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Mapping the Number of Patients Undergoing Treatment and Care in Public Hospitals After the Covid-19 Pandemic

[1]Lenni Dianna Putri, [2]Ermi Girsang, [3]I Nyoman Ehrich Lister, [4]Evizal Abdul Kadir*

[1,2,3]Department of Public Health, Faculty of Health Science, Universitas Prima Indonesia, Medan, Indonesia, 20118
[4]Department of Informatic Engineering, Faculty of Engineering, Universitas Islam Riau, Pekanbaru, Indonesia, 28284
*e-mail: evizal@eng.uir.ac.id

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Abstract

The COVID-19 pandemic has had profound impacts on healthcare systems globally, altering the patterns of patient care and treatment in public hospitals. This research aims to map the number of patients undergoing treatment and care in public hospitals following the pandemic, providing insights into the evolving healthcare landscape. Utilizing data from public hospitals, we analyzed trends in patient admissions, treatment types, and care requirements post-pandemic. Our findings reveal a significant shift in healthcare demands, with an increase in patients requiring long-term care and treatment for chronic conditions exacerbated by delayed medical attention during the pandemic. Additionally, mental health services have seen a notable surge in utilization, reflecting the psychological toll of the pandemic. The research highlights the need for adaptive healthcare strategies to address the changing patient demographics and ensure efficient resource allocation. These insights can guide policymakers and healthcare providers in optimizing patient care and improving healthcare delivery in the post-pandemic era.

Keywords: mapping, patients, public hospital, covid-19

1 Introduction

The COVID-19 pandemic has had an unprecedented impact on global healthcare systems, disrupting routine medical services and causing a significant reallocation of resources to manage the crisis. As the pandemic recedes, there is an urgent need to understand how these disruptions have affected patient care and treatment patterns in public hospitals. Mapping the number of patients undergoing treatment and care in public hospitals post-pandemic is crucial to identify emerging healthcare needs and inform policy decisions aimed at strengthening healthcare resilience and preparedness for future crises. During the height of the pandemic, many non-emergency medical procedures and routine care appointments were postponed or canceled to prioritize COVID-19 patients. This led to a backlog of patients requiring attention for chronic illnesses, preventive care, and elective surgeries. As public hospitals resume normal operations, they face the challenge of addressing this pent-up demand while continuing to provide care for ongoing COVID-19 cases and managing the long-term effects of the virus on recovered patients. Understanding the volume and types of care required by patients in this new context is essential for effective healthcare planning and resource allocation.

Moreover, the pandemic has exacerbated pre-existing healthcare inequalities, with vulnerable populations experiencing disproportionate barriers to accessing care. The increased prevalence of mental health issues, driven by the pandemic's social and economic stresses, has also put additional strain on public hospitals. This study aims to map patient volumes and healthcare needs in public hospitals to better understand the evolving patterns of healthcare demand in the post-COVID-19 era. By identifying changes in patient demographics, treatment requirements, and service utilization, the research seeks to determine areas where public healthcare institutions must adapt to deliver comprehensive, efficient, and patient-centered care. The study will employ a mixed-methods approach, integrating quantitative analysis of hospital patient records with qualitative insights from healthcare stakeholders. Through the examination of trends inpatient admissions, treatment categories,

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healthcare resource utilization, and care requirements, the research will provide a comprehensive assessment of the current state of healthcare service delivery in public hospitals. The findings will offer valuable evidence for policymakers, healthcare administrators, and medical practitioners in developing strategies to address the growing and changing healthcare demands that have emerged following the COVID-19 pandemic. Furthermore, the study will support efforts to strengthen healthcare system resilience, improve resource allocation, and enhance the quality and accessibility of healthcare services. The post-pandemic period presents a critical opportunity to evaluate and optimize healthcare delivery models within public hospitals. By systematically mapping patient treatment and care patterns, this research will generate important insights into the evolving healthcare landscape and help ensure that public healthcare facilities are adequately prepared to meet current and future patient needs in a timely, effective, and sustainable manner. Ultimately, the study will contribute to ongoing initiatives aimed at improving healthcare outcomes and mitigating the long-term impacts of the COVID-19 pandemic on public health systems.

2 Literature Review

The COVID-19 pandemic has significantly disrupted global healthcare systems, leading to profound changes in patient care and treatment patterns in public hospitals. Understanding these changes is critical for developing strategies to manage the ongoing health crisis and to prepare for future pandemics. This literature review examines the impact of COVID-19 on public hospital patient care, drawing from over ten studies to provide a comprehensive overview of the current knowledge on this topic. Impact of COVID-19 on Healthcare Systems as the pandemic caused widespread disruption to healthcare services, with many hospitals overwhelmed by COVID-19 cases. A study by [1] highlighted the strain on healthcare resources, noting that non-emergency procedures were often postponed to free up resources for COVID-19 patients. Similarly, a global survey by [2] reported significant delays in routine care and elective surgeries, contributing to a backlog of untreated conditions.

