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Emphasizing AI in Healthcare to Transform Food Systems: A Critical Review

Mohammad Hasan Amin[1*]

[1]Kettering University, Michigan

[1]amin3672@kettering.edu

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Corresponding Author
Mohammad Hasan Amin
amin3672@kettering.edu

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ABSTRACT

Artificial Intelligence (AI) is changing the landscape of healthcare and food systems and seems to bring enormous potentially influential opportunities to be more efficient, sustainable, and equitable. Nowadays AI is applied in healthcare to make diagnostics, treatment improvement, and resources management. The same can be said about the food systems where AI is utilized to optimize food supply chains and cater to food safety and even enable personalized nutrition. However, the concerns of privacy of data, regulatory complaints, and ethical concerns raised in press must be surmounted to achieve successful integration. Although the AI application across sectors offers the possibility of innovation, special analysis regarding viability and fairness should be carried out to prevent the exacerbation of the inequalities. The future is still optimistic since there is an expectation of enhancing AI models, regulation clarity and interdisciplinary advancements that aim at coming up with viable AI adoption in the two industries with the umbrella aim being to come up with responsible, fair, and applicable adoption of AI adoption.

INTRODUCTION

The Initiative which occupies the border between Artificial Intelligence (AI) and healthcare, has caused an incredible change over the last years. Thanks to machine learning (ML), natural language processing (NLP) and computer vision, not to mention a myriad of other capabilities, AI is transforming the manner in which healthcare systems are run in providing a better diagnosis, targeted treatment, and predictive analytics [1]. It may be in the form of automating some of the routine administrative tasks or clinical decision making but AI is transforming healthcare faster and at an

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unprecedented level. But that is not everything, since a rapidly growing necessity to find out how other significant spheres of the world can be profited under the influence of AI technologies exists, and first of all, the system of food [2].

Similar to the case of healthcare, food systems are data rich, and complex, and significant to human welfare. Sustainability, food safety and availability of nutrition is one of the challenges that are presented to global food supply chain. BY ENHANCING FOOD SYSTEMS THROUGH AI WE will be able to apply it to food systems so that we can affect efficiency in the food system in terms of resource allocation, predictive models and individualized feed [3]. Despite the success of AI in healthcare, now researchers are trying to come up with a solution that will transform the way the food systems are being operated and make them more effective and sustainable besides being equitable [4].

This review tries to talk about what role of AI in healthcare plays and what way this role can drive innovation in the food system. Looking at all the technologies that are already beneficial in healthcare we can obtain some more knowledge over how the same methods could be altered and scaled during the preparation to rectify the same problem that the food industry is faced with [5]. Along with this, we will explain to merge of AI in these two fields might drive broader and cross sector innovations, which, in the long term, will contribute to the global health and sustainability goals [6].

Although the potential of AI both in healthcare and in the food systems is immense, it will do well to recognize the challenges of such a far-reaching cross-use. The matters of data privacy problems, regulatory concerns, ethical aspects and the looming danger of increasing inequality are only some of such problems that are to be considered with significant care and to which a reasonable resolution should be found. The assumption that the AI is likely to exacerbate the existing inequality, or that it will also bear the repercussions is still looming [7].

This article will critically re-examine the situation with AI in healthcare today, analyze the similarities between healthcare and food systems, discuss the opportunities, challenges, and ethical issues of doing so with food systems [8].

UNDERPINS OF AI IN HEALTHCARE

Artificial Intelligence (AI) has increasingly become a pillar of the modern day health establishing the expansion of the clinical, medical research and healthcare administration of today. Essentially AI is the idea of using advanced algorithms, machine learning (ML) and data analytics to digitalize a process, draw insights, and expand decision making [9]. Incorporation of AI into rations in health care system is related with a sequence of technologies that have dissimilar diagnosing practices in raising the degree of real life care efficacies and operational operations [10].

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Multiple studies on the basis of different fields of engineering, such as the utilization of heat transfer analysis, based on dimensionless numbers, the reduction of the high amount of BOD in sewage treatment, and the research in the elementary vibration, serve as a solid technical context which well fits the new domain of AI developments in healthcare [11]. Modeling and control of the dynamic systems like ball and beam based manipulators and the design and simulation of the planar anthropomorphic manipulators using MATLAB/Simulink are directly concerned with medical robotics and assistive devices [12].

