

Utilizing Artificial Intelligence For The Enhancement Of Public Health

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Abstract

Since the term "artificial intelligence" (AI) was initially introduced by a cohort of researchers in 1956, significant progress has been made in this domain. Although numerous AI applications have been implemented in high-income countries, their utilisation in resource-poor environments is still in its early stages. Indications suggest that a shift is underway. (Alali, et al., 2022) A global conference was organised by the United Nations (UN) in 2017 with the purpose of deliberating on the advancement and implementation of artificial intelligence (AI) applications that have the potential to alleviate destitution and provide an extensive array of essential public services. Recently, a diverse range of stakeholders convened at an additional United Nations meeting to evaluate the potential contribution of artificial intelligence (AI) towards the realisation of the Sustainable Development Goals (SDGs). (Sarker, 2021).

Introduction

A multitude of methodologies, including computer vision, natural language processing, and machine learning, comprise the extensive domain of AI. For pattern recognition, prediction, and large-scale data analysis, these techniques are beneficial. Artificial intelligence (AI) possesses the capacity to bring about significant changes in the healthcare sector. Utilising AI in disease diagnostics, predicting the progression of infectious

diseases, and identifying novel drug targets are all examples of applications. In addition to guiding the interpretation of medical imaging, AI has been implemented in drug delivery and discovery. (Rajpurkar, et al. 2022) Amidst the COVID-19 pandemic, nevertheless, the application of artificial intelligence shifted from the medical field to public health. AI performed critical functions throughout the pandemic, including contact tracing, pharmacovigilance, rapid testing and detection, and COVID-19 spread forecasting. Some of these epidemiology informatics tools facilitated international initiatives to contain the COVID-19 virus's transmission and enhanced patient care. Additionally, AI can aid in the discovery of novel insights and patterns that human analysts may overlook. (Caskey, et al. 2022) However, substantial ethical and regulatory considerations must be taken into account, including issues of data privacy and bias in AI systems. Furthermore, the implementation of AI for the purpose of enhancing public health is not uniformly distributed worldwide. Accessibility and governance of data, the presence of requisite infrastructure, a deficiency in technical expertise, and the potential for bias or

inequity arising from data inconsistencies are significant impediments to the progress of AI in public health. (Xiong, et al. 2022) Collaboration among researchers, healthcare practitioners, and policymakers is imperative for the ethical and responsible implementation of AI within healthcare systems. Recent developments in artificial intelligence (AI) for public health are examined in this article, along with the prospective benefits and challenges of this technology.

History of AI in public health

Research into artificial intelligence (AI) began in the 1960s with the initial objective of developing systems capable of simulating human intelligence. Early artificial intelligence (AI) applications in healthcare primarily revolved around expert systems that supplied decision support for medical diagnosis and treatment planning by leveraging the expertise of human specialists. Despite the continued emphasis on expert systems, healthcare AI research during the 1980s and 1990s also explored machine learning and natural language processing. (Pramod, et al. 2021) Scholars commenced investigating the potential of artificial intelligence (AI) in fields including public health surveillance, drug discovery, and medical diagnosis due to the accessibility of vast databases containing medical data and advanced computing systems. (Malik, et al. 2021)

Researchers were able to develop ever more intricate AI systems capable of analyzing immense quantities of data and forecasting future outcomes due to developments in computer vision, natural language processing, and machine learning during the 2000s. As a consequence, diagnostic systems utilizing artificial intelligence were developed, including those that discern diseases such as cancer through the analysis of medical images. (Lee & Yoon, 2021) Insightful conclusions could also be derived from immense quantities of unstructured data, such as electronic health records, by academics thanks to advancements in text mining and natural language processing practices enabled by AI. The application of artificial intelligence (AI) in the domains of public health surveillance and predictive modelling has garnered increased attention in recent years. For instance, public health officials have been able to take preventative measures by utilizing AI algorithms to predict the spread of infectious diseases such as

COVID-19 and influenza.

