Artificial Intelligence in Collective Health Campaigns: Potentialities and Challenges for SUS

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Abstract

Introduction: The Fourth Industrial Revolution has boosted the use of technologies such as artificial intelligence (AI) in the public sector, including healthcare. AI can potentially optimize public health campaigns by enabling predictive analysis and more effective strategies. **Objective:** To identify, in the current literature, ways of applying AI in public health campaigns, focusing on its use in the SUS. **Methodology:** Integrative literature review, with searches in databases such as Medline and Lilacs. Free, complete texts, in Portuguese or English, that addressed the use of AI in public health were included. **Results:** Five major areas of application of AI were identified: epidemiological surveillance, vaccination campaigns, patient support, health education, and combating misinformation. Brazilian initiatives include models to predict tuberculosis outbreaks and data-driven vaccination strategies. **Discussion:** Despite advances, there are still gaps between theory and practice. Studies point to obstacles such as algorithmic biases and, lack of specific regulation. Effective implementation requires legal frameworks and interdisciplinary action. **Conclusion:** AI can improve SUS campaigns, but its adoption requires strategic planning, ethical regulation, and integration with public policies.

Key-words: Artificial Intelligence; Public Health; Health Campaigns; SUS; Technological Innovation

Resumen

Inteligencia Artificial en Campañas de Salud Colectiva: Potencialidades y Desafíos para el SUS

Introducción: La Cuarta Revolución Industrial ha impulsado el uso de tecnologías como la inteligencia artificial (IA) en el sector público, incluida la atención médica. La IA tiene el potencial de optimizar las campañas de salud pública al permitir análisis predictivos y estrategias más efectivas. **Objetivo**: Identificar, en la literatura actual, formas de aplicación de la IA en campañas de salud pública, con foco en su uso en el SUS. **Metodología**: Revisión integradora de la literatura, con búsquedas en bases de datos como Medline y Lilacs. Se incluyeron textos gratuitos y completos en portugués o inglés que abordan el uso de IA en salud pública. **Resultados**: Se identificaron cinco áreas principales de aplicación de la IA: vigilancia epidemiológica, campañas de vacunación, apoyo al paciente, educación sanitaria y lucha contra la desinformación. Las iniciativas brasileñas incluyen modelos para predecir brotes de tuberculosis y estrategias de vacunación basadas en datos. **Discusión**: A pesar de los avances, aún existen brechas entre la teoría y la práctica. Los estudios señalan obstáculos como sesgos algorítmicos, falta de regulación específica. Una implementación efectiva requiere marcos legales y acción interdisciplinaria. **Conclusión**: La IA puede mejorar las campañas del SUS, pero su adopción requiere planificación estratégica, regulación ética e integración con políticas públicas.

Palabras clave: Inteligencia Artificial; Salud pública; Campañas de Salud; SUS; Innovación tecnológica

Resumo

Inteligência Artificial em Campanhas de Saúde Coletiva: Potencialidades e Desafios para o SUS

Introdução: A Quarta Revolução Industrial impulsionou o uso de tecnologias como a inteligência artificial (IA) no setor público, incluindo a saúde. A IA tem potencial para otimizar campanhas de saúde coletiva ao permitir análises preditivas e estratégias mais eficazes. **Objetivo**: Identificar, na literatura atual, formas de aplicação da IA em campanhas de saúde coletiva, com foco em sua utilização no SUS. **Metodologia**: Revisão integrativa de literatura, com buscas em bases como Medline e Lilacs. Foram incluídos textos gratuitos, completos, em português ou inglês, que abordassem o uso da IA na saúde coletiva. **Resultados**: Foram identificadas cinco grandes áreas de aplicação da IA: vigilância epidemiológica, campanhas de vacinação, suporte ao paciente, educação em saúde e combate à desinformação. Iniciativas brasileiras incluem modelos para prever surtos de tuberculose e estratégias vacinais baseadas em dados. **Discussão**: Apesar dos avanços, ainda existem lacunas entre teoria e prática. Estudos apontam obstáculos como vieses algorítmicos, ausência de regulação específica e limitações. A implementação efetiva exige marcos legais e ação interdisciplinar. **Conclusão**: A IA pode aprimorar campanhas do SUS, mas sua adoção requer planejamento estratégico, regulação ética e integração com políticas públicas.

Palabras-chave: Inteligência Artificial; Saúde Pública; Campanhas de Saúde; SUS; Inovação Tecnológica

INTRODUCTION

The fourth industrial revolution[1], characterized by the extensive use of information technologies such as artificial intelligence (AI), nanotechnology, quantum computing, augmented reality, and the Internet of Things, has triggered profound and rapid transformations towards a digital society. Organizations, including public institutions, are adapting to this new production model to improve their performance and optimize the delivery of services[2].