OpenFOAM exploration of Computational Fluid Dynamics (CFD) analysis and mesh optimization provide one of the key tools in modeling physiological processes found in sectors of air in lungs or blood in arteries and which are required in predictive modeling and in AI-driven diagnostics [13]. Even such studies as environmental engineering, such as the enhancement of the sewerage system, can be used to energize data filtering and processing techniques in healthcare AI and make the systems more efficient and accurate. Altogether, this multidisciplinary literature shows how basic engineering principles (and modeling tools based on computations) are becoming intertwined with artificial intelligence in a way that is transforming the infrastructure of the contemporary healthcare zed society [14].

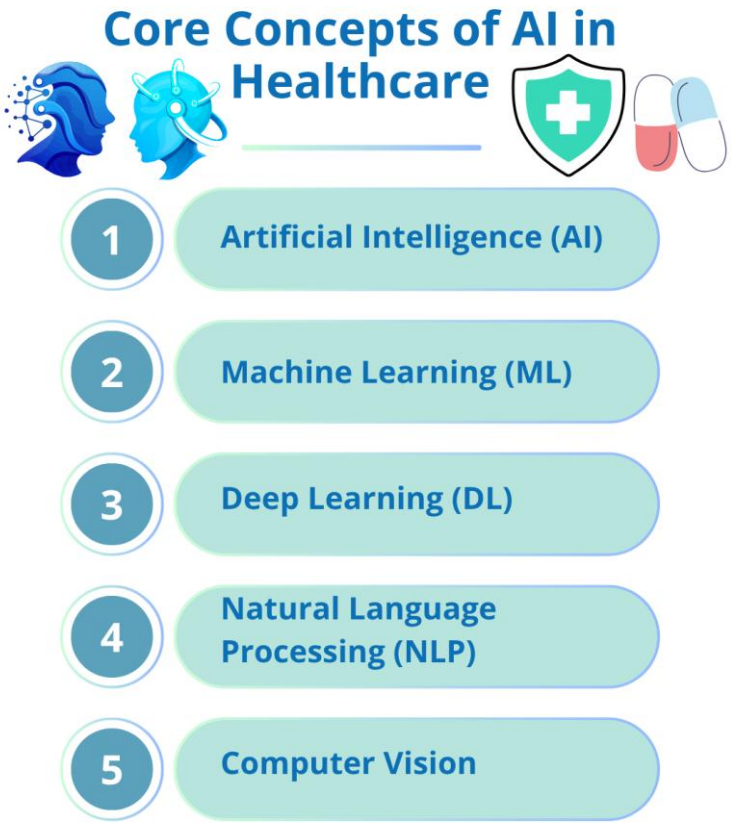


Figure: 1 showing core concepts of AI in healthcare

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The medical imaging has been faced with the challenge of Computer Vision that enables machines to interpret visual data. Computer vision systems including AI allow radiologists and clinicians to more precisely detect abnormalities, including tumors, fractures and organ abnormalities. These technologies are trickling towards surgical robotics that apply AI manual codes to aid real time decision-making in the surgery thus making it more accurate and free of human mistakes [15].

The main themes include quality and access to healthcare data, data privacy issues and AI regulatory environment in the field of medicine. Accessibility of transparent, accountable and ethically conceived AI technologies is essential to maintain patient trust and safety; the foundations of AI paradigm in healthcare are highly effective technologies such as ML, NLP, and computer vision [16]. Although these innovations are already transforming most sectors of the healthcare system, there is still more that needs to be developed to act on emerging challenges and explore even more benefits in patient care [17].

SIMILARITY IN THE FOOD AND HEALTHCARE SYSTEM

Although the operation of the healthcare and food systems occurs in different spheres, they have much in common and this is why the application of AI in the two realms is very promising. They are both data-driven, multi-layered structures (human and technological) which are very intricately tied to human well-being and that much of the same issues exist when it comes to their efficiency, sustainability and access [18].

Data Complexity Both healthcare and food systems generate vast data, in the form of patient records and medical imaging in healthcare, and agricultural data, nutritional data and food safety records in food systems. The question within the healthcare industry is how we capture this information and derive some useful information out of it. On the same note, within the food systems, the data must also be manipulated effectively to maximize on best supply chains, food safety and food nutrition [19]. The ability of AI to detect complex patterns of data; clarify inefficiencies in the two areas; and improve decision-making is important in these two areas.