In addition, they have been employed to analyse extensive volumes of data sourced from social media and various other platforms with the purpose of identifying potential outbreaks and monitoring the transmission of diseases. Due to the increased availability of vast data sets and sophisticated computing resources, the application of AI in public health has expanded to encompass novel domains such as personalized treatment and drug development. Overall, the history of artificial intelligence in public health has witnessed an evolution from rudimentary expert systems to more sophisticated systems capable of analyzing enormous quantities of data and generating forecasts. There are a number of potential public health benefits associated with the use of AI in healthcare, but ethical and legal concerns, including safety, transparency, fairness and biases of algorithms, data privacy and surveillance, and the function of human judgement, must be considered prior to integrating this technology into healthcare systems. (Naik, et al. 2022)

AI implementations in the sphere of public health:

1. Prediction

Predictive modelling uses machine learning and statistical models to examine data and predict outcomes. Public health predicts influenza and COVID-19 transmission using predictive modelling. Predictive models can analyse past epidemic data,

meteorological conditions, and population demographics to discover patterns and trends that might influence public health measures. AI can help us forecast infectious disease transmission and inform public health measures through predictive modelling. (Ali, et al. 2022) AI for predictive modeling—disease forecasting, risk prediction, and spatial modeling—will improve public health decision-making in precision, efficacy, and actionable insights. Conventional methods in these domains struggle to manage complex data, identify trends, and make accurate projections. AI offers revolutionary solutions to these issues, providing more efficient results. The lack of a precise classification and synopsis of conventional and artificial intelligence predictive modelling methods, including disease forecasting, risk prediction, and spatial modelling, hinders public health decision-making, productivity,

accessibility, and scientific cooperation. Without organized classification, technique selection,

implementation, and adoption are difficult and discouraged. A uniform taxonomy and concise explanations for each technique are crucial to advance the field. This will help experts traverse procedures, make decisions faster, and collaborate on research. (Kakhi, et al. 2022)

• Predicting the occurrence of diseases

Artificial intelligence can help us predict contagious disease transmission and guide public health treatments. Public health relies on this to prevent outbreaks and respond quickly. Historically, time-series analysis and other statistical methods predicted illnesses. However, artificial intelligence has allowed more complex algorithms and data analysis to make more accurate forecasts. (Lim & Zohren, 2021) One of the biggest AI advances is disease prediction using machine learning algorithms. These algorithms may analyse electronic health records and social media to find patterns and predict disease transmission. Massive data sets and cutting-edge computing resources greatly boost AI disease prediction. This allows the examination of large data sets including sensor data, electronic health records, and social media to better anticipate the future and find previously undetected trends. AI can analyse large amounts of data, identify patterns and trends, and predict future outcomes for public health disease prognosis. (Battineni, et al. 2020) This may help direct public health efforts and reduce infectious disease spread. AI in disease prediction may

improve forecast accuracy and efficacy, improving community and individual health. AI for public health disease prediction has limitations. Finding high-quality data is difficult since forecast accuracy depends on the completeness and quality of the data used to train the algorithms. When using AI in public health, ethical and legal issues including data security and privacy must be considered. (Tuli, et al. 2020) Artificial intelligence for public health sickness prediction is predicted to improve. Integrating AI with other technologies like the Internet of Things (IoT) and wearable devices may provide real-time data and increase forecast accuracy and timeliness. Explainable AI (XAI) approaches are also being developed to make AI-based sickness forecasting systems more accountable and transparent by revealing how algorithms make predictions. AI in tailored disease prognosis is another growing area. (Chen, 2020) In this arena, algorithms use electronic health records and other data to assess patient illness risk and

advise treatment decisions. Integrating geographical data with GIS technology can improve local forecasts

and target disease prediction actions. Predicting disease spread and impact is the main difficulty in disease prognosis. Traditional methods that use previous data and statistical tools may struggle to understand complex dynamics and patterns. Machine learning and deep learning algorithms can analyse large datasets, find hidden relationships, and detect complicated patterns to address this issue. The goal is to provide timely notifications, practical understanding, and disease outbreak prevention methods. Predicting Covid-19 transmission with AI. The Google AI algorithm can anticipate COVID-19 cases in a region two weeks in advance.

Prognosis of hazards

Public health relies on hazard diagnosis to focus disease prevention and management. Traditional risk prediction approaches use manual computations from clinical and demographic data and are slow and unreliable. AI could increase risk prediction accuracy and efficacy, improving public health. Machine learning algorithms can find patterns in massive data sets like electronic health records and predict illness risk. These algorithms may also scan large data sets like medical imaging and genetics for disease severity patterns. Public health AI risk prediction should improve. Integration of AI with genomics and wearable sensors may improve prediction capabilities by providing real-time, more precise

data. Explainable AI (XAI) solutions can also improve AI-driven system transparency and accountability by disclosing algorithmic prediction processes, boosting healthcare AI confidence. The key to risk prediction is identifying people at higher risk for certain diseases. (Kang, et al. 2022) Traditional methods focus on demographic and clinical data, which may miss subtle risk factors or developing illnesses. AI methods like natural language processing and machine learning combine data sources, locate latent patterns, and find non-linear relationships to improve risk prediction. Customizing interventions, efficiently distributing resources, and improving personalized healthcare strategies are goals. Predicting heart attacks, strokes, and car accidents with AI. For instance, IBM Watson Health can predict myocardial infarctions with 90% accuracy. (Johnson, et al. 2021)

