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Chatbot for virtual medical assistance

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ABSTRACT

A healthy population is vital for societal prosperity and happiness. Amidst busy lifestyles and the challenges posed by the COVID-19 pandemic, individuals often neglect their health needs. To address this, we introduce a novel approach utilizing a chatbot for virtual medical assistance. Tailored for individuals confined indoors or hesitant to visit hospitals for minor ailments, our chatbot offers personalized medical support by diagnosing ailments based on user-reported symptoms and engaging in interactive conversations. Leveraging a robust dataset containing 132 symptoms, 41 diseases, and corresponding medications, our chatbot employs a systematic approach for symptom refinement, enhancing diagnostic precision. Upon identifying a disease, the chatbot promptly suggests basic medications tailored to the specific ailment. Furthermore, our system integrates user demographics to evaluate medication history and current state, allowing for personalized medication recommendations based on individual needs. Through extensive testing and validation, we demonstrate the effectiveness of our chatbot in accurately predicting ailments and providing timely treatment advice. Our study introduces a novel paradigm for medicine recommendation and disease prediction, with the potential to enhance healthcare accessibility and effectiveness.

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1. INTRODUCTION

In recent years, the importance of community health and societal well-being has become increasingly evident. A prosperous society relies on the health and contentment of its people. However, modern lifestyles often lead individuals to prioritize other responsibilities, resulting in a concerning lack of awareness about their well-being. The demands of contemporary life can cause people to overlook their health needs and remain uninformed about their current health status. This challenge has gained unprecedented urgency amid the ongoing COVID-19 pandemic [1], underscoring the critical need for innovative solutions in remote healthcare [2]. The pandemic has accentuated the importance of finding new ways to address healthcare needs globally.

The intersection of technology and healthcare has seen significant advancements, driving transformative changes in medical service delivery. In our work, we propose a pioneering approach that utilizes chatbot technology to offer personalized virtual medical assistance [3]. Tailored for individuals confined indoors during the pandemic or hesitant to seek medical care for minor ailments, our chatbot system serves as a virtual medical companion proficient in diagnosing ailments based on user-reported symptoms and engaging in interactive conversations to address health concerns.

The rise of chatbot technology, especially in healthcare, has been prominent, driven further by the COVID-19 pandemic's demand for remote medical care. Our innovative chatbot system [4] integrates natural language processing (NLP) [5] and artificial intelligence (AI) to understand user symptoms, predict illnesses, and offer tailored therapy recommendations [6]. It also serves as a proactive tool for remote health monitoring, aiding medical professionals in assessing vital signs and medication adherence. Several studies have explored chatbot technology in healthcare, each with unique focuses and methodologies. However, common limitations such as lack of specific drug advice, insufficient validation, and real-world applicability challenges have been identified.

Jayashree *et al.* [7] introduces a chatbot for disease prediction based on user symptoms but lacks detailed medication recommendations. In contrast, our paper enhances this aspect by incorporating a medication evaluation module and conducting rigorous validation. Prasad *et al.* [8] prioritizes disease prediction and general conversation via Google APIs, but faces challenges in dataset limitations and training times. Our work aims for a comprehensive virtual medical assistant, addressing a broader range of healthcare needs with convincing datasets and medication recommendation features. Swathi *et al.* [9] presents a Java-based medical chatbot utilizing NLP, particularly focusing on COVID-19 FAQs to aid users in disease diagnosis and providing medical advice. It lacks detailed dataset information and validation procedures. Evaluation relies on user feedback, raising concerns about its reliability. Contrary, our paper employs Python and Streamlit, offering userfriendly approach emphasizes for detailed dataset. Gupta *et al.* [10] primarily focus on Florence using the RASA framework using NLP and machine learning but lacks dataset details and validation. We use Python, Streamlit, and pandas for development. We include real-world validation and offers a systematic and userfriendly approach for medicine suggestion. Gori *et al.* [11] introduces MEDBOT, it lacks real-world validation and sufficient discussion on ethical considerations. Our chatbot offers actionable medication advice, improves accuracy, and ensures patient privacy with security measures. Mathew *et al.* [12] uses NLP and the KNN algorithm for symptom identification and treatment recommendation to improve healthcare accessibility but faces challenges in human oversight and sustained user engagement. Our chatbot enhances user engagement and safety with proactive healthcare measures and a user-friendly interface. Hwang *et al.* [13] aims to offer personalized health advice through biological signal analysis but lacks integration with healthcare systems, sensor accuracy validation, real-world testing, and AI algorithm transparency. Conversely, our approach delivers precise diagnosis, tailors interactions, conducts thorough symptom analysis, and ensures user safety with medication checks. Srivastava and Singh [14] provides personalized diagnoses and remedies but it lacks thorough comparison with existing solutions and neglects data privacy concerns. In contrast, our approach offers interactive symptom collection, medication recommendation, and proactive consultation, enhancing diagnostic precision and user privacy by security keys. Rahman *et al.* [15], a Facebook Messenger-based chatbot diagnoses diseases using IBM Watson, performing well but with limitations in accuracy, particularly for conditions like gastroenteritis. Evaluation is restricted to a small disease set, requiring broader testing for comprehensive diagnostic insights across various medical conditions.

Studies against existing methods offers insights into strengths and weaknesses. Our work addresses limitations in existing studies by integrating medication evaluation, rigorous validation, user-friendly interfaces, and proactive healthcare measures. We prioritize comprehensive datasets, extensive testing, and ethical considerations to enhance prediction accuracy and improve healthcare accessibility. Continuous evaluation and refinement are crucial for chatbot system enhancement. Our approach aligns with existing findings, contributing to better healthcare delivery.

2. RESEARCH METHOD

The methodology for the present work is depicted in Figure 1, which provides a high-level overview of the chatbot's workflow. This includes stages such as user input, symptom refinement, condition prediction, medication recommendation, and ongoing supervision. Each step in the process is designed to ensure accurate and timely medical assistance for users.

2.1. User input

User input initiates the process by collecting essential health-related information, including personal details (name, gender, age), physical attributes (height, weight), symptoms, medical history, and current feelings. This data forms the basis for symptom refinement, accurate condition prediction, and medication recommendations. The chatbot analyzes this input to guide users in clarifying their symptoms, ensuring a systematic and accurate diagnostic process.

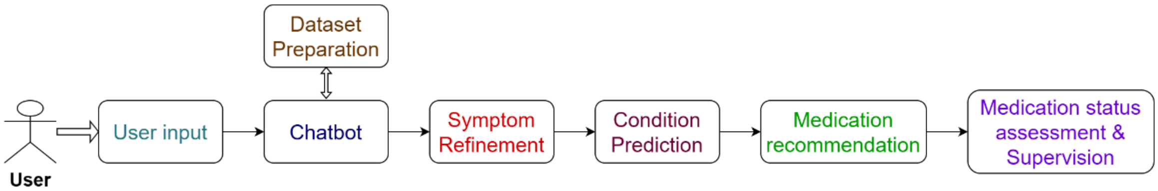


Figure 1. Overview of the chatbot process workflow

2.2. Dataset preparation

The dataset, obtained from [16], comprises 132 symptoms, 41 diseases, and corresponding Level 1 medications. Elementary medications for each disease were added to ensure completeness as shown in Figure 2. Data was collected from reliable sources, including medical literature, databases, and expert consultations, and underwent preprocessing steps such as normalization, cleaning, and validation to maintain its quality and consistency [17].

silver_like_dusting	small_dents_	inflammatory	blister	red_sore_	yellow_crust	prognosis	Medicine
0	0	0	0	0	0	Fungal infection	clotrimazole
0	0	0	0	0	0	Allergy	Desloratadine
0	0	0	0	0	0	GERD	esomeprazole
0	0	0	0	0	0	Chronic cholestasis	Phenobarbital
0	0	0	0	0	0	Drug Reaction	diphenhydramine
0	0	0	0	0	0	Peptic ulcer diseae	Proton pump inhibitors
0	0	0	0	0	0	AIDS	Ciprofloxacin
0	0	0	0	0	0	Diabetes	Metformin
0	0	0	0	0	0	Gastroenteritis	doxycycline
0	0	0	0	0	0	Bronchial Asthma	Inhaled corticosteroids
0	0	0	0	0	0	Hypertension	thiazide diuretic.

Figure 2. Sample dataset showing symptoms, diseases, and corresponding medications

2.3. Chatbot development

The chatbot interface was developed using Python and the Streamlit framework [18], providing a user-friendly web application for seamless interaction. The system's backend was implemented using essential libraries such as `zipfile`, `os`, `csv`, `pandas` (as `pd`), and `Streamlit` (as `st`). The following key functions were developed to support the backend:

– extract_csv_from_zip: Extracts a CSV file from a ZIP archive.
– load_dataset: Loads the dataset from a CSV file using Pandas.

```
csv_file_path = os.path.join(output_dir, csv_file_name)
dataset = load_dataset(csv_file_path)
symptoms = dataset.columns[1:-1].tolist()
initial_symptoms = st.multiselect('Initial symptoms:', symptoms)
related_diseases_initial = find_related_diseases(initial_symptoms, dataset)
if related_diseases_initial:
    for idx, (row_index, disease) in enumerate(related_diseases_initial, start=1):
        st.write(f"{row_index}: {disease}")
        related_medicine = find_related_medicine(disease, dataset)
        #st.write(f"Medicine: {related_medicine}")
else:
    st.write("No related diseases found for initial symptoms.")
```

– find_related_diseases: Finds related diseases based on selected symptoms from the dataset.

```
def find_related_diseases(selected_symptoms, dataset):
    """Finds related diseases based on selected symptoms."""
    related_diseases = []
    for idx, row in dataset.iterrows():
        if any(row[symptom] == 1 for symptom in selected_symptoms):
            related_diseases.append((idx, row['prognosis']))  # Adding row index along with disease name
    return related_diseases
```

– find_related_medicine: Finds related medicine for the predicted disease from the dataset.

```python
def find_related_medicine(predicted_disease, dataset):
    """Finds related medicine for the predicted disease."""
    medicine_column_index = dataset.columns.get_loc('Medicine')
    row_index = dataset[dataset['prognosis'] == predicted_disease].index
    related_medicine = dataset.iloc[row_index, medicine_column_index].tolist()
    return related_medicine
```

In terms of execution, the main () function is used to run the script, initiating the process in Streamlit [19]. The user is guided through a multi-level symptom selection process [20], enabling the system to predict diseases and recommend appropriate medications. The chatbot also prompts users for additional details, such as prior medication use and its effectiveness.

After completing the backend development, the next step involved integrating the chatbot with a graphical user interface (GUI) using Streamlit. This ensures a smooth and intuitive user experience, making it easy for users to interact with the system. To make the Streamlit app accessible over the internet, a tunneling service was used. This creates a temporary public URL for the local server running the app, allowing users to access it from any internet-connected device securely.

The integration and deployment process involved the following steps:

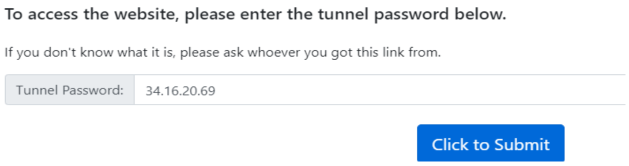
– Install Streamlit: Streamlit was installed in the Python environment to set up the web application.

```
!pip install streamlit

Collecting streamlit
  Downloading streamlit-1.32.0-py2.py3-none-any.whl (8.1 MB)
     ---------------------------------------- 8.1/8.1 MB 17.2 MB/s eta 0:00:00
Requirement already satisfied: altair<6,>=4.0 in /usr/local/lib/python3.10/dist-packages (from streamlit) (4.2.2)
```

– Download Public IP Address File: This step retrieves the public IP address of the local machine, necessary for remote access.
– Run Streamlit App: The application is launched by running the command streamlit run app.py in the terminal, which starts the Streamlit server.

```
[2] !wget -q -O - ipv4.icanhazip.com

34.16.20.69

! streamlit run app.py & npx localtunnel --port 8501

Collecting usage statistics. To deactivate, set browser.gatherUsageStats to False.

  You can now view your Streamlit app in your browser.

  Network URL: http://172.28.0.12:8501
  External URL: http://34.16.20.69:8501

npx: installed 22 in 4.32s
your url is: https://shaky-meals-repair.loca.lt
```

– Expose Local Server to Internet: A tunneling service, such as LocalTunnel [21], was used to expose the local server to the internet, enabling remote access to the application.
– Accessing the Streamlit App: Once the tunneling service is active, a URL is generated, which can be shared with others to access the chatbot from anywhere. The IP address generated acts as the tunnel password, ensuring secure access.



2.4. Symptom refinement and condition prediction

An algorithmic approach was developed to refine user-provided symptoms and enhance diagnostic precision. As shown in Figure 3, the process is structured into three stages:

– Stage 1: Constricting symptoms for an initial assessment.
– Stage 2: Further refinement to narrow down possible conditions.

– Stage 3: Final refinement to arrive at a conclusive set of symptoms.

This structured methodology aligns with hierarchical symptom evaluation approaches [22], which classify symptoms into distinct categories for systematic analysis. Refined symptoms are then processed using a condition-prediction algorithm that calculates a Matching Score to quantify alignment between user-selected symptoms and known disease profiles:

$$\text{Matching Score}(d) = \frac{|\,U\,|}{|\,U \cap Dd\,|}$$

where U represents the set of user-selected symptoms and D_d is the set of canonical symptoms associated with the disease. This approach ensures accurate and transparent disease prediction based on refined symptom data. Figure 3 illustrates the decision-making flow for health monitoring and treatment.

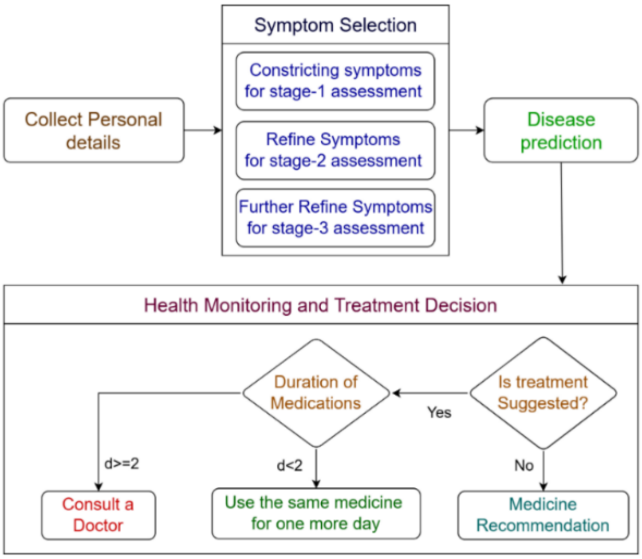


Figure 3. Detailed chatbot user interaction and decision-making flow

2.5. Medication recommendation

Based on the predicted illness, the chatbot suggests Level 1 medications tailored to the user's demographics, medical history, and real-time symptom data [23]. By considering prior medication usage and its effectiveness, the system ensures personalized and accurate recommendations aligned with the user's needs. This approach leverages advanced techniques in medical recommendation systems to enhance the precision and relevance of the suggestions [24].

2.6. Medication status assessment and supervision

The chatbot continuously monitors the user's condition through a threshold-based system, evaluating medication type, duration, and effectiveness. Based on these assessments, it provides tailored advice:

– Prolonged medication durations: Suggest consulting a doctor.
– Shorter durations: Advise continuing the same medication for an additional day.
– Ineffective treatment: Recommend alternative medications or professional consultation.

This ongoing supervision ensures users receive continuous support, promoting better treatment outcomes and satisfaction [25].

3. RESULTS AND DISCUSSION

Extensive testing and validation procedures were conducted to evaluate the chatbot's performance in terms of disease prediction accuracy, medication recommendation efficacy, and user satisfaction. Real-world user interactions and feedback were collected and provided to medical practitioners for scrutiny, assessing the chatbot's usability, effectiveness, and overall impact on virtual health assistance. The integration of the chatbot model with a GUI developed using Streamlit is depicted in Figure 4.

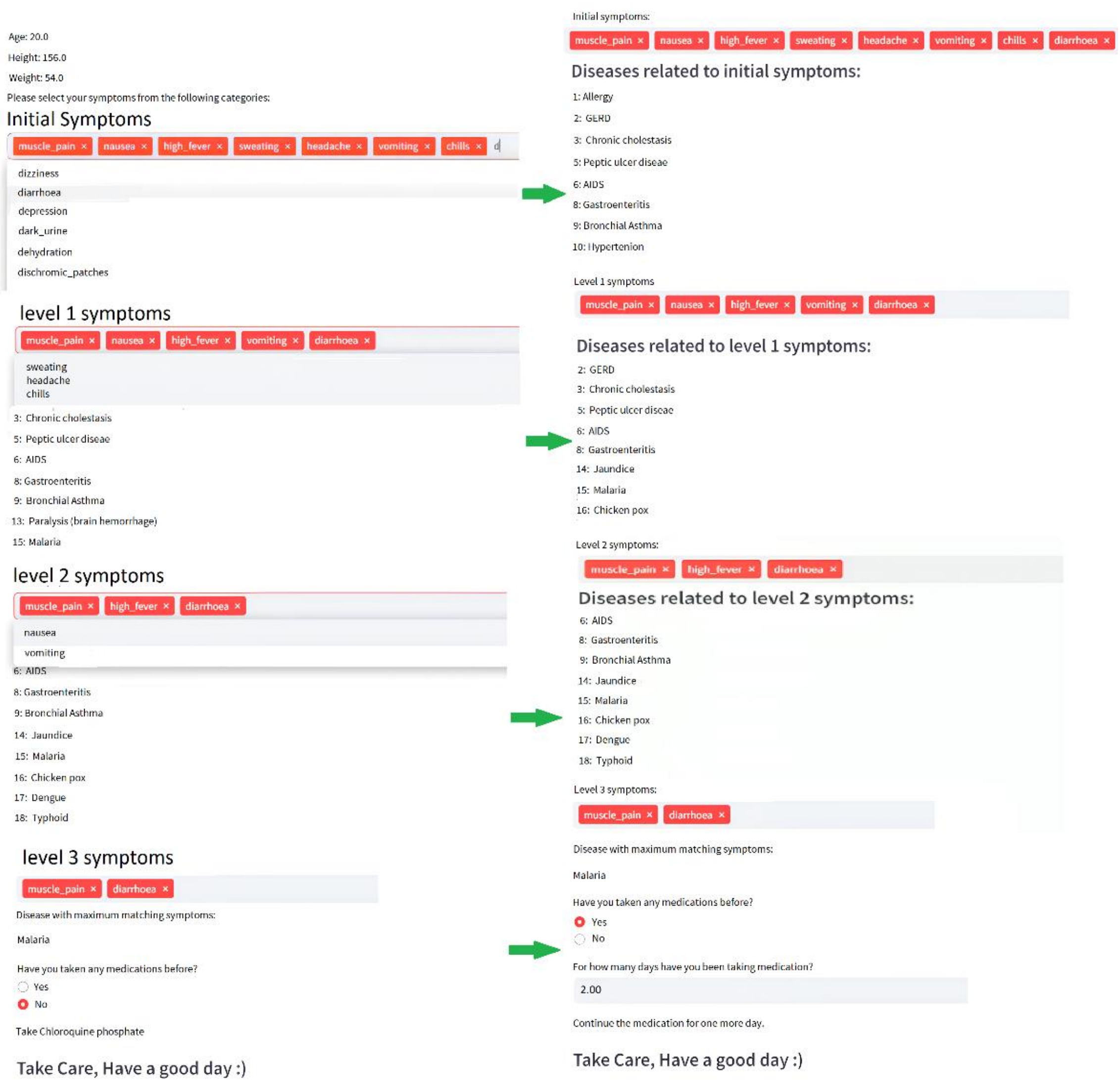


Figure 4. Chatbot GUI for symptom assesment and disease prediction and medicine recommendation

The chatbot collects initial user information, including name, age, and first symptoms, through interactive elements like text inputs, radio buttons, and dropdown lists. Users can also provide natural language inputs, which the chatbot interprets to identify patterns and correlations between symptoms and diseases. This foundational information personalizes interactions and supports systematic symptom refinement through a hierarchical assessment process:

– Level-1 Assessment: Users select a specific subset of symptoms, enabling the system to identify and predict likely diseases at the initial level.
– Level-2 Assessment: Predicted diseases are further refined by analyzing an expanded or adjusted set of user-selected symptoms.
– Level-3 Assessment: The system determines the final disease by prioritizing the most dominant symptom from the refined set, ensuring precise predictions.

Although multiple diseases may share similar symptoms, the chatbot predicts the most likely condition and recommends appropriate medications. It also monitors user health using predefined threshold values and alerts users for timely medical attention if needed. Upon completing the interaction, the system displays a farewell message, advising users to take care, as illustrated in Figure 5.

By evaluating current medication status and providing consultation advice, our chatbot empowers users to manage their health effectively. Implementing a two-day threshold for medical attention emphasizes timely care, aiming to prevent treatment delays and ensure optimal healthcare outcomes.

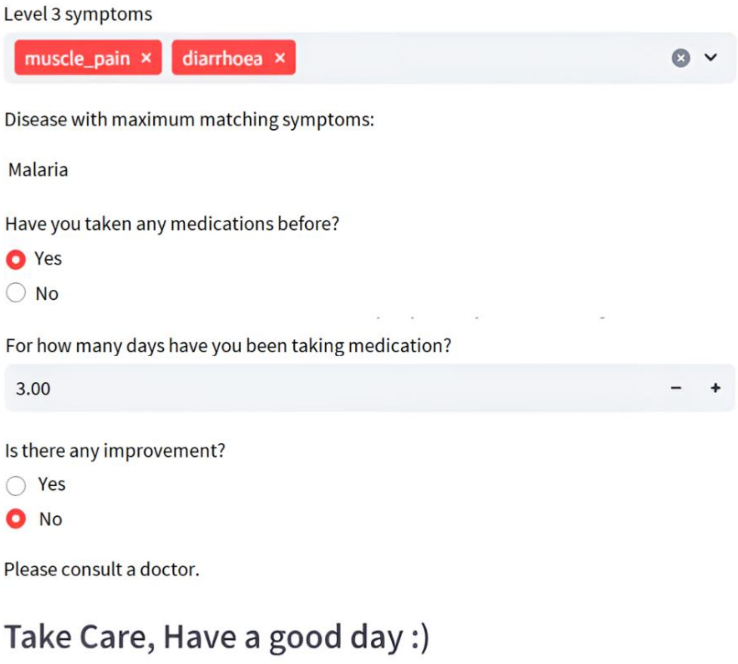


Figure 5. Consultation advice

4. CONCLUSION

This study presents the development of a chatbot system that utilizes NLP to provide virtual medical assistance, including accurate disease prediction and personalized medication recommendations. By employing a multistage symptom refinement approach, the system systematically analyzes user-reported symptoms, ensuring precise health predictions. Its integration with a robust dataset of 132 symptoms, 41 diseases, and associated medications enables the delivery of tailored and relevant healthcare advice, enhancing accessibility and proactive health management during periods of limited access, such as the COVID-19 pandemic. Extensive testing and real-world feedback demonstrate the chatbot's reliability, user-friendliness, and potential to improve health outcomes and patient satisfaction. This innovation marks a significant step forward in remote healthcare, offering practical solutions for virtual health support.

Future advancements will focus on expanding the dataset and enhancing the symptom refinement algorithm. Integration with smart wearables to utilize sensor data, such as heart rate and BMI, will improve disease prediction accuracy. Planned features like video consultations with healthcare providers and GPS functionalities to locate nearby medical facilities will further enhance usability. Regular validation and updates by medical experts will ensure the chatbot evolves into a comprehensive Virtual Assistant model, offering even greater value to users.

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AUTHOR CONTRIBUTIONS STATEMENT

Name of Author	C	M	So	Va	Fo	I	R	D	O	E	Vi	Su	P	Fu
Aravalli Sainath Chaithanya	✓	✓		✓	✓	✓			✓	✓	✓	✓	✓	
Sampangi Lahari Vishista	✓	✓	✓	✓	✓	✓	✓	✓			✓			
Adepu MadhuSri	✓	✓	✓	✓	✓	✓	✓	✓			✓			

C : **C**onceptualization	I : **I**nvestigation	Vi : **Vi**sualization
M : **M**ethodology	R : **R**esources	Su : **Su**pervision
So : **So**ftware	D : **D**ata Curation	P : **P**roject administration
Va : **Va**lidation	O : Writing - **O**riginal Draft	Fu : **Fu**nding acquisition
Fo : **Fo**rmal analysis	E : Writing - Review & **E**diting	

CONFLICT OF INTEREST STATEMENT

Authors state no conflict of interest.

INFORMED CONSENT

Not applicable.

ETHICAL APPROVAL

Not applicable. This study did not involve human participants, clinical trials, or the collection of sensitive personal data requiring ethical approval.

DATA AVAILABILITY

The dataset used in this study is publicly available on Kaggle: Kaggle Dataset [https://www.kaggle.com/datasets/kaushil268/disease-prediction-using-machine-learning]. The dataset is licensed under the Open Data Commons Database Contents License (DbCL) 1.0, permitting use, modification, and redistribution with proper attribution. Preprocessing steps detailed in the study ensure reproducibility. Supplementary processed datasets and implementation details can be provided upon reasonable request.

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