New Technological And Innovative Strategies For Disease Surveillance And Control: A Systematic Review

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Abstract

Background: New technological advancement in disease surveillance and control is an emerging issue globally. This is particularly associated with the improvement in public health functions including prevention, timely reporting and rapid response for infectious diseases globally.

Aim: This systematic review will examine the effectiveness of new technological advancement in disease surveillance and control through literature review.

Method: To perform systematic review, researches published between 2019 and 2023 were included. Search was done through search engines including Google scholar, Web of Science and Scopus.

Inclusion and exclusion criteria: Inclusion criteria were, researches should be in published din English, studied the effectiveness of technological advancement for disease control and surveillance. In total eight studies were included after initial screening and quality assessment out of 58,200 searched articles.

Results: In total 54 researches were found relevant based on the key words used for the search. Out of these only 08 researches were more relevant with the study scope. Findings of the systematic review revealed that technological advancement in disease prevention and control was found more effective for disease prevention, reporting and rapid response, especially for infectious diseases.

Conclusion: The study concluded that new technological advancement can bring more accuracy to modern method of treatment, would be more effective in timely reporting of pandemic or in outbreak of infectious diseases. Therefore, a more exclusive research needs to be done in developing countries too, to strengthen the more global approach towards disease prevention and surveillance.

Key words: Disease surveillance, technological advancement, disease control, new technology

Introduction

During the twentieth century, before the advent of advanced technology, infectious diseases stood as the primary cause of millions of deaths globally. Smallpox, plague, and cholera-wreaked havoc, claiming millions of lives before the implementation of more effective control measures in the twentieth century (Golinelli

D, 2020). The past few years have witnessed the resurgence of infectious diseases, posing a global threat. Pathogens such as coronavirus, influenza (H5N1), severe acute respiratory syndrome (SARS), Ebola, chikungunya, and dengue have resulted in significant mortality rates in West Africa, the Middle East, and various other countries (WHO, 2019). Despite technological advancements in disease control, infectious diseases continue to be a leading cause of death, particularly in low and middle-income countries. (Alruwili et al., 2023; Noshili et al., 2023)

To address the high mortality rates and the impact of outbreaks, the World Health Organization (WHO) has recommended infectious disease surveillance at multiple levels and through various methods. These include community-based surveillance, active surveillance, and passive surveillance (Park, 2018). Technological advancements in disease surveillance and control have been widely accepted globally. Many countries have adopted different emerging technologies to enhance governance and provide individuals with access to their data, with a focus on safety, security, and individual control, as seen in Germany and the US (Zuckerberg et al., 2019).

The urgency for effective public health surveillance became evident with the outbreak of the COVID-19 pandemic. Public health surveillance is a critical component of health systems, indicating health-related threats and facilitating effective disease surveillance. It plays a crucial role in early intervention, prevention, and timely responses to epidemics and pandemics. However, in many countries, existing disease surveillance systems are poorly coordinated, resulting in less effective early threat detection. (Altalhi et al., 2023; Yakout et al., 2023; Noshili et al., 2023)

The World Health Organization (WHO) defines public health surveillance as the "continuous, systematic collection, analysis, and interpretation of health-related data, required for planning, implementation, and evaluation of public health" (WHO, 2019). To enhance health information systems, WHO proposes that by 2025, the establishment of effective and integrated disease surveillance systems in all countries, including low and middle-income countries, must be followed. (Al Ali et al., 2022; Alselaml et al., 2023; Alselami et al., 2023; Alruwaili et al., 2023)

In the face of increasing outbreak risks and infectious diseases, technology emerges as a beacon of hope and success. Advanced technologies such as Artificial Intelligence, the Internet of Things, remote sensing, real-time monitoring, predictive outbreak risk analysis, point-of-care diagnostics, and telemedicine can significantly improve the speed and effectiveness of outbreak responses (World Bank, 2019). However, the implementation of these technologies comes with challenges such as data integration, cybersecurity, ethical considerations, and policy frameworks. (Altalhi et al., 2023; Yakout et al., 2023; Noshili et al., 2023). To accelerate early detection and response to outbreaks, African countries are encouraged to adopt information integration and communication technologies. These technologies have demonstrated significant benefits in global infectious disease surveillance (Abad, 2021; Okeleke, 2019; Mustafa, 2023).

