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COLLECTIVE HEALTH - TECHNOLOGICAL INNOVATIONS AND THE CHALLENGES OF GLOBAL HEALTH IN THE 21ST CENTURY

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ABSTRACT

This study investigates the impacts of technological innovations on public health systems, with a focus on Collective Health, addressing the opportunities and challenges related to the implementation of emerging technologies such as telemedicine, artificial intelligence (AI), big data, and biotechnology. The research was conducted through a systematic literature review, using academic databases and international sources to select relevant articles and reports published in the last five years. The research methodology involved combining Boolean terms and operators to refine the results and ensure the relevance of the selected studies. The results indicate that, although health technologies have the potential to improve access, efficiency, and disease management, their implementation faces significant barriers, especially in contexts of social vulnerability and limited infrastructure. The ethical issues associated with the use of health data, such as privacy and algorithmic biases, also emerge as important challenges. In addition, public policies play a crucial role in overcoming these barriers, promoting digital inclusion and ensuring that technological innovations are accessible to all layers of the population. The research concludes that, for technological innovations in the health sector to be effectively inclusive and fair, it is necessary to develop public policies that integrate technical and ethical aspects, ensuring equitable access to the benefits of these technologies. International cooperation, strengthening digital health infrastructure, and proper regulation are key elements to ensure fairer and more accessible global health.

Keywords: Technological innovations, Collective Health, Telemedicine, Artificial Intelligence, Health Equity, Public Policies, Ethics, Access to Health.

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INTRODUCTION

The twenty-first century is marked by an unprecedented technological revolution that has redefined all aspects of daily life, especially in the field of health. The development and implementation of technological innovations, such as telemedicine, artificial intelligence (AI), biotechnology, and the use of big data, have provided new possibilities for healthcare, allowing significant advances in the efficiency of treatments, the personalization of care, and the expansion of access to medical services. However, while these innovations open up a promising horizon, they also bring to light a number of challenges that require critical reflection, particularly with regard to equity and social justice. The introduction of these technologies into public health systems has the potential to generate substantial improvements in disease control, health promotion, and the management of health crises, such as the COVID-19 pandemic, but it can also accentuate preexisting inequalities, widening the gap between more developed and developing countries (Bashshur, Shannon, & Smith, 2020; Horton, 2020; Obermeyer et al., 2016).

Thus, Collective Health is faced with a challenging scenario, in which technological innovations need to be carefully integrated into health systems in order to ensure that their benefits reach all social strata, without discrimination or exclusion. The digital divide, for example, represents a significant barrier to the implementation of health technologies in underserved regions, where a lack of infrastructure and professional training prevents technological advances from being harnessed equitably. In addition, ethical and privacy issues involving the use of health data and the potential for algorithmic biases present in AI systems demand stricter regulation so that the technology does not reproduce discrimination or amplify inequalities (Pope et al., 2019; Obermeyer et al., 2016).

This text aims to explore, in detail, the main technological innovations in the field of health, discussing both positive and negative impacts on global public health systems. The objective is to analyze the challenges that arise with the integration of these new technologies, as well as the strategies that can be adopted to ensure that technological advances translate into more accessible, efficient and fair health. To this end, a reflection will be made on the importance of robust international cooperation and the creation of inclusive public policies that ensure that the use of technology in health benefits all populations, leaving no one behind (Gibson, Rosen, & Stucker, 2015; World Health Organization [WHO], 2020).

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METHODOLOGY

The present study adopts a qualitative exploratory approach, with the objective of investigating the impacts of technological innovations on Collective Health, analyzing their effects on public health systems, especially with regard to access, equity and effectiveness of care. To this end, the research was conducted through a systematic literature review, focusing on academic articles, reports from international organizations, and specialized documents on emerging technologies in health. The choice of this method is justified by the need to understand the most current trends and challenges related to the implementation of these innovations, in addition to evaluating the ethical and social implications of their use.

The type of study adopted is the literature review, whose selection of articles, books and case studies followed strict criteria of relevance and recency. Studies published between 2018 and 2023 were prioritized in order to ensure that the analysis reflected the most recent advances in the field of public health and emerging technologies, such as telemedicine, artificial intelligence (AI), big data, and biotechnology. To ensure a more precise and useful approach to the theme in question, Boolean operators such as AND, OR, and NOT were used to intersect the key terms of the research, among which the following stand out: "health technology", "telemedicine", "artificial intelligence", "access to health", "health inequality", and "public health policies". For example, searches were carried out such as "telemedicine" AND "health inequality" and "artificial intelligence" AND "access to health" AND "ethics", in order to refine the search and ensure the relevance of the articles found.

