

# Mathema Asclepius: A Systematic Review of Mathematics Shaping Medical Frontiers

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Received July 18, 2024; Revised August 20, 2024; Accepted August 27, 2024

**Abstract** The incorporation of mathematics and medicine is considered a deep interdependence, significantly influencing healthcare aspects and driving innovations in medical technology and treatment methodologies. The interplay between mathematics and medicine advances healthcare science and enhances mathematical practices and theories, promising transformative progress in personalized healthcare. Despite the fragmented nature of existing research, a comprehensive synthesis is needed to fully grasp mathematics' broad implications in medicine, addressing challenges and unlocking its full potential in revolutionizing healthcare practices. The study utilized a systematic review approach integrating social network analysis, text mining, and content analysis methodologies to explore mathematics' implications in medicine comprehensively. Inclusion criteria focused on peer-reviewed articles employing quantitative and qualitative methodologies within the medical context from 2014-2024, resulting in eleven (11) selected studies. Thematic analysis and cross-study comparison facilitated a cohesive narrative, exploring the overarching role of mathematics in advancing various domains within medicine. The review of the eleven articles underscores mathematics' indispensable role in healthcare, impacting patient safety, education, research, and analytical endeavors profoundly. The result highlights the critical need for solid mathematical proficiency among healthcare professionals; the articles stress the importance of enhancing mathematics education programs to prepare students better, fostering confidence, precision, and innovation in navigating complex medical tasks and driving improved health outcomes.

**Keywords:** *mathematics education, mathematics and medicine, systematic review*

**Cite This Article:** Evan P. Taja-on, Dennis B. Roble, and Laila S. Lomibao, "Mathema Asclepius: A Systematic Review of Mathematics Shaping Medical Frontiers." *Journal of Innovations in Teaching and Learning*, vol. 4, no. 1 (2024): 37-43. doi: 10.12691/jitl-4-1-6.

## 1. Introduction

The integration of mathematics and medicine is characterized by a deep interdependence, where mathematical principles significantly influence and advance various aspects of healthcare and contribute to innovations in medical technology and treatment methodologies. From refining the precision of medical apparatus to facilitating early disease detection, mathematical modeling and computational algorithms play crucial roles in medical diagnostics. The interconnectedness of mathematics and medicine continues to evolve, fostering innovations that enhance diagnostic accuracy, treatment effectiveness, and overall healthcare outcomes [1]. Additionally, medicine and mathematics advance healthcare science and catalyze the enhancement of mathematical practices and theories, shaping fields such as statistics and computational modeling [2]. As modern technology advances and our understanding of both disciplines deepens, the collaborative interaction between mathematics and

medicine promises to drive transformative progress in pursuing better, more personalized, and efficient healthcare solutions [3,4].

Existing literature showcases the diverse applications of mathematics in medicine, highlighting its potential to revolutionize healthcare practices across multiple domains. Mathematical modeling has been utilized in epidemiology to predict the spread of disease [5], inform public health policies and protocols [6], and guide intervention strategies during outbreaks [7]. Moreover, mathematical techniques such as machine learning and data mining have helped analyze large-scale medical datasets and facilitate medicinal development through predictive analytics and treatment optimization [8,9]. Furthermore, mathematical models have enhanced medical imaging technologies, improved diagnostic accuracy, and enabled early disease detection [10,11]. However, despite these advancements, the literature also highlights the fragmented nature of research in this field, underscoring the need for comprehensive synthesis to explain mathematics' implications in medicine fully.

The complexity of medical data and systems is continuously increasing [12], presenting a challenge that

mathematical methodologies have the potential to address with innovative solutions [13]. Mathematics offers promising avenues for revolutionizing multiple facets of medicine [14], from enhancing diagnosis and treatment optimization to deepening our understanding of disease mechanisms [15,16]. However, despite this promise, the current literature on the intersection of mathematics and medicine needs to be more cohesive across various disciplines. This fragmentation complicates efforts to grasp mathematical medical approaches' broad implications and applications fully. As a result, there is a need for a comprehensive synthesis of existing research to understand better the depth and breadth of mathematics' impact on medical frontiers.