- **Geographical modelling**

Geographical modelling—analyzing geographic data to identify health outcomes patterns and trends—is vital to public health because it localizes treatments to disease hotspots. Manual data collection and analysis for geographical modelling can be inaccurate and time-consuming. AI can improve public health by enhancing spatial modelling accuracy. Machine learning algorithms can discover trends and predict disease transmission using huge geographic data like satellite photos. Such methods have been used to predict dengue fever risk, including cases, rate, peak time, and intensity, as well as mosquito biting rate. Public health spatial modelling advances with GIS-AI integration. This allows spatial analysis of huge and diverse data sets like social media and electronic health records to improve forecasts and detect previously difficult trends. AI is also trending towards spatial modelling in public health using deep learning. (Li & Dong, 2022) These algorithms can detect patterns in genetics and medical pictures that indicate illness risk in certain places. One study examined how brain areas are linked to neurological illnesses. Other studies employed audio recordings of coughs and symptom reports to enhance respiratory illness diagnosis. A thorough scoping review by Gunasekaran et al. (2021) examined digital health applications for COVID-19 public health responses. Their review highlights AI in predictive modelling. AI algorithms allow prediction models to analyse massive volumes of demographic, health, and environmental data. These models predict disease propagation, identify high-risk populations, and devise tailored therapies. The main challenge of spatial modelling is identifying

health outcome trends by location. Traditional approaches struggle to handle spatial data complexity, discover interactions, and generate local predictions. AI and GIS provide solutions using machine learning and deep learning. This identifies complex spatial patterns like disease clusters and promotes data-driven targeted intervention decisions. AI is modelling space borne illnesses and other phenomena. Berkeley University created a wildfire prediction model.

2. Electronic health records

EHR data tremendously aids public health research and practice. EHRs store medical history, prescription use, lab results, and other data. They are more common in healthcare yet provide a wealth of public health

research and practice data. Due to the volume of data in EHRs, manual analysis is laborious and requires innovative technology to derive conclusions. AI can boost EHR data processing efficiency and accuracy, benefitting public health. Vital signs, test findings, and medicine prescriptions can be extracted. Public health AI for EHRs emphasizes machine learning techniques. These algorithms can discover trends and predict disease transmission in massive data sets like electronic health records. NLP is another AI development for public health EHRs. These approaches can extract data from unstructured text sources like doctor's notes to assess patient health. Deep learning algorithms are widely used in EHR analysis to analyse complex data and make accurate predictions. These formulas have been used to predict patient outcomes, including hospital readmissions, and can help develop public health policy by determining whether specific population groups would benefit from targeted interventions. (Gruetzemacher & Paradice, 2022) AI can increase EHR prediction accuracy, improving health outcomes for individuals and communities. AI systems can analyse big EHR data sets to gain insights. These findings help identify illness patterns, personalize treatment, and detect epidemics. AI in EHR analysis helps healthcare practitioners make better decisions and improve treatment. However, public health EHR AI implementation is difficult. Finding high-quality data is important because algorithm training data quality and completeness affect prediction accuracy. AI on EHRs must comply with US standards like HIPAA to secure patient data. Data from several sources can be difficult to analyse due to EHR system inconsistency. The depth and diversity of EHR data—unstructured text, images, and time series data—may make it

difficult to build dependable AI systems for analysis. Future predictions call for public health EHR AI to advance and expand. AI for personalized medicine, where computers analyse electronic health records and other data to predict illness risk and guide treatment decisions, has growth potential. AI for public health EHRs could improve data analysis and public health outcomes. (Liu, et al. 2021) AI has many potential benefits for public health, despite its ethical and data requirements. Algorithm precision and efficiency, moral and legal issues, and EHR platform standardization should be the focus of future research. Recently, research on Electronic Health Records (EHRs) and Natural Language Processing

(NLP) and Artificial Intelligence (AI) has sought to obtain insights from EHRs' unstructured textual data.