In this review, focus is on to analysis advanced technologies and solutions that can be effectively use for disease surveillance and control. The aim is to shed light on how emerging advanced technologies and strategies can be used for more human benefit and disease control. This study reflects the effectiveness of advanced technology for early detection, prevention of outbreaks, rapid response to life threatening pandemics. This systematic review analyzes the modern technologies for real time data collection, and monitoring of infectious diseases globally for rapid response. It also brings into light the challenges and ethical issues for disease surveillance and global collaboration. The review also reflects the importance of the advanced technological solutions for pandemic preparation on global scale.

Method

Research objective

The aim of this systematic review is to examine the new technological and innovative strategies for disease surveillance and control.

Research Question

Research question in this systematic review include the following:

- How does the new technology and innovative strategies can improve the disease surveillance and control?

Literature Search Strategy

Literature search was done using key words; new technological and innovative strategies, disease surveillance and control, key words were used interchangeably to get the maximum results. Articles were searched from PubMed, Scopus and Web of Science database.

- From Google scholar about 98,800 articles were found.
- Web of science 28,800,Most relevant were 13,800
- Scopus 58,100 , most relevant were 26,200

Table 1 Syntax Search

Syntax 1	Technological advancement in disease control
Syntax 2	Prevention of disease control and technology
Year of publications	2019-2023
Scopus	58,100
Web of Science	28,800

Articles were published during the last five years, published during 2019 to 2023.

Inclusion and exclusion criteria

The search on the effect of advanced technological and innovative for disease surveillance and control, is in English, with the exclusion of non-English, outdated and grey publication. Papers published between 2019 and 2023 are selected for the review.

Quality Assessment

Selected research articles were assessed for quality assessment based on clarity of methodology, literature search, clear conclusion, were marked as “Good” for their quality.

Table Assessment of the literature quality matrix

S.no	Author	Are the selection of studies described appropriately	Has the literature covered all relevant studies	Does the method section described	Were findings clearly described	Quality rating
1	R Niakan Kalhori,2021	Yes	Yes	Yes	Yes	High
2	Wolff, Josephine. 2021	Yes	Yes	Yes	Yes	High
3	Abad, Z.H.S	Yes	Yes	Yes	Yes	High
4	Okeleke, K,2019	Yes	Yes	Yes	Yes	High
5	Mustafa, U.-k.;2023	Yes	Yes	Yes	Yes	High
6	Albahri, A. S.;2020	Yes	Yes	Yes	Yes	High
7	Parisa Eslami	Yes	Yes	Yes	Yes	High
8	Allison.E, 2020	Yes	Yes	Yes	Yes	High
9	Steven Haenchen, 2023	Yes	Yes	Yes	Yes	High
10	Jasmin Ambas,2023	Yes	Yes	Yes	Yes	High

Study Selection

For relevant research studies selection, used inclusion and exclusion criteria, search engines are identified.

Table Selected Studies for SR (Systematic Review)

