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**Review Article**

# Role of artificial intelligence in public health

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## ABSTRACT

Artificial intelligence (AI) is quickly reshaping public health by facilitating faster, more precise and scalable responses. As global burden of infectious and non-communicable diseases grows, AI's capacity to analyze extensive and varied datasets, recognise patterns, and produce practical insights makes it a valuable asset for enhancing health outcomes worldwide. The current review provides a comprehensive synthesis of AI applications in public health, examining enabling technologies, key benefits, prevailing challenges, and future directions. It aims to guide researchers, practitioners, and policymakers in leveraging AI for equitable and effective public health strategies. We conducted a narrative review of recent literature and case studies, concentrating on AI's role in disease surveillance, predictive modelling, diagnostics, healthcare operations, and public health communication. The review also explores the integration of AI with mobile health (mHealth), tele-health, cloud computing, Internet of Things (IoT), and blockchain technologies. AI has transformed disease monitoring and early outbreak identification by combining inputs from electronic health records (EHR), social media platforms, environmental monitoring systems, and satellite data. Through machine learning (ML) and natural language processing (NLP), it enables real-time data analysis, predictive modelling, and risk assessment, facilitating timely interventions and optimal use of resources. AI offers transformative potential for public health, improving surveillance, diagnostics, operational efficiency, and access to care. To fully realize these benefits, it is crucial to address technical, ethical, and infrastructural challenges through robust governance, workforce development, and global collaboration. With responsible innovation and inclusive policy, AI can help build more responsive, equitable, and resilient public health systems worldwide.

**Keywords:** Artificial intelligence, Disease surveillance, Public health, Predictive modelling, mHealth, Digital health

## INTRODUCTION

Public health is undergoing a significant shift propelled by artificial intelligence (AI), big data, and digital innovation. As challenges from infectious diseases such as COVID-19, dengue, and malaria persist alongside a surge in non-communicable conditions, there is a pressing need for scalable and inventive approaches. AI's capacity to analyze large volumes of data, identify patterns, and deliver meaningful insights makes it a vital asset in advancing public health initiatives across various levels.[1]

AI's applications in public health are wide-ranging and rapidly growing. From early outbreak detection and surveillance to predictive modelling, diagnostics, resource management, and personalised care, AI is transforming how health professionals predict, prevent, and respond to threats. Machine learning models can now forecast disease spread, identify high-risk groups, and optimise the use of resources like hospital beds, vaccines, and supplies. NLP enables real-time analysis of unstructured data from health records, social media, and news, helping identify emerging risks quickly.[2]

Integration of AI with technologies like mobile health (mHealth), telehealth, cloud computing, Internet of Things (IoT), and blockchain further enhances its impact. These tools support continuous data collection, remote monitoring, and secure information sharing, making AI solutions viable even in low-resource settings. For instance, AI chatbots and virtual assistants provide mental health support where specialists are scarce, while mobile AI tools enable early detection of conditions like birth asphyxia and cancer in low- and middle-income countries (LMICs).[3]

However, adopting AI in public health poses significant challenges. Issues like bias, data privacy, infrastructure gaps, and lack of regulation persist. Without careful oversight, AI could worsen existing health inequalities, especially if models are based on biased data or used in poorly equipped settings. Ethical concerns around consent, transparency, and surveillance also demand thoughtful governance.[4,5]

Current review presents a comprehensive overview of AI in public health, exploring its key applications, supporting technologies, benefits, and challenges. It includes real-world case studies from diverse settings and discusses future directions for research, policy, and practice. By offering a balanced and evidence-based perspective, this article aims to guide stakeholders in leveraging AI for equitable health outcomes.

## APPLICATIONS OF AI IN PUBLIC HEALTH

AI is transforming landscape of public health by enabling more timely, accurate, and scalable interventions across a range of domains.[6] The following subsections detail the principal applications of AI, drawing on recent research and real-world implementations.

### *Disease surveillance and early outbreak detection*

AI has revolutionized disease surveillance, allowing for the rapid detection of outbreaks and emerging health threats. By leveraging diverse data sources, encompassing EHRs, environmental sensors, social media, as well as satellite imagery, AI systems can identify abnormal patterns and generate early warnings.[4] Following AI techniques involved in epidemic surveillance.