NLP includes Named Entity Recognition (NER) for medical terms, sentiment analysis for patient feedback, and text classification for diagnoses. Combine structured EHR data with NLP-processed textual information to predict disease outcomes, prescribe therapies, and enable personalized care using AI approaches like machine learning and deep learning. Deep learning models like RNNs and transformer-based architectures (e.g., BERT) thrive at sequential data and complex contextual linkages in EHR narratives. Medical text analysis requires reliable information extraction and semantic interpretation, which these models provide. (Fitzpatrick, et al. 2021)

3. Diagnostics

Public health relies on timely and accurate disease diagnosis for effective treatment and management. Laboratory testing can be expensive, time-consuming, and unreliable. Diagnostic speed and precision can be improved by AI, boosting public health. Machine learning algorithms can uncover patterns and predict disease in enormous data sets like lab test results and medical imaging. Deep learning algorithms can analyse complex data and make accurate predictions, making them useful for identifying illness patterns in medical images like x-rays and CT scans. NLP can also extract data from unstructured medical literature like doctor notes and medical reports to identify disease-predicting patterns. (Fitzpatrick, et al. 2021) AI can improve diagnosis speed and accuracy, boosting individual and societal health. With human expert guidance, AI can reduce lab test and other diagnostic costs. AI diagnosis in public health has downsides. Finding high-quality data to train

algorithms is difficult because prediction accuracy depends on it. Compare AI-based diagnostic systems' performance tests, validation, and comparisons to conventional diagnostic methods. A large volume of labelled data may not always be available, which is another issue. Doctors may need training to understand how AI-based diagnostic algorithms work to explain their predictions to patients or policymakers. The use of AI technologies like Convolutional Neural Networks (CNNs), Transformer-based models, NLP-based approaches, and more to analyse ultrasound, X-ray, CT, MRI, and physiological pictures has transformed medical diagnosis. (Liu, et al. 2021) Combining powerful AI approaches with multi-modal medical data has improved diagnostic accuracy, speed, and

personalized therapy suggestions. CNNs excel at image analysis and have transformed medical imaging diagnoses. CNNs automatically learn hierarchical features from pictures to identify patterns, anomalies, and abnormalities in X-rays, CT scans, and MRIs. Disease detection, localization, and classification have improved using spatial picture capture. Originally created for natural language processing, transformer-based models like BERT are now used for medical diagnostics. These models capture contextual relationships well, making medical text reports, clinical notes, and radiology data understandable. Their use aids decision-making and difficult diagnosis. NLP-based technologies can extract insights from medical records, patient histories, and research publications. Named Entity Recognition (NER) and sentiment analysis help diagnose and treat patients by understanding patient experiences and recognising key medical phrases. Public health diagnostics using AI could improve population health by speeding up and boosting accuracy. AI in public health has many benefits, but it requires high-quality data and raises ethical concerns. Develop more accurate and effective algorithms, address moral and legal issues, and increase labelled data availability for AI model training in future research. Explicable AI methods for diagnostic systems may increase public confidence in AI in healthcare and public health policy and improve system accuracy. (Arabahmadi, et al. 2022)

4. Monitoring the public's health

Public health surveillance has long required laborious, error-prone manual data collection and analysis. Due to the increase in health data from EHRs, social media, and sensors, AI is a powerful tool for public health surveillance. Artificial

intelligence can analyse massive volumes of data faster than conventional methods, discover trends, and predict disease outbreaks and epidemics. AI is helping the CDC track COVID-19. The CDC employs AI to analyse electronic health records, social media, and travel data. This technology can detect outbreaks and track virus spread in real time. Infodemiology and infoveillance use AI and data mining to analyse search behaviour, social media interactions, and publication trends. AI-driven technologies reveal disease trends, public mood, and misinformation in real time. Early detection, response preparation, and good communication can be used by public health authorities. AI could improve public health surveillance by analyzing vast volumes of data, identifying patterns, and forecasting. This can lead public health efforts to stop infectious disease spread. AI can improve public health surveillance prediction accuracy, which could improve individual and community health. Public health monitoring data often comes from multiple sources and has varied formats, making integration and administration difficult. Since data combination and consistency may be difficult, predictions may be inaccurate. AI may also cause bias and discrimination in public health surveillance. If algorithm training data is biased, the algorithm's predictions may be too. Public health surveillance is notably affected by erroneous estimates, which can lead to unequal resource distribution and harm marginalized people.

