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Opinion

Sixth wave of global public health progress

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ABSTRACT

The "Sixth Wave of Global Public Health Progress" concept introduces a transformative approach to address contemporary health challenges by leveraging historical advancements and innovative strategies. This wave emphasizes the integration of data-driven decision-making, personalized public health, and technological innovations, such as artificial intelligence and digital tools, to enhance global health outcomes. By focusing on the connectedness of human, animal, and environmental health systems through the One Health approach, the framework aims to tackle critical threats like climate change, pandemics, and social inequities. It advocates for global collaboration, community-centric approaches, and sustainable practices to ensure equitable health access. Ultimately, this paper proposes a comprehensive framework that catalyzes social and scientific discourse, paving the way for resilient and adaptive health systems that align with the United Nations' Sustainable Development Goals.

We propose the "Sixth wave or era of Global Public Health Progress" concept, which emphasizes the necessity for the public health sector to continue its historical advancements to tackle humanity's most significant threats, such as climate change, pandemics, and conflicts, while striving to meet the 2030 sustainable development goals. This proposed sixth wave seeks to build on the achievements of previous waves by incorporating innovative strategies to address current and future global health challenges. The focus is on determining the key techniques and approaches required to initiate this wave effectively.

The evolution of public health can be characterized by distinct developmental "waves or eras," each marked by significant advancements and shifts in focus. These phases reflect societies' adaptive strategies to address emerging health challenges and capitalize on new opportunities over time [1].

The Era of Infectious Diseases (Antiquity—19th Century) was predominantly concerned with combating infectious diseases through public health measures to control the spread of pathogens. Key strategies included enhancing sanitation, ensuring the provision of clean water, and isolating infected individuals. These foundational public health actions, such as basic hygiene practices and the establishment of quarantines, were instrumental in reducing transmission rates and managing outbreaks [1].

Era of Disease Prevention (Late 19th Century - 20th Century): With the advent of microbiology and the development of vaccines, the focus of public health shifted towards preventive measures. Immunization campaigns and health education became central components in the fight against infectious diseases. This period saw a significant reduction in morbidity and mortality rates as vaccines were developed for diseases such as smallpox, polio, and measles, highlighting the efficacy of prevention over treatment [1].

Era of Medical Care (Mid-20th Century); during this period, there was an increased emphasis on expanding access to medical care and improving treatment options for various diseases. Establishing more structured public health systems facilitated the delivery of medical services, making healthcare more accessible to broader populations. This era also witnessed the development of antibiotics and other medical technologies that transformed the management of infectious and chronic diseases [1].

In the Era of Risk Factors (1960s—1990s); public health focused on identifying and modifying risk factors associated with chronic diseases. Efforts were directed towards reducing smoking prevalence, promoting healthier diets, and encouraging physical activity. Public health

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campaigns aimed at lifestyle changes became common, as evidence mounted linking behavioral factors to conditions such as heart disease, cancer, and diabetes [2].

Era of Global Health and Social Determinants (Late 20th Century—Early 21st Century): Recognizing social determinants of health, such as poverty, education, and environmental conditions, became increasingly important. This era marked a shift towards understanding and addressing the broader socio-economic factors that impact health outcomes. Additionally, the interconnectedness of global health systems became a central focus, emphasizing the need for international collaboration in addressing health challenges that transcend national borders [2].

Era of Digital and Personalized Health (Sixth wave of public health); technological advancements have ushered in a new era of public health, using data, artificial intelligence, and digital tools to tailor healthcare interventions. Personalized medicine and health monitoring at both individual and population levels are becoming increasingly feasible, offering the potential to enhance the precision and effectiveness of public health strategies. A crucial aspect of this approach is the "One Health" concept, which acknowledges the interconnectedness of climate, animals, conflicts, and human health. The COVID-19 pandemic has profoundly affected all age groups, revealing short-, medium-, and long-term consequences, particularly for vulnerable populations. It has forced health systems worldwide to respond creatively, leaving valuable lessons and challenges for future public health initiatives. The pandemic has underscored the necessity of prioritizing public health in political decisions, as global stability and survival depend on it [3,4].

These developmental "waves" illustrate how public health has continuously evolved, adapting to new scientific discoveries and societal changes. This progression shows the inner dynamic of public health in addressing the planet's complex challenges.

The COVID-19 pandemic has accelerated scientific and human efforts, demanding higher levels of humanity, efficiency, and governance [5,6]. The sixth wave should focus on societal values, scientific acceleration and transparency, a green economy, organizational and community resilience, and ethical standards [7,8]; transitioning from the fifth to the sixth wave is ongoing. This sixth wave urgently needs transformation in health systems, new care models, mental health and behavioral changes [9,10], and climate change impacts.

Promoting social development with an ecological mindset is crucial. COVID-19 highlighted the need to address social inequities effectively to face future health challenges [11,12]. No country was fully prepared for the pandemic's impact, necessitating systemic changes and prioritizing social welfare in healthcare services [13–15]. The pandemic has shown the importance of integrating various knowledge areas—epidemiology, sociology, communication, economics, political science, and environmental sciences—to achieve positive outcomes. Innovative tools and the power of social media are essential for facing new threats, emphasizing the need to understand information flows, social media algorithms, and AI's role in society.