Efficiency and Resource Allocation: A health system and also a food system will entail a good utilization of resources in whatever form they may be human, financial, or material. A makes good use of AI in the healthcare sector to attain efficiency in the distribution of medical resources like reducing the time of waiting, predicting the outcomes of patients, and streamlining hospital processes [20]. As regards food systems, Food systems, AI can prefer the farm acts, reduce the food wastage and anticipate the demand and the distribution of the foods. Simulation of AI can significantly reduce wasteful activities in these two sectors so that they can meet the growing demand of the world population in access to health services and food [21].

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Personalization and Customization: The second significant similarity is the demand of more and more personalized services. The artificial intelligence has become able to mine individualistic factors based on the genetic, environmental, and lifestyle based factors and, therefore, personalized medicine, custom catalyzed treatments, and precision healthcare are getting the spotlight in the healthcare field [22]. Similarly in food systems the role of AI would be to understand the personalized nutrition and diet recommendation based on individual health conditions, tastes and preferences as even cultural factors all the way to actually being able to modify dietary pattern and general health can be changed and improved [23].

Sustainability and Equity: The pressing issues of the healthcare systems and the food system are sustainability and equity. AI may assist in attaining a higher level of environmental sustainability of the food production and distribution process in conjunction with the balanced access to healthy food and health care. What is required is an integrated systems based approach to management of these challenges wherein what is happening in one system can influence and determine what results in the other [24].

Along with similarities in the use of data, efficiency requirement and importance of personification and sustenance, healthcare and food systems are very similar. It is upon such similarities that AI will find its Subject to develop effective solutions in the two fields [25].

THE TRANSLATION OF HEALTHCARE AI TO FOOD SYSTEMS

The opportunity to create a better food production, distribution, consumption with the help of the innovations that were borrowed in the sphere of healthcare and applied to the food systems is new territory where ample space to implement the chosen changes is offered. Even though the mechanisms of the healthcare sector and food systems have to encounter different challenges, the technologies and the style of the work created in the healthcare system can be transferred to the development of more advanced, responsible, and environment-friendly food systems that will be effective, sustainable, and personalized [26].

One of the most straightforward ways the healthcare AI has been implemented on food systems is at predictive analytics. Healthcare- AI healthcare takes the shape of predicting the outcome, progression of disease and requirements of resources. Similarly, AI can be employed to forecast the demand of food, maximize the exploitation of supply chain and reduce wastages [27]. Using the logical process of inferring the way, say, weather pattern, consumer-wants and market trend are the nodal point where AI can guide the farmers, food manufacturers and distributors into a more proactive degree- predicting the bounce up or down, in supply and demand. Such predictive option can a long way in reducing wastage of food to a bare minimum and efficiency and the food will reach appropriate

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markets in appropriate time and at appropriate time [28].

The diagnosis of illnesses and abnormalities through medical imaging is the other critical role of the AI in health care. Similarly AI could also be applied to food systems in the area of food safety/quality. It is possible to train machine learning algorithms to identify contaminants or spoil in any food product, declaring themselves, and, therefore, to meet the requirements of the food safety that minimizes the potential health risks to the consumers [29]. Technologies of computer vision that have already been used within the field of health care imaging can similarly be used in the food inspection of the food along production lines without relying on the quality control of the human eye [30].

