Artificial Intelligence in Public Health

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Artificial intelligence (AI) can rapidly analyze large and complex datasets, extract tailored recommendations, support decision making, and improve the efficiency of many tasks that involve the processing of data, text, or images. As such, AI has the potential to revolutionize public health practice and research, but accompanying challenges need to be addressed. AI can be used to support public health surveillance, epidemiological research, communication, the allocation of resources, and other forms of decision making. It can also improve productivity in daily public health work. Core challenges to its widespread adoption span equity, accountability, data privacy, the need for robust digital infrastructures, and workforce skills. Policy makers must acknowledge that robust regulatory frameworks covering the lifecycle of relevant technologies are needed, alongside sustained investment in infrastructure and workforce development. Public health institutions can play a key part in advancing the meaningful use of AI in public health by ensuring their staff are up to date regarding existing regulatory provisions and ethical principles for the development and use of AI technologies, thinking about how to prioritize equity in AI design and implementation, investing in systems that can securely process the large volumes of data needed for AI applications and in data governance and cybersecurity, promoting the ethical use of AI through clear guidelines that align with human rights and the public good, and considering AI's environmental impact.

There is no consensus on a definition of artificial intelligence (AI), but WHO has proposed "the performance by computer programs of tasks that are commonly associated with intelligent being". AI is seen by many as having the ability to revolutionize health systems. It can rapidly analyse large and complex datasets, extract recommendations tailored to patients or settings, support decision making, and improve the efficiency of many tasks that involve processing data, text, or images. These capabilities have captured the attention of policy makers at national and international levels. However, many will know, especially those with experience in procuring technology that the benefits of AI can be exaggerated and the risks downplayed. These risks include potential data privacy breaches, misinterpretation of results, perpetuation of biases, and the danger of professionals becoming over-reliant on technology, leading to the erosion of critical skills.

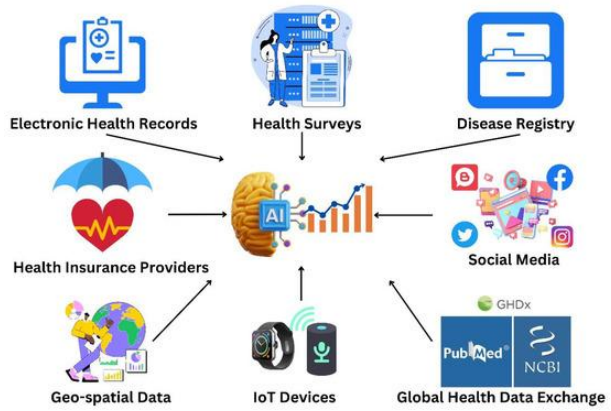
Traditionally, public health surveillance relies on manual data collection and analysis, which can be time consuming and prone to errors. AI can transform this process by automating data analysis, quickly identifying potential outbreaks, and issuing timely warnings. For example, the US Centres for Disease Control and Prevention used AI to track the spread of COVID-19 during the pandemic by combining data from multiple sources, such as electronic health records, social media, and news outlets.

AI can also assist in monitoring trends in risk factors for non-communicable diseases by analysing demographic, behavioural, and environmental data and feeding these data into projections used in planning. AI's ability to process large volumes of data rapidly can speed up the flow of information. For instance, AI can extract and analyse free-text data from sources such as death certificates to identify drug-related deaths well before formal coding processes are completed. This type of analysis can enable public health authorities to respond more effectively to emerging threats.

AI can be particularly useful in behavioural epidemiology, in which data from mobile apps and social media can be analysed to track health behaviours, such as diet, physical activity, and mobility. AI can also evaluate the impact of interventions designed to change these behaviours and model the trade-offs involved. These insights can then be linked to disease

prevalence, providing a holistic understanding of the factors contributing to public health issues. Machine learning algorithms have been used to extract people's sentiments and beliefs from social media interactions, an approach that has found several mental health applications. Another example comes from the field of environmental health, in which AI-powered tools use machine learning to monitor air quality in urban areas.

AI can also help optimize resource allocation. During the COVID-19 vaccination campaigns, AI models analyzed demographic data, health records, and geographical information to establish the best locations for vaccination sites. AI plays an increasingly important part in public health communication by improving the tailoring of messages to specific populations. AI tools can segment populations on the basis of demographic and behavioral data (e.g., through the use of k-means clustering and lasso regression) to increase the likelihood that health messages are culturally appropriate and accessible. AI can also assist in crafting public health messages in multiple languages and at various health literacy levels and can help identify misinformation. AI-driven chatbots offer a new means of communicating health-related messages. During the COVID-19 pandemic, WHO used AI-powered chatbots on platforms such as WhatsApp to provide real-time information on the virus, including guidance on symptoms, prevention measures, and vaccination. A recent review concluded that chatbots, by providing instant responses, can help to dispel misinformation and guide the public to reliable resources.