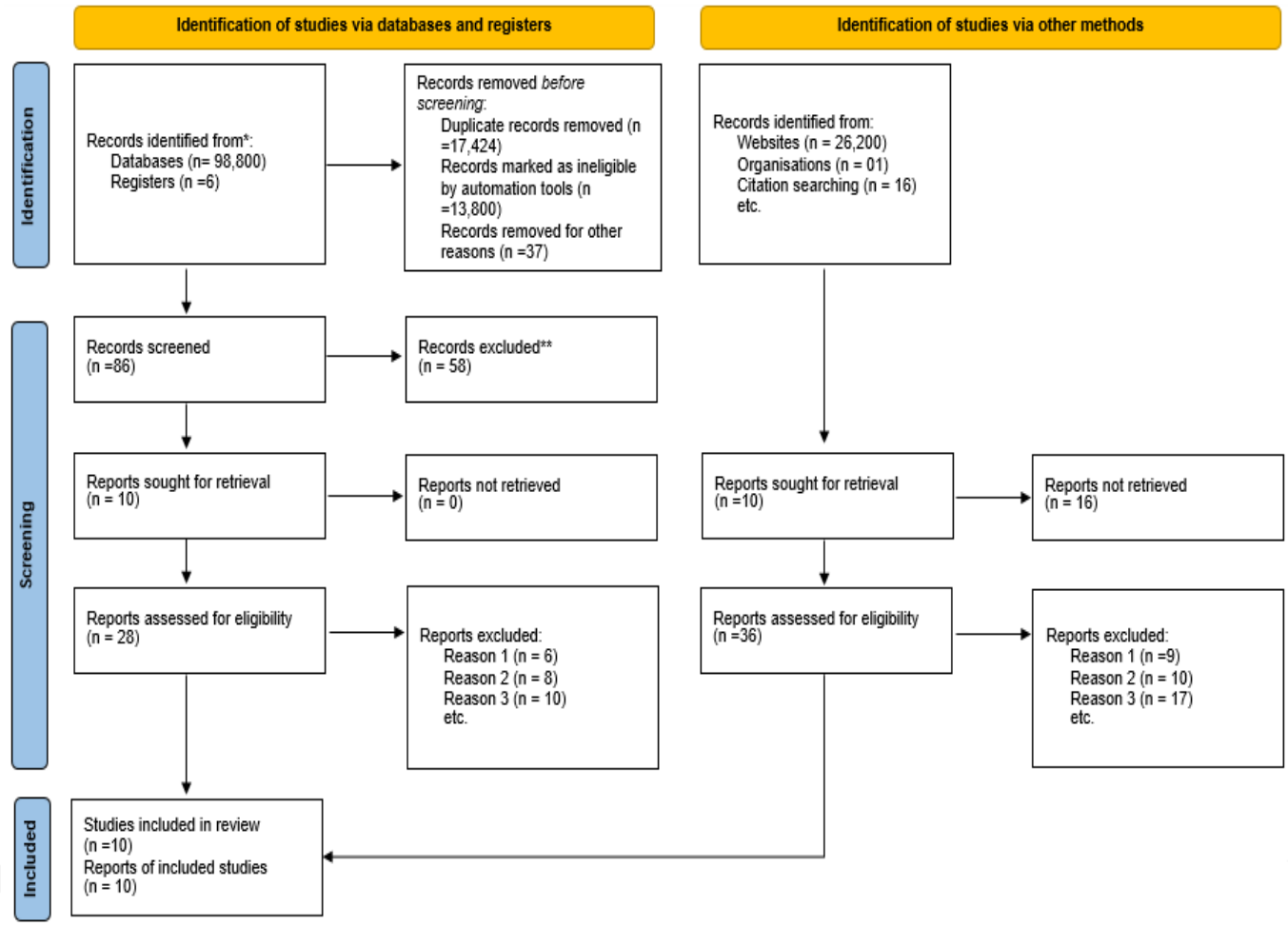
No	Author	Research	Year
1	R Niakan Kalhori	Digital Health Solutions to Control the COVID-19 Pandemic in Countries with High Disease Prevalence: Literature Review	2021
2	Wolff, Josephine	How Is Technology Changing the World, and How Should the World Change Technology?	2021
3	Abad, Z.H.S	Digital public health surveillance: a systematic scoping review	2021
4	Albahri, A. S	IoT-based telemedicine for disease prevention and health promotion: State-of-the-Art	2020
5	Parisa Eslami	eHealth solutions to fight against COVID-19: A scoping review of applications	2021
6	Caitlin Pley	Digital and technological innovation in vector-borne disease surveillance to predict, detect, and control climate-driven outbreaks	2021
7	WHO	Strategic framework for the prevention and control of emerging and	2019–2023

		epidemic-prone infectious diseases in the Eastern Mediterranean Region	
8	Sahalu et al	Recent Advancements in Emerging Technologies for Healthcare Management Systems: A Survey	2022
9	Jasmin Ambas	Innovations in Global Health: Leveraging Technology for Disease Surveillance and Pandemic Preparedness	2023
10	Steven Haenchen	Use of Telehealth Information for Early Detection: Insights from the COVID-19 Pandemic	2023

Result

Identification of studies via database and registers

Quality evaluation is systematic procedures that assess the quality of a study using data from peer-reviewed publications and overall assessment. Because of the initial search, 98,800 results were obtained from Google Scholar; key words were technological advancement+ disease control. Most of the results were systematic analysis (16,900) and review papers (50) and 1 book.



Data Extraction

Using PRISMA method, data was extracted to investigate New Technological and innovative Strategies for Disease Surveillance and Control. Study parameters used as the inclusion and exclusion criteria.