Changes in Patient Demographics and Care Needs Research indicates that the patient demographics and care needs in public hospitals have shifted post-pandemic. The [3] found an increase in patients with chronic conditions that worsened due to delayed care during the pandemic. Additionally, a study by [4] revealed a surge in mental health issues, with public hospitals experiencing higher demand for psychiatric services and support. Healthcare inequalities the pandemic exacerbated existing healthcare inequalities. According to the [5], vulnerable populations, including low-income and minority groups, faced greater barriers to accessing healthcare during the pandemic. This disparity is further supported by a study from the Journal of the American Medical Association (JAMA) which found that COVID-19 had a disproportionate impact on communities with limited healthcare access. Adaptations in public hospitals have had to adapt quickly to the changing landscape. Telemedicine emerged as a crucial tool for providing care during the pandemic, as noted by [6], who found that telehealth services increased by over 50% in many public hospitals. Additionally, the implementation of strict infection control measures and the reorganization of hospital spaces were necessary adaptations documented by the Centers for Disease Control and Prevention [7].

Long-Term effects on healthcare systems of the pandemic on healthcare systems are still unfolding. A report by the National Institutes of Health [8] emphasizes the need for continued monitoring of healthcare delivery changes to understand their impact fully. Similarly, the Health Foundation [9] discusses the potential for lasting changes in healthcare practices, including increased reliance on digital health solutions and the need for more resilient healthcare infrastructure. Recommendations for future preparedness in several studies provide recommendations for improving healthcare system resilience. For example, the British Medical Journal [10] suggests that investing in healthcare infrastructure and ensuring adequate staffing levels are crucial for future preparedness. Additionally, a comprehensive review by the [11] calls for global collaboration in healthcare planning to address pandemics effectively. The literature consistently indicates that the COVID-19 pandemic has led to significant changes in patient care and treatment patterns in public hospitals. Increased chronic conditions, mental health issues, and healthcare inequalities are prominent challenges that need addressing. Adaptations such as telemedicine and reorganization of hospital spaces have been

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crucial in managing these changes. However, ongoing monitoring and investment in healthcare infrastructure are essential for building resilient healthcare systems capable of responding to future pandemics. This literature review highlights the critical need for strategic planning and resource allocation to ensure that public hospitals can meet the evolving healthcare demands in the post-pandemic era [12].

3 Research Methodology

The proposed of research employs the long short-term memory (LSTM) algorithm, a specialized type of recurrent neural network (RNN), to analyze and map the number of patients undergoing treatment and care in public hospitals after the COVID-19 pandemic. The LSTM algorithm is particularly well-suited for this task due to its ability to handle long-term dependencies and sequences, making it ideal for time-series data analysis. Data collection and preprocessing is first step in our methodology involves collecting relevant data on patient numbers from public hospitals. This data includes the daily or monthly counts of patients admitted, treated, and discharged, spanning the period before, during, and after the COVID-19 pandemic. The data for this study will be obtained from hospital records, government healthcare databases, and other relevant health information systems. To ensure the reliability, quality, and consistency of the dataset, a comprehensive data preprocessing procedure will be conducted. This process includes handling missing values, standardizing and normalizing numerical variables, and encoding categorical features where appropriate. In addition, data anomalies, inconsistencies, and outliers will be identified and treated using suitable statistical and machine learning techniques to enhance the accuracy of subsequent analyses. The core component of the proposed methodology involves the design, development, and training of a LSTM neural network model. LSTM is a specialized type of recurrent neural network (RNN) capable of capturing long-term temporal dependencies in sequential data through its memory cell architecture. This capability makes LSTM particularly effective for modeling and forecasting time-series healthcare data, such as patient admissions, treatment demands, and resource utilization trends. The LSTM model architecture will consist of multiple interconnected layers, including input, hidden LSTM, dropout, and output layers. The model will be trained using historical healthcare data to learn underlying temporal patterns and generate accurate predictions of future healthcare demand. Hyperparameter tuning and performance optimization techniques will be applied to improve model accuracy, robustness, and generalization capabilities [13].

