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Review Article

Artificial Intelligence in Public Health: A Review Article

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Abstract: Artificial intelligence (AI) is the simulation of human intelligence processes by machines, such as learning, reasoning, and problem-solving. AI has the potential to transform the field of public health, which is concerned with promoting and protecting the health of populations and preventing diseases. AI can help public health organizations perform their essential functions more efficiently, effectively, and equitably; AI can transform the public health field, but it also poses some challenges and risks that must be addressed carefully and responsibly. This paper reviews the current and potential applications of AI in public health, discusses the opportunities and challenges of AI for public health, and provides recommendations for the ethical and responsible use of AI in public health. AI can improve the speed and accuracy of diagnosis, screening, and treatment of various diseases and support disease surveillance, outbreak response, and health systems management. However, AI poses significant challenges and risks, such as ethical, legal, and social implications, data quality and security, algorithmic bias and fairness, and environmental impact. It has the potential to revolutionize public health, but it comes with risks that must be addressed. Promoting digital literacy, establishing modern data governance frameworks, and investing in advanced data infrastructure and procedures are essential. Public health organizations must also train their workforce to collaborate with AI. By doing so, they can improve health outcomes, reduce health disparities, and advance public health science and practice.

Keywords: Artificial intelligence, public health, academia, research

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Introduction: The potential of AI to revolutionize the healthcare domain is enormous, with many applications already realized in the field [1]. However, with the onset of the COVID-19 pandemic, the focus of AI applications in healthcare shifted from medicine to public health [3]. AI research started in the 1960s to build systems that could imitate human intelligence. The first AI applications in healthcare focused on expert systems, which used human expert knowledge to provide decision support for medical diagnosis and treatment planning [4]. Expert systems, machine learning (ML), and natural language processing (NLP) remained the central areas of AI research in healthcare in the 1980s and 1990s. With the availability of large-scale medical data and robust computer systems, researchers started to explore the possibilities of AI in areas such as medical diagnosis, drug discovery, and public health monitoring [5]. The 2000s witnessed computer vision, NLP and ML breakthroughs, enabling researchers to develop more sophisticated AI systems to analyze vast amounts of data and predict future outcomes [6]. In this article, we focused on the application, advantages, and challenges of AI in public health, which is the science and practice of protecting and improving the health of populations through prevention, promotion, and intervention.

Methodology: Narrative synthesis is the process of conducting a systematic review and synthesis of findings from multiple studies that heavily rely on words and text to summarize and explain the synthesis's findings [16]. In this review article, a narrative synthesis was employed. Moreover, the literature was reviewed systematically to explore AI in public health. The literature and information were obtained from various research articles on Google Scholar, PubMed, and SCOPUS. The inclusion criteria were studies that clearly defined AI in all aspects of public health, were published and written in English, and were peer-reviewed. The data were reviewed between 1 November 2023 and 29 December 2023. To search the database, the researcher identified a set of controlled keywords related to AI in public health. The controlled keywords identified were public health*AND *advantage*OR *application*OR *challenge*s* OR "*machine learning*" * OR "*artificial intelligence*" * AND *medicine*

Results:

AI for Disease Surveillance and Response: One of the primary applications of AI in public health is to enhance disease surveillance and response, especially in the context of emerging and re-emerging infectious diseases, such as COVID-19, Ebola, Zika, and influenza [7,1,2]. AI can help public health authorities monitor and analyze large amounts of data from various sources, such as social media, news, health records, and sensors, to detect and track outbreaks, identify risk factors, and predict trends and scenarios. AI can also assist in developing and evaluating interventions, such as vaccines, diagnostics, and treatments, and optimize resource allocation and logistics [8].

For example, during the COVID-19 pandemic, AI has been used to forecast the spread and impact of the virus, to diagnose and triage patients, to design and test drugs and vaccines, and to inform policy and public communication. A recent report by the World Health Organization (WHO) provides a comprehensive overview of AI's current and potential applications for health in the COVID-19 response and beyond [1,3].

However, AI poses challenges and risks for disease surveillance and response, such as data quality and availability, privacy and security, ethical and legal issues, and social and behavioral implications [7,8]. For instance, AI may generate false or misleading information or discriminate or exclude certain groups or individuals based on biased or incomplete data. AI may also infringe on human rights and dignity or create distrust and resistance among the public if not designed and used transparently, accountably, and participatory [9].

Therefore, the WHO has issued six guiding principles for the design and use of AI for health, which are protecting human autonomy; promoting human well-being and safety and the public interest; ensuring transparency, explainability, and intelligibility; fostering responsibility and accountability; ensuring inclusiveness and equity, and promoting AI that is responsive and sustainable [10].

AI for Health Promotion and Prevention: Another use of AI in public health is to support health promotion and prevention, which aim to enhance individuals' and communities' health and well-being and reduce the burden of chronic and non-communicable diseases, such as diabetes, cancer, and cardiovascular diseases. AI can help public health practitioners and researchers to design and deliver personalized and tailored interventions, such as health education, behavior change, and risk assessment, based on the analysis of individual and population data, such as genetics, lifestyle, environment, and social determinants of health [11,7,9].

