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Data Analytics for Informed Healthcare Leadership Decision Making: A Scoping Review

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ABSTRACT

Background: In recent decades, data analytics has emerged as a transformative force in healthcare, leveraging advanced technologies to analyze vast and complex datasets. This evolution has revolutionized how healthcare organizations operate, from enhancing clinical decision making to optimizing resource allocation and improving patient outcomes. Key applications include medical image analysis, disease surveillance, outbreak prediction, and personalized treatment strategies. The integration of big data analytics, machine learning, and artificial intelligence has enabled healthcare providers to extract valuable insights from both structured and unstructured data sources, stored in electronic health record systems and other repositories. These insights not only inform strategic decisions but also support evidence-based practices and operational efficiencies across various healthcare settings. Despite its promise, challenges such as data quality assurance, security concerns, and the need for robust analytical methodologies remain critical for the widespread adoption and effective implementation of data analytics in healthcare.

Methodology: This scoping review follows the Preferred Reporting Items for Systematic Reviews and Meta-Analyses Extension for Scoping Reviews checklist to explore the impact of data analytics on healthcare system performance. A systematic search was conducted on PubMed for English-language articles published in 2023 using key terms "data analytics," "leadership," "decision making," and "hospital." Initially identifying 20 relevant articles, screening of titles and abstracts led to the selection of 5 articles for full-text review. Three articles met the inclusion criteria and were synthesized to examine trends, challenges, and outcomes related to the utilization of data analytics in healthcare leadership. The review centers around the population, intervention, comparison, and outcome (PICO) question "Among hospital leadership, does the utilization of data analytics for decision making compared to traditional methods improve healthcare system performance?"

Conclusion: The findings reveal the transformative potential of data analytics in healthcare leadership, revealing significant insights into clinical practices, patient management, and system-wide efficiencies. The review identifies a need for continued integration of qualitative and quantitative analytics methodologies to address complex healthcare challenges effectively. Future research should prioritize refining data collection processes, enhancing interdisciplinary collaboration, and investing in advanced analytics capabilities to support evidence-based decision making and improve healthcare outcomes globally.

Keywords: data analytics, leadership, data-driven decision making

INTRODUCTION

Data analytics has been continually emerging as a transformative force within the healthcare setting. Within the last few decades, the healthcare field has rapidly adopted data analytics, automating areas such as medical image analysis, disease recognition, outbreak monitoring, and clinical decision support.[1] Advancements in technology are leading to widespread use of analytics into various healthcare scenarios. Big data analytics technology in healthcare has proven effective in observing data behavior and uncovering relevant insights for strategy and decision making.[2] Data analytics is deeply rooted in the field of data science. Data science is an interdisciplinary field that uses big data, machine learning, data mining, and scientific methods to extract insights from large volumes of structured and unstructured data.[3] The healthcare industry generates extensive datasets on patient demographics, treatment plans, medical exam results, and insurance coverage, stored in electronic health record systems, which are valuable to data scientists for processing, managing, analyzing, and integrating massive amounts of structured and unstructured data.[3]

Advancements in technology are leading to consolidation and interoperability of systems through cloud computing. Cloud-based information systems offer healthcare systems benefits that decentralizes applications, strategies, and data analytics by bringing storage and computation closer to the user, thereby supporting artificial intelligence and management strategies.[4] Healthcare analytics can be used in various clinical, operational, and research settings to improve performance and quality of deliverables. Recent advancements in data analytics have improved the ability for researchers to data mine biologically relevant and commercially useful results to improve the depth of analysis and promote future studies.[5] Data analytics can be useful to gather demographic information to align health services with rapid changes to public health information. Urban environments continuously generate vast data volumes, which, through big data analysis and machine learning algorithms, can provide descriptive and predictive models to support the development of data-driven applications and improvements in city policies and urban issues.[6] The advent of modern information technologies, digital data transformation, and affordable high-performance computing has propelled data science to revolutionize various sectors including business, industry, health, and medicine.[7]