The COVID-19 pandemic has significantly accelerated the demand for public policies that use digital tools such as applications, digital platforms, telemedicine, big data, and artificial intelligence[2]. Among these, artificial intelligence is one of two major fields currently under research. It can be understood as a discipline focused on creating and analyzing computational agents capable of performing tasks intelligently[3]. These agents are essentially autonomous software programs that interact with their environment, collect information, make decisions, and execute actions to achieve specific objectives[4]. Consequently, the integration of digital tools has become essential in the realm of public policies and in the field of public health[2].

Public health is a field of production of multidisciplinary and interdisciplinary knowledge aimed at understanding health and its determinants, with a priority focus on health promotion and community well-being[5]. One significant area of focus is health campaigns, which constitute a promotional strategy to increase public awareness and education, improving quality of life[6]. Despite ongoing challenges in this field, many can be addressed through technological advances, especially with the use of AI.

Health campaigns play an essential role in delivering health promotion services, focusing on educating the population and supporting preventive practices. However, these initiatives often face ongoing challenges such as low vaccine uptake and resistance to preventive practices. Considering the potential of AI to personalize, optimize, and expand communication strategies and interventions in public health, it is crucial to investigate how this technology can be effectively integrated into these campaigns.

This study aims to identify, through an integrative literature review, the main forms of application of artificial intelligence in collective health campaigns in the Single Health System (SUS-Sistema Unico de Saude), with a focus on strategies aimed at promoting health and expanding population adherence.

METHODOLGY

This is an integrative review of literature, according to the methodology proposed by Whittemore and Knafl (2005)[7], which allows different types of studies to provide a broader understanding of the topic investigated. The temporary cut was established between 2023 and 2024 to capture the most current initiatives aligned with recent technological evolution, mainly after the COVID-19 pandemic.

The inclusion criteria are: (i) publications in Portuguese or English, (ii) full and free texts, (iii) publications that directly address the use of AI in collective health, with a focus on health promotion campaigns and/or population development strategies. The studies excluded are the ones that only address the application of AI in clinical or hospital environments.

The search was carried out in the Medline and Lilac databases. The search terms include keyword combinations such as "Inteligência Artificial", "e-Saúde", "Promoção da Saúde", "Campanhas de Vacinação", "Saúde Coletiva", "Public Health Campaigns", "Artificial Intelligence", and "Health Promotion".

The selection of two studies is carried out in two stages: (i) reading of titles and abstracts according to the inclusion criteria, and (ii) complete reading for thematic analysis. The data extracted are organized in descriptive tables and discussed qualitatively, with emphasis on the practical applications identified, their impact, and challenges for implementation in public policies in the Brazilian context.

RESULTS

The application of Artificial Intelligence (AI) in public health campaigns is advanced in different contexts around the world, including Brazilian and international initiatives. Next, the main sections of literature are presented, organized by thematic areas.

Epidemiological Surveillance and Prediction of Diseases

AI has been essential has proven to be crucial in recognizing epidemiological patterns and forecasting future outcomes, optimizing health interventions. In Brazil, we developed a machine learning model with an AUC-ROC of 0.81 to predict tuberculosis clusters in Amazonian municipalities, which has enabled targeted preventive campaigns in these areas.[8] Similarly, Artificial Neural Networks are being used to predict arbovirus outbreaks, combining climatic and surveillance.[9]

Internationally, the use of predictive models extends to things such as pre-eclampsia[10,11] and rare genetic conditions, such as the lack of use of AI for facial triage in fetuses.[12] Mental health also benefits from these models, such as the Australian study by Chai et al.[13] (2024),

which used AI to predict responses to treatments for anxiety in community services.

Otimization of Vaccination Campaigns

AI has demonstrated significant potential to increase the effectiveness of vaccination campaigns. In Brazil, Cabral et al.[14] (2023) have correlated vaccine coverage with mortality from COVID-19 in Santa Catarina, while Mendes et al.[15] (2023) conducted a comparative analysis among Northeastern states. Their findings suggest strategies informed by predictive models to increase vaccine uptake.

Medical Advice and Patient Support

The use of chatbots in health has been expanded for genetic and oncological counseling,[16] preparations for surgeries,[17,18] and promotion of healthy habits.[19] These technologies offer personalized support, expanding access to information and care.