The research sought to bridge the gap in understanding the application of mathematics in medicine by synthesizing and integrating findings from diverse research streams. The study aimed to provide a comprehensive exploration of how mathematics influences medical frontiers and to guide future research endeavors in this interdisciplinary field.

## 2. Methodology

### 2.1. Research Method and Design

The study employed a systematic review approach [17] following the social network analysis (SNA) [18], text mining [19], and content analysis [20] approach to enhance the depth and validity of the findings. By integrating the methodologies, the study aimed to triangulate the available information and gain a comprehensive understanding of the implications of mathematics in medicine. SNA provided insights into relational structures, while Content Analysis facilitated systematic interpretation of textual data, and text mining extracted valuable insights from texts. Figure 1 presents the research design.

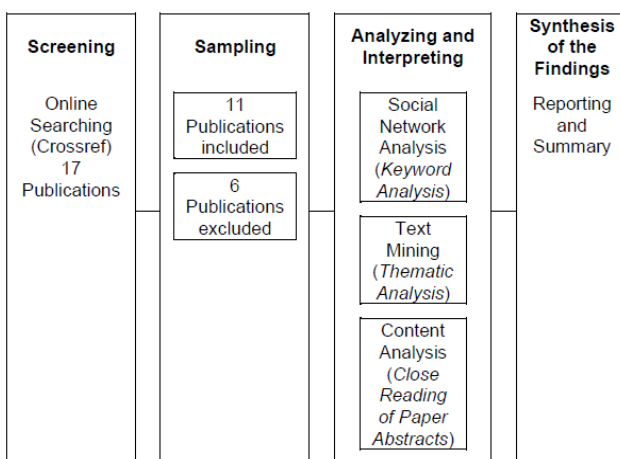


Figure 1. Schematic diagram

### 2.2. Inclusion and Exclusion Criteria

The inclusion criteria for the articles in this systematic review study encompass a focus on publications that directly contribute to understanding the application of mathematics in medicine. Included articles must be peer-reviewed journal articles, meta-analyses, systematic

reviews, or conference proceedings employing quantitative and qualitative methodologies, mathematical modeling, statistical analyses, systematic reviews, or numerical simulations in the context of medical applications. A temporal consideration will be applied from 2014-2024, preferring recent research unless historical context proves pertinent. Articles must be in English for ease of comprehension and readily accessible in full-text form. There are no specific geographic limitations unless the study concentrates on a region-specific aspect of the application of mathematics in medicine [21,22,23].

Conversely, the exclusion criteria involve the omission of articles that need more direct relevance to the integration or application of mathematics in medicine. Non-peer-reviewed sources, books, opinion pieces, letters, and editorials will be excluded, along with studies lacking a clear mathematical or quantitative focus within the context of medical applications. Publications outside the specified time range (2014-2024), those not available in English, inaccessible in full-text form, or with a solid geographic focus that does not contribute to a broader understanding of the subject will be excluded from consideration. These criteria collectively ensure a rigorous selection process, promoting the inclusion of pertinent and high-quality articles for the meta-synthesis study [21,23,24].

### 2.3. Literature Search

The Crossref database served as the sampling source for this study, adhering strictly to the predefined inclusion and exclusion criteria, resulting in the initial screening of seventeen (17) articles. The researcher reviewed the abstracts of all papers, resorting to full texts when necessary to ascertain the articles' relevance to the study's context and eliminate any duplicate sources. Following the final screening process, six (6) publications were removed from the inclusion in the research corpus. Finally, the final research corpus comprised eleven (11) published studies between the years 2014 to 2024.