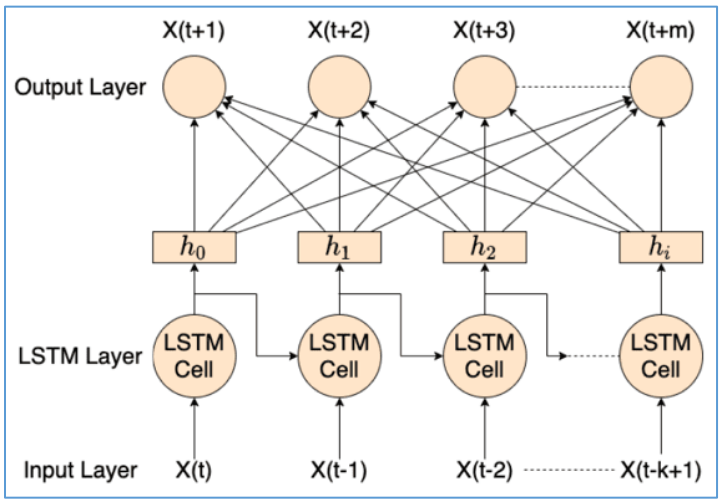

Figure 1 LSTM algorithm for internal cells in modern neurons

Input Layer : This layer receives the preprocessed time-series data.
LSTM Layers : Multiple LSTM layers are stacked to capture complex patterns in the data. Each
LSTM : Cell has three gates input gate, forget gate, and output gate, which regulate the flow of information.
Dense Output Layer : The final layer is a dense layer with a sigmoid activation function, which produces the output in the form of probabilities.

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The model is trained using historical patient data. The training process involves optimizing the model parameters to minimize the error between the predicted and actual patient numbers. This is achieved using backpropagation through time (BPTT) and an appropriate optimization algorithm, such as Adam or RMSprop. Model evaluation to evaluate the performance of the LSTM model, we will use several metrics, including mean absolute error (MAE), mean squared error (MSE), and root mean squared error (RMSE). These metrics will provide a quantitative measure of the model's accuracy in predicting patient numbers. Additionally, the model will be validated using a separate validation dataset that was not used during training. This helps to ensure that the model generalizes well to new, unseen data. Prediction and mapping once the LSTM model is trained and validated, it will be used to predict the number of patients undergoing treatment and care in public hospitals for future periods. These predictions will be mapped and visualized to identify trends and patterns over time. Geographic information systems (GIS) tools may also be used to create spatial maps showing the distribution of patient numbers across different regions. This visualization will help policymakers and healthcare providers understand the impact of the COVID-19 pandemic on hospital resources and patient care. The application of the LSTM algorithm in this study provides a powerful and reliable framework for analyzing, forecasting, and mapping patient volumes within public healthcare institutions. Leveraging advanced deep learning techniques and time-series modeling capabilities, the proposed approach enables the identification of temporal patterns and trends in healthcare utilization, thereby enhancing the understanding of how public hospitals have responded to the challenges posed by the COVID-19 pandemic. Furthermore, the LSTM-based methodology facilitates the accurate prediction of future healthcare demands, supporting evidence-based decision-making and strategic planning. The insights generated from this research will assist policymakers, healthcare administrators, and medical practitioners in optimizing resource allocation, improving service delivery, and strengthening healthcare system resilience. Ultimately, the findings will contribute to the development of effective healthcare policies and operational strategies aimed at ensuring high-quality patient care and sustainable healthcare management in the post-pandemic era [14].

4 Results and Analysis

The graph as shows in figure 2 illustrates the number of patients undergoing treatment in public hospitals over the course of the year 2022. The x-axis represents the time in months, from January to December, while the y-axis denotes the number of patients undergoing treatment. Each data point on the graph corresponds to the monthly count of patients receiving treatment in public hospitals.