The research was carried out in several scientific databases, such as PubMed, Scopus, Web of Science and Google Scholar, which are widely recognized for the quality and scope of the publications. These databases provide access to peer-reviewed academic articles, technical documents, and reports from international organizations, which are essential for the development of a critical and reasoned analysis of the impact of technological innovations on health systems. Initially, about 300 articles were found that dealt with the topics of interest, however, many did not meet the criteria of recency or relevance, or were outside the scope of the study, thus being excluded.

After applying filters of year of publication (prioritizing articles between 2018 and 2023), language (only articles in Portuguese and English), type of study (prioritizing empirical articles, reviews, and institutional reports), and accessibility (giving preference to studies with complete access to the text), the number of selected articles was reduced to

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50. These articles underwent a detailed analysis, focusing on approaches to the use of emerging technologies in public health, critical analysis of the digital divide, and ethical issues involving the use of health data, such as privacy and algorithmic biases.

The selected studies addressed various aspects of the topic, including the effectiveness of telemedicine in addressing inequality in access to medical care, the application of artificial intelligence in the diagnosis and management of diseases, the implications of using big data to personalize treatments, and the ethical issues surrounding the use of these technologies. In addition, special attention was paid to public policies that seek to promote social inclusion in the use of technologies, in order to ensure more equitable and just access to the benefits provided by these technological innovations

RESULTS AND DISCUSSION

Collective Health in the twenty-first century is in a phase of intense transformations, driven by technological innovations that, although they offer new horizons, also impose significant challenges on the global health system. The advancement of technologies, such as telemedicine, artificial intelligence (AI), biotechnology, and the use of big data, has the potential to reconfigure the dynamics of public health care, promoting improvements in the effectiveness of treatments and expanding access to health care. However, these innovations can also widen inequalities in access and, consequently, create new barriers between countries and between different social strata within the same country. Integrating new technologies into public health systems requires careful alignment with local needs, ensuring that technological advancement does not translate into exclusion and inequality (Bashshur et al., 2020; Horton, 2020; Obermeyer et al., 2016).

Telemedicine, for example, represents a considerable advance in access to healthcare, especially in remote regions and during health crises, such as the COVID-19 pandemic, when physical distancing was necessary to ensure the safety of populations. However, the use of these technologies is limited by the digital divide, an issue that primarily affects developing countries and low-income populations. The lack of adequate technological infrastructure and the scarcity of professional training to operate these tools result in unequal access to the benefits of telemedicine. In many cases, the introduction of digital health technologies in places without a solid infrastructure can result in the further marginalization of already vulnerable populations, exacerbating existing inequalities in access to care (Pope et al., 2019; Bashshur et al., 2020).

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In addition, the application of artificial intelligence and big data in public health opens up innovative possibilities for the prevention and early diagnosis of diseases. AI has the ability to analyze large volumes of data, identify epidemiological patterns, and personalize treatments, which can substantially improve efficiency and accuracy in patient care. However, the implementation of these systems also raises serious questions about data privacy and algorithmic biases, which can reproduce biases and discriminate against certain social groups, especially those in vulnerable situations. Proper regulation of the use of personal data and ethical oversight of AI technologies are therefore essential to ensure that these advancements do not result in exclusion or discrimination (Obermeyer et al., 2016).

Biotechnology, in turn, has shown great potential in the revolution of medical treatments, with the development of personalized therapies, based on the genetic profile of each individual, and in the treatment of diseases that were previously incurable. However, the high cost of these therapies and the complexity of the infrastructures required for their large-scale implementation pose significant challenges to their adoption in public health systems. Biotechnology may therefore end up benefiting only the highest social strata, further exacerbating inequalities in access to advanced treatments (Gibson et al., 2015). Responding to these challenges requires a global regulatory approach that ensures that the benefits of biotechnology can be shared fairly, even in low- and middle-income countries (WHO, 2020).

On the other hand, global challenges to health are not limited to technology, but are deeply rooted in issues of structural inequality. Globalization has allowed the constant flow of people, food, products and diseases, which facilitates the spread of epidemics and increases the vulnerability of populations to health risks. The COVID-19 pandemic has exposed the weaknesses of health systems in many countries and the disparity in access to care, revealing the urgent need for more effective international cooperation to address global health crises (Horton, 2020). Antimicrobial resistance, for example, is one of the major threats to global health in the twenty-first century, and its resolution depends on coordinated action to ensure the responsible use of antibiotics and other therapies (WHO, 2020).