Public health must constantly reinvent, adapt, and modernize to protect health and well-being in ever-changing societies. Creating useful knowledge from the abundant data generated during the pandemic is crucial for timely policy and decision-making. The pandemic has highlighted the need for a fresh wave of public health improvement, considering the changing world, evolving threats, and diverse communities.

Some essential goals and concepts for transitioning to the sixth wave of public health improvement include big data-driven decision-making and analytics to predict and manage health trends and personalized public health, which leverages genomics, wearable technology, and personalized medicine to create tailored health interventions. Integrated healthcare systems ensure seamless integration between public health systems and clinical care, adopting a holistic approach to health. This includes better coordination between different healthcare providers and public health agencies. Global collaboration is necessary to enhance international cooperation in tackling global health threats, sharing data, resources, and best practices across borders to address pandemics, climate change, and antibiotic resistance. Social-focused strategies engage local populations in creating and carrying out public health projects, ensuring culturally relevant interventions with local support, which is vital for success. Technological advancements, such as artificial intelligence, machine learning, telemedicine, and blockchain, can enhance health outcomes and make public health processes more efficient. Additionally, health equity emphasizes minimizing health inequalities and ensuring all community groups access the resources needed for optimal health, addressing social factors like education, housing, and income. Integrating sustainability involves including environmental health in public health plans to tackle climate change effects and encourage sustainable methods that safeguard human health and the environment. Preventive healthcare shifts attention from disease treatment to prevention, advocating for healthy living, vaccination initiatives, and early intervention methods to lessen the impact of chronic illnesses. Finally, policy and advocacy efforts aim to strengthen public health policies and champion laws and regulations that foster health, such as tobacco control, food safety, and environmental protection.

In today's interconnected world, developing new global health strategies is imperative to effectively tackle emerging health threats like pandemics, antibiotic resistance, and infectious diseases. These threats can rapidly cross borders, necessitating a coordinated global response for effective containment and management. Many countries, particularly those with low—and middle-income levels, experience significant health inequities. Adopting a new international health approach can help mitigate these disparities by enhancing access to healthcare, improving health infrastructure, and ensuring the equitable distribution of resources and vaccines.

As globalization and mobility increases, the movement of people and goods can accelerate the spread of diseases. A robust global health framework is essential for monitoring and controlling health threats more effectively and ensuring swift containment of outbreaks. Additionally, climate change significantly impacts global health. Innovative global health strategies must confront these challenges and protect vulnerable populations.

Health is pivotal to the United Nations' Sustainable Development Goals (SDGs). A comprehensive global health initiative can align with these goals to enhance health outcomes, reduce poverty, and foster sustainable development worldwide. The rapid evolution of healthcare technologies, including digital health tools and telemedicine, calls for reevaluating global health strategies. By effectively integrating these innovations, we can ensure they are accessible to all, improving healthcare delivery globally.

Collaboration among countries, international organizations, and the private sector is crucial for developing effective global health policies and practices, but fundamentally in social thinking, a new wave or era of attention and health development. These partnerships can lead to improved health management and delivery, ultimately advancing global health outcomes and ensuring a healthier future.

This paper's true contribution lies in introducing an innovative-framework and social thought for social and scientific discourse onhealth rooted in the One Health concept. This frame framework and social thought for social and scientific discourse on health rooted in the One Health concept. This framework intricately weaves together the multifaceted impacts of the COVID-19 pandemic, the transformative capabilities of artificial intelligence, and the expansive reach of digital resources. By doing so, it not only catalyzes contemporary health discourse but also signals the advent of a new historical epoch within the field of public health.

The One Health framework is central to this discussion, highlighting the interdependence of human, animal, and environmental health systems. It promotes a cooperative, cross-sectoral strategy for addressing health issues, acknowledging the close ties between human well-being,

animal health, and our environment. This highlights the necessity for a more unified approach to managing health [16].

Furthermore, we call attention to how artificial intelligence can be harnessed to address these complex interdependencies. AI offers powerful tools for data analysis, predictive modeling, and personalized healthcare, enabling new disease surveillance, diagnosis, and treatment strategies. These technological advancements are complemented by digital resources, which facilitate remote health monitoring, telemedicine, and access to health information, broadening public health interventions' reach and effectiveness [17].

This paper synthesizes these elements and posits that we are at the threshold of a transformative period in public health. By leveraging the synergies between the One Health concept, AI, and digital innovation, we can foster more resilient health systems, enhance disease prevention efforts, and promote global health security. This comprehensive approach addresses current health challenges and prepares us for future pandemics and health crises, establishing a robust foundation for the ongoing evolution of public health.

Ethical approval and consent to participate

The data used in this study are public sources of information, and ethical approval was already obtained by the institutions responsible for its implementation in each country. Databases are anonymous, ensuring data confidentiality.

Consent for publication

All authors reviewed and approved the manuscript for publication.

Availability of data and materials

Data is available upon reasonable request.

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CRediT authorship contribution statement

Jesus Cortes: Writing – original draft, Conceptualization. **Deborah Aluh:** Writing – review & editing. **Inês Fronteira:** Writing – review & editing. **Diana Gil:** Writing – review & editing. **Pedro Aguiar:** Supervision.

Declaration of competing interest

We declare no competing interests.

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Data availability

No data was used for the research described in the article.

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