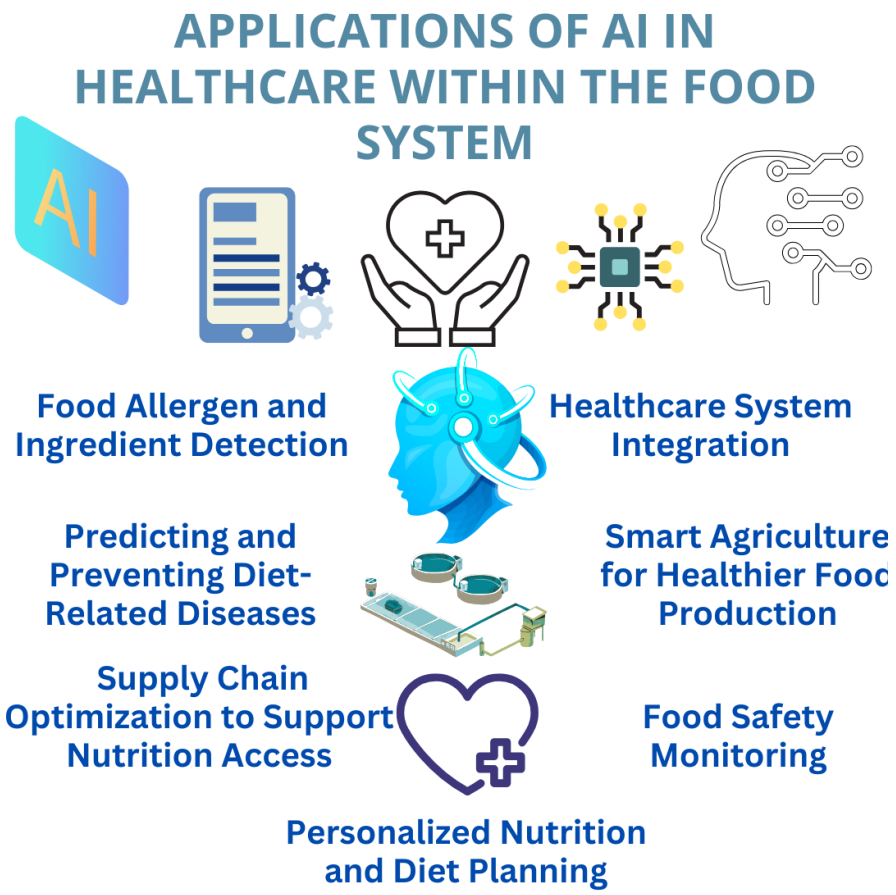


Figure: 2 showing applications of AI in healthcare within the food systems

Since AI is the driver of this type of personalized medicine in the field of health care, they can be utilized to personalize nutrition advice. The things AI can do is to study the eating habits of character and creating a food habit in a manner that the health conditions and the genetic makeup of the people and even the mode of life choices, which materializes changes in the eating habits can be conquered [31]. To take one specific example, the rising popularity of AI powered apps and platforms will probably mean that people with specific health issues, say diabetes or obesity, will be able to get

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informed decisions as to what food means to them in terms of nutrition and specific needs. Also, such sites would be able to optimize on meal planning and grocery shopping, which provides individuals with eating only balanced nutritional meals [32].

AI will be able to provide sustainability in food production just as they can in the health care industry. In farming, AI has the capability to help farmers manage their resources better with the information on the right time to plant crops, creation of irrigation systems, monitoring as well as ensuring the good health of crops minimizing its need on high consumption of pesticides. Similarly, in the same way that the use of AI can automate the process of processing and distribution of the food, minimizing energy consumption, food waste as well as the carbon footprint of the planet [33].

The applications of the AIs technologies in health care to food systems reveals enormous scope in terms of augmentation of supply chains, food safety, personal nutrition as well as sustainability. Using healthcare-spurred AI advancements, food systems can be updated and become more productive and fair besides environmentally agreeable [34].

CHALLENGES IN CROSS-SECTOR IMPLEMENTATION

Although the potential of AI to reshape the world of healthcare and food system is enormous, there are still realistic challenges in an attempt to implement AI solutions in these industries. These difficulties are data privacy, interoperability, regulatory, and societal implications and all these need to be addressed carefully to ensure a successful integration [35].

Data Privacy and Security: Both in healthcare and in food systems, AI strongly relies on the sets of data to perform effectively. Healthcare patients data is a sensitive data and is regulated by different privacy standards, (HIPAA in the US example). On the same note, food systems can involve sensitive information on suppliers, the production and consumer predispositions [36]. Such information must be gathered, stored and processed safely and that is a big hurdle to surmount. Privacy laws are also important besides preventing the occurrence of data breaches as there is more cross sector data sharing [37].

Interoperability: The other problem facing the AI systems is the interoperability of the systems where the systems can deliver and integrate easily within the current technologies and infrastructures of the health and food systems. An example is the popular use of legacy or disintegrated IT infrastructures in healthcare systems, which causes challenges in accepting AI tools [38]. Similarly, food systems can involve various diversity of stakeholders such as farmers, manufacturers, distributors, and retailers who use various platforms and technology. In order to make AI work, these systems must be able to communicate and this means that there would be a high level of interoperability and standardization but these two sectors do not embody them currently [39].