Table Research Matrix

Author ,year	Aim of study	Methodology	Sample	Setting	Result
Ummul-khair Mustafa, 2021	to summarize available literature on the applicati	Literature review	Researches related to mobiles use	Tanzania	Impact on public health surveillance.

	on of mobile phones and compute r-based technolo gies for infectiou s disease surveilla nce in Tanzania and to inform on existing gaps				
A.S. Alb ahri, 2020	Bring new opportu nities for telemedi cine	Systema tic and meta-analysis	4 million patients ,remote health care monitori ng	US	Improve use of IoT based telemedi cine
Caitlin Pley, 2018	Detect vector born disease through digital technolo gy	Compara tive study	Populati on effected with vector-born disease	Tanza nia and south Africa	Digital disease detection is more effective than tradition al method
Steven Haench en, 2020	Teleheal th data improve forecast s of	Observat ional study	Sample from 10.5 telemed icine	50 US state and Colum bia	Modest improve ments can be observed while

	mortality or not		counters		adding Telehealth data
Parisa ,2019	Review literature to find out e Health solutions	Literature review	423 studies were included	Covid-19	Findings were found useful in finding solution of covid-19 prevention, treatment and management.
B. Ncube, 2020	Examined the need for telemedicine	Situational analysis of eHealth activities	Grey literature	Botswana	eHealth can improve pre-existing health strategies
Sharareh R Niakan Kalhori	Review digital technology to control infectious diseases	Data based searching	Literature related to digital health	US, Australia and China	More digital health products need to be introduced for the management of health related crisis
Allison E, 2020	Ethics of social	Highlight integrati	Search related	Digital data	Reduce disease

	media and internet based data collection	ng digital surveillance in public health and current application	to Hybrid system, traditional surveillance system		burden using digital data
Jasmin Ambas, 2023	Investigate role of various technological solutions in global health system	Article review	Articles exclusively related to technological solutions	Articles	Highlight the potential of technology revolutionize global health practice and collaborative efforts at all levels
Sahalu, B. 2022	Review health care shifting from conventional hub-based system to personalized health care	Survey	Users of more advanced healthcare devices	IoT assisted wearable sensor systems, HMS devices	High cost was observed a major barrier in adapting IoT assisted devices.

Discussion

The aim of this systematic review was to analyze effectiveness of new technological advancement for disease surveillance and control, through structures overview of the researches published from 2019 to 2023. The main objective was to review technological intervention that could benefit public health system at larger scale.

Based on the literature search, it was found that the public health system has been evolving, and the COVID-19 pandemic has compelled advancements in new technologies for effective global disease control, accelerating the digitalization of various health aspects (CDC Global Report, 2021). As Salathe et al. (2018) discovered that public health surveillance, involving the systematic and continuous collection, analysis, and interpretation of data, increasingly relies on information extracted from various social media forums not originally intended for disease-related information storage. The integration of data from non-health sources into the public health system signifies technological advancement. (Noshili et al., 2023)

Whereas it was also found in literature that, Lapao et al. (2021) identified that new digital, technologies are being introduced to public health with the aim of achieving a more significant impact on the health system. They emphasized the practical implementation of these technologies to enhance the healthcare system. Odone and colleagues concluded that digital technologies could positively influence public health by integrating social, political, educational, and research aspects. Research indicates that the Eastern Mediterranean Region has developed robust health system programs encompassing public health aspects to prevent, detect, and respond to control diseases. (Al Ali et al., 2022; Alselaml et al., 2023; Alselami et al., 2023; Alruwaili et al., 2023)

Similarly, Budd et al. (2020) stressed the need to integrate public health data with electronic patient records. They highlighted the necessity for a fit-for-purpose digital public health system, particularly in regions where new technological advances are being introduced. Moreover, Poljak et al. (2019) observed that technological advancements in lower-middle-income countries may not be as effective as in developed countries due to social, political, and environmental factors. Environmental conditions,

such as temperature variations and high humidity, can act as barriers to the functionality of certain technologies, including bioscience and nanotechnology.

Additionally Sworna (2021) noted that successful technological advancements are predominantly reported from developed nations. Caitlin Pley (2021) and others, in a study on vector-borne diseases, emphasized that timely warnings from surveillance systems can aid in early detection and control of infectious disease outbreaks. They highlighted that innovative surveillance models outperform traditional models in disease risk detection and stressed the importance of engaging communities in designing technology to improve disease surveillance.

Therefore, this systematic review underscores the necessity for an initial assessment before introducing new technology and strategies for disease control and surveillance. This assessment aims to streamline effective disease control, preventive measures at the global level, and strengthen infrastructure for rapid response and action.