NLP analyses emergency room (ER) logs, news, and social media for detecting early signs of outbreaks, encompassing flu-like symptom spikes on Twitter.[2]

ML methods such as random forests (RF), support vector machines (SVM), long short-term memory (LSTMs), convolutional neural networks (CNNs), as well as graph neural networks (GNNs), predict outbreaks, track sentiment, and model transmission pathways.[6]

Hybrid models combine AI with epidemiological frameworks (e.g., susceptible-infectious-recovered (sir)/susceptible-exposed-infectious-recovered (seir) for adaptive forecasting; simulations test interventions like lockdowns and vaccination.[7]

Internet-based tools (e.g., program for monitoring emerging diseases (ProMED and global public health intelligence network (GPHIN), SENTINEL) use AI to process diverse data for real-time outbreak alerts.[4,6]

### *Case example*

BlueDot, AI-powered platform, detected COVID-19 outbreak days before the WHO official announcement by analysing global travel data and disease reports.[7] In the Philippines, machine learning models that combine environmental, meteorological, and vector data have been used to predict dengue outbreaks, enabling targeted vector control and public awareness campaigns.[2]

#### *Challenges*

Despite these advances, AI-based surveillance faces challenges related to data quality, coverage, and interpretability. Online data can be biased or noisy, and deep learning models may lack transparency, complicating their use in policy decisions.[2,4,6]

#### *Predictive modelling and risk stratification*

AI-driven predictive analytics enable disease forecasting, risk identification, and intervention planning.7 Time series forecasting: models like EpiDeep and DEFSI predict case trends using environmental, demographic, and behavioural data.[7] Risk mapping: geospatial AI tools identify hotspots for targeted responses.[2] Personalised risk assessment: AI stratifies risk based on individual and population-level data to guide preventive strategies.[2]

### *Case example*

In Bangladesh, AI and IoT have been leveraged to forecast COVID-19 and dengue outbreaks, assess risk levels, and guide public health actions despite limited diagnostics and infrastructure.[9]

#### *Challenges*

Effective modelling depends on high-quality, representative data-often scarce in low-resource settings. Bias can also arise if models lack diverse training datasets.[10]

#### *Diagnostics and personalized health*

AI is making significant strides in diagnostics and personalised health, improving accuracy and enabling tailored interventions. Image recognition: deep learning (DL) algorithms analyse medical images (such as X-ray, retinal scans) for detecting diseases such as tuberculosis, diabetic retinopathy, and cancers, often surpassing human

specialists in accuracy.[6] Signal processing: AI processes physiological signals, such as newborn cries, to detect conditions like birth asphyxia in resource-limited settings. Wearables and genomics: AI integrates data from wearable devices, genomics, and EHRs to support personalised medicine and continuous health monitoring.[3]

***Case example***

In Nigeria, mobile-based AI analyses newborn cries to identify birth asphyxia, enabling early intervention and potentially reducing neonatal mortality. In India, Thailand, and China, NLP tools are used to guide cancer treatment by extracting relevant information from clinical notes and research literature.[2]

*Challenges*

Ethical concerns arise around data privacy, especially with genetic and biometric data. There is also necessity for robust validation and regulatory oversight for ensuring reliability.[10]

*Healthcare operations and resource optimisation*

AI optimises healthcare delivery by improving patient flow, hospital management, and supply chain logistics. Hospital readiness: predictive models forecast ICU bed occupancy, ventilator demand, and other resource needs during pandemics. Resource allocation: AI is used to optimise vaccine logistics, cold chain management, and medical supply distribution. Digital assistants: chatbots and virtual health assistants provide symptom checking, triage, and mental health support, reducing the burden on healthcare systems.[7]

***Case example***

AI-powered scheduling tools have improved the efficiency of community health worker outreach in several African countries. In Bangladesh, AI-driven mobile apps and wearables have supported contact tracing and outbreak monitoring.[2]

*Challenges*

Infrastructure barriers, such as limited internet bandwidth and digital literacy, can impede the implementation of AI-based operational tools, particularly in low-resource settings.[2]

*Public health communication and education*

AI enhances public health communication by automating the generation of evidence-based reports, personalised messaging, and educational content. Automated reporting and messaging: NLP tools summarise research findings, generate health news, and create educational materials tailored to specific audiences.[11] Behavioural interventions: AI-powered apps nudge users toward healthy behaviours and support chronic disease management.[2] Policy simulation: AI models simulate the outcomes of different public health policies, helping decision-makers evaluate potential interventions before implementation.[11]

***Case example***

AI chatbots have provided mental health support and health education in resource-constrained settings, overcoming barriers such as stigma and specialist shortages.[11]

*Challenges*

Ensuring the accuracy and cultural appropriateness of AI-generated content is critical. There are also issues regarding transparency as well as accountability of AI-driven communication tools.[10]