Education, Engagement, and Social Inclusion

AI tools have also found applications in health education. In Brazil, Silva et al.[20] (2023) developed interactive materials focused on HPV aimed at adolescents, promoting support for preventive examinations. Medical training simulators[19] and virtual reality[21] are being tested to train professionals in realistic and complex environments.

Also, AI-based technologies are being integrated into health campaigns, such as in Africa, where formats are adapted to address various deficiencies[22] In the American context, Bazzano et al.[23] (2024) highlight the role of AI in engaging different publics in prevention actions.

Resource Management and Combating Disinformation

In Brazil, Borba[24] (2023) used machine learning algorithms to predict neonatal mortality, with potential adaptation for preventive campaigns. Brooks et al.[25] (2023) proposed a virtual center against infodemics, using AI to monitor social networks and combat misinformation in times of pandemic.

Health applications integrated with AI also gain space, such as urology[26] and do not support patients with HIV.[27]

DISCUSSION

The findings from this review indicate significant advancements in the use of artificial intelligence (AI) within public health initiatives, both in Brazil and in other countries. These applications range from epidemiological surveillance and outbreak prediction to patient counseling, optimization of vaccination campaigns, and combating misinformation. However, despite this progress, the studies reveal a significant gap between the technical and scientific development of AI-based solutions and their large-scale practical implementation, especially within public health systems like the SUS.

The use of AI for disease prediction, such as tuberculosis in the Amazon[8] and arboviruses[9], demonstrates the potential of technology to anticipate epidemiological scenarios and support the territorial management of campaigns. However, the implementation of these strategies requires data infrastructure, system interoperability, and specialized technical training, elements that are still scarce in several regions of the country. The international literature, such as the studies by Ranjbar et al.[10] (2024) and Hennessy et al.[11] (2024), reinforces that effective predictive models depend on the quality and diversity of databases — a challenge that is even more pronounced in areas with unequal access to technology.

Recent research by Cabral et al. (2023) and Mendes et al. (2023) highlights the potential of AI in identifying critical areas and personalizing strategies to enhance vaccination adherence. However, the implementation of these technologies within the Unified Health System (SUS) remains hesitant, often confined to pilot projects or specific collaborations with academic institutions. Furthermore, while automated engagement tools, such as alert systems and chatbots, show promise, they require validation across diverse populations, taking into account their social and cultural contexts as well as varying levels of digital literacy. Another crucial point revealed in the studies is the ability of AI to support educational and inclusion actions, as in the case of mothers with disabilities[22] and adolescents in HPV prevention campaigns.[20] These experiences suggest that technology can expand access to health and make campaigns more equitable, as long as they are implemented with a focus on diversity and the local context.

However, significant challenges remain in the application of AI within public health, facing ethical and legal issues that have not yet been fully addressed. Colcelli[28] (2024) highlights the risks of algorithmic biases, which can reinforce pre-existing inequalities when applied to vulnerable populations without rigorous control over the quality and representativeness of the data. Cornejo-Plaza and Cippitani29 (2024) warn of the lack of specific regulations for neurodata and other sensitive data, the collection and use of which still lack clear standards in Brazil and many developing countries.

CONCLUSION

The application of artificial intelligence (AI) in public health campaigns has emerged as a promising strategy in both local and global contexts. It has made a significant impact in areas such as epidemiological surveillance, disease prediction, patient counseling, community engagement, and resource optimization. In Brazil, research shows a growing use of AI for predicting outbreaks, allocating resources, and health education, especially in regions with social and structural vulnerabilities. The use of algorithms to identify disease clusters, predict mortality, and optimize vaccination campaigns reveals the potential of technology to support strategic decisions and broaden the reach of preventive actions.

Artificial intelligence is emerging as a strategic tool for strengthening public health campaigns, especially in the Unified Health System (SUS). Its ability to analyze large data sets, predict population behaviors, and customize communication strategies can play a crucial role in increasing the effectiveness of health promotion and prevention actions. However, for its potential to be fully utilized, there must be continuous investment in applied research, professional training, and the development of regulatory frameworks that ensure equity, safety, and transparency in the use of these technologies. The ethical and structured incorporation of AI can represent a significant advancement for the SUS, leading to more effective, inclusive, and evidence-based health campaigns.