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Regulatory Hurdles: Both healthcare and food systems are highly regulated, and the AI technologies have to conform to the standards and regulations, which apply to this industry. When it comes to healthcare, AI has to undergo a more serious proving and approval process so that it would be adopted in the clinical domain. Food safety regulation, the standard of controlling quality of foods, and the sustainability of the environment should accompany the AI application in food systems with all applications worldwide. Developing regulatory formulations that would be able to keep pace with the explosive rate of increase of AI in the case we have to address are a serious issue [40].

Social and Ethical Implications: The use of AI in the given spheres leads to the emergence of a significant problem of ethics. To illustrate, the use of AI in decision making in the healthcare sector certainly may influence the outcomes of patients, and biased algorithms may further complicate the situation of health disparity. Alternatively, AI may influence the food production within the realms of the small scale farmers or result in additional food inequities in food systems [41]. Alleviating these ethical issues, openness and the removal of bias in the AI models, will make this faith of people towards the AI to achieve optimal make-up of the society and the benefits of the AI to levels of the society. Whereas AI could be transformative to health care and food systems, it is likely that several challenges will impede the achievement of such cross-sectional application, such as data privacy, interoperability, regulation and ethics. The necessity of overcoming these challenges should be emphasized in order to access the full potential of the AI and make the people worldwide better in terms of health and food security [42].

GREENNESS AND SOCIAL JUSTICE IMPLICATIONS

As the use of artificial intelligence (AI) technologies incurs in healthcare and food systems, it is critical to assess what effects they bring to sustainability and equity. Though, AI has the potential to improve efficiency and result not only in the two sectors, but also in any other sector and when implementing AI factors such as environmental sustainability and fair equality to access AI should be put into consideration in ensuring that the benefits of AI are shared equitably and ethically [43].

Sustainability in Healthcare and Food system:. In healthcare AI may be used to increase the sustainability of the healthcare system, by ensuring the efficiency of resource distribution, reducing wastage and by enabling more specific treatment where suggestions on the appropriate course of practices or drugs are not present [44]. As an example one can say that with Artificial Intelligence enabled systems not only will one be able to predict patient admission but also be able to realize greater hospital resource utilization and reduce operational inefficiencies. As well as AI might be used to design energy saving buildings, which would lower the emission footprint of the medical institutions, or even streamline the supply chain of medical produce. Residual waste would be done

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away with [45].

