, and physics, which provide the basis for biomechanics (Syaukani et al., 2023). Despite the complexity of the human body, biomechanics primarily

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focuses on mechanical concepts (H. Wang et al., 2022; Y. Wang et al., 2022; Y. P. Q. W. C. Z. M. W. Y. Wang, 2022). It examines the different ways people move during exercise to better understand movement.

The correctness of sports movements is important because it can have an impact on the success of rehabilitation and injury prevention in athletes (Dirette, 2016). Insufficient movement quality can lead to further damage or re-injury even after successful rehabilitation (Wilke et al., 2017). Objective methods such as biomechanical analysis are seen as the international gold standard for assessing movement quality, but they are not always practical for daily exercise routines (Seuter et al., 2020). Subjective test protocols exist to assess movement quality, but currently do not have sufficient validity. However, there are few practical approaches to assess movement quality after injury (Wren et al., 2020). It is important to identify risk factors and perform pre-injury assessments of movement quality to improve injury prevention. To correctly carry out the technical phases of pencak silat, it is necessary to periodically correct the movements to be more mechanically correct, with more effectiveness and efficiency, and to minimize movement errors (Haqiyah et al., 2020). Understanding biomechanics can help improve mobility and minimize the risk of injury during physical activity (Wu et al., 2023).

There has been a lot of research carried out in the past which has produced pencak silat learning media, including: videos (Sasmitha et al., 2020), Android applications (Marwan, 2018), multimedia (Mardius et al., 2023), mobile applications based on Augmented reality (Muktiani et al., 2022), and training models (Hadiana et al., 2022; Subardi et al., 2021).

In the study of pencak silat martial arts, biomechanical analysis is crucial. This aids in comprehending the stresses and torques produced by a specific strategy. This approach sheds light on variables like knee extension angle and calf length that affect the moment of force. Researchers can ascertain the effects of these strategies on kick speed and moment of inertia by examining the biomechanics of pencak silat techniques. Additionally, biomechanical study can aid in the creation of certain fighting tactics and methods. Additionally, it can assist in creating training plans that fit the physical requirements of the sport. To enhance performance and maximize training methods, biomechanical research in pencak silat fighting is therefore crucial. The application of biomechanical analysis of pencak silat techniques is the goal of this study, according to the researchers, who have based their decision on the aforementioned. Researchers hope that the findings of this study will offer recommendations for how to analyze the biomechanics of the pencak silat technique so that they may build a solid foundation for their work.

Materials and methods

Study participants

The words "Analysis biomechanic" and "Martial Arts or Pencak Silat" were searched for in published articles from the Sinta (Science and Technology Index) and Scopus Collection (Science Citation Index Expanded; Social Science Citation Index; Arts & Humanities Science Citation Index) from the years 2019 through 2023.

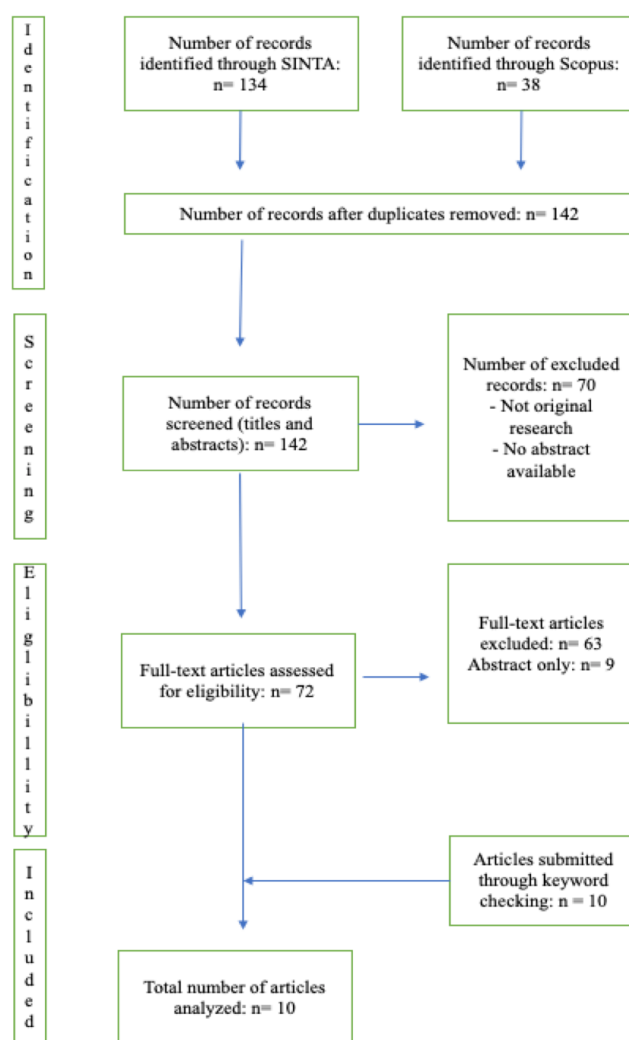


Fig. 1. Flow diagram used to select articles

As shown in the flow diagram (Figure 1), a total sample of 10 articles was obtained from a total of 142 articles by adhering to the Preferred Reporting Items for Systematic Reviews and Meta-Analysis (PRISMA) guidelines (Moher, Stewart, et al., 2016) during the phases of identification, screening, suitability, and inclusion.