Evolving data analytics technologies are impacting how healthcare professionals obtain and analyze data. High-performance data analytics represents a recently emerging trend in e-science research, aiming to merge traditional high-performance computing with modern data analytic frameworks.[8] Recent analytics research has focused on leveraging data mining for pandemic prevention and treatment to uncover trends and inform future academic and organizational strategies.[9] Data analytics can offer an array of quality performance measurements that are applicable to various clinical settings, including nursing home treatment assessments.[10] The use of data analytics can improve the depth of analysis performed by healthcare systems. Exploratory data analysis, descriptive and diagnostic analyses, can be effective for evaluating past and current information to predict various clinical outcomes.[11] Data analytics techniques can efficiently process many different types of clinical data. For example, big data analytics has been useful in assessing protein-ligand complexes, enhancing the identification of specific protein properties crucial for accurately predicting protein-ligand binding.[12] Data analytics plays a pivotal role in epidemiology research, employing various techniques including artificial intelligence to uncover relationships, patterns, and trends from COVID-19 data, enabling effective

prediction and response strategies to combat the pandemic's challenges.[13]

Despite the recent advancements and proven advantages of data analytics in clinical laboratories, practical demonstrations of its real-world impact remain limited in organizational settings due to institutions facing challenges such as data accessibility, resource allocation constraints, and varying levels of data literacy.[14] Big data holds promise to enhance traditional research capabilities, inform clinical practice with real-world data, and optimize health system and service delivery; however, challenges including data suitability, quality assurance, security, and analytical methodologies must be addressed for effective big data analytics implementation.[15]

The intent of this scoping review is to critically assess the current state of data analytics within healthcare. The review uses the population, intervention, comparison, and outcome (PICO) question framework. A PICO question is a structured query used in evidence-based practice that defines the population, intervention, comparison, and outcome components to guide focused research inquires.[16] The PICO question is as follows: "Among hospital leadership, does the utilization of data analytics for decision making compared to traditional methods improve healthcare system performance?"

MATERIALS & METHODS

The purpose of a scoping review is to identify the types of available evidence in each area, summarize existing evidence, identify gaps in the literature, and provide recommendations for future research.[17] This scoping review adheres to the Preferred Reporting Items for Systematic Reviews and Meta-Analyses Extension for Scoping Reviews (PRISMA) checklist for structured guidance. The review searches PubMed for relevant and credible literature. PubMed is a comprehensive database of quality peer-reviewed articles, providing access to current and historical information across various health-related disciplines.[18] The search strategy included querying PubMed, free full-text accessible, English-language articles published in the year 2023. The search keywords included "data analytics," "leadership," "decision making," and "hospital."

All results returned from the search strategy were considered eligible for selection. The search returned 20 results. The author reviewed the titles and abstracts of all 20 results. Next, the author selected 5 most applicable articles and reviewed the full text. Of the 5 articles, the author selected 3 of the most appropriate studies for evidence synthesis.

RESULT

This scoping review uses a simple data charting process to consistently evaluate data among the selected studies. The scope, study design, population, and statistical relevance are established. The study scope identifies the general intent of the article. The study design refers to the framework and method used within the study. Appropriately selecting the study design and sampling strategy is crucial to develop measurable findings.[19] The study population refers to the group of individuals being investigated.[20] The statistical relevance refers to the impact of study findings being applicable to the study topic. The evidence from the selected articles is charted in Table 1.