REFERENCES

1. Schwab K. Fourth Industrial Revolution. London, UK u. a: PENGUIN GROUP; 2017. 192 p.

2. Souza LFR de. A contribuição do governo digital e da transformação digital para as políticas públicas de saúde [Internet]. [Rio de Janeiro]: Universidade do Estado do Rio de Janeiro; 2023 [citado 19 de julho de 2024]. Disponível em: https://www.bdtd.uerj.br:8443/bitstream/1/21021/2/Tese%20-%20Luiz%20Fernando%20Rezende%20de%20Souza%20-%202023%20-%20Completa.pdf

3. Poole DL, Mackworth AK. Artificial Intelligence: Foundations of Computational Agents [Internet]. 3º ed. Cambridge: Cambridge University Press; 2023 [citado 19 de julho de 2024]. Disponível em: https://artint.info/3e/html/ArtInt3e.html

4. Weiss G. Multiagent Systems: A Modern Approach to Distributed Artificial Intelligence | BibSonomy [Internet]. Cambridge: MIT Press; 1999 [citado 19 de julho de 2024]. 547 p. Disponível em: https://www.uma.ac.ir/files/site1/a_akbari_994c8e8/gerhard_weiss___multiagent_systems___a_modern_approach_to_distributed_artificial_intelligence.pdf

5. Vieira-da-Silva LM, Paim JS, Schraiber L. O que é Saúde Coletiva ? Em: Saúde Coletiva: Teoria e Prática [Internet]. 4º ed Rio de Janeiro: Medbooks; 2014. Disponível em: https://www.unirv.edu.br/conteudos/fckfiles/files/O%20que%20%C3%A9%20sa%C3%BAde%20coletiva.pdf

6. Bugshan W, Qahtani S, Alwagdani N, Alharthi M, Alqarni A, Alsuat H, et al. Role of Health Awareness Campaigns in Improving Public Health:A Systematic Review: Life Sciences-Public Health. International Journal of Life Science and Pharma Research. 8 de setembro de 2022;L29-35. Disponível em: https://www.researchgate.net/publication/363412994_Role_of_Health_Awareness_Campaigns_in_Improving_Public_HealthA_Systematic_Review_Life_Sciences-Public_Health

7. Whittemore R, Knafl K. The integrative review: Updated methodology. Journal of Advanced Nursing. 2005 Dec;52(5):546-53.

8. Silva L, Gomes L, Eberly L. Prediction of tuberculosis clusters in the riverine municipalities of the Brazilian Amazon with machine learning. Revista Brasileira de Epidemiologia. 2024 Jan 1;27.

9. Polo-Triana SI, Sierra YAR, Arias-Osorio JE, Martínez-Vega RA, Lamos-Díaz H. Métodos de aprendizaje automático para predecir el comportamiento epidemiológico de enfermedades arbovirales: revisión estructurada de literatura. Revista de la Universidad Industrial de Santander/Salud UIS. 2022 Nov 28;55(1).

10. Ranjbar A, Montazeri F, Ghamsari SR, Mehrnoush V, Roozbeh N, Darsareh F. Machine learning models for predicting preeclampsia: a systematic review. BMC pregnancy and childbirth (Online). 2024 Jan 2;24(1).

11. Hennessy A, Tran TH, Sasikumar SN, Al-Falahi Z. Machine learning, advanced data analysis, and a role in pregnancy care? How can we help improve preeclampsia outcomes? Pregnancy Hypertension. 2024 Sep 1;37:101137-7.

12. Tang J, Han J, Xie B, Xue J, Zhou H, Jiang Y, et al. The Two-Stage Ensemble Learning Model Based on Aggregated Facial Features in Screening for Fetal Genetic Diseases. International journal of environmental research and public health [Internet]. 2023;20(3):2377. Available from: https://pubmed.ncbi.nlm.nih.gov/36767743/

13. Chai KEK, Graham-Schmidt K, Lee CMY, Rock D, Coleman M, Betts KS, et al. Predicting anxiety treatment outcome in community mental health services using linked health administrative data. Scientific Reports. 2024 Sep 4;14(1).

14. Cabral LD, Longo PMG, Lima LC, Prudêncio AL de M, Silva HCG. Avaliação da correlação entre cobertura vacinal e mortalidade por covid-19 em Santa Catarina. Revista de APS [Internet]. 2023 Nov 22 [cited 2024 Apr 4];26. Available from: https://periodicos.ufjf.br/index.php/aps/article/view/e262338999

15. Mendes RC, Sousa FM, Siqueira HDS, Santos CJA dos, Teixeira PH, Santos PH, et al. Cobertura Vacinal: Uma Análise Comparativa Entre Os Estados Da Região Nordeste Do Brasil Com Ênfase No Estado Do Maranhão. Arquivos de Ciências da Saúde da UNIPAR (Impresso). 2023 Jul 27;27(7):4120-34.