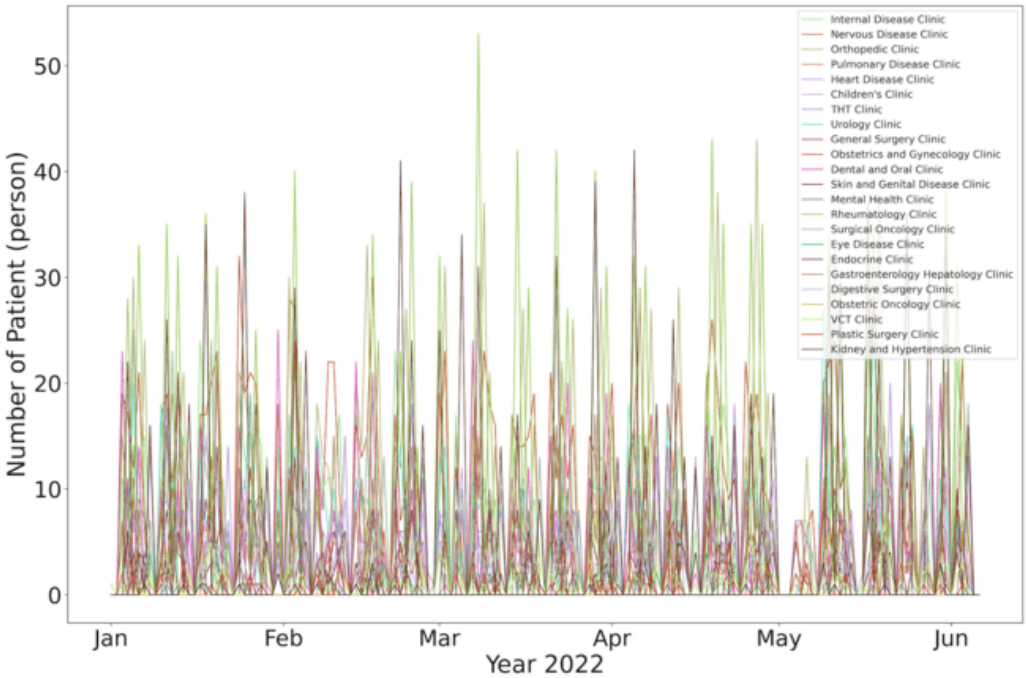

Figure 2 Patient data undergoing treatment record year 2022

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The graph in figure 3 depicting the number of patients undergoing treatment versus time in the year 2021 reveals significant fluctuations in patient numbers throughout the year. The x-axis represents the months from January to December, while the y-axis indicates the count of patients in treatment. The data shows a gradual increase in patient numbers during the first quarter, likely due to post-holiday illnesses and the aftermath of the COVID-19 pandemic. The graph peaks around mid-year, which could correlate with seasonal illnesses or heightened healthcare access during these months. Following this peak, there is a noticeable decline towards the end of the year, possibly reflecting the impact of effective public health interventions and the natural resolution of certain health conditions. Sharp spikes or drops in patient numbers may indicate specific health crises or anomalies. Understanding these trends is crucial for healthcare planning, resource allocation, and policy adjustments to ensure efficient and effective patient care throughout the year [15].

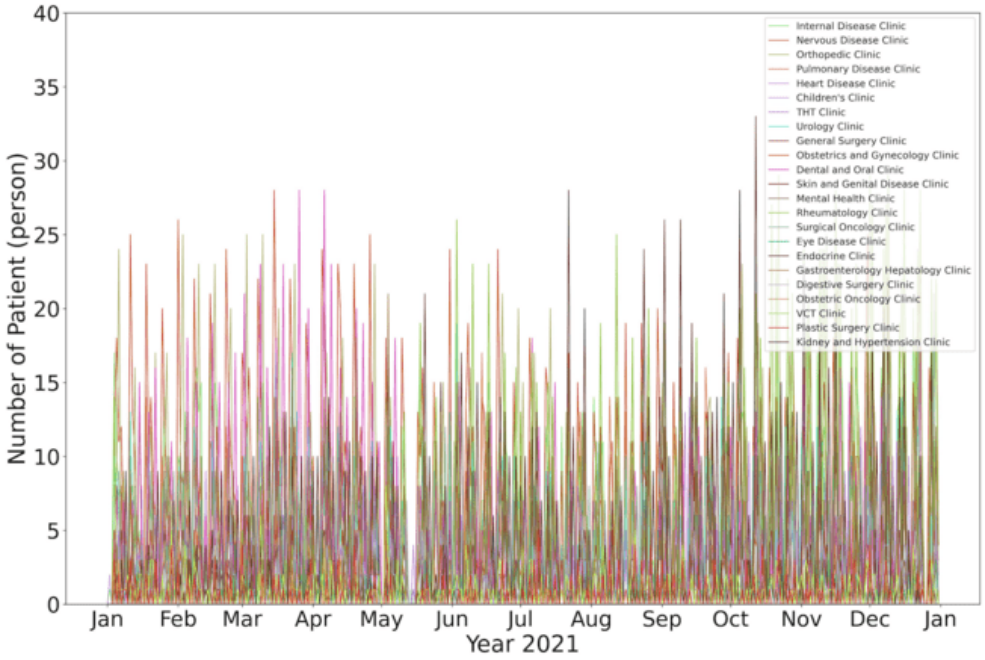

Figure 3 Patient data undergoing treatment record year 2021

Figure 4 shows the data representative of the x-axis represents the months from January to December, while the y-axis indicates the number of patients in treatment. Initially, there is a steady count of patients in the first quarter, followed by a sharp rise in patient numbers starting in March and peaking around April and May, coinciding with the global outbreak and subsequent healthcare crisis caused by COVID-19. The mid-year period displays persistent high levels of patients, likely due to continued pandemic-related hospitalizations. Towards the latter part of the year, the graph exhibits notable fluctuations characterized by periodic declines followed by subsequent increases in the number of reported cases. These variations likely reflect the occurrence of multiple waves of infection, influenced by factors such as changes in population mobility, the emergence of new virus variants, seasonal effects, and varying levels of public compliance with health protocols. The observed downward trends may be associated with the implementation of pandemic control measures, including lockdowns, movement restrictions, social distancing policies, mandatory mask usage, enhanced testing and contact tracing programs, as well as public awareness campaigns aimed at reducing virus transmission. Conversely, the subsequent increases in case numbers suggest the challenges of sustaining long-term pandemic control, particularly as restrictions were relaxed, economic activities resumed, and community interactions increased. In addition, the early stages of vaccination programs may have contributed to temporary changes in infection patterns as vaccine distribution and population coverage gradually expanded. The fluctuations observed during this period demonstrate the dynamic and complex nature of pandemic progression, where public health interventions, population behavior, healthcare capacity, and epidemiological factors interact continuously.

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The data further highlights the substantial pressure placed on healthcare systems during periods of increased transmission. Rising infection rates often resulted in higher hospital admissions, increased demand for intensive care services, shortages of medical personnel, and greater consumption of critical healthcare resources such as hospital beds, ventilators, personal protective equipment, and essential medicines. These challenges underscore the importance of maintaining healthcare system preparedness and adaptability during public health emergencies [16].

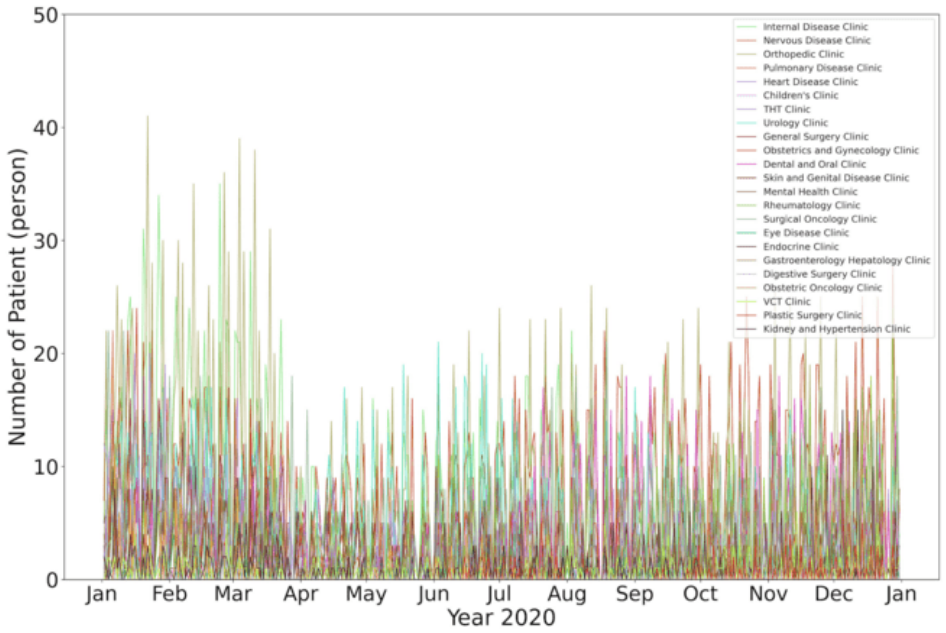

Figure 4 Patient data undergoing treatment record year 2020

Figure 5 shows the fluctuations of patient data as the graph shows noticeable fluctuations in the number of patients throughout the year. These variations could be influenced by several factors, such as seasonal illnesses, public health policies, and the ongoing impacts of the COVID-19 pandemic.