*Enabling technologies complementing AI*

AI's transformative impact on public health is deeply intertwined with several complementary digital technologies that facilitate data collection, processing, analysis, and secure sharing.[2]

## MOBILE HEALTH AND TELEHEALTH

Mobile platforms, including SMS systems and smartphone apps, empower community health workers and patients by enabling symptom reporting, follow-ups, and health education, especially in underserved and remote regions. Telehealth solutions, often integrated with AI-powered chatbots along with virtual assistants, offer scalable mental health support and triage services, reducing the burden on overstretched healthcare systems.[2]

## ELECTRONIC MEDICAL RECORDS AND HEALTH INFORMATION SYSTEMS

Open-source platforms like Open MRS and DHIS2 enable structured, interoperable data collection critical for AI analytics. These systems support longitudinal patient tracking and population health management but face challenges in data standardisation and integration, particularly in low-resource settings.[2]

## CLOUD COMPUTING AND EDGE AI

Cloud infrastructure offers scalable storage and computational power, allowing complex AI models to operate even with limited local IT capabilities. Edge AI complements this by enabling real-time data processing directly on devices such as smartphones and wearables, which is crucial for privacy preservation and functionality in low-bandwidth environments.[2]

## INTERNET OF THINGS (IOT) AND WEARABLES

IoT devices, including wearable sensors, environmental monitors, and GPS trackers-collect continuous real-time data on physiological parameters, environmental exposures, and vector populations. This data feeds AI models for enhanced disease surveillance, personalized health monitoring, and outbreak prediction.[9]

## BLOCKCHAIN FOR DATA INTEGRITY AND SECURITY

Blockchain technology offers a decentralised, tamper-evident ledger for health data transactions, enhancing data integrity, transparency, and trust. In public health, blockchain can be used to secure patient records, track vaccine supply chains, and ensure the authenticity of surveillance data. When combined with AI, blockchain enables secure data sharing across institutions and borders, supporting collaborative epidemic response while safeguarding privacy.[3,7]

## BENEFITS OF AI IN PUBLIC HEALTH

AI is swiftly becoming a foundational element of innovation in public health, providing significant advantages in areas such as surveillance, diagnostics, healthcare management, and patient interaction. The combination of AI and digital health tools holds promise for overcoming persistent issues within healthcare systems, especially in settings with limited resources. The key advantages of AI in public health are outlined below, supported by current evidence and real-world implementations.

### *Enhanced decision-making and real-time analytics*

A significant contribution of AI is its ability to process massive, complex datasets and deliver actionable insights in real-time. AI-driven analytics support timely and evidence-based decision-making for public health officials, clinicians, and policymakers. For instance, AI-powered surveillance systems can synthesize data through EHRs, environmental sensors, social media, as well as laboratory reports for detecting outbreaks faster than traditional methods. This enables the rapid deployment of interventions and can significantly decline spread and impact of infectious diseases.[1,12] AI-based predictive models also support scenario planning and resource allocation, allowing health systems to anticipate demand for ICU beds, vaccines, and medical supplies. During COVID-19 pandemic, AI tools were instrumental in forecasting disease trajectories and informing public health responses.[7]

### *Increased access to care and health equity*

AI technologies, especially when combined with mobile health (mHealth) and telehealth platforms, expand access to healthcare services for underserved and remote populations. AI-powered chatbots, virtual assistants, and telemedicine platforms provide symptom checking, triage, and mental health support, reducing barriers to care caused by distance, stigma, or workforce shortages.[2,3] In LMICs, community health workers equipped with AI-driven mobile tools can reach patients in rural areas, conduct follow-ups, and deliver health education. These scalable solutions are particularly valuable in settings where health infrastructure is inadequate and specialist care is scarce.[2]

### *Improved efficiency and cost-effectiveness*

AI streamlines healthcare operations by optimizing resource allocation, automating routine tasks, and improving workflow efficiency. Predictive analytics can reduce unnecessary hospital admissions, improve patient flow, and optimize scheduling for both staff and resources. AI-driven supply chain management ensures that vaccines and medical supplies are distributed efficiently, minimizing waste and shortages.[1,7] By automating data analysis, reporting, and administrative tasks, AI frees up valuable time for healthcare professionals to concentrate on direct patient care. This is especially important in overburdened health systems and during public health emergencies.