The following variables were taken into account in the bibliometric analysis: (a) The annual trend of articles published between 2019 and 2023; (b) the distribution of publications at the institution of the first author; (c) the number of authors; (d) the subject area (training, health, management, education, other, or mixed); (e) the type of study (experimental, descriptive, correlational, other); and (f) the average number of citations per article.

Study organization

The following variables were taken into account in the literature review: (a) The annual trend of articles published between 2019 and 2023; (b) the distribution of publications at the institution of the first author; (c) the number of authors; (d) the subject area (training, health, management, education, other, or mixed); (e) the type of

study (experimental, descriptive, correlational, other); and (f) the average number of citations per article.

Statistical analysis

Article titles, abstracts, and keywords were focused as these were sufficient to produce a reliable and sufficient core of articles for further use and analysis. Only open access articles were included in this review study because the authors of this review did not wish to exclude anyone who did not have access to their research. The following inclusion and exclusion criteria were deployed to derive only relevant studies dealing exclusively with a particular topic.

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 per year

Year of publication	Number of articles	Percentage
2019	132	23%
2020	27	19%
2021	26	18%
2022	34	24%
2023	23	16%
Total	142	100%

Various time periods can be seen in the evolution of the number of publications, as depicted in Figure 2. First, there has been a noticeable rise in scientific output from 2019 (19 articles), 2020 (27 articles), 2021 (16 articles), 2022 (29 articles), 2023 (23 articles).

According to the literature, biomechanical analysis that can be applied in pencak silat techniques is shown in the table

Table 2. Summary table of studies

Topic	Sample	Result	Source
Motion Analysis of the Front Kick	Fighter athletes	Angles	(Hariono et al., 2021)
Pencak silat combat time motion analysis	Fighter athletes	Time	(Subekti et al., 2021)
Pencak Silat Side Kick	Fighter athletes	Direction, flexion, extension, rotation, adduction, visual focus.	(Irawan et al., 2021)
Biomechanical Analysis of Horse Kick Athletes Single Art Category Pencak Silat	Athletes single art	Angles of flexion and extension	(Risa Billah & Awang Irawan, 2022)
Biomechanical analysis enhance the learning outcomes of Pencak Silat	Undergraduate students	Angles	(Lubis et al., 2022)
Biomechanics analysis on Jejag kick	Fighter athletes	The magnitude of the moment of force, moment of inertia, rotational kinetic energy, effort, and power	(Doewes et al., 2022)
Movement Compatibility Analysis of Side Kick	Fighter athletes	Time and angle	(Syaifullah & Doewes, 2020)
Analysis Of Round House Kick	Fighter athletes	Angles	(Sonia and Bhanu Pratap, 2023)
Biomechanical Analysis of Martial Arts Fore Kick	Fighter athletes	Time, speed, flexion angle and extension angle	(Yan et al., 2022)

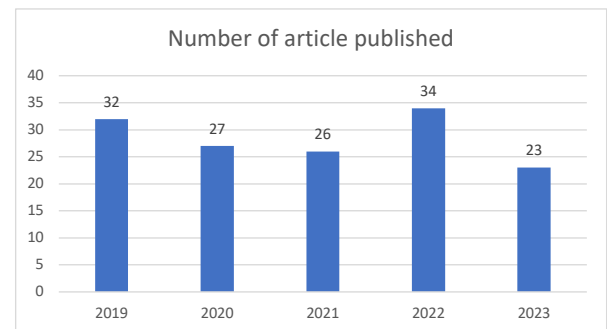


Fig. 2. Evolution of the number of publications per year

above. This review comprised ten studies. In eight studies, combat techniques were discussed, as were art trends and pupils. 9 research looked at kick assaults, whereas 1 looked at postures. Four research point to time and speed. Angles in pencak silat movements are suggested by six research. Others propose flexion, extension, rotation, adduction, and visual attention. Moment of force, moment of inertia, rotating kinetic energy, effort, and power are all measured in magnitude.

Discussion

Pencak silat techniques encompass numerous and distinct pencak silat techniques, as well as their distinct qualities, functions, and performance, as well as theories and strategies for their execution, which are divided into four components: postures, movements, attacks, and defenses. The primary goal of teaching pencak silat is to develop martial arts practitioners who understand the structure of pencak silat techniques and processes (management), as well as tips on how to perform them practically, pragmatically, effectively, efficiently, creatively, tactically, and productively, all of which can create a competitive advantage.

Pencak silat techniques generally use punches, kicks, locks, blocks, and evasion. Each technique is still broken

down again, for example punches are divided into palm punches, backhand punches, scratches, plugs, and so on (Vai et al., 2023; Widiastuti et al., 2022). In addition, in pencak silat, traditional weapons such as swords, machetes, sticks, spears, celurit, knives, tridents, kerambit (a type of knife), keris, and others are taught. Pencak Silat in the psychomotor domain is inseparable from biomechanics, understanding the factors that govern human movement is very important for technique (Ihsan et al., 2022; Kusuma & Novita, 2023; Muzakki et al., 2023). Harnessing biomechanics for training enables intelligent training planning so you can get the most out of it in the shortest time and in the safest way.

