Building Early Warning Systems for Public Health Concerns Using AI-assisted Electrical Modelling for Epidemic Pattern Recognition

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KEYWORDS

Building, Early, Warning Systems, Public, Health, Artificial Intelligence, Electrical, Epidemic, Pattern, Recognition, Surveillance, Predictive, Healthcare

ABSTRACT

A rapid recognition and handling of new threats to public health is crucial for reducing large-scale epidemic outbreaks as well as related consequences. However, this study is relevant because it could enhance the surveillance capabilities that can be used to respond swiftly and effectively to major outbreaks. While there are numerous challenges facing the use of artificial intelligence (AI) in epidemiological research, such technology has a lot of promise. Some of these include integration of complex data sources, validating data, managing computational requirements, and identifying and addressing privacy and security concerns No one doubts that Surveillance Predictive Modeling System-Based Healthcare Framework (SPMS-HF) will overcome these setbacks. SPMS-HF works by using potent AI algorithms to analyze electrical data and hence predict outbreak conditions. This allows for more accurate predictions and early warnings of potential public health risks. There could be different uses for SPMS-HF including real-time disease surveillance, resource efficiency, and public health. Implementation of this program enables healthcare givers alongside police officers to boost community health outcomes while improving their counter-response attitudes. To illustrate the applicability of SPMS-HF simulation analysis was carried out on historical epidemiological data. The results suggest that the model can identify possible health hazards as well as predict future outbreaks with accuracy These findings illustrate how e-images with AI can produce credible warning systems for public health.

1. Introduction

Early public health warning systems that use artificial intelligence-driven electronic models to identify developing epidemic patterns are an important step toward better preparedness and response [1]. These systems can explore mountains involving data from sources such as medical records, environmental variables and social media trends ill health problems or epidemics [2]. This analytical approach to avoiding movement and detecting small changes and new trends can be used [3]. Early detection is essential to reduce healthcare costs, improve patient outcomes, and slow the spread of the disease [17]. Combining artificial intelligence and electronic modeling makes pattern recognition more accurate and faster [5], opening the door for preventive actions such as public health advisories, travel restrictions, targeted vaccination and etc [4]. problems and non-communicable diseases in many [6, 7]. , their health care providers and epidemiologists contribute to understanding the development, mechanisms of infection, and potential populations [8], which in turn influences evidence-based policy and decision-making Key changes in public health preventive measures are AI-enabled and represent the electrical paradigm of warning systems [19]. These platforms can improve health outcomes by reducing the global burden of disease by facilitating faster interventions and increasing collaboration between healthcare agencies and data scientists [10]. With the intention of build a robust health care system that can effectively address current and future public health issues, it is important to embrace technological advances in this area [11].

2. Literature Review

Many industries, like healthcare, city planning, and epidemic response, have been profoundly affected by the lightning-fast development of technology. An Artificial Neural Network (ANN) [20] can improve regularisation and unconstrained optimization, two key components of an AI-based illness prediction system [12]. The result Outperformed previous models with an accuracy of 0.89 and a miss rate of 0.11, showcasing exceptional performance in disease prediction and efficient outbreak management. To improve the accuracy of fire hazard predictions in smart cities made using Internet of Things (IoT) data, people propose a Deep Belief Network (DBN) coupled with a Recurrent LSTM Neural Network (R-LSTM-NN) [13]. Outperformed previous methods and found useful for a range of smart city prediction issues; achieved 98.4% accuracy with a 0.14% error rate. Public health tactics can be improved by utilising AI [14] to anticipate, prevent, and fight infectious disease epidemics. With the use of context-specific interventions and global connections, healthcare can be revolutionised in many ways, including improved epidemic response, better knowledge of health behaviours, cost savings, greater access to health information, and more individual responsibility for their health [22]. An improved reaction to epidemics can be achieved by suggesting a comprehensive evaluation of AI [15] applications in the fight against infectious diseases, with a focus on COVID-19. Found important clinical research variables and data formats; this will help with epidemic management, early detection, and prevention; and it could lessen the effects of future pandemics [18]. Offering a bibliometric and latent Dirichlet analysis (LDA) [16] of 3,447 scholarly articles concerning the use of machine learning during epidemics. The result: Throughout the three categories of COVID-19, other diseases, and public opinion, twelve topics stood out as particularly relevant [21]. These topics demonstrated the preponderance of research pertaining to machine learning and its uses in prediction, diagnosis, and epidemic management. To transform healthcare and public health efforts, the SPMS-HF framework integrates AI, predictive modelling, and surveillance, making it the most effective solution.