16. Webster EM, Ahsan MD, Perez L, Levi SR, Thomas C, Christos P, et al. Chatbot Artificial Intelligence for Genetic Cancer Risk Assessment and Counseling: A Systematic Review and Meta-Analysis. JCO Clinical Cancer Informatics. 2023 Sep 1;(7).

17. Lee JC, Hamill CS, Shnayder Y, Buczek E, Kiran Kakarala, Bur AM. Exploring the Role of Artificial Intelligence Chatbots in Preoperative Counseling for Head and Neck Cancer Surgery. The Laryngoscope. 2023 Dec 21;

18. Shiraishi M, Tanigawa K, Tomioka Y, Miyakuni A, Moriwaki Y, Yang R, et al. Blepharoptosis Consultation with Artificial Intelligence: Aesthetic Surgery Advice and Counseling from Chat Generative Pre-Trained Transformer (ChatGPT). Aesthetic Plastic Surgery. 2024 Apr 8;48(11):2057-63.

19. Suazo Galdames I. Chatbots for Promoting Healthy Habits and Scientific Culture. International Journal of Medical and Surgical Sciences. 2023 Dec 27;1-4.

20. Silva PGC, Ferreira IP, Vasconcelos LA de, Jesus HG de, Gonçalves TF, Peixoto IVP. Construction and validity of educational technology about the human papillomavirus vaccine for adolescents. Revista Brasileira de Enfermagem [Internet]. 2023 [cited 2024 Nov 7];76(suppl 4). Available from: https://www.scielo.br/j/reben/a/QqDvN5nhJJnWZWjnLCPLSjL/?lang=en

21. Zisquit M, Shoa A, Oliva R, Perry S, Anat Brunstein Klomek, Slater M, et al. AI-Enhanced VR Self-talk for Psychological Counseling: A Formative Qualitative Study (Preprint). JMIR Formative Research [Internet]. 2024 Oct 21 [cited 2024 Apr 2]; Available from: https://doaj.org/article/4f93d6b02f3f4c729c1b2142eeb05ade

22. Bolarinwa O, Mohammed A, Igharo V, Shongwe S. Leveraging artificial intelligence for inclusive maternity care: Enhancing access for mothers with disabilities in Africa. Women's health (London, England) [Internet]. 2024;21:17455057251326675. Available from: https://pubmed.ncbi.nlm.nih.gov/40089873/

23. Bazzano AN, Mantsios A, Mattei N, Kosorok MR, Culotta A. AI Can Be a Powerful Social Innovation for Public Health if Community Engagement Is at the Core. Journal of medical Internet research [Internet]. 2024 Summer;27:e68198. Available from: https://pubmed.ncbi.nlm.nih.gov/39841529/

24. Borba MF. Análise da generalização de algoritmos de machine learning e suas aplicações na otimização de decisões em saúde. 2023 May 19 [cited 2024 Apr 4]; Available from: https://www.teses.usp.br/teses/disponiveis/6/6141/tde-05022024-163230/pt-br.php

25. Brooks I, D'Agostino M, Marti M, McDowell K, Mejia F, Betancourt-Cravioto M, et al. An anti-infodemic virtual center for the Americas. Revista panamericana de salud pública (Impresa). 2023 Mar 10;47:1-1.

26. Shah YB, Ghosh A, Hochberg A, Mark JR, Lallas CD, Shah MS. Artificial intelligence improves urologic oncology patient education and counseling. The Canadian journal of urology [Internet]. 2024 Oct;31(5):12013-8. Available from: https://pubmed.ncbi.nlm.nih.gov/39462532/

27. Koh MCY, Ngiam JN, Yong J, Tambyah PA, Archuleta S. The role of an artificial intelligence model in antiretroviral therapy counselling and advice for people living with HIV. HIV medicine (Print). 2024 Jan 2;

28. Colcelli V. O quadro jurídico da União Europeia para o uso de inteligência artificial e bases de dados de imagens e biobancos de imagens para fins de pesquisa: aplicando a noção de justiça| Cadernos Ibero-Americanos de Direito Sanitário [Internet]. Cadernos Ibero-Americanos de Direito

Sanitário. 2024 [cited 2024 Apr 4]. Available from: https://www.cadernos.prodisa.fiocruz.br/index.php /cadernos/article/view/1288/1654

29. Cornejo-Plaza I, Cippitani R. Los Neurodatos y su protección frente a la Inteligencia Artificial y las Neurotecnologías. CADERNOS IBERO-AMERICANOS DE DIREITO SANITÁRIO [Internet]. 2024 Nov 20 [cited 2024 Apr 4];13(4):110-23. Available from: https://www.cadernos.prodisa.fiocruz.br/index.php /cadernos/article/view/1289

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