Limitation & Implication

This systematic review, related to; New Technological and innovative Strategies for Disease Surveillance and Control, aimed to examine the link between disease control, early rapid response and effectiveness of advancement in technology. For this review only accessible and printed studies within the period from 2019-2023 were included, potentially exclusion of prior studies that might be more relevant to the topic. The review might present biased results due to its limited scope for literature review of only those studies published during last five years.

Recommendations

Based on the findings from this review, studies published in other countries focusing exclusively on the effectiveness of advance technology in disease control and prevention should be included for the review. It will also give a broaden horizon to adapt more effective technology to strengthen health system and rapid response along with projection at global level.

What this article is adding to existing literature?

This article will add to existing literature the ways to link with global health forum and which advance technology can be incorporated at global level to improve health system in specific country.

What is its impact and contribution to Saudi context?

This review will be an additional source that will reflect the light in to those areas where future research can be done and which technological advancements can be more effective based on the context of Saudi Arabia. Since there are almost no research exclusively done on this topic. This assumption is based on the literature review done for this systematic review, and other researches done, might have been excluded due to period search.

Conclusion

It is concluded that in disease prevention, using advance technology is the key innovation to enhance the rapid response and decrease the chances of mortality at larger scale due to pandemic at global level. New technology will provide more options for treatment, in taking early preventive measures and reducing health cost overall.

References

Abad, Z.H.S.; Kline, A.; Sultana, M.; Noaeen, M.; Nurmambetova, E.; Lucini, F.; Al-Jefri, M.; Lee, J. (2021). Digital public health surveillance: A systematic scoping review. NPJ Digit. Med. 4, 41

Abbass, K.; Qasim, M. Z.; Song, H.; Murshed, M.; Mahmood, H.; Younis, I., (2022). A review of the global climate change impacts, adaptation, and sustainable mitigation measures. Environmental Science and Pollution Research (28), 42539-42559

Ahmad, S. S., Khan, S. & Kamal, M. A. (2019).What is block chain technology and its significance in the current healthcare system? A brief insight. Curr. Pharm. Des. **25**, 1402–1408

AL ALI, Y. T., AL QAHTANI, A. A., ASSIRI, H. Y., ALYAHYA, A. M., AL ALKHARSH, F. S., ASSIRI, A. Y., ... & ALASIRI, Y. H. (2022). Effectiveness Of Technology On Organizational Development And Services In The Saudi Health Sector. Journal of Pharmaceutical Negative Results, 2144-2155.

Albahri, A. S.; Hamid, R. A.; Alwan, J. k.; Al-qays, Z. T.; Zaidan, A. A.; Zaidan, B. B.; Albahri, A. O. S.; AlAmoodi, A. H.; Khlaf, J. M.; Almahdi, E. M.; Thabet, E.; Hadi, S. M.; Mohammed, K. I.; Alsalem, M. A.; Al-Obaidi, J. R.; Madhloom, H. T., (2022). Role of biological Data Mining and Machine Learning Techniques in Detecting and Diagnosing the Novel Coronavirus (COVID-19): A Systematic Review. Journal of Medical Systems

Almutairi, S. M., Noshili, A. I., Almani, H. A., Aldousari, N. Y., Aljedani, G. H., Bakhsh, A. A., ... & Shahbal, S. (2022). The Magnet Hospital Concept is an Ideological Approach to Job Satisfaction and Quality of Care: A Systematic Review. Journal of Positive Psychology and Wellbeing, 137-145.

Alruwaili, M. A., Ali, R. M., Shahbal, S., Alotaibi, S. G., Althiyabi, N. A., Aldosari, M. K., ... & Alharthi, F. M. (2023). Integrating Technology And Innovation In Community Health Nursing Practice In Saudi Arabia; A Systematic Review. Journal of Namibian Studies: History Politics Culture, 35, 2829-2852.

Alruwili, T. O., Batool, R., Kariri, M. E., Alanazi, B. A., Almutairi, A. M., Albalawi, R. S., ... & Alharbi, R. M. (2023). STRATEGIES AND TECHNOLOGIES TO PREVENT HOSPITAL-ACQUIRED INFECTIONS: LESSONS FROM SARS, EBOLA, AND MERS IN SAUDI ARABIA; A SYSTEMATIC REVIEW. Journal of Population Therapeutics and Clinical Pharmacology, 30(17), 1225-1236.

Alselaml, M. M. A., Shahbal, S., Alharbi, A. M. A., Al-Bishri, K. O. E., Alhrbi, S. E. