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Applications Of Artificial Intelligence In Public Health

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Abstract

The effective application of artificial intelligence (AI) in the healthcare industry depends on managing its enormous promise while addressing its substantial inherent drawbacks. The progression from rule-based expert systems to modern, data-driven predictive models highlights an incredibly inventive past. By facilitating the transition from reactive to proactive, individualized, and preventive care, this transformation holds the potential to drastically alter public health. This bright future is not assured, though, and depends on overcoming significant challenges that could jeopardize its ethical and equitable implementation.

Global equity is the most pressing of these issues. Due to notable differences in digital infrastructure, processing power, and specialized knowledge, there is a "AI divide" between countries and groups, meaning that the advantages of AI are not shared equally. This could worsen already-existing health disparities and further disadvantage vulnerable groups. At the same time, there is an urgent need to address the ethical and legal aspects of AI deployment. Widespread issues like algorithmic bias, which can reinforce and magnify social injustices, and the critical need to protect patient data privacy pose serious risks to public confidence and the ethics or do not harm.

For this reason, having sophisticated technology is not enough. For AI to reach its full potential, a strong and cooperative governance structure is required. It is the responsibility of a multi-stakeholder coalition, comprising technologists, healthcare professionals, and, most importantly, legislators, to create thorough legal guidelines and oversight procedures. For AI to be used properly, this proactive governance is a necessary precondition. AI-powered health projects can genuinely benefit all of humankind by consciously addressing the dual imperatives of global fairness and ethical integrity. This will create a more equitable and healthy world.

Introduction

Artificial intelligence (AI) is a vast field that informs us about various approaches that contribute to public health (Olawade, Wada et al. 2023). Numerous devices, including smartphones, automobiles, and other operating room equipment, use artificial intelligence All these methods are computer vision, natural language processing and machine learning. These methods of artificial intelligence are also useful in the diagnosis and treatment of various diseases (Ghaffar Nia, Kaplanoglu et al. 2023). AI has been also used to find the targets of action of different medicines in various diseases (Hoffman 2008).

With the help of artificial intelligence people get awareness about the various risks of side effects of disease. They would also well aware, how to protect himself and other people (Leary 2007). As we know that during the CIVID-19 pandemic with the use of different medicines in cure of disease induce the change in use of artificial intelligence and also necessary for the rapid research of the disease . The benefits of AI boost public health interventions' efficacy (Olawade, Wada et al. 2023). Additionally, Al helps us in the data analysis of numerous diseases. However, there are important moral and legal issues that need to be resolved, like prejudice in AI systems and data privacy .

With the application of sophisticated AI algorithms, robots are employed to treat various illnesses and conduct procedures (Ness, Xuan et al. 2024). We can use artificial intelligence (AI) to learn about the risks of disease and take preventative measures early on to prevent it and lessen the harm it will do. AI-based applications can provide easily accessible, economical, and interactive solutions for health education and promotion from the standpoint of public health (Wang and Li 2024). Artificial intelligence also can help people manage chronic conditions like diabetes, high blood pressure, and asthma on their own. Additionally, people can use AI tools to (semi-)automatically manage and monitor health data, symptoms, and treatments; access remote or automated health services, screenings, diagnosis, and therapy; or receive emotional support for mental health difficulties.

The applications of AI are very helpful for public health and play an important role in prevention of disease and management of different diseases (Olawade, Wada et al. 2023). With the help of new technique and latest tools AI helps us in the processing and scanning of data related to health care. It also plays an important role in decision making, health care and in the treatment of individual patients. The predictive analysis of AI make the institute of health care more effective (Agarwal 2021). It also help the recognition of the high risk disease of the patient and more utilization for the satisfaction of the patient. We would also be well aware of the the risk of the up coming disease in time and control that disease easily (Aronowitz 2009).

In addition the use of artificial intelligence in public health is nor equally distributed across the world . In the regulation and availability of inner structure, expertise in techniques and the less availability of proper data may have chances of many misconceptions (Smith Iii, DiSessa et al. 1994). There are some important problems which may cause challenge in the development of AI. It is necessary to include AI in

the supervision of the system of health care, medical related professionals and people establish law (Kiseleva, Kotzinos et al. 2022). This indicates that the use of AI is established with a lot of understanding and sensibly. This article review the benefits of AI in the welfare of healthcare (Chustecki 2024). The maintenance between the benefits and disadvantage is necessary to gel good result in field of health care. Scientists, medical professionals and politicians are spreading awareness of AI in public health. It is imperative to tackle ethical concerns such as algorithmic bias, data privacy, and transparency to ensure that AI-powered public health initiatives equitably benefit a variety of populations. Notwithstanding these obstacles, artificial intelligence (AI) has the potential to revolutionize public health and open the door to more proactive and individualized medical care (Hashmi 2025). This review article mainly focuses mainly on different types of benefits which we can get from artificial intelligence (AI) in the field of public health. We have briefly describe the different main uses of artificial intelligence which are helpful for us related to public health.