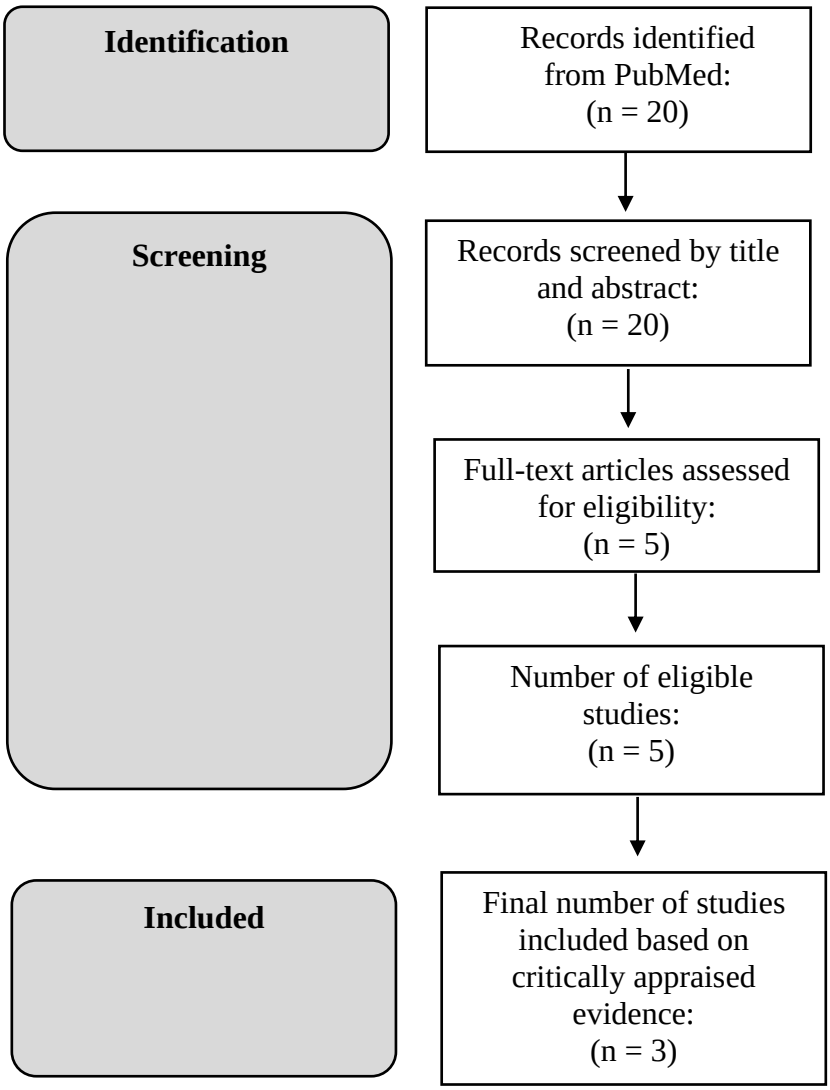

Figure 1: PRISMA Flow Diagram

Scope	Type of study	Population	Statistical relevance
Examined gendered power dynamics in Pacific health systems during the COVID-19 pandemic [21]	Qualitative study	Included 116 consenting healthcare workers and other stakeholders from at least 15 different Pacific Island Countries and Territories (PICTs)	Qualitative data provided valuable insights into healthcare workers' experiences and perspectives, deepening understanding of gender dynamics in healthcare systems during the pandemic
Investigates barriers and facilitators in managing fever episodes in hospitalized Kenyan children with cancer [22]	Mixed-methods study combining quantitative data analysis	Pediatric cancer patients at Moi Teaching and Referral Hospital in Kenya	Qualitative data analysis was conducted, along with descriptive statistical analysis of median and ranges for categorical demographics, using Stata V.16.0, with statistical significance defined as a p-value less than 0.05
Assessed nutrition delivery practices in critically ill COVID-19 patients admitted to Australian ICUs [23]	Observational study	Critically ill patients with COVID-19 admitted to Australian ICUs, meeting the inclusion criteria	Continuous and categorical data, comparisons between patient groups, and statistical tests to assess significance, with a threshold set at $p < 0.05$ for statistical significance

Table 1

DISCUSSION

The first scholarly article, a qualitative study, presents the experiences of Pacific women healthcare workers during the COVID-19 pandemic, underscoring the need for gender-transformative health system policies to bolster their support and empowerment.[21] Through effective data analytics, the study enhances understanding of gendered power dynamics within healthcare systems, informing decision making and fostering quality improvement initiatives. Analytics in this study excel in revealing gender-specific challenges faced by women healthcare workers and pinpointing areas for policy intervention.[21] However, the study identifies that limitations may stem from potential biases in data collection and analysis, requiring ongoing refinement of analytical methods to ensure accuracy and relevance in addressing gender inequities in healthcare.