3. Methodology

To reduce the impact of pandemics, it is important to identify emerging public health threats and address them as soon as they occur. The proposed method uses electrical modeling and AI to develop a state-of-the-art warning system that can detect epidemic patterns. This approach applies advanced AI algorithms to the SPMS-HF framework to improve the preparedness and response quality of healthcare providers and regulators by providing more accurate and timely assessments of public health risks on the possibility.

Improved access to health records with artificial intelligence

Application of AI in health records medicine to perform data entry, analysis and anomaly detection improves the decision-making process, improving efficiency e.g., machine learning algorithms can search large images in databases, predict disease outbreaks, and identify the best way to allocate resources This combination of highly educated planning and personalized disease care encourages proactive approaches to health care, and which in turn improves public health outcomes.

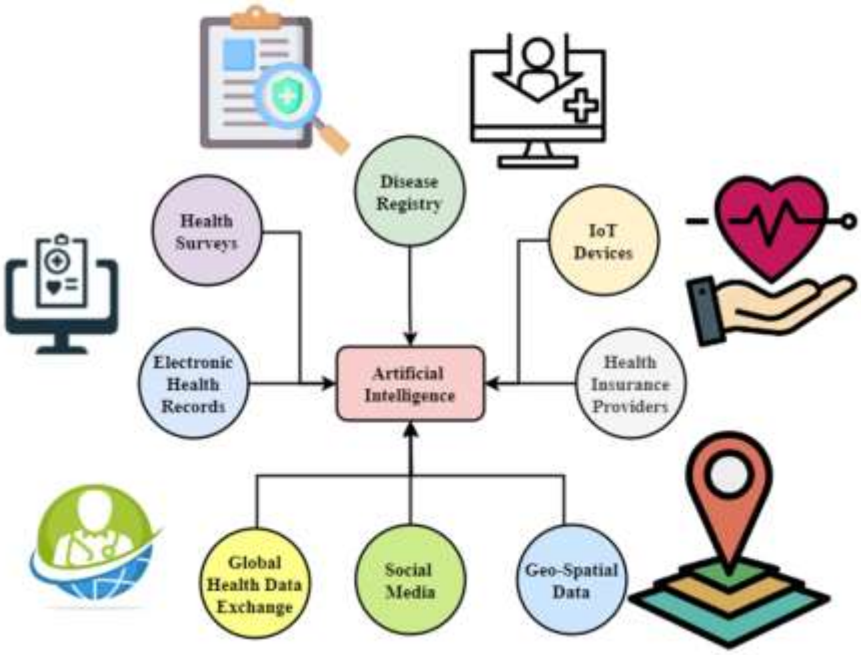

Figure 1. Application of AI to the Administration of Public Health Records

Figure 1 shows how AI combines with data sources to improve health information from population management and outcomes Center of the picture is AI, which collects data from multiple sources such as health surveys, diseases records, insurance services, geospatial data online community, Health Insurance Companies, and IoT devices. Health analytics shed light on potential health and public health issues of a community, while artificial intelligence analyzes data from electronic health records to track patient histories and treatment outcomes supports public health initiatives Disease registries enable AI to monitor outbreaks and track outbreaks. IoT data allows predictive and immediate health monitoring, for example through wearable health monitors. AI analyzes data provided by health insurance companies to analyze health information and allocate more consumer products. Combining social media data with geospatial information allows AI to better understand public opinion and other health concerns, as well as better map health issues and identify health disparities at the regional. Finally, global level the shared exchange of health information enables AI to assess local healthcare, lending support to global healthcare systems. Health outcomes, illness management, and health system efficiency may all be improved with the use of artificial intelligence (AI), which improves monitoring, prediction, and management of public health by integrating various data sources.