History of artificial intelligence (AI) in public health

Research on artificial intelligence (AI) began in the 1960s with the goal of developing systems that could simulate human intelligence (Haenlein and Kaplan 2019). Early AI applications in healthcare focused on expert systems, which used human professionals' knowledge to provide decision support for medical diagnosis and treatment planning. Then, at the MIT AI Laboratory, Joseph Weizenbaum created Eliza, the first chatterbot in history, in 1964 (Shrager 2024). After identifying important terms in the incoming text, Eliza's system produced a response using reassembly principles. Eliza created text answers that may mimic a conversation with a real therapist in this manner (Cristea, Sucala et al. 2013).

In the 1970s, AI with observable medicinal uses started to gain traction. The first artificial medical consultant in history, INTERNIST-1, was developed in 1971 (Mangrolia 2025). Based on the symptoms of the patients, the system used a search algorithm to determine clinical diagnoses. Because it had the obvious potential to relieve healthcare providers of part of the clinical diagnosis burden and give doctors a way to cross-check their differential diagnoses, INTERNIST-1 marked a significant change in AI in clinical research. The National Institutes of Health sponsored the first AI in Medicine symposium at Rutgers University since it was now so evident that AI had intriguing medical applications (Kulikowski 2015). Interdisciplinary seminars where academics from various fields of AI exchanged ideas and systems contributed to the explosion of medical AI. MYCIN was one such system that emerged from network integration. A system called MYCIN helped doctors prescribe the right medications to patients with infectious disease diagnoses by using a set of input criteria. The University of Massachusetts made the next significant breakthrough in the 1980s (O'Shea, Allen et al. 2007). A tool called DXplain was created to assist medical professionals in making a diagnosis. The system would provide a possible diagnosis based on the symptoms entered by clinicians. (Hirani, Noruzi et al. 2024). AI has numerous uses in field of health care like surveillance, transparency and human judgement.

The latest era of AI starts after 2000s and we have seen a lot of new modifications in the field of healthcare and human daily routine life (Dandotiya, Gupta et al. 2024). With the passage of time more advanced modifications have been introduced related to AI and are helpful in the welfare of public health. To assist with patient care in a number of ways, new methods were developed. For instance, Pharmbot was created in 2015 to educate patients and their families about medicines and treatment procedures (Mangrolia 2025). (Malik, Sircar et al. 2021).

Methods

Different methods are used in the application of AI to improve the public heath. All these methods are related to the machine learning, which helps in data analysis and control of disease with use of computer. And many other AI techniques and methods are used in the field of public health.

Machine learning

Machine learning is the process of using data and algorithms to create predictions within the vast and frequently challenging field of artificial intelligence (Sarker 2021). Instead of using direct human input, machine learning aims to make these decisions only using information extracted from data. Therefore, ML's main focus is on the particular kinds of algorithms that are employed (Binkhonain and Zhao 2019). Statistical learning mechanisms are the traditional source of machine learning algorithms. Random forest, logistic regression, and linear regression are a few popular statistical learning techniques. K-nearest neighbor is a statistical learning technique used for regression and data classification (Daghistani and Alshammari 2020). These algorithms can be applied singly or quickly to support the data processing, training, and task execution that are important to machine learning as a whole.

Unsupervised and semi-supervised learning approaches provide supplementary avenues for revealing latent patterns in medical data, in addition to supervised learning (Ren 2024). Without using pre-labeled data, unsupervised learning can provide insights into patient stratification and disease subgroups using techniques like clustering. Unsupervised learning is a potent instrument for exploratory data analysis in the healthcare industry because of its capacity to identify novel patterns on its own (Park and Bae 2004). When labeled data is hard to come by or prohibitively expensive, semi-supervised learning, which makes use of both labeled and unlabeled data, provides a workable way to increase model accuracy. These methods, along with reinforcement learning's capacity to streamline decision-making, constitute a full suite of predictive analytics tools that push the boundaries of medical innovation (Bayyapu, Turpu et al. 2019).