### 2.4. Data Analysis

The study used a comprehensive examination and integration of findings from the selected studies to explain the overarching role of mathematics in medicine. Thematic analysis [25] was employed to categorize the findings based on recurring themes and concepts from the selected studies [26]. A cross-study comparison [27] was conducted to identify similarities and differences in the methodologies and medical applications across the included studies. The comparative analysis [28] facilitated a deeper understanding of the breadth and depth of mathematical contributions to various domains within medicine. The findings from the individual studies were synthesized thematically to construct a cohesive narrative that explicates the role of mathematics in medicine.

## 3. Results and Discussion

The study evaluated eleven (11) articles on the influence of mathematics on the medical field. It followed

the inclusion and exclusion criteria formulated in the study to select the eleven (11) articles. The study used the systematic review process to evaluate the eleven (11) articles.

### 3.1. Overview of the Articles

Table 1 presents an overview of the different articles used in the study. Additionally, the table depicts the different study objectives, research methodology, and respondents or materials used in the study.

As shown in Table 1, the study evaluated a total of two (2) qualitative articles, six (6) quantitative articles, and three (3) systematic review articles following varied methodologies. A total of eighty-seven (87) participants were declared for the qualitative articles, and a total of two-thousand three-hundred and fifty-three (2353) respondents and four (4) focused group discussions were declared for the quantitative articles. The article that used the systematic review process focused on texts with

historical, psychological, and research materials. Moreover, the study objectives of the different articles stated the evaluation of the relationship between the medical field and the mathematical field.

Table 2 presents the summary of the different findings of the articles that were used in the research.

As presented in Table 2, three (3) primary themes can be extracted from the result of the study: Integration and relevance of mathematics in healthcare education; the role of mathematics in advancing healthcare innovation; and motivation and support for mathematics learning in healthcare. The first theme on *integration and relevance of mathematics in healthcare education* is derived from Art-1, Art-4, Art-9, and Art-11. The theme incorporates the challenges and importance of integrating mathematics into healthcare courses while ensuring its application to real-world medical practice. The theme also highlights the importance of contextualizing mathematics within healthcare to facilitate adequate mastery of mathematical concepts, such as drug dosage calculations and medical imaging.

**Table 1. Overview of the objectives, methodologies and respondent/materials of the articles reviewed**

Article	Author	Study objective	Methodology	Respondents/ Materials
Art-1	Prescott et al. (2014)	Determining the importance pharmacy students placed on science and mathematics subjects for pursuing a career in pharmacy.	Descriptive Quantitative Method	244 Masters in Pharmacy Students
Art-2	Røykenes (2015)	Identifying patterns and themes regarding nursing students' experiences with mathematics education.	Narrative Method	11 Student Nurses
Art-3	Jarvis et al. (2015)	Identifying potential improvements in course structures, content, pedagogy, or other recommendations to better prepare nurses for the workplace considering mathematics and technology demands.	Qualitative Method	8 Student Nurses and 68 Practicing Nurses
Art-4	Bagnasco et al. (2016)	Identifying appropriate educational interventions to address mathematical knowledge gaps of nursing students.	Descriptive Quantitative Method	726 Students Nurses
Art-5	Gregory et al. (2019)	Examining the factors that influence nursing students' mathematics self-efficacy.	Quasi-Experimental Cohort Study	715 Student Nurses
Art-6	Zayed (2019)	Present simple mathematical formulations to illustrate various applications of mathematics in medicine.	Systematic Review	Research Articles
Art-7	Roth and Walshaw (2019)	Developing the idea of Vygotsky's uniting intellect and affect into a cohesive psychology mathematics education.	Systematic Review	Psychological Text
Art-8	Johnson et al. (2020)	Understanding the nursing students' experiences and perspectives regarding learning math for medication calculations.	Interpretative Description Method	4 Focused Group Discussions
Art-9	Ogbonnaya and Awoniyi (2021)	Exploring the student and professional nurses' perceived relevance and application of mathematics in nursing.	Descriptive Method	301 Professional and Student Nurses
Art-10	Chisholm-Burns et al. (2021)	Examining the relationship between academic resilience and academic success in Doctor of Pharmacy (PharmD) students.	Cross-Sectional Survey Method	367 Doctor of Pharmacy Students
Art-11	Aliyev and Muhammadjonov (2023)	Analyzed the study and implementation of mathematical modeling and mathematical statistics for students in the medical field.	Text and Historical Analysis	Historical Text