Safeguarding Health Monitoring User Verification

Secure and private patient health monitoring data may be achieved with the use of biometric identification methods like fingerprint or face recognition. This method protects private medical records from prying eyes by combining it with the technology known as blockchain, which allows for immutable records. Such approaches strengthen faith in and adherence to strict healthcare data rules.

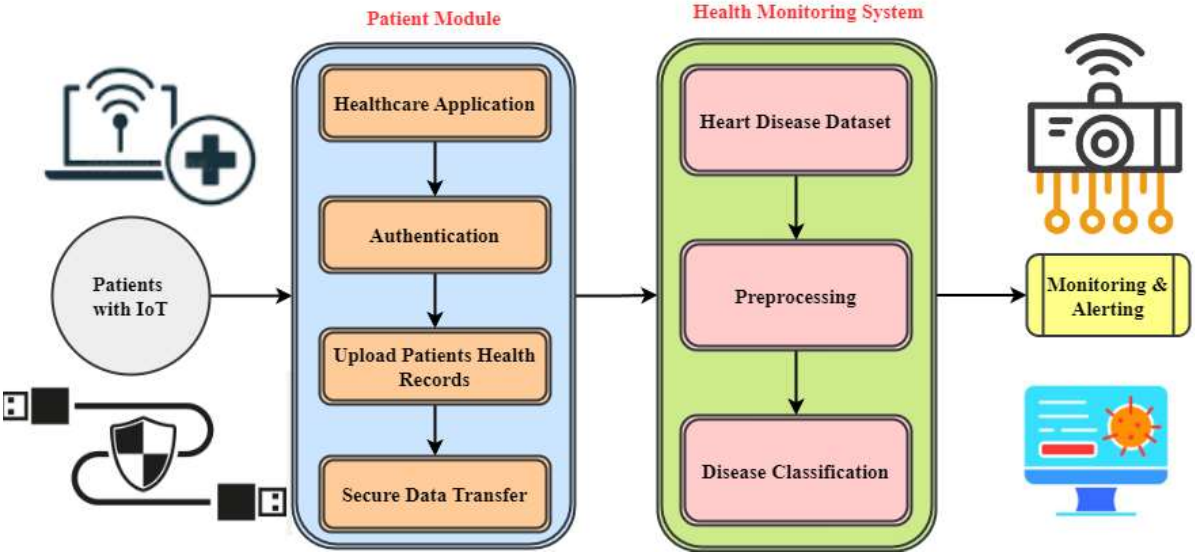

Figure 2. Secure Method of Verifying Users for Health Monitoring Patients

Attaching the device to the patient's body marks the beginning of the intended procedure are determined in Figure 2. The HC app will get readings from the device, which will detect the patient's vital signs via the well. Verification of Identity is a crucial first step in distributing to approval. The application is the only place where the authentication mechanism ever works. Different systems may have different requirements for user identification. A password, which is secret and known only to the user and the system, is a common form of the credential. The suggested method, text-centered hashing, is an approach to high-secure authentication. The password for the patient's registration and verification process. The substitution of ciphertext for plaintext units according to a predetermined scheme characterizes SCs, an encryption method in cryptography. The combination of the preceding elements could be one, two, or three letters long, etc. Next, the substation ciphertext's hash value is determined using SHA 512, and the receiver deciphers the text by executing the inverse substitution. Using this, a hash code is generated for the block.

Artificial Intelligence and Electrical Modeling for Public Health Epidemic Detection

By evaluating massive data sets through public health sources, electrical modeling with AI enhancements allows for the real-time identification of epidemic tendencies. This method enhances reaction and readiness plans by facilitating systems for warning and proactive actions. Optimizing the deployment of resources for successful epidemic management is made possible with the integration of machine learning algorithms, which boost the accuracy of recognizing emergent health concerns.

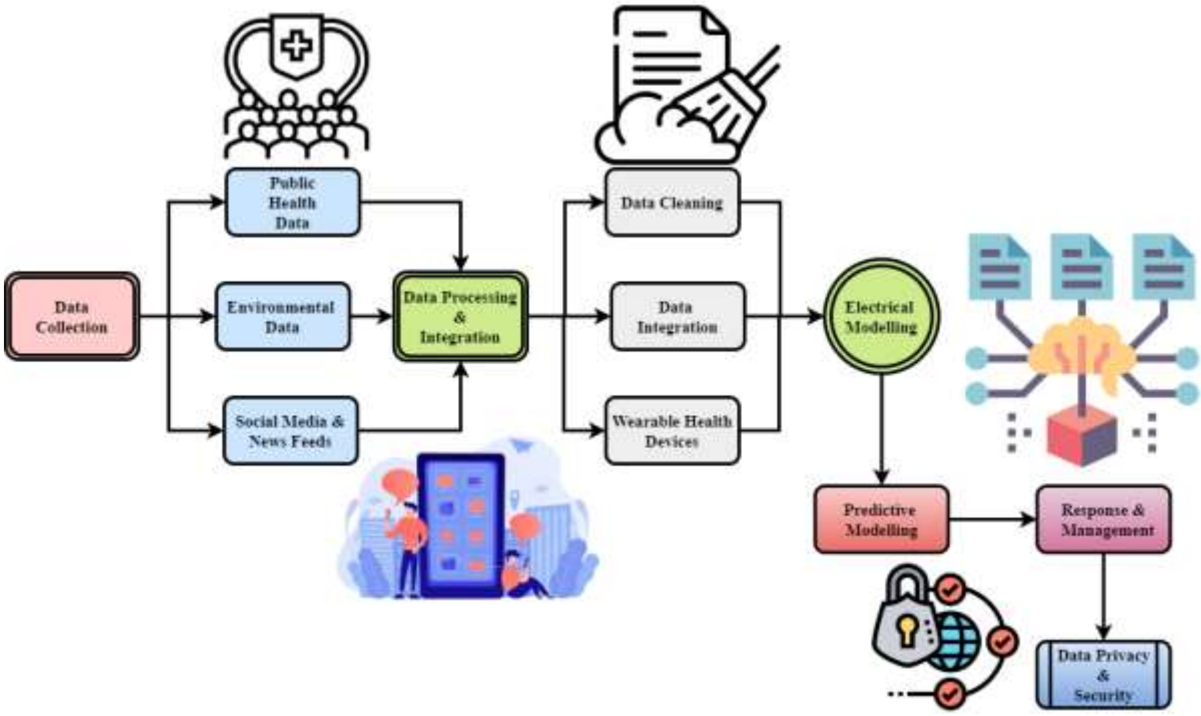

Figure 3. Electrical Modeling with Artificial Intelligence for Recognizing Epidemic Patterns in Public Health

Figure 3, allows one to see that the use of electrical sampling together with artificial intelligence to detect epidemic patterns can lead to early warning systems for public health issues. Data are initially collected using a variety of sources, including public health data, environmental records, social media, and news releases. The processing and integration of this data includes operations such as data washing and integration, as well as integration of data from smart health devices. The combined data is analyzed by a complex AI system to predict future health risks and epidemics, which in turn generates electrical models The results of using predictions to guide staff response efforts and better preparedness and public health outcomes. Data security and confidentiality are maintained throughout the process, assuring responsible use of the information obtained. This holistic approach seeks to provide accurate and timely forecasts to effectively manage public health risks.

Statistical analysis of the best possible results of the proposed method

Quantitative analysis using mathematical models evaluates the effectiveness of the method. Metrics such as sensitivity, specificity, and predictive values are used to evaluate the performance of the method. Health care decisions are made more efficiently and predictive variables are further developed using statistical tests such as regression analysis and hypothesis testing. Government health policies are validated and continuously improved through a research-based approach.

$$P_{f+wq} = e + f - \sum_{l=1}^{4} O_f(3 - \sigma\mu) + \ (r_d - 2p) \quad (1)$$

The projected health risk factor is represented by the equation 1, P_{f+wq}, where e is the ambient variable, f is the current epidemiologic factor, and O_f is the observed frequency modified by a factor of $3 - \sigma\mu$. The four important factors that affect differing reactions are represented by $(r_d - 2p)$.

$$\max J = \sum_{g=2}^{F}\left(F_{d-2} + w_{l-ky}\right) + \sum_{s=1}^{fe} f_{q-1}^{r} - s_f\left(\left(sj - \frac{1}{2}\right)\right) \quad (2)$$

This second summation records the influence of the frequency F, modified by a power J and adjusted oversampling frequency f_{q-1}^{r}, and the adjusted frequency factor is represented by Equation 2 $F_{d-2} + w_{l-ky}$. The weighted term accounting for certain epidemiological variables is $sj - \frac{1}{2}$.

$$J_e + (T, mh): \sum_{p=1}^{f} e_w + 4_f(ku - tp) + \sum_{k-pk}^{s} k_{m+n} - T_{fw} \quad (3)$$

Environmental factor weightings adjusted for epidemiologic variables J_e are represented by the equation 3, e_w, and dynamic risk factors impacted by e_w and modified by temporal parameters $4_f(ku - tp)$ are addressed by the equation k_{m+n}. The combined measurement of geographic health variables, T_{fw}, is modified by the tolerance factor.

$$\sum_{m>2}^{r} p_{-1} + q(v - ew) > 1 + \sum_{e=1}^{f}(rs) - \left((pe - sp)\right) \quad (4)$$

Environmental variables are impacted by changing circumstances p_{-1} and modified by a sensitivity factor $q(v - ew)$. The equation p_{-1} indicates a baseline factor adjusted for early warning signals, whereas (rs) integrates these variables $(pe - sp)$.

$$\sum_{U+1}^{g} v_f(f - jp) > 1 - \sum_{p-w}^{e}(r^2 sa - 1) + T_{w+1} \quad (5)$$

The objective is to identify crucial health thresholds where the weighting factor for predictive variables, denoted as $v_f(f - jp)$, is affected by temporal considerations. To improve the accuracy and responsiveness of the prediction model, the second summation $r^2 sa - 1$ incorporates parameters such as regional risk assessment r^2, spatial attributes sa and temporal boundaries T_{w+1}.

$$C_d = \sum_{t=1}^{g} \frac{1}{4\left(se + w_q(v - pk)\right)} + \sum_{E}^{V}\left(b_v - s(np - q)\right) \quad (6)$$

The weighted components of epidemiological importance C_d are integrated using the equation 6, $se + w_q(v - pk)$, which accounts for both static variables $(b_v - s(np - q))$ and environmental impacts (V).

$$C_q = \sum_{t=1}^{g} \frac{1}{2}\left(N_{d-pk}\right) + \sum_{E}^{W}\left(f_g - f_e(p - 2w)\right) \quad (7)$$

The resource optimization of capacity management based on the metric N, modified for factors, may be expressed as the equation N_{d-pk}. The second calculation, which takes into consideration both operational needs (C_q) and strategic planning (E), finds the optimal allocation of resources (f_g) concerning strategic adjustments $(f_e(p - 2w))$.

$$M(L) = \frac{1}{f} + \sqrt{\left(gp - \frac{ft}{\propto} - kp\right) + (m - jy)} = \int_{K}^{p} s^{-pfr} \quad (8)$$

Important for accuracy in predictive modeling, the equation $M(L)$ shows a baseline accuracy factor that is inversely linked to frequency $\frac{1}{f}$. Integrating growth rates gp, temporal adjustment $\frac{ft}{\propto}$, and environmental variables kp, the sum of $m - jy$ influences the accuracy assessment s^{-pfr}.

The SPMS-HF, an AI-assisted electrical modeling system for early epidemic identification, is introduced as part of the suggested strategy. With the use of sophisticated AI algorithms and data integration, SPMS-HF hopes to reliably forecast and alert the public to any public health dangers. Results from simulation studies utilizing real-world epidemiological data show that the framework may successfully detect potential health risks and foretell when epidemics will occur. Better community health outcomes and readiness against future epidemics may be achieved via the use of this strategy, which shows great potential in improving public health monitoring, allocating resources more effectively, and allowing proactive actions to promote health.

4. Results and discussion

An important step forward in the detection of epidemics and the optimisation of resources is the incorporation of electromagnetic modelling and artificial intelligence (AI) into public health early warning systems.

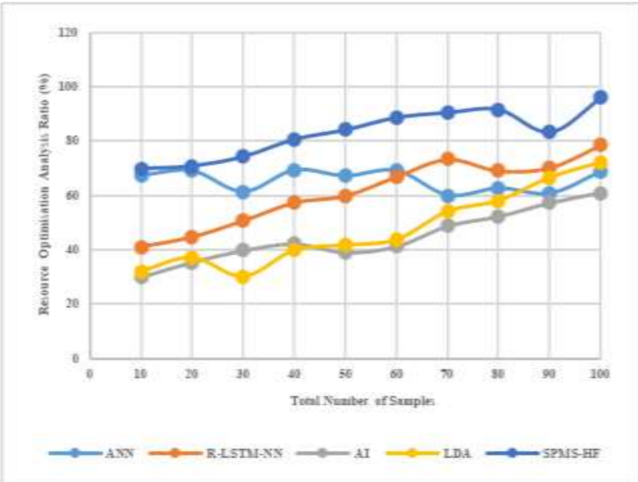

Figure 4. Resource Optimisation Analysis

In the above figure 4, when developing early notification public health warning systems using artificial intelligence electromagnetic sampling to detect epidemic patterns, optimizing available resources is of utmost importance. This technology is able to detect potential outbreaks in an instant because it uses artificial intelligence and machine learning to analyze mountains of epidemiological data. As a result of this efficiency, operating costs are reduced and mass demand is reduced. Using AI systems, data can be processed in real time and monitored continuously, enabling new health risks to be quickly identified and mitigated. Efficient allocation of medical supplies, personnel, and other critical resources is made possible by electrical models that make accurate and reliable epidemiological predictions, which in turn improve resource utilization improve produces 96.2%. Facilitating the integration of data from multiple sources and ensuring complete and accurate analysis can be achieved through the use of the SPMS-HF. By focusing treatments where they will have the greatest impact, this approach enhances early warning systems and makes better use of existing resources. Additionally, healthcare systems can shift their focus from data management to actionable responses through automated data analytics and prediction systems. The public health infrastructures that are best equipped to respond to epidemics and reduce impact are those that optimize their products through electrical sampling supported by artificial intelligence.

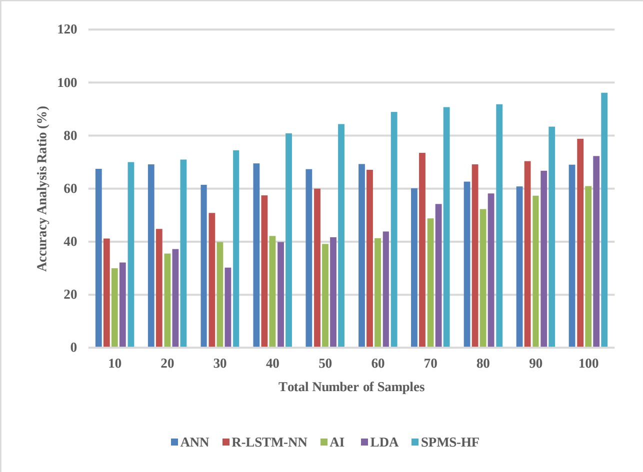

Figure 5. Accuracy Analysis

In the above figure 5, accuracy is of utmost importance in building early warning systems for public health problems using AI-assisted electromagnetic modeling for epidemiological detection. These systems rely on advanced algorithms to analyze complex epidemiological data, and accurately predict potential outbreaks. The integration of AI increases the accuracy by learning from historical data and continuously improving predictive capabilities. Electrical modeling continues to refine these forecasts by accounting for various factors such as population, transportation, and environmental factors to provide a comprehensive picture of epidemic spread but great accuracy is difficult to achieve due to variability in terms of data quality and because of disease progression. Obtaining accurate data from a variety of sources is critical, as errors or biases can significantly impact forecasts. Validation with real-world epidemic scenarios and continuously updated models are critical to maintain accuracy, resulting in a result of 98.4%. Additionally, strong mathematical abilities are required to handle big data and the computational complexity that comes with it. Despite these challenges, the effective use of AI-assisted lightning models can provide early warning, enable timely intervention and effective resource allocation. Through continuous refinement of these models and by adding additional information, public health professionals can improve the accuracy of their forecasts. A new era in dynamic, data-driven epidemiological management is emerging with artificial intelligence and electrical models embedded in public health The ability to anticipate, prevent and respond to health emergencies will continue to improve as new technologies emerge. It will also support international initiatives for the development of large-scale products.

5. Conclusion and future scope

Efforts to use artificial intelligence (AI) to identify epidemic patterns and early warning systems represent a major step forward in public health care for rapid detection and management of emerging health threats role is paramount to mitigate the impact. Although AI, SPMS-HF appears to be a promising solution, which uses AI algorithms to analyze electrical data and accurately predict outbreaks. By increasing early warning and preparedness in public health agencies, SPMS-HF stands to transform disease surveillance and resource allocation. Simulation studies using historical data demonstrate the effectiveness of the system in predicting epidemic outbreaks, emphasizing its potential for improving local health outcomes. Integrating SPMS-HF into health and regulatory policy can provide stakeholders with timely insights, enabling them to address public health concerns more quickly. As AI-powered electricity modeling continues to evolve, its role in building robust public health warning systems will become increasingly important. Embracing these technological advances promises to strengthen our ability to better identify, manage, and mitigate health risks, and pave the way for more resilient and efficient public health systems around the world.

Reference

[1] Yang, H., Zhang, S., Liu, R., Krall, A., Wang, Y., Ventura, M., & Deflitch, C. (2021). Epidemic informatics and control: A holistic approach from system informatics to epidemic response and risk management in public health.

In *AI and Analytics for Public Health-Proceedings of the 2020 INFORMS International Conference on Service Science* (pp. 1-46). Berlin/Heidelberg, Germany: Springer.

[2] Alahmari, A. A., Almuzaini, Y., Alamri, F., Alenzi, R., & Khan, A. A. (2024). Strengthening Global Health Security through Health Early Warning Systems: A Literature Review and Case Study. *Journal of Infection and Public Health*.

[3] Bhattacharyya, S. (Ed.). (2021). *Intelligent modeling, prediction, and diagnosis from epidemiological data: COVID-19 and beyond*. CRC Press.

[4] S. Neelima, Manoj Govindaraj, Dr.K. Subramani, Ahmed ALkhayyat, & Dr. Chippy Mohan. (2024). Factors Influencing Data Utilization and Performance of Health Management Information Systems: A Case Study. *Indian Journal of Information Sources and Services*, *14*(2), 146–152. https://doi.org/10.51983/ijiss-2024.14.2.21

[5] Kaur, I., Sandhu, A. K., & Kumar, Y. (2022). Artificial intelligence techniques for predictive modeling of vector-borne diseases and its pathogens: a systematic review. *Archives of Computational Methods in Engineering*, *29*(6), 3741-3771.

[6] Pham, Q. V., Nguyen, D. C., Huynh-The, T., Hwang, W. J., & Pathirana, P. N. (2020). Artificial intelligence (AI) and big data for coronavirus (COVID-19) pandemic: a survey on the state-of-the-arts. *IEEE access*, *8*, 130820-130839.

[7] Alamer, L., Alqahtani, I. M., & Shadadi, E. (2023). Intelligent Health Risk and Disease Prediction Using Optimized Naive Bayes Classifier. *Journal of Internet Services and Information Security*, *13*(1), 01-10.

[8] Adly, A. S., Adly, A. S., & Adly, M. S. (2020). Approaches based on artificial intelligence and the internet of intelligent things to prevent the spread of COVID-19: scoping review. *Journal of medical Internet research*, *22*(8), e19104.

[9] Mohamed, K.N.R., Nijaguna, G.S., Pushpa, Dayanand, L.N., Naga, R.M., & Zameer, AA. (2024). A Comprehensive Approach to a Hybrid Blockchain Framework for Multimedia Data Processing and Analysis in IoT-Healthcare. Journal of Wireless Mobile Networks, Ubiquitous Computing, and Dependable Applications (JoWUA), 15(2), 94-108. https://doi.org/10.58346/JOWUA.2024.I2.007

[10] Yang, H., Zhang, S., Liu, R., Krall, A., Wang, Y., Ventura, M., & Deflitch, C. (2022). Epidemic Informatics and Control: A Review from System Informatics to Epidemic Response and Risk Management in Public Health. In *AI and Analytics for Public Health: Proceedings of the 2020 INFORMS International Conference on Service Science* (pp. 1-58). Springer International Publishing.

[11] Chen, J., Li, K., Zhang, Z., Li, K., & Yu, P. S. (2021). A survey on applications of artificial intelligence in fighting against COVID-19. *ACM Computing Surveys (CSUR)*, *54*(8), 1-32.

[12] Navya, D., & Sunandini, M. (2021). Secure Home Entry with Face Recognition and Notification via Telegram. Journal of VLSI Circuits and Systems, 3(1), 7-13.

[13] Zhang, Y., Geng, P., Sivaparthipan, C. B., & Muthu, B. A. (2021). Big data and artificial intelligence based early risk warning system of fire hazard for smart cities. Sustainable Energy Technologies and Assessments, 45, 100986.

[14] Ganasegeran, K., & Abdulrahman, S. A. (2020). Artificial intelligence applications in tracking health behaviors during disease epidemics. Human Behaviour Analysis Using Intelligent Systems, 141-155.

[15] Shariaty, F., Shariati, S., Navvabi, S., Oshnari, M. N., & Novikov, B. (2022). Application of Artificial Intelligence for Rapid Prevention of Epidemic Diseases (COVID-19).

[16] Riswantini, D., & Nugraheni, E. (2022). Machine learning in handling disease outbreaks: a comprehensive review. Bulletin of Electrical Engineering and Informatics, 11(4), 2169-2186.

[17] Mahmoudi, T., Naghdi, T., Morales-Narváez, E., & Golmohammadi, H. (2022). Toward smart diagnosis of pandemic infectious diseases using wastewater-based epidemiology. *TrAC Trends in Analytical Chemistry*, *153*, 116635.

[18] Allin Geo A.V., et.al Concealed information aggregation theme for multiple applications in wireless device networks, World Applied Sciences Journal, V-29, I-14, PP:115-120, 2014.

[19] Umamaheswari, S., Arun Kumar, S., & Sasikala, S. (2023). Expert systems for improving the effectiveness of remote health monitoring in COVID-19 pandemic: A critical review. *System Design for Epidemics Using Machine Learning and Deep Learning*, 99-121.

[20] Ali, L., Alnawayseh, S. E., Salahat, M., Ghazal, T. M., Tomh, M. A., & Mago, B. (2023). AI-Based Intelligent Model to Predict Epidemics Using Machine Learning Technique. Intelligent Automation & Soft Computing, 36(1).

[21] Kutlu, Y., & Camgözlü, Y. (2021). Detection of coronavirus disease (COVID-19) from X-ray images using deep convolutional neural networks. *Natural and Engineering Sciences*, *6*(1), 60-74.

[22] Jamshidi, M. B., Roshani, S., Talla, J., Lalbakhsh, A., Peroutka, Z., Roshani, S., ... & Lalbakhsh, P. (2022). A review of the potential of artificial intelligence approaches to forecasting COVID-19 spreading. *Ai*, *3*(2), 493-511.