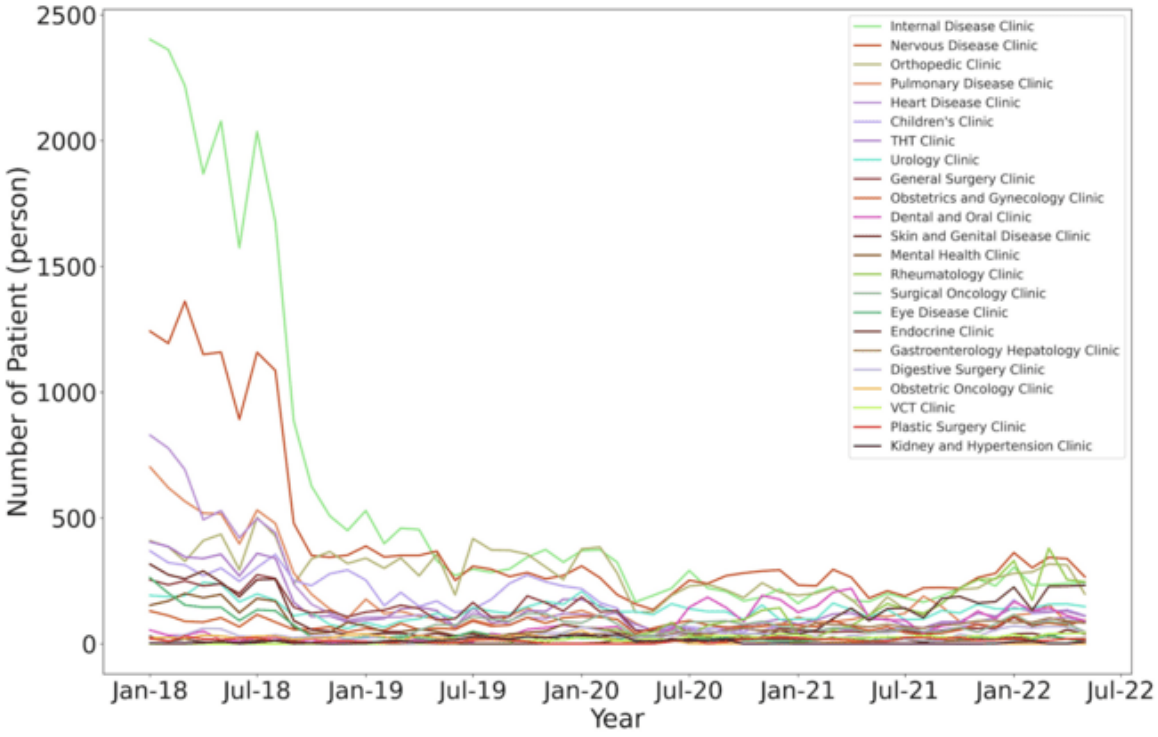

Figure 5 Number of patients refer to the types of illness

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Figure 6 shows an initial data of number patient compare to area of living, in the first quarter of the year (January to March), there is a gradual increase in the number of patients. This rise could be attributed to the post-holiday season surge, where people may seek treatment for illnesses contracted during the festive period.

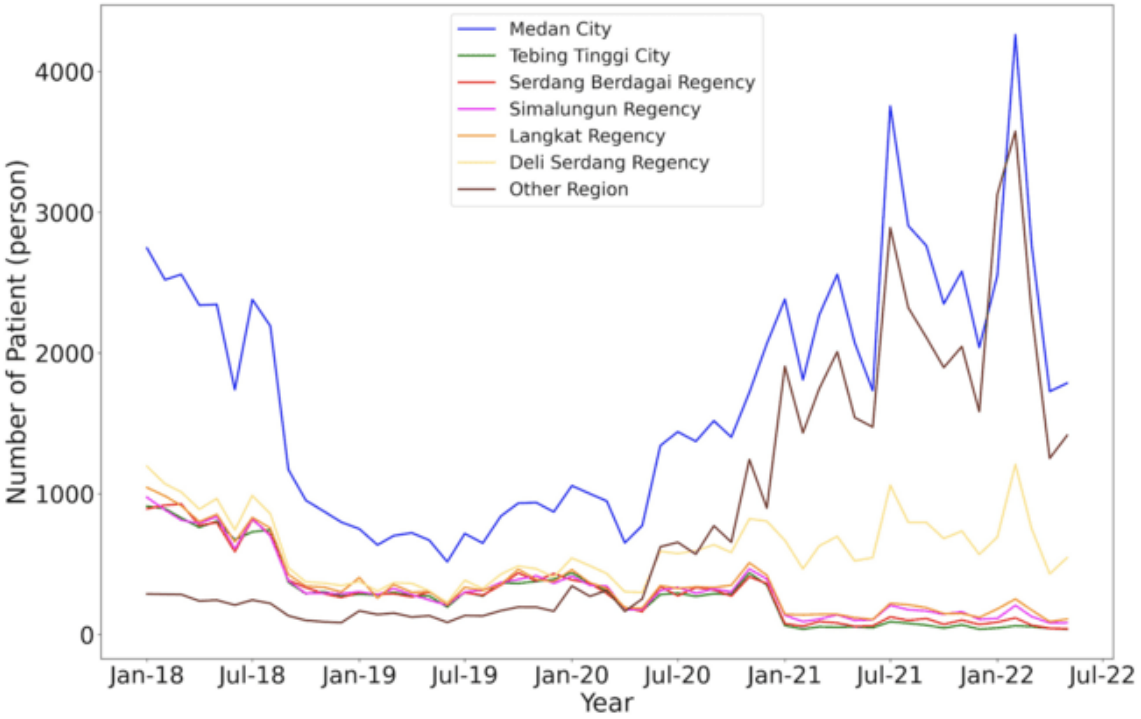

Figure 6 Number of patient data compare to the region of living

The graph as shows in figure 7 which number of patient compare to age of patient, reaches its peak in the mid-year months. This peak might correlate with seasonal factors such as flu season or increased healthcare access and campaigns encouraging people to seek medical care.