The study of exercise biomechanics enables the user to comprehend how the body reacts to various forms of exercise intensity, angle, and posture. In other words, studying exercise biomechanics magnifies these impacts, allowing players to select the best sport for them. Biomechanical analysis can throw light on the facts and help understand what pressures poor technique is exerting on joints and surrounding tissues when form and technique are poor. Athletes of all ages and abilities can benefit from biomechanical analysis, whether to ease discomfort or improve performance. In brief, these are some of the biomechanical advantages: improving movement speed, improving strength, and assisting in the elimination of muscular imbalances. reduced wear and tear on joints and ligaments, better sport-specific form and technique.

Biomechanics is a scientific discipline that integrates factors that affect human movement, drawn from basic knowledge such as physics, mathematics, chemistry, physiology, anatomy and engineering concepts to analyze the forces that occur in the body. forces and moments imposed on workers so that work accidents do not occur. Biomechanics is a scientific discipline that applies mechanical principles to understand performance systems in the human body (Keogh, 2021; Norman et al., 2021; Y. Wang, 2022). It focuses on the study of movement in living organisms, including the interaction of forces, moments, and mechanical properties on the movement or balance of body segments. Biomechanics also examines the mechanical behavior of biological systems and subsystems, such as the musculoskeletal system and its ligaments and tendons (Bandeiras, 2019; Bavi et al., 2022; Papageorgiou, 2020).

Biomechanics knowledge is critical to engineering education, particularly for those working in the biomedical sector, because it permits the development of equipment such as prosthetics and rehabilitation tools that promote healing, restoration, and simulate lost biological capabilities. Overall, biomechanics is a subfield of biophysics that studies the structure, function, and movement of living organisms. Biomechanics is a science that combines physics (particularly mechanics) and engineering, as well as knowledge of the work environment. General biomechanics is the branch of biomechanics that studies the fundamental laws that govern the organic human body at rest and in motion. Biomechanics is a study that specializes in analyzing segments of human body motion, one of which is quantitative data on angles in degrees (Hughes et al., 2021).

There are two major benefits to studying the effects of these factors. For starters, it enables training to enhance technique while avoiding harm. This research also aids in the enhancement of performance and physical fitness in terms of strength, cardiovascular fitness, and flexibility. There

are numerous advantages to doing biomechanical analysis, because biomechanics gives a wealth of information for various types of human movement analysis, particularly to improve athlete performance (increase performance) and lower the risk of injury (Teferi & Endalew, 2020).

Conclusions

Based on the outcomes of using techniques for biomechanical analysis of pencak silat by searching literature related to the analysis of pencak silat biomechanics, it can be concluded that the biomechanical analysis that can be applied to pencak silat techniques is time, angles, direction, flexion, extension, rotation, adduction, visual focus, force, moment of inertia, rotational kinetic energy, effort.

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Conflict of interest

The authors reported no potential conflicts of interest.

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АНАЛІЗ ТЕХНІК ПЕНЧАК-СИЛАТУ З ВИКОРИСТАННЯМ БІОМЕХАНІЧНОГО ПІДХОДУ: СИСТЕМАТИЧНИЙ ОГЛЯД ЛІТЕРАТУРИ

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Авторський вклад: А – дизайн дослідження; В – збір даних; С – статаналіз; D – підготовка рукопису; Е – збір коштів

Реферат. Стаття: 7 с., 2 табл., 2 рис., 44 джерела.

Мета дослідження. Метою цього дослідження є вивчення використання біомеханічного аналізу в техніках бойових мистецтв пенчак-силату.

Матеріали та методи. У цьому оглядовому дослідженні дотримувалися стандартів PRISMA, передбачених для систематичних оглядів і метааналізів. Дослідження повинно було бути опубліковане упродовж попередніх п'яти років, із січня 2019 року до липня 2023 року. У процедурі пошуку використовувалися такі ключові слова: (1) пенчак-силат; (2) біомеханічний аналіз. У дослідженні використовували пошукові системи SINTA (Science and Technology Index – «Науково-технологічний індекс») та Scopus.

Результати. Ця оцінка включала результати 10 статей. У шести статтях розглядали тактику бою, у двох – учнів і мистецтво пересування, у дев'яти статтях розглядали атаки ударами ніг, а в одній – ставлення. У чотирьох статтях пропонували до уваги час і швидкість. У шести статтях досліджували кути руху в пенчак-силаті.

Висновки. Час, кут, напрямок, згинання, розгинання, обертання, приведення, зоровий фокус, сила, момент інерції, кінетична енергія обертання та зусилля – це всі одержані як висновок фактори для технік пенчак-силату.

Ключові слова: біомеханічний аналіз, техніка, пенчак-силат.

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