The interpretation of images and videos by machines that are at or above human level, including object and scene identification, is known as computer vision (Borji and Itti). Image-based diagnostics and image-guided surgery are two fields where computer vision is having a significant influence. The use of AI and computer vision in surgery to enhance specific surgical abilities and features, such suturing and knotting, is a noteworthy application (Lu 2019). When it comes to some surgical procedures, such bowel anastomosis in animals, the Johns Hopkins University smart tissue autonomous robot has proven that it can do better than human surgeons (Shademan, Decker et al. 2016). Robotic surgeons that are completely autonomous are still a ways off, but academics are interested in applying AI to enhance many elements of surgery. One example is a team at the Alpen-Adria Universität Klagenfurt's Institute of Information Technology (Eder) that uses surgical videos as training material to pinpoint a particular surgical intervention.

The ability of unconventional learning to spot until unexplored design in data for the new research in curative data and complete analysis of disease (Mukherjee, Abraham et al. 2025). Unconventional algorithms have the ability to point out different disease substance by recognize small difference in victim data, everyone applied different method for the diagnose. The method of machine learning left behind the approach in which one type is fits in understanding of all type of diseases (Caballé-Cervigón, Castillo-Sequera et al. 2020). But with machine learning tells us exact understanding of disease more successfully and accurate treatment. The response to any out break or spread of disease or other medical emergencies (Alwidyan, Trainor et al. 2020). This

is due to the machine learning method which predict new health pattern and give early response for any disease in public health. The change in probability of the learning which not under any supervision (Nikolic and Fu 2003). It helps us in treatment of both individual patients and making strategy for more general public health. Since 1970s the pixel analysis make it possible for machine learning algorithm in detraction of abnormalities in imaging study. It has aimed to identify cancer and the spread of cancer cell from origin to other parts of the body (Marx 1989). In present days the more advanced algorithm is used for the detection of disease and its prevention (Badidi 2023). This advanced algorithm permit medical professionals for ultrasound for detection of disease, and this procedure is only performed by the licensed medical professionals (Rana and Bhushan 2023). Machine learning is the one of the most important invention in field of artificial intelligence.

Predictive analytics

Predictive analytics is providing a new ground which enable us to detect and treat the disease early in the field of healthcare in co-relation with machine learning (ML) (Ghazal, Hasan et al. 2021). For example the algorithm of machine learning with predictive analytics can now classify through broad volume of data of any disease. It helps to predict the development of any chronic disease like cancer, diabetes and cardiac related diseases before time (Alanazi 2022). By enable the new prompts we can get great increase in the chances of successful outcome, as well as the customization in the rules of treatment and each patient get personal or unique profile.In hospitals we can get better resources for any treatment and AI related tools. It easy to take care the patient in hospital and the risks of admission and readmission in hospital for treatment are low (Krumholz, Wang et al. 2017).

With the use of machine learning method we can get more accurate results with low risk margin and it also helps us in the identification of disease and in making of plans for any individual therapy. (Giesinger, Kemmler et al. 2009). All this data is include predictive modeling which helps in point out the high risk individuals, their medical case history, clinical parameters and their profile of genetic makeup. This would enhance the efficiency and reduce the side effects of any coming disease (Bloom 2001). The use of machine learning technique in artificial intelligence in co-relation with predictive analytics decrease the cost of healthcare. This is done by different companies by providing maximum allowance and it also not prefer the use of needles in medical care (Tan, Hawk Iii et al. 2001).

The combination of machine learning algorithm and medical professionals are essential components of modern healthcare analytics and usually more beneficial (Ahmed, Mohamed et al. 2020). With the use of organized data and machine learning technique the doctors are able to diagnose or judge the disease under particular conditions and enhance the expertise in that field (Caballé-Cervigón, Castillo-Sequera et al. 2020). For the treatment of cancer a domain is created by the system for the treatment of cancer with the use of machine learning model and this show realistic impact, show great increase the results too. Moreover in the analytics of machine learning the medical staff allowed more time to enhance the standard of patient care (Shahid and Khattak 2022). They also highlight the human components that are in the team of health care (National Research, Division of et al. 2011).