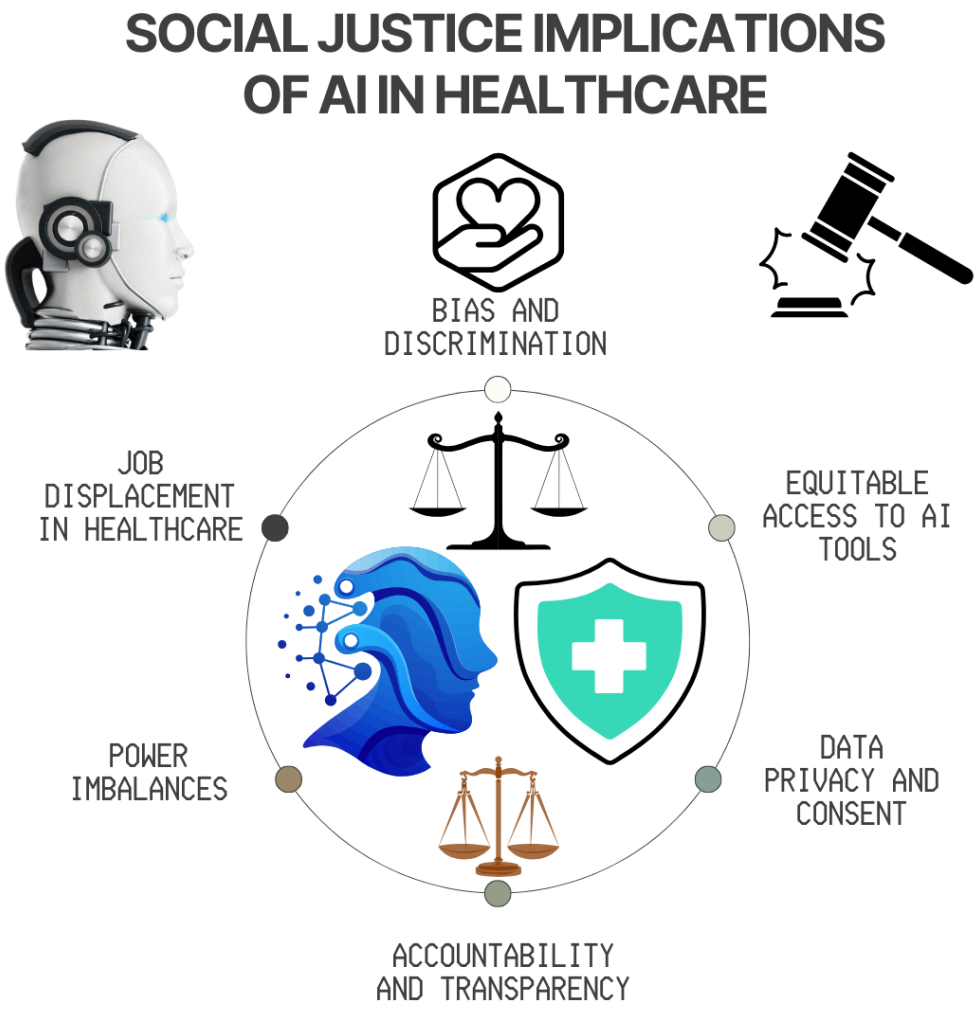


Figure: 3 showing social justice implications of AI in healthcare

AI can be used by food systems to streamline their farming activities; reduce food wastes; and improve the ecological potential of food production. Along with estimating crop volumes, AI can assist farmers in the production of food that does not burden the environment by using a lot of water or adverse pesticides [46]. Equally AI will allow improved management of the supply chains in the distributors of foods that will help address wastage all the way to tables. In the era of acute issues related to climate change, food shortage and depletion of resources; AI value chain will play a pivotal role in making food sustainable [47].

Fairness in Paid AI tools: The major issue though in implementing AI in different sections is that it will be raising the disparities present in the society. But in healthcare, there is a risk that the underprivileged communities cannot have access to them as well; as with AI, diagnosis and treatment can be enhanced. Geographic, socioeconomic, and racial disparities in the healthcare may even increase in size in case only a fraction of people may get access to AI tools [48]. This may be, e.g.,

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rural lands lacking many benefits of AI-based healthcare provision and the disadvantaged groups failing to enjoy benefits of better diagnosis and a remedy that AI can bring [49].

Equally, in the food systems AI driven applications may exclude the small scale farmer and put unfair advantage to large food producers or food companies. To avoid further division of the community that is already divided, one should strive to make AI technologies easily available and beneficial to all entities (both service providers and other stakeholders) including the poorly served and whose community has, in most cases, not been given attention by the vast majority of enterprises. This can be through the development of affordable AI programs, whose products will be available to small scale farmers and, hence, also not a socio economic obstacle with regards to the availability of healthy food [50].

Ethical AI: Ethical advancement of AI is key to achieving sustainability and equity of healthcare and food systems respectively. This implies to come up with transparent algorithm that is without bias and equal in the distribution of benefit of AI. A collaboration between policymakers and AI developers must exist where policy exists to collaborate rather than create the policymakers one and the developers to create the technologies of reducing inequality and not reproducing inaccessibility to other people [51].

Reflectively, the potential of AI, in terms of the contribution to transforming healthcare and food systems by means of making sustainability and equity a reality, is enormous. Nevertheless, to get the full benefit of the AI solutions, the stake holders should work hand in hand so that the solutions can be implemented in a manner that will be environmentally friendly and include all populations but more particularly the traditionally under-served or marginalized [52].

RECOMMENDATIONS FUTURE DIRECTIONS

The role AI plays in the medical industry and food systems is already mind-blowing but there is still a need to develop other technologies that would allow implementing the power of AI fully. The two industries need an update as they have to deal with the challenges as they learn on how to utilize the new opportunities that are ushered by the AI technologies. Direction of AI in these areas refers to ideas in technology, policy development, interdisciplinary, and responsible approach to the development of AI [53].