### *Support for personalized and precision health*

AI supports customized healthcare by combining information from EHRs, wearable devices, and genomic data. Through ML algorithms, it can pinpoint individuals at elevated risk for certain illnesses, suggest personalized prevention measures, and assist in developing tailored treatment approaches. For instance, AI-based systems have been successfully applied to identify diabetic retinopathy and various cancers from medical imaging with significant precision, allowing for earlier and more targeted interventions.[3,6] Personalized health messaging, delivered through AI-powered apps, can nudge users toward healthier behaviours and improve chronic disease management.[11]

### *Scalability and adaptability*

AI solutions can be rapidly scaled and adapted to diverse health systems and geographies. Cloud-based platforms and edge AI allow for the deployment of sophisticated analytics even in low-resource settings, where local IT infrastructure may be limited. AI models can be retrained and updated as new data becomes available, ensuring that public health interventions remain relevant and effective.[2,7]

### *Strengthening surveillance and early warning systems*

AI enhances the sensitivity and specificity of disease surveillance systems, enabling earlier detection of outbreaks and more accurate risk mapping. By integrating multiple data sources such as meteorological,

entomological, and social media data AI models can identify emerging threats and support targeted interventions.[4,12] For example, AI-driven dengue prediction models in the Philippines and Bangladesh have enabled proactive vector control and community engagement, reducing disease burden.[2]

### *Empowering health workforce and public engagement*

AI supports healthcare providers by offering decision support, automated literature reviews, and evidence-based recommendations. This reduces cognitive burden and helps clinicians stay abreast of rapidly evolving knowledge, especially during pandemics. AI-powered educational tools and personalized health messaging also empower the public to make informed health decisions, improving engagement and adherence to public health recommendations.[11]

## CHALLENGES AND ETHICAL CONSIDERATIONS

Even with these advancements, several key obstacles remain. Concerns around data security, bias within algorithms, insufficient infrastructure, and absence of uniform regulatory standards pose risks to fair and ethical use of AI. While artificial intelligence offers transformative potential for public health, its deployment is accompanied by substantial challenges and ethical dilemmas. These issues must be addressed for ensuring that AI-driven innovations are safe, equitable, and trustworthy.

**Table 1: Challenge areas and key issues & risks in AI.**

| Challenge area | Key issues and risks |
|---|---|
| **Data privacy and security** | Consent loopholes, data breaches, and lack of privacy frameworks[3,5] |
| **Bias and equity** | Algorithmic bias, exacerbation of health disparities[2,6] |
| **Infrastructure and workforce** | Digital divide, lack of trained staff, unreliable hardware[2,9] |
| **Regulatory and governance** | No standardised ethics, transparency, or accountability; lack of sunset clauses[2,12] |
| **Interpretability and trust** | Black-box models, lack of explain ability, and limited validation[3,6] |
| **Data quality and integration** | Poor data quality, fragmentation, and lack of interoperability[2,6] |

**Table 2: Innovation area, key opportunities, and challenges/needs in AI.**

| Innovation area | Key opportunities | Challenges/needs |
|---|---|---|
| **Multimodal diagnostics** | Integrate genomics, imaging, and wearables for precision health | Data integration, privacy, validation |
| **Real-time monitoring** | One Health, pandemic preparedness, early warning systems | Data sharing, cross-sector collaboration |
| **Ethical AI** | Explainable, transparent, and fair models | Technical complexity, public trust |
| **Workforce development** | AI literacy, interdisciplinary training | Investment, curriculum development |
| **Federated/edge AI** | Privacy-preserving analytics, decentralized model training | Technical maturity, infrastructure |
| **Blockchain integration** | Secure, transparent data and supply chain management | Interoperability, regulatory clarity |
| **Policy and collaboration** | International standards, sunset clauses, equitable access | Governance, harmonization of regulations |

## FUTURE DIRECTIONS AND INNOVATIONS

AI in public health is at a pivotal juncture, with rapid advances promising to reshape disease prevention, surveillance, and care delivery. However, realising the full potential of AI will require addressing current limitations, embracing emerging technologies, and ensuring that progress is guided by ethical, equitable, and practical considerations.

## CONCLUSION

AI is revolutionizing public health by enhancing disease surveillance, predictive modelling, diagnostics, healthcare operations, and personalized care. Its integration with complementary technologies like mobile health, IoT, and cloud computing enables scalable, real-time interventions that improve outcomes and expand access, especially in underserved areas. Although AI offers many advantages, several challenges, such as protecting data privacy, mitigating algorithmic bias, bridging infrastructure gaps, and addressing regulatory deficiencies, must be resolved to ensure its ethical and fair application. Developing AI systems that are transparent and explainable, enhancing workforce skills, and encouraging international cooperation is crucial to fully realize AI's potential. With sustained innovation and strong governance, AI can lead to more efficient, adaptable, and equitable public health

systems globally, ultimately enhancing health outcomes across all communities.

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