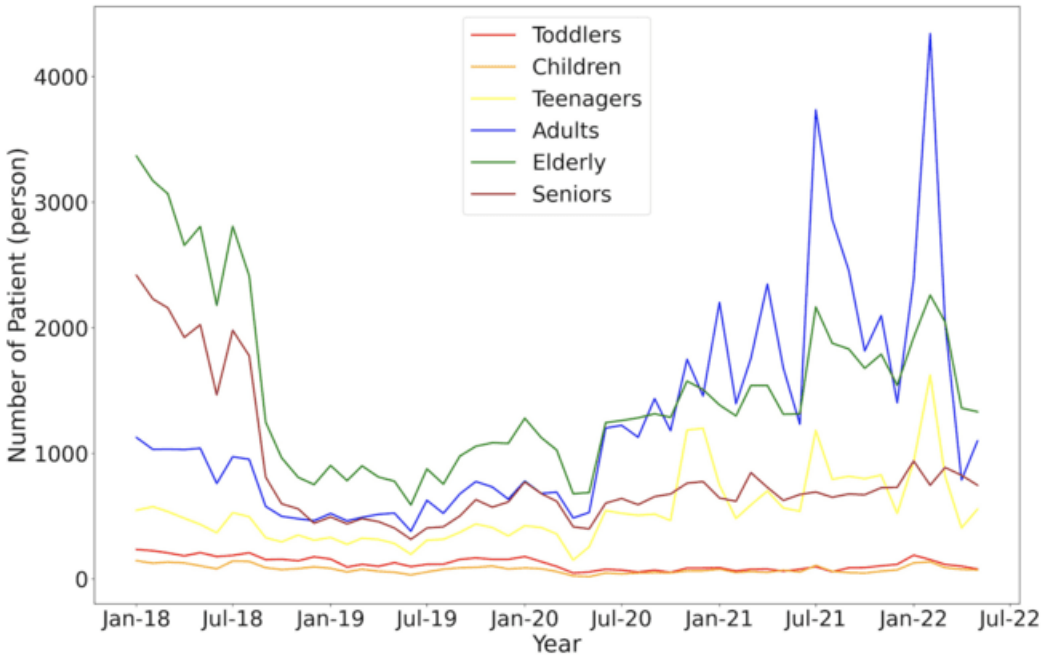

Figure 7 Number of patients compare to the age level

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In figure 8 shows the number of patients compare to the desease having by patient, in the early year increasing in maximun then lower down to the normal of the peak, there is a gradual decline in patient numbers towards the end of the year. This decline could result from various factors, including the effectiveness of public health interventions and the natural resolution of certain health conditions.

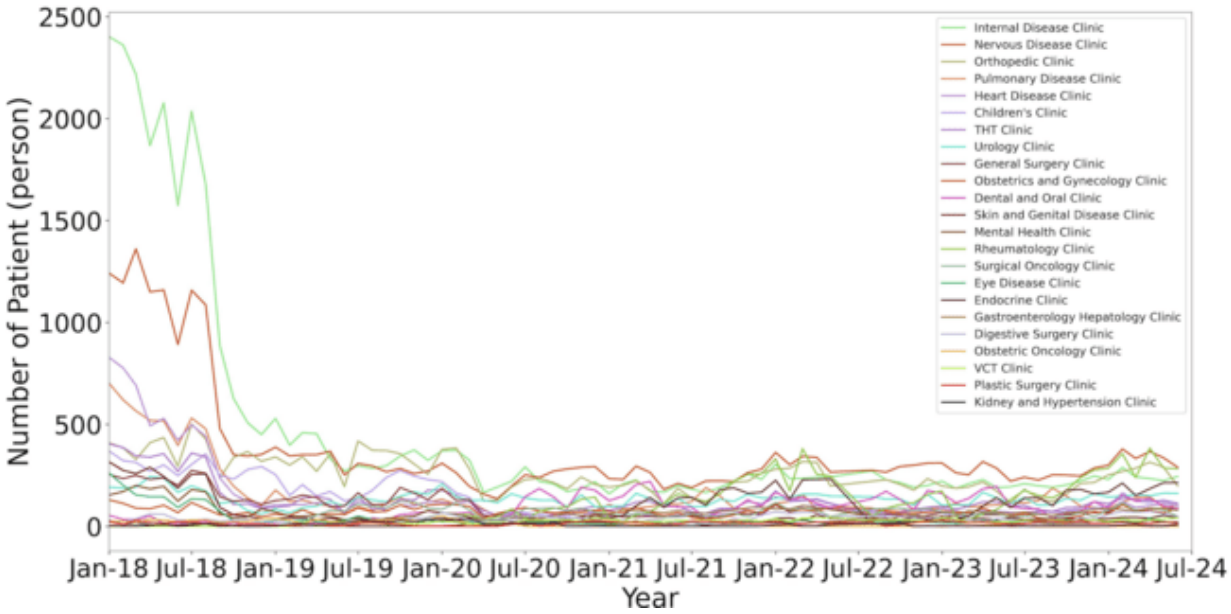

Figure 8 Number of patients compare to the types of desease

Anomalies and outliers as shows in fugure 9 is the oveall data of patient get warded and treatment in the public hospital. The sharp spikes or drops in patient numbers may indicate extraordinary events or data anomalies. For instance, an unexpected rise in patients during a particular month might signal an outbreak of a contagious disease or a public health crisis.