Public health issues posed by AI

Prior to the successful and secure implementation of this AI in public health, a number of obstacles must be surmounted. Among these are legal and ethical considerations, specifically concerning data privacy and security. Similar regulations govern the use and dissemination of protected health information (PHI) in the European Union (General Data Protection Regulation, GDPR) and the United Kingdom (Data Protection Act 2018). Ensuring data privacy is critical for instilling confidence in the application of artificial intelligence (AI) to facilitate the advancement of healthcare policy and practice. Also of concern are the ethical ramifications of bias and discrimination concerns in AI-based systems, which can disproportionately injure vulnerable individuals. (Edemekong, et al. 2018)

Conversely, the efficacy and precision of AI-driven systems are contingent upon the exhaustiveness and accuracy of the data employed in their training. The lack of clarity and

comprehensibility in AI-based systems is a significant obstacle for AI applications in public health. Consequently, policymakers might encounter difficulties in comprehending the algorithm's methodology, which could engender doubt regarding the application of AI in the realm of public health. However, from the COVID-19 pandemic, a number of principles surfaced that may serve as a valuable reference for the implementation of AI in the realm of public health. (Jordan, et al. 2022) The WHO Pillars document for operational planning and guidance, which provides countries with a framework for preparing for and responding to public health emergencies, is one such set of guidelines. This contains multiple sections discussing the application of

AI to public health. One of these pillars, Pillar 1: Coordination, planning, and monitoring at the country

level, suggests the implementation of artificial intelligence to monitor the progression of diseases, detect possible epidemics, and synchronize the handling of public health crises. Case investigation and surveillance, rapid response teams, and the use of artificial intelligence to collect data on disease outbreaks, identify and investigate cases, and monitor the efficacy of interventions are the focal points of the second pillar. Comparable factors were examined during the AI for Health Global Summit that took place in 2021. (Kiseleva, et al. 2022) A number of recommendations for the use of AI in public health were generated at the summit, including the promotion of ethical and responsible use of AI in public health and the development of capacity for the use of AI in public health. These strategies ought to be in accordance with the WHO pillars document and founded on research that is supported by evidence. A plethora of guidelines have surfaced since the COVID-19 pandemic, some of which may serve as a reference for the implementation of artificial intelligence in the field of public health. These guidelines underscore the potential of artificial intelligence to enhance public health and provide countries with a framework for preparing for and responding to public health emergencies. (Chua, et al. 2021) It is critical to prioritise the safeguarding of data security and privacy in order to effectively implement AI in the field of public health. Although it is inevitable to incorporate patient data from various centers into durable and generalizable AI models, it is of the utmost importance to safeguard patient privacy and data security. Collaborative endeavors that encompass the exchange and collaboration of data via methodologies such as

federated learning present prospective resolutions to these obstacles. The incorporation of patient data from various centers into AI models increases their diversity and comprehensiveness, leading to the development of algorithms that are more precise and flexible. Nonetheless, in order to protect patient privacy, this procedure must be accompanied by stringent protocols for data de-identification, aggregation, and anonymization. Adherence to regulatory requirements, including but not limited to the Health Insurance Portability and Accountability Act (HIPAA), guarantees the adequate safeguarding of sensitive patient information. By collaborating and exchanging data, it is possible to combine insights from various sources without the need to centralize sensitive information. Federated learning, a

decentralized methodology, permits the training of AI models across multiple centers without the need to share raw data. By utilizing locally stored data, models are updated collaboratively, thereby reducing potential privacy risks. This methodology guarantees the preservation of data at its origin.

Public health surveillance

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Since data combination and consistency may be difficult, predictions may be inaccurate. AI may also cause bias and discrimination in public health surveillance. If algorithm training data is biased, the algorithm's predictions may be too. Public health surveillance is notably affected by erroneous estimates, which can lead to unequal resource distribution and harm marginalized people. (Ariffin, et al. 2021)

Conclusion:

AI has the potential to revolutionize the delivery of healthcare services in environments with limited resources. By leveraging AI in conjunction with other emerging disciplines and technological advancements, numerous obstacles within health systems of this nature could be surmounted. Increasing investments in supporting technologies (e.g., mHealth, EMR, and cloud computing) and the pervasiveness of smartphone usage present ample opportunities to enhance public health outcomes in low-income country settings through the use of AI applications. Although we have presented a number of instances where AI is presently being utilized to enhance health outcomes, there are undoubtedly numerous additional applications in development, and it is highly probable that further advancements will be made in the coming years. Transitioning from pilot to scale will necessitate the resolution of numerous concerns and must be based on the insights gained from the recipients of these potent instruments. This indicates that when developing and implementing novel AI applications, human-centered design must be utilized. It also entails examining legal and ethical issues, such as ownership, informed consent, privacy, confidentiality, and data security, through the lens of human rights. Additionally, comprehension of the local social, epidemiological, health system, and political contexts will be necessary for successful implementation. Moreover, extensive implementation will require the direction of a comprehensive research agenda. AI is one of several tools that could aid in attaining the health-related SDG targets, especially those pertaining to universal health coverage, although it is not a panacea.

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