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AI-Powered Symptom Checker and Risk Assessment Web Application for Tuberculosis (TB)

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Abstract- ***Tuberculosis remains among the greatest public health challenges, especially in developing countries where lack of early diagnosis due to limited access results in late treatment and increased transmission. Rapid advances in Artificial Intelligence and Natural Language Processing bring forth digital health tools as strong solutions in preliminary symptom assessment and risk evaluation. This paper provides an overview of the current landscape on AI-based TB detection systems, prevailing gaps in the digital health solution space, and an AI-driven web application capable of analyzing symptoms, vitals, and risk factors based on conversational inputs. It assessed how such platforms could contribute to enhancing conventional workflows of healthcare by providing timely advice, raising awareness, and improving access in resource-poor settings. Further development could include the use of imaging-based diagnostics, extending multilingual capabilities, and further developing models of AI that could work offline in rural environments.***

Keywords: Tuberculosis, AI in Healthcare, Symptom Checker, NLP Chatbot, Public Health Screening, Digital Health, Early Diagnosis, Risk Assessment, Machine Learning, India TB Burden.

I. INTRODUCTION

Tuberculosis remains one of the most common infectious diseases worldwide, with most of the TB burden found in low- and middle-income countries. Despite multiple government-initiated health programs, India continues to bear the world's highest burden of TB. One of the main reasons for this persistence is delay in diagnosis, brought about in most cases by lack of awareness, stigma, and difficulty in reaching health facilities. Traditional methods of diagnosing tuberculosis include sputum testing, chest radiography, and GeneXpert systems, which, besides requiring specially trained personnel and laboratory infrastructure, are beyond the reach of millions living in remote areas.

AI-powered tools, in the wake of increasing digital adoption, offer early symptom detection and risk assessment. By harnessing Natural Language Processing, conversational interfaces help users to state symptoms in layman's terms for personalized risk scores and advice on further medical help. These can be used as first contact points for those who might hesitate to visit clinics or have no access to professional medical support.

The paper explores recent advances in AI-driven TB screening, showing how an AI-powered symptom-checking web application can help bridge critical gaps in access, user engagement, and early detection.

II. RELATED WORK

Interest in the application of AI to healthcare diagnostics, particularly for infectious diseases, has increased in recent years. Several studies conducted on TB detection accentuate the potentials of machine learning and deep learning:

- Image-based Diagnostics: Studies like Rajpurkar et al. (2017) have shown the use of convolutional neural networks in detecting markers of TB in chest X-rays with high accuracy. While efficient, such systems require imaging equipment and remain unsuitable for preliminary community-level screening.

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- Machine Learning Risk Prediction: Several studies use algorithms like logistic regression, random forests, and support vector machines to predict the likelihood of TB from structured data of symptoms and demographic factors. These methods are promising, but many of them rely on strict input formats.
- NLP-Driven Health Chatbots: Research during the COVID-19 pandemic illustrated how NLP-based chatbots improved triage efficiency by collecting self-reported symptoms and advising users on next steps. The success of these systems indicates an opportunity to scale up similar approaches to TB.
- Digital Public Health Platforms: Initiatives by the government, such as the Nikshay platform of India, focus on case reporting and monitoring. While very successful in regard to surveillance, these systems do not offer AI-driven personalized risk assessment.

While progress is being made, a gap remains in AI solutions specialized for TB, multilingual capabilities, and helping populations in low-connectivity environments. This gap motivates the development of an accessible, user-friendly TB symptom checker.

III. PROPOSED SYSTEM

The proposed AI-powered TB Symptom Checker and Risk Assessment Web App offers a streamlined digital solution that enables users to receive a preliminary analysis based on their symptoms, vitals, and risk factors.

A. System Overview

The system consists of three core components:

1. Frontend (Streamlit):

A simple and intuitive interface enabling users to input symptoms, demographic details, and vitals. The form-based layout supports all age groups and users with limited technical literacy.

2. Backend (FastAPI + Gemini):

- FastAPI handles API endpoints and data processing.
- Google's Gemini model performs risk scoring, symptom interpretation, and recommendation generation.

3. AI Reasoning Engine: The AI analyzes:

- primary symptoms (e.g., cough duration, fever, weight loss),
- vital signs (temperature, respiratory rate, blood pressure), lifestyle and exposure factors,
- environmental conditions (e.g., crowded living spaces).

4. It then generates a risk percentage and actionable suggestions such as diagnostic tests and precautionary steps.

B. Design Considerations

- Multilingual Capability: Essential for reaching rural populations.
- Low-Data Mode: Lightweight responses and caching for slow networks.
- Privacy Preservation: Minimal data storage; anonymized processing.
- User-Centric Flow: Conversations mimic familiar interaction patterns, reducing hesitation and improving engagement.

This combination enables the system to be efficient, accessible, and aligned with the needs of India's population.

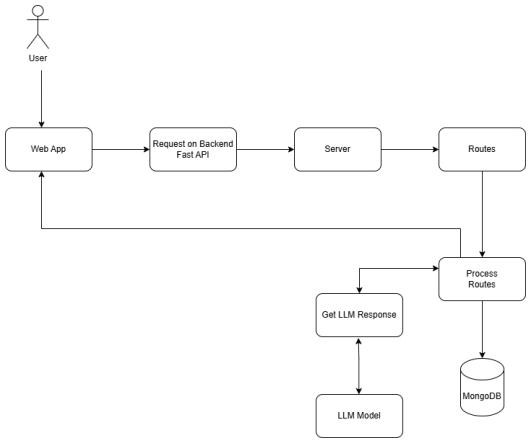

Fig. Comprehensive Framework for AI-Powered Symptom Checker and Risk Assessment Web Application for Tuberculosis (TB)

IV. DISCUSSION

AI-powered digital tools can significantly transform TB screening by addressing long-standing challenges in accessibility and early intervention. The conversational interface encourages users who may ignore or hide symptoms due to stigma or lack of knowledge. The availability of risk scores and tailored recommendations helps users understand the severity of their condition and motivates them to seek timely medical attention.

Moreover, aggregated (anonymous) symptom data can provide valuable insights into localized TB trends. This can support health organizations in targeted awareness campaigns, early cluster detection, and optimized resource allocation.

However, the system is not a replacement for clinical diagnosis. The guidance offered is preliminary and must be validated through laboratory testing. Integrating the tool with official public health channels such as NTEP could strengthen both surveillance and early screening.

V. FUTURE SCOPE

The potential for development in this domain is extensive. Future enhancements include:

A. AI Integration with Chest X-ray
Interpretation: Allowing users or healthcare workers to upload chest X-rays that can be analyzed using CNN models for TB detection.

B. Cough Sound Analysis: Emerging
research shows AI can detect TB signatures from cough audio. Users could record a short cough sample for analysis.

C. Wearable Sensors for Vitals
Tracking: Smart bands and IoT devices could continuously monitor respiratory rate, fever spikes, and sleep disturbances—factors relevant to TB risk.

D. Offline AI Models: Deploying on-device
inference through models like TensorFlow Lite to support remote, internet-poor regions.

E. Integration with Government
Systems: Direct referral to TB testing centers, digital follow-up reminders, and linkage with
Nikshay could significantly strengthen impact.

F. Community-Level TB Heatmaps:
Aggregated, anonymous data could help health authorities identify emerging TB hotspots earlier.
These future directions can elevate the system from a screening tool to a significant pillar in national TB elimination efforts.

VI. CONCLUSION

AI-powered digital solutions provide a transforming opportunity in the fight against Tuberculosis. By providing early symptom analysis, personalized risk assessment, and accessible health guidance, the proposed web application enables individuals and communities while informing public health imperatives. While it is by no means a diagnostic tool, it bridges the gap between initial symptom recognition and professional medical intervention. With continued improvement in the form of image support, on-device models, and integration with national health programs, this solution has the potential to meaningfully reduce TB transmission and progress toward a TB-free future.

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