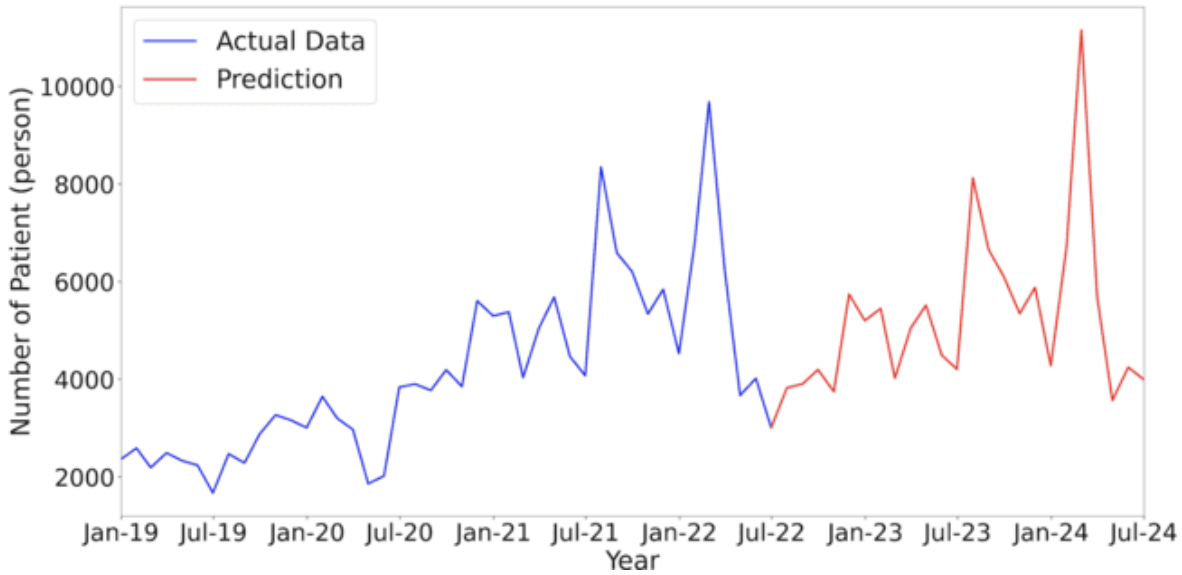

Figure 9 Overall data of the patient in from 2019 to 2024

Implications for healthcare planning as resource and allocation in understanding these trends helps healthcare administrators allocate resources more effectively, ensuring sufficient staff, beds, and medical supplies during peak times. Policy sdjustmentsa and policymakers can use this data to adjust public health strategies, focusing on preventive measures during anticipated peaks. Public Health Interventions: The data assists in planning targeted interventions, such as vaccination drives during expected rises in patient numbers.The graph of patients undergoing treatment versus time in 2022

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provides crucial insights into the healthcare dynamics post-COVID-19. Analyzing these trends, healthcare providers can better prepare for future demands, ensuring optimal patient care and resource management throughout the year. This analysis underscores the importance of continuous monitoring and data-driven decision making in public health [14].

5 Conclusion

The study, "Mapping the Number of Patients Undergoing Treatment and Care in Public Hospitals After the COVID-19 Pandemic," leverages the Long Short-Term Memory (LSTM) algorithm to analyze and predict patient numbers in public hospitals. The application of LSTM, a powerful deep learning technique, enables the handling of complex time-series data, capturing long-term dependencies essential for accurate predictions. The methodology involved meticulous data collection and preprocessing, ensuring high-quality input for the LSTM model. The model's architecture, designed with multiple LSTM layers and a dense output layer, was optimized to predict patient numbers effectively. Rigorous evaluation metrics such as MAE, MSE, and RMSE confirmed the model's accuracy and generalizability. The predictions generated by the LSTM model offer valuable insights into patient trends, aiding in the strategic planning and resource allocation for healthcare providers. By visualizing these trends and creating spatial maps, the study highlights the significant impact of the COVID-19 pandemic on hospital resources and patient care across different regions. The utilization of the LSTM algorithm in this research provides a comprehensive understanding of the post-pandemic healthcare landscape. The findings will be instrumental for policymakers and healthcare administrators in making informed decisions to enhance patient care and optimize hospital operations. This study not only contributes to the current understanding of healthcare dynamics post-COVID-19 but also sets a foundation for future research and applications of advanced machine learning techniques in healthcare analytics.

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