Predictive modeling

Predictive modeling is used for data analysis and prediction of future results with co-relation with other methods statistical models and machine learning (Raturi and Kumar 2019). In the field of public health, we use predictive modeling to detect or predict the spread of infectious diseases like influenza and COVID-19. Predictive

models can help in the identification of pattern and trends of data analysis which can help in public health (Folasole 2023). This is done by the analysis of data on past epidemic and other related factors such as geographic population and pattern of weather. In artificial intelligence predictive modeling has very important role (Yang 2022). It can help us in the improvement of our ability to predict the risk of spread of any infectious disease with interference of public health care (Christaki 2015). The decision making is main issue for artificial intelligence in predictive modeling, it also includes the prediction of disease and prediction of risk. In related increase accuracy and efficiency also are challenges in the field of artificial intelligence in related to health care (Lee and Yoon 2021). Traditional techniques face lot of difficulties in or struggle to handle the complex data in many fields.

The public heath care industry is working on different clinical apps that process the procedure and show increment in the outcome of patient (Estrela, Monteiro et al. 2018). The predictive modeling related to artificial intelligence accelerating the process of development of applications of health care. The therapeutic applications are made in less time period and are more effective in this field (MacKenzie 1996). The predictive model work on the principle of artificial intelligence and using complex algorithm and machine learning This help to analyze the vast amount of healthcare data like clinical trial results and genetic information with help of artificial intelligence (Xu, Yang et al. 2019). The predictive results, clinical optimization, designed clinical applications and identification of different patterns is done by these models we have already discussed about. Artificial intelligence can be used by different health care companies for boost up the speed of development, increase accuracy, applications, low cost and early distribution or delivery to the market (Lee and Yoon 2021). The length of clinical trials is shortened with the relation of predictive modeling with artificial intelligence by its potential. The expensive and time consuming clinical studies involve many number of tests and regulate these procedure with predictive modeling (Luo, Phung et al. 2016). With the help of models of artificial intelligence we can increase the speed of any procedure and make the shorter time. It is done by rapid identification of side effect and prediction of patient reaction. This increase in the speed may leads to the high access to medicines and therapy, healthcare provider and pharmaceutical companies (Henry and Lexchin 2002).

In the field of public health care we should well aware in decision making, performance, accessibility, and collaborative research and artificial intelligence modeling technique (Shahid, Rappon et al. 2019). Such as prediction of disease, risk of danger and due to lack of modern modeling it is hurdle for us. Due to the lack of structured classification problem for the wider range, cause delay in implementation and make selection of method difficult (Alsalem, Zaidan et al. 2018). For implication of discipline we have to make perfect strategy comparatively and we have to provide short explanations in every condition. This strategy help practitioners to discover more methods which are effective, increase the speed of decision making and also get confidence to promote collaborative research. Predictive modeling capabilities have been greatly enhanced in recent years by machine learning and artificial intelligence (Hatta, Wahid et al. 2024). Large, complicated datasets, like genomic data and medical imaging, are increasingly being analyzed using methods like support vector machines, k-nearest neighbors, and deep learning. More accurate forecasts and individualized treatment regimens are made possible by these models' ability to spot patterns and connections that are not immediately obvious to human observers. Furthermore, useful information can be extracted from unstructured data, including patient records and clinical notes, using natural language processing (NLP), and this information can then be included to predictive models (Zhang, Wang et al. 2024).

Predictive models can offer a thorough picture of a patient's health by combining data from multiple sources, such as wearable technology and electronic health records (EHRs) (Dinh-Le, Chuang et al. 2019). This enables more precise forecasts and better clinical judgments (Sanders, Doust et al. 2015).

Disease forecasting

Disease forecasting is an important use of artificial intelligence in the welfare of public healthcare (Olawade, Wada et al. 2023). It improves our caliber in prediction of spread of any infectious disease and in return it provide us guidance and advices for the betterment of public health(Lutz, Huynh et al. 2019). Because it helps the medical professionals in the prevention of outbreak or spread of any disease and take action quickly in any situation which is occur due to that disease (World Health 2023). Disease forecasting is used for the analysis of series of time and other traditional statistic methods in the past (Zhang, Liu et al. 2013). But with the passage of time we have seen advancement in artificial intelligence, we can use it now practically with increase advanced algorithms. It can analyze the wide range of data which predicts is about different disease and their danger and it is more accurate (Vijiyarani and Sudha 2013). Disease forecasting is the main development in artificial intelligence which helps us in prediction of the outbreak of disease and its precautions. The uses of artificial intelligence have to grow further in the field of public health for the early prediction of the sickness (Olawade, Wada et al. 2023).