Population aging is another crucial challenge, with the increasing prevalence of chronic diseases such as hypertension, diabetes, and cardiovascular disease requiring significant changes in the way healthcare is organized. The longevity of the population,

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especially in developed countries, demands a health system adapted to the new needs of an older population, with a focus on primary health care and health promotion, to prevent the health system from being overloaded. Primary health care is essential for comprehensive care, which is not limited to the treatment of diseases, but is also aimed at prevention and the well-being of the population throughout their lives (World Health Organization, 2015; Starfield, 2003). In this sense, emerging technologies can play a significant role, offering tools for remote monitoring and early interventions, improving access to care and continuity of treatment for chronic diseases.

Another relevant aspect in the current context is the growing urbanization, which has contributed to the increase in lifestyle-related diseases, such as obesity, cardiovascular diseases, and respiratory diseases, especially in large urban centers. Urbanization, by creating environments with high levels of pollution and sedentary lifestyle, requires a public health approach that contemplates not only curative care, but also the promotion of healthy lifestyles and health education (Watts et al., 2018). Digital technologies, such as online health platforms and monitoring apps, can help promote healthy habits by providing data on physical activity, diet, and mental health, but their implementation must be carefully planned to ensure that all segments of the population, especially the poorest, have access to these resources.

Finally, the construction of a truly global health system requires constant and multidisciplinary international cooperation, in which countries of different economic and social realities share knowledge, resources, and experiences. Global solidarity and the integration of health technologies are key to addressing health threats such as emerging diseases and antimicrobial resistance, as well as providing a more resilient health system capable of responding to public health crises more effectively and quickly (WHO, 2020). The COVID-19 pandemic, despite its devastating effects, has shown the importance of international collaboration in combating global threats, highlighting that health is a collective issue, which requires coordinated and integrated responses (Horton, 2020).

In short, technological innovations in the field of health represent a significant potential for improving care and quality of life for populations. However, its successful implementation depends on a balanced approach, which takes into account not only technical advances, but also the ethical, social and economic aspects that shape the reality of each country and each community. Building an equitable and accessible global health system requires a deep reflection on how technologies can be integrated into health

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systems in a way that benefits all, without excluding the most vulnerable, and without losing sight of social justice and international solidarity.

CONCLUSION

The analysis of technological innovations in the field of public health reveals a scenario of complexity and ambiguity, in which technological advances offer significant opportunities to transform public health systems, while presenting substantial challenges in terms of access, equity, and ethics. Technologies such as telemedicine, artificial intelligence (AI), big data, and biotechnology have the potential to improve the efficiency of healthcare, expand access to treatments and services, and even optimize the management of chronic diseases and epidemics. However, its implementation must be carefully planned and regulated, so as to ensure that pre-existing inequalities are not perpetuated or amplified, but rather that they contribute to a more inclusive and equitable health model.

From the literature review and the analysis of the selected studies, it was evident that, although technological innovations can contribute substantially to the improvement of health services, their adoption in public systems faces significant obstacles, especially in developing countries. The digital divide and lack of adequate infrastructure are barriers that hinder the effective implementation of these technologies in contexts of vulnerability. In addition, the use of technologies such as AI and big data raises complex ethical questions related to privacy and the possibility of algorithmic biases that can reproduce or even increase existing inequalities in health care.

On the other hand, public policies are fundamental in overcoming these challenges, and it is necessary to develop strategies that promote digital inclusion, professional training and the accessibility of technologies for all populations, without discrimination or exclusion. The creation of a robust regulatory environment, which ensures the protection of personal data and transparency in the use of algorithms, is also crucial so that the benefits of technological innovations in health are not distorted by commercial interests or algorithmic biases.

Therefore, the successful implementation of health technologies will depend on an integrated approach, involving not only health professionals, but also governments, international organizations, and civil society. It must be ensured that technological innovations are used as tools to achieve a fairer and more equitable global health, where

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advances are not only technological, but also social, effectively benefiting all layers of the population, especially the most vulnerable.

This study demonstrated that, despite the transformative potential of health technologies, it is essential to adopt inclusive public policies that integrate technical and ethical aspects, so that the benefits of these innovations can be enjoyed in a fair and equitable manner. International cooperation and building a strong digital public health infrastructure will be key to addressing the challenges posed by inequality in access and technological gaps, ensuring that public health in the twenty-first century is truly accessible and fair for all.

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