**Table 2. Summary of the significant finding of the articles**

Article	Significant Findings
Art-1	The result suggests that the integration and contextualization of mathematics within the pharmacy curriculum may need to be improved due to a perceived dilution of scientific content. The results indicate that pharmacy educators need to ensure that <b>mathematics remains relevant and understood within the applied pharmacy context.</b>
Art-2	The findings emphasized how past experiences shape nursing students' views on mathematics, emphasizing the need for customized teaching methods and the crucial role of educators in nurturing students' confidence and attitude towards mathematical learning.
Art-3	The study highlighted the need to improve mathematical and technological competencies among nursing students.
Art-4	The study reveals the challenges nursing students face in drug dosage calculation due to a lack of basic math knowledge, <b>underscoring the necessity for redefining essential math skills and redesigning educational programs.</b>
Art-5	The study revealed varying levels of mathematics self-efficacy among nursing students, with higher levels found among males and those with more formal mathematics education. Structured numeracy interventions significantly improved students' math self-efficacy, correlating with better performance in their initial numeracy tests, underscoring the importance of such support in nursing education.
Art-6	The study highlights the critical role of mathematics in medicine, particularly in CT scan and MRI technology. The result showcases how mathematical theories like the Radon transform and recent advancements such as compressed sensing have <b>significantly enhanced medical imaging.</b>
Art-7	The study highlights the emerging interest in integrating emotions and intellect in mathematics education, emphasizing the need to unite emotion and intellect into a unified framework. The result also outlines the effort to extend and apply Vygotsky's ideas to mathematics classroom practices.
Art-8	The results suggest that the fear of making medication errors motivates students to take mathematics seriously; however, this fear can hinder their learning, leading to struggles with math content and eroding confidence. Thus, there is a need for contextualized <b>math education to facilitate successful mastery of dosage calculations and promote self-directed learning.</b>
Art-9	The study includes the identification of Statistics, Ratios, Rates, and Percentages as the most relevant mathematical topics perceived by both student and professional nurses. The result suggests the need for mathematics teachers to emphasize real-life relevance in teaching and for nursing education curricula to incorporate pertinent mathematical concepts to prepare future nurses.
Art-10	The study found that academic resilience did not influence the pharmacy students' performance in Pharmacy Math. However, their final grade correlated with the pre-pharmacy grade point average, suggesting further research to explore resilience's impact on performance in other courses or aspects of the curriculum.
Art-11	The study underscores the indispensable role of mathematics in medicine, stressing its necessity for medical discoveries, treatment planning based on digital proportions and probability theory, and efficient, accurate clinical practice from early medical education to everyday life.