The ability to promptly apply effective therapies is the main advantage of precise illness predictions (Hayes, Markus et al. 2014). This gives the health agency a head start in estimating the response plans before cross-country transmission intensifies. For example, if projections indicate that the number of flu cases would rise, health officials can encourage vaccination, spread awareness, and work to relocate all the resources required for medical care to these locations (Ndiaye and Alfares 2008). This aspect can be viewed as contributing to the saving of lives and even the control of health-related costs because the actions that are likely to be taken during the implementation of a forecast incorporated in important diseases are likely to reduce the impact of diseases to certain population-definable standards. The right allocation of healthcare resources is made because disease outlooks are accurate (Drummond 1987). Therefore, health care can provide facilities, personnel, and equipment where they will be most helpful depending on the projection of such diseases. For instance, hospitals may purchase all necessary medications and equipment to handle a sizable patient population in anticipation of a communicable illness outbreak (Zhang, Lu et al. 2020). Furthermore, time-based planning of measles vaccination distribution and the utilization of time-orbit medical centers in the most vulnerable locations can benefit from accurate estimation, which increases the effectiveness of mass health-oriented initiatives.

Machine learning and artificial intelligence Supercomputers in data centers are becoming more crucial than ever for forecasting and disease prediction (Narla, Valivarthi et al. 2020). Students will be able to complete complicated computational tasks and big data analysis in a matter of minutes in the upcoming courses thanks to high performance computing (HPC). This feature helps the researchers with a number of simulations, such as creating models, especially to improve accurate forecasts (Makridakis 1988). As a result, the applicability of the high-complexity Machine learning and artificial intelligence techniques that have been presented to computations made by contemporary healthcare companies will also be pertinent (Lin and Stead 2009).

Risk prediction

Risk prediction is the very important component in public health because it mainly focuses on management of diseases and action taken for prevention of disease (Rockhill, Kawachi et al. 2000). Conventional methods of risk prediction, such manual calculations based on demographic and clinical data, can be time-consuming and may not always produce accurate results. Risk projections could become more accurate and effective using AI, which would improve public health outcomes (Xiao, Choi et al. 2018). Additionally, these algorithms may analyze complex data, such as medical imaging and genetics, to identify patterns that can determine the probability of a disease (Dias and Torkamani 2019).

Finding those who have a higher chance of contracting particular diseases is the main challenge for risk prediction (Davis, Chawla et al.). Conventional methods depend on the examination of clinical and demographic data, which might not adequately capture nuances in risk factors or changing situations (Pearce 2011). Through the integration of many data sources, the detection of non-linear correlations, and the identification of latent patterns, artificial intelligence (AI) techniques such as machine learning and natural language processing improve risk prediction (Li and Dai 2024). Improving individualized healthcare plans, allocating resources, and customizing interventions are the goals. AI is being used to predict the probability of incidents like auto accidents, heart attacks, and strokes (Rojek, Kotlarz et al. 2024). IBM Watson Health, for instance, has created a model that has a 90% accuracy rate in predicting the chances of a heart attack (Guidi, Miniati et al. 2016).

Conclusion

In conclusion, even though artificial intelligence has the potential to completely change healthcare and usher in a time of highly personalized, proactive, and predictive medicine, achieving this future depends on our capacity to handle a challenging array of obstacles. The transition from early expert systems to today's complex algorithms shows how quickly technology is developing, but this development also brings with it important challenges that must be carefully and purposefully balanced.

The severe worldwide inequality in AI capabilities, where differences in digital infrastructure and technical know-how run the risk of causing a new health divide and leaving disadvantaged communities behind, is one of the most urgent challenges. Furthermore, preserving patient trust and equity requires both ethical and legal considerations when implementing AI, such as preventing widespread algorithmic bias and guaranteeing strong data privacy.

Thus, the way forward necessitates a coordinated, cooperative effort. Innovation in technology is not enough on its own. Strong, progressive government is necessary for AI to live up to its potential and fairly benefit all populations. To create thorough legal frameworks and strict oversight procedures, practitioners, technologists, and legislators must collaborate. We can guide this potent technology toward a future where it consistently improves public health, promotes equity, and empowers patients and caregivers by proactively tackling these issues—closing the global capability gap and integrating moral values into the foundation of AI systems. We can only guarantee that the AI-powered health projects of the future fulfill their promise of a healthier, more just world by implementing such inclusive and reasonable governance.

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