Perhaps the most straightforward application of AI is in automating routine tasks, such as generating standard letters or any task that entails summarizing large amounts of information (e.g., regulations, guidelines, or scientific reports) to produce concise summaries or recommendations. This type of application can substantially reduce the administrative burden on public health professionals, allowing them to focus on strategic tasks such as policy development and program implementation.

Although AI's potential in public health is considerable, there are notable challenges to its widespread adoption. One of the most important considerations is ensuring that AI is used equitably. AI models are often prone to bias, particularly if they are trained on non-representative datasets. This bias can exacerbate existing health disparities, particularly affecting marginalized and disadvantaged communities. AI systems must be developed with an equity lens that ensures diverse populations are adequately represented in training data. Developers and users must also be aware of issues such as dual valence (whereby a factor that serves as a marker of disadvantage or stigmatization, such as a postcode, is included in the algorithm) and automation bias (whereby AI-generated decisions are privileged over the wishes of the individuals affected). Bias and equity are distinct concerns in algorithmic decision making, as bias pertains to the fairness of the prediction algorithm itself, ensuring that prediction errors are not systematically related to specific individual characteristics, whereas equity addresses justice in the allocation principles that govern how outcomes are distributed among individuals on the basis of broader ethical considerations. Preferences for what constitutes a so-called fair algorithm can vary substantially among stakeholders, who might value different fairness metrics, reflecting diverse ethical principles.

Many public health institutions still rely on outdated health information systems that are not equipped to handle the large-scale data analysis that AI requires. Upgrading these systems and improving data-sharing mechanisms are essential steps for successfully integrating AI into public health. A 2023 survey on digital health in the WHO European region found that a little over half of countries reported having a unified interoperability strategy for secure information

sharing across the health system, whereas only a third had a specific policy on using big data and advanced analytics in the health sector.

Public health institutions (including public health agencies) cannot ignore developments in AI. Yet many stakeholders, including public health institutions and health ministries, can feel overwhelmed and unclear about actions to prioritize.

First, public health institutions must ensure that their staff are familiar with relevant legal and regulatory frameworks and principles that guide the use of AI. Their approach should be dynamic and adaptable to the evolving landscape of AI technology. Second, public health institutions should think about how to prioritize equity in AI design and implementation, minimizing the risk of reinforcing existing health disparities. Training datasets must be inclusive and representative of diverse populations. Explainable AI technologies might help ensure decisions made by AI systems are understandable and fair, helping build accountability. Prainsack and Kickbusch advocate for three pillars of "data solidarity": making data use easier when there are large potential benefits; prohibiting uses that pose high risks; and sharing benefits among those who supply data and those who consume it. Third, they must invest in systems that can securely process the large volumes of data needed for AI applications. Many public health institutions still rely on outdated information technology systems, which limit their ability to do so. Fourth, public health institutions must invest in training public health professionals in the appropriate use of AI technologies and ideally recruit and retain a dedicated workforce that can work confidently across both domains (an example of what this could look like is the approach of the Artificial Intelligence Centre for Public Health Research at Germany's national public health institute, the Robert Koch Institute). Fifth, special attention must be given to data governance and cybersecurity. Systems should already be in place to protect against risks such as reidentification or misuse of personal health information, but these should be reviewed, taking what is possible with AI into consideration. Investing in robust cybersecurity measures is essential to safeguard against data breaches and unauthorized access, which could undermine public confidence in AI applications. Sixth, promoting the ethical use of AI through clear guidelines that align with human rights and the public good is important. Public health institutions should engage a wide range of stakeholders in discussions about AI's role in their work. This participatory approach will help ensure that AI is used responsibly and that its benefits are distributed equitably, fostering greater public trust. Finally, given their role in promoting planetary health, public health institutions have a particular role in highlighting AI's environmental impact.

If they are to implement these considerations, public health institutions will have to undergo substantial structural, organizational, and cultural transformations. These will include establishing robust digital infrastructures capable of handling large-scale data and ensuring interoperability across systems. Organizations must invest in workforce development recruiting AI and data analytics experts while still providing ongoing training to equip public health staff with the skills needed to use AI tools effectively. Cross-sector networks and partnerships are essential to facilitate knowledge sharing and promote best practices, allowing institutions to learn from successful implementations of AI in public health globally. Additionally, public health institutions must prioritize equity and ethics with datasets that include diverse populations, the adoption of explainable AI technologies, and engagement with stakeholders in participatory decision-making processes.

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