**Table 3. Summary of the medical application considering the articles mathematical implication**

Article	Medical Application	Mathematical Implication
Art-1	Provides insights into pharmacy students' perceptions regarding the relevance of science and mathematics subjects to their careers in pharmacy.	Highlights pharmacy students' views on the importance of mathematics subjects, such as physics, logarithms, statistics, and algebra, in relation to a career in pharmacy.
Art-2	Provides insights into the significance of past mathematics learning experiences for nursing students, particularly in drug calculation.	Highlights the importance of mathematical proficiency in drug calculation.
Art-3	Identifies areas for potential improvement in nursing education programs to better prepare nurses for the realities of the workplace, particularly the demands on their relationship to mathematics and technology.	Examines the role of mathematical skills in the nursing practice and the adequacy of mathematics education within nursing programs.
Art-4	Recognizes the significant impact of nursing students' poor mathematical skills on their ability to accurately calculate drug dosages, with potentially severe consequences for patient safety.	Proposes an educational intervention to address mathematical knowledge gaps and enhance dosage calculation skills.
Art-5	Indicated the impact of structured numeracy instruction on improving mathematics self-efficacy among nursing students.	Highlights the relevance of structured medication numeracy pedagogical approaches in nursing undergraduate programs.
Art-6	Sheds light on the mathematical principles underlying medical imaging techniques such as CT scans and MRI, showcasing the role of mathematics in improving diagnostic accuracy and patient care.	Highlights the integral role of mathematics in advancing medicine, particularly in the development of technological innovations.
Art-7	Vygotsky's idea suggested a potential implication for medical education: Understanding emotions and intellect could enhance learning and patient care.	Vygotsky's ideas should be utilized as a foundation for developing an integrated approach to mathematics education, considering emotions and intellect as essential components.
Art-8	Raises awareness about the inconsistencies in the application of math skills by clinical instructors, which could potentially affect students' understanding and practice in the clinical settings.	Highlights the impact of the perceived complexity of mathematics in nursing education on student attitudes and performance.
Art-9	Indicated that drug administration and compilation of patients' medical reports are primary areas where mathematical knowledge and concepts are applied in nursing.	Identification of Statistics, Ratios and Rates, and Percentages as the most relevant and applicable topics in school mathematics for nursing study and practice.
Art-10	Provides insights into the factors influencing academic success in pharmacy education, contributing to developing strategies for student support and intervention in pharmacy Mathematics courses.	Highlights the significance of the pre-pharmacy grade point average (GPA) in predicting performance in pharmacy mathematics, suggesting the importance of academic preparedness in mathematics subjects for pharmacy students.
Art-11	Emphasizes using probability and statistical analysis in medicine to understand morbidity rates and other factors influencing health outcomes.	Highlights the importance of digital proportions and numerical calculations in medical discoveries and practice.

The second theme of *the role of mathematics in advancing healthcare innovation* was derived from Art-6. The theme focuses on the essential role of mathematics in driving innovation within the healthcare sector. Additionally, the article explores the potential for integrating emotions and intellect into mathematics education to foster a deeper understanding of mathematical concepts and their applications in healthcare innovation. The third theme on *motivation and support for mathematics learning in healthcare* was derived from Art-2, Art-3, Art-5, Art-7, Art-8, and Art-10. The theme centers on the motivational factors and support systems necessary for successful mathematics learning in healthcare education. Moreover, the articles' findings highlighted the importance of structured numeracy interventions and academic resilience in reinforcing students' mathematics self-efficacy and overall performance in healthcare education.

### 3.2. Medical Application and Mathematical Implication of the Articles

Table 3 summarizes the medical application and mathematical implication of the articles used in the research.

The summary, presented in Table 3, delves into the interconnectedness between medicine and mathematics as portrayed in each of the eleven (11) articles, emphasizing the important role that mathematics plays in various medical fields. The eleven (11) selected articles used in the study form a comprehensive avenue in exploring the varied relationship between the fields of medicine and mathematics cohesively.

#### 3.1.1. Medical Application

The first theme regarding the *medical application is the foundational role of mathematics in healthcare professions*. The theme is captured in Art-2, Art-4, Art-6, and Art-9, emphasizing the fundamental importance of mathematics in various aspects of the healthcare profession. The theme highlights how mathematical skills are crucial for tasks such as drug calculation, techniques in diagnosing, and compilation of medical reports, showcasing the essential role of mathematics in healthcare practice.

Moreover, the theme underscores how proficiency in mathematics is essential for critical responsibilities like drug calculation, diagnostic procedures, and compiling medical reports [4,14]. By emphasizing the indispensable nature of mathematics in healthcare practice, the theme highlighted the necessity for healthcare professionals to possess strong mathematical skills to ensure accuracy, efficiency, and quality in patient care [29,30,31].

The second theme is *improving mathematics education for healthcare professionals*. The theme is evident in Art-3, Art-5, Art-7, and Art-8, which discussed the need to enhance mathematics education programs for healthcare professionals. It emphasizes the importance of addressing inconsistencies in teaching mathematics, integrating mathematics education with medical practices, and enhancing mathematics self-efficacy among students to better prepare them for the realities of the healthcare workplace.

Moreover, the theme underscores the importance of addressing inconsistencies in mathematics instruction, integrating mathematical concepts with medical practices,

and bolstering the confidence and proficiency of healthcare students in mathematics [4,32,33]. By concentrating on these aspects, the theme emphasizes the importance of aligning mathematics education with the practical demands of the healthcare workplace, eventually leading to better equipping future healthcare professionals with the necessary mathematical skills [1,34,35].

The third theme is *enhancing patient safety through mathematics proficiency*. It arises from Art-4 and Art-8, focusing on the significant impact of poor mathematical skills on nursing students' ability to calculate drug dosages accurately and the potential consequences for patient safety. The articles underscore the importance of ensuring healthcare professionals possess strong mathematics proficiency to mitigate risks and ensure optimal patient care.

Moreover, the theme highlights the adverse effects of inadequate mathematical skills, predominantly in duties like drug dosage calculations, which can directly impact patient outcomes [30]. By emphasizing the potential risks that are associated with poor mathematical proficiency, the theme highlights the imperative of ensuring that healthcare professionals possess strong mathematical abilities to mitigate errors, uphold safety standards, and deliver optimal care to patients [1,16,33].

The last theme is on *research and analytical applications of mathematics in healthcare*. It emerges from Art-10 and Art-11, which provide insights into the factors influencing academic success in medical education and emphasize the use of mathematics, specifically probability and statistics. The theme highlights how mathematics is utilized in healthcare research to understand factors influencing health outcomes, morbidity rates, and other important medical phenomena, contributing to advancements in medical knowledge and practice.

The theme underscores how mathematical tools such as probability statistics are integral to understanding complex factors influencing health outcomes and medical phenomena. By emphasizing the use of mathematics in healthcare research, the theme emphasizes its contribution to advancements in medical knowledge and practice, ultimately leading to improved patient care and outcomes [2,13]. Additionally, the theme suggests the importance of integrating mathematical methodologies into healthcare research to gain deeper insights and facilitate evidence-based decision-making in the medical field [36,37].

#### 3.1.2. Mathematical Implication

The first theme is *the importance of mathematics in healthcare education and practice*. The theme incorporates Art-1, Art-2, Art-3, and Art-6, emphasizing the critical role of mathematics in various fields in healthcare. The theme highlights how mathematical proficiency is essential for understanding core concepts, performing dosage calculations accurately, and advancing medical technologies.

Moreover, the theme emphasizes the necessity of mathematical proficiency for healthcare professionals to understand core concepts, execute precise dosage calculations, and contribute to advancing medical technologies [14,38]. By highlighting the critical interplay between mathematics and healthcare, the articles stress the importance of integrating mathematical education into healthcare curricula and daily clinical practice, ensuring that professionals are well-equipped to provide safe and effective



care while driving innovation in the field [1,10,29,34].

The second theme is *educational interventions to enhance mathematical skills*. It arises from Art-4, Art-5, Art-7, Art-8, and Art-10 and focuses on recommendations for educational interventions to address mathematical knowledge gaps and improve calculation skills among healthcare students. The theme emphasizes the importance of a structured pedagogical approach and integrated mathematics education to enhance student attitudes, performance, and overall mathematical proficiency.

Moreover, the theme emphasized integrated mathematics education, underscoring the importance of incorporating mathematical concepts into the healthcare curriculum to improve student attitudes, performance, and overall mathematical proficiency [30,32,35,36]. The theme highlights the need for targeted interventions, suggesting a proactive approach to enhancing dosage calculation skills among healthcare students, ultimately aiming to prepare them for their professional roles better and ensure optimal patient care and safety [7,33,34].