The second scholarly article, a mixed-method study, investigates the barriers to and facilitators of managing fever episodes in hospitalized Kenyan children with cancer.[22] Integrating clinical data analysis, workflow evaluations, antibiotic resistance patterns, and healthcare provider perspectives, the study aims to inform evidence-based guidelines, enhance clinical practices, and mitigate infection-related mortality in resource-limited settings.[22] The study showcases the strength of comprehensive data analysis approaches, offering profound insights into the multifaceted factors influencing fever management. The study does identify potential biases in data collection and the need for continual assessments to adapt to evolving hospital policies and procedures represent noteworthy limitations.[22]

The third scholarly article, an observational study, explores nutrition delivery practices among critically ill COVID-19 patients in Australian ICUs, with a focus on post-ICU nutritional strategies.[23] The study includes 103 predominantly male patients, averaging 58 years in age. Predominantly, patients received oral nutrition in the ICU, followed by enteral and parenteral methods, with enteral nutrition administered for longer durations than oral and parenteral options. Post-ICU, oral nutrition predominated, with fewer patients opting for enteral or parenteral nutrition, amidst common nutrition-related symptoms such as reduced appetite.[23] Notably, patients on mechanical ventilation experienced ICU-related weight loss, contrasting with the cohort's overall stable weight. Post-ICU, oral nutrition supplements were frequently prescribed, indicating enhanced nutritional intake over time. The study uses an extensive analysis of nutrition practices across ICU and post-ICU settings, offering crucial insights into patient outcomes and nutritional requirements. However, the study limitations include potential biases inherent in retrospective study designs and the study's specific focus on a particular geographic and demographic cohort, constraining broader generalizability.[23]

The three articles collectively underscore the evolving role of data analytics in healthcare leadership by revealing trends, patterns, and challenges across diverse healthcare contexts. [21-23] Each highlight how qualitative and quantitative data analytics can empower healthcare leaders with actionable insights. The first article demonstrates how qualitative data analytics can illuminate gendered power dynamics and guide the development of inclusive, gender-transformative policies. [21] The second article exemplifies the comprehensive insights data analytics can provide by integrating quantitative data on clinical outcomes with qualitative data on healthcare practices, thereby informing evidence-based guidelines and improving patient care protocols. [22] The third article illustrates how data analytics can optimize clinical pathways, enhance patient outcomes, and identify areas for improvement, despite challenges such as data biases and limited generalizability. [23] These studies collectively emphasize the need for healthcare leaders to embrace data-driven decision making strategies, invest in

advanced analytics capabilities, and foster interdisciplinary collaborations to effectively navigate and improve healthcare delivery systems.

CONCLUSION

The evidence from the articles showcases the transformative potential of data analytics in healthcare leadership, revealing critical insights into gender dynamics, clinical management practices, and patient outcomes. [21-23] Moving forward, healthcare leaders should prioritize the integration of qualitative and quantitative data methodologies to comprehensively understand and address complex healthcare challenges. Emphasis should be placed on refining data collection processes to mitigate biases and enhance the generalizability of findings across diverse populations. Additionally, fostering interdisciplinary collaboration between healthcare providers, data analysts, and policymakers is crucial for translating data-driven insights into actionable strategies that improve healthcare delivery and patient outcomes. Investment in ongoing training and infrastructure for robust data analytics capabilities will be essential to support evidence-based decision making and ensure continuous improvement in healthcare systems worldwide.

Declaration by Authors

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