It is necessary to note that the development of more advanced types of AI and tools is essential to healthcare as well as food systems. AI has a potential to dislodge these sectors due to better efficiency such as in say, algorithmic learning, data manipulation, and real time analytics. Especially with this, one of the areas of future development will be to ensure the accuracy and reliability of AI in terms of predicting health outcome scenarios and food production scenarios [54]. In medical practice, this

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would take more beautiful models that predict the health of patients over time, and in food systems, AI might be more insightful regarding climate-resistance or even crop disease pathing. Moreover, there should also be enhanced connectivity between AI in the two sectors, whereby the flow of data should be efficient amongst them and to the partners, who are the healthcare providers, the food producers and consumers [55].

Enhancement of Policy and Regulation The mutation of AI-technologies requires a clear regulatory framework that will be used to ensure that the tools are applied in the right way and pretty safely. Policymakers must develop retuned standards and guidelines depending on the pace of advances of AI. In healthcare, it pertains to protection of privacy of the patient; the other is ensuring that the AI systems comply with the standards of health regulations [56]. Some of the matters that should be discussed concerning the food sector are how AI effects the safety and sustainability of the food and how fair it is including the use of resources and behavior of labor. Governments too can promote the study of games of AI that seeks the precise formulations of solutions to world issues like food insecurity, malnutrition and disparity in medical availability among others [57].

The application of ai in healthcare and food systems is effective when there is a combination of experiences of professionals in different areas who come together to implement such technologies, which consist of, include data science, agriculture, medicine, public policy, and ethics. These professionals should work together in order to supplement each other and develop comprehensive solutions that could enable us to exploit the potential of AI and make sure that every sphere of our society would be able to enjoy AI [58]. Future studies must also undertake the formulation of cross sector models so that innovations in AI in healthcare can become transferable to food systems, and innovations in AI in food systems can become transferable to healthcare. Other initiatives should also become concerted in the attainment of the fact that there would be fair allocation of AI technologies to the underserved nations [59].

With increasing incorporation of AI in health-care and food systems, it is of utmost importance to give preference to ethical development of AI. This involves examining the enquiries on bias, transparency, accountability concerning artificial intelligence algorithms [60]. Not only should the design of artificial intelligence models be transparent, but they should also be refined to be interpreted such that they do not get denied discrimination, the most current field being health care and food security. Moral rules must be established so that AI development can comply with human rights, sustainability and environmental, social justice [61].

The possibility, that the future of artificial intelligence in healthcare and food systems is created. By means of technological innovations, engineering transparency, cooperation optimism is in the idea

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that, AI might create significant differences within both industries. The continued growth of the AI, however, reveals a chance of a lifetime to mitigate some of the most imminent world issues, including health disparity and food necessity, so long as people properly plan out how to go there [62].

CONCLUSION

Artificial Intelligence (AI) and healthcare, as well as food systems will be an interesting area of innovation whereby, through significant transformation we will be able to affect both spheres of life. Artificial intelligence systems including: machine learning, natural language processing and computer vision have already begun to create a new vision of health care, organizing diagnostics, personalizing treatment and organizing resource distribution. Similarly, AI can promise to change the functioning of food systems by enhancing the efficacy of the manner food is distributed, elevating the safety of food, and reducing the breakage as well as advancing personalized nutrition.

Despite the opportunities, the realization of the transformation of the use of AI in these industries is challenged by different difficulties. To supply the fact that such aimed solutions are secure and effective, such problems as data privacy, interoperability and regulatory complexity have to be solved. Moreover, the matters of fairness, transparency, and equity must become a priority since AI technologies expand and across many aspects the most important of which is the exacerbation of the gaps that were already present and the process of socializing the benefits of the technological paradigm to encompass all, down to even no communities.

To one day enjoy the full potential of AI in these areas, future enhanced versions must attempt to meet accurate prediction and integration of such models with the reality, to establish a clear regulatory framework, and also encourage cross-disciplinary cooperation. Ethical AI development is relevant in the manner that it is used to make sure that AI tools can bring better people and the planet where people would have a sustainable and fair health and food system. Additionally, the future study ought to center on providing AI answers to certain issues given in the world, such as health equity and famine.

It is an effective system to improve healthcare and food systems around the world with the help of AI, and before being integrated in any context, the corresponding issues, which AI is currently confronting, such as ethics, and the possibility of trans sector collaboration, need to be considered. Living off responsible innovation, the idea of making AI technologies available to the population in an equitable way, we will be able to open a world where the health, sustainability, and well-being of people in the world will start being the focus of AI.

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