The third theme is *relevant mathematical topics in healthcare education*. It is reflected in Art-1, Art-9, and Art-11, identifying specific mathematical topics such as logarithms, statistics, ratios, rates, percentages, digital proportions, and numerical calculations as relevant and applicable in healthcare education and practice. The theme underscores the importance of focusing on these topics to ensure that healthcare professionals have the necessary mathematical skills for their respective fields.

Moreover, the theme implies that focusing on these specific mathematical topics is crucial for ensuring healthcare professionals possess the necessary mathematical skills to excel in their respective fields [8,37]. The theme's emphasis on relevant mathematical concepts aligns with the intention to adequately prepare healthcare students to navigate the complexities of calculating dosages, data analysis, and other mathematical aspects inherent in healthcare practice [1,31,38].

The last theme is on *technological advancements and mathematical innovation in medicine*. The theme is evident in Art-6 and Art-11, emphasizing the integral role of mathematics in advancing medicine, mainly through the development of technological innovations. The theme highlights how mathematical principles and numerical calculations contribute to medical discoveries and advancements, driving progress in healthcare.

Moreover, the theme underscores how mathematical principles and numerical calculations contribute to groundbreaking discoveries and advancements in healthcare [14,37]. The theme implies that advancements in medical technology often rely heavily on mathematical innovation, whether in the development of diagnostic tools, treatment modalities, or predictive models [5,9,13]. The theme highlights this connection, suggesting that continued investment in mathematical research and education is essential for driving further progress and innovation in medicine, ultimately leading to improved patient outcomes and healthcare delivery [2,3,4].

## 4. Summary and Conclusion

The medical application and mathematical implication

underscore the vital role of mathematics across various facets of healthcare. Firstly, the articles emphasized the foundational importance of mathematical skills in healthcare, showcasing their indispensability in tasks like drug calculation and diagnostics. Secondly, the articles highlighted the urgent need for improvement in mathematics education programs for healthcare professionals to bridge gaps and better align with the demands of the healthcare workplace. Thirdly, the articles stressed the critical link between mathematics proficiency and patient safety, urging more vital skills to mitigate risks and ensure optimal care delivery. Lastly, the articles illuminated the significance of mathematical research and analytical applications in healthcare, showcasing how mathematical tools drive advancements, deepen understanding, and contribute to evidence-based decision-making in the medical field.

The result of the review of the eleven (11) articles underscores the indispensable role of mathematics in the healthcare professions, emphasizing a profound impact on patient safety, education, research, and analytical endeavors. The articles highlighted the critical need for strong mathematical proficiency among healthcare professionals to ensure accurate calculations, mitigate risks, and enhance patient care. Additionally, the articles stress the importance of improving mathematics education programs to better prepare students for the challenges of the medical workplace. By integrating mathematics with medical practices and fostering mathematics self-efficacy, healthcare professionals can navigate complex tasks with confidence and precision. Furthermore, the articles shed light on how mathematics propels advancements in healthcare research, contributing to improved health outcomes. Overall, the implication of the articles emphasized the transformative potential of mathematics in shaping the future of healthcare, driving innovation, and ultimately enhancing the quality of patient care.

## 5. Further Studies

The findings reported in this paper serve as several avenues for further investigation. Primarily, a study could delve into the specific mechanisms by which mathematical principles influence healthcare aspects and propel the development and innovations in medical technology and treatment methodologies. Secondly, a study could explore the effectiveness of different educational interventions to improve mathematical proficiency among healthcare professionals and the subsequent impact on patient outcomes. Thirdly, a study could examine emerging technologies' role, such as artificial intelligence and machine learning, in leveraging mathematical models for personalized healthcare delivery. Lastly, comparative studies across different healthcare systems and regions could help identify best practices for integrating mathematics into medical education and practice.

## ACKNOWLEDGEMENTS

The researchers would like to extend their sincerest gratitude to Dr. Sol G. Simbulan for her valuable insights

and advice for the refinement of this paper.

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