For example, AI can create chatbots or virtual assistants that can provide health information, advice, and coaching or generate nudges or reminders to motivate and support healthy behaviors, such as physical activity, nutrition, and smoking cessation. AI can also create digital biomarkers or sensors to measure and monitor health status and outcomes, such as blood pressure, glucose level, and mood [12].

However, AI also faces challenges and risks for health promotion and prevention, such as data privacy and consent, user engagement and retention, user empowerment and autonomy, and user trust and satisfaction. For instance, AI may collect and use sensitive or personal data without the user's knowledge or consent or manipulate or coerce the user to adopt certain behaviors or choices without respecting the user's preferences or values. AI may fail to meet the user's expectations or needs or cause harm or adverse effects if not validated or evaluated correctly [8, 9].

Therefore, using AI for health promotion and prevention requires a human-centered and ethical approach involving the user and other stakeholders in designing, developing, and evaluating AI solutions and ensuring the user's rights, interests, and well-being are protected and promoted [9,12].

AI for Health Research and Innovation: Furthermore, AI in public health facilitates health research and innovation, which aims to generate and disseminate new knowledge and evidence and create and implement new solutions and technologies that can improve the health and well-being of populations. AI can help public health researchers and innovators access and analyze large and complex data sets, such as text, images, and genome sequences, and discover and test new hypotheses, patterns, and insights to advance the understanding and treatment of various diseases and conditions [3,4,6].

For example, AI can perform natural language processing or computer vision, extracting and interpreting information from text or images, such as scientific literature, medical records, or pathology slides. AI can also perform machine learning or deep learning, which can learn and improve from data and make predictions or recommendations, such as disease diagnosis, prognosis, or therapy[13].

However, AI also presents challenges and risks for health research and innovation, such as data quality and reproducibility, scientific rigor and validity, ethical and regulatory standards, and social and environmental impact. For instance, AI may produce inaccurate or unreliable results or introduce errors or biases due to poor or insufficient data. AI may also lack transparency or explainability or violate ethical or legal principles, such as informed consent, beneficence, or justice. AI may also have unintended or harmful consequences, such as displacing or replacing human workers or consuming or polluting natural resources [9, 14].

Therefore, using AI for health research and innovation requires a rigorous and responsible approach that follows the scientific method and ethical guidelines, evaluates and monitors the performance and impact of AI solutions, and engages and communicates with the scientific and public communities [14,15].

Discussion: Artificial Intelligence (AI) is a rapidly evolving field that has the potential to transform various aspects of public health, from disease prevention and diagnosis to health promotion and policy-making [16],[13]. However, the application of AI in public health also poses significant challenges and risks, such as ethical, legal, social, and technical issues, that need to be addressed and mitigated. In this review, we have summarized some of the current and emerging uses of AI in public health and the main opportunities and limitations of this technology [18].

One of the most promising areas of AI in public health is medical imaging, where AI can enhance the accuracy, speed, and efficiency of image analysis and interpretation and enable new modalities of imaging that were not possible before [19]. AI can also help integrate and analyze various data types, such as text, genomic, and environmental data, to generate novel insights and discoveries for public health research and practice [20]. Moreover, AI can assist with clinical decision-making, health education, and behaviour change by providing personalized and tailored recommendations and interventions to patients and populations [19].

However, AI in public health also faces several challenges and risks that need to be carefully considered and addressed [16,17]. For instance, AI may introduce biases and errors in data collection, processing, and interpretation, which may affect the quality and validity of the results and the fairness and equity of the outcomes [21]. AI may also raise ethical and legal concerns, such as privacy, consent, accountability, and liability, especially when dealing with sensitive and personal health data [6,19]. Furthermore, AI may have unintended and adverse consequences, such as displacing human workers, increasing health disparities, and harming the environment [18].

Therefore, it is essential to develop and implement ethical and governance frameworks and guidelines for the design, development, and use of AI in public health in order to ensure that AI is aligned with the values and principles of public health, such as human rights, public interest, and social justice [21]. Such frameworks and guidelines should involve the participation and consultation of various stakeholders, including public health professionals, AI developers, policymakers, and the public, to ensure that AI is transparent, trustworthy, and beneficial for public health [17,21].

Conclusion: As a powerful and promising technology, AI can bring numerous benefits to public health. However, it also presents significant challenges and risks that must be carefully managed and mitigated. People of all ages must be equipped with digital literacy skills to understand their online rights. Public health organizations need to prioritize developing strategies and policies that establish contemporary data governance frameworks. This will ensure that data sharing is balanced with the risks involved while investing in modernized data and analytic infrastructure and procedures that enable the integration and analysis of diverse and dynamic data sources. Therefore, it is essential to adopt a balanced and cautious approach to the application of AI in public health and to ensure that it is used responsibly, ethically, and sustainably for the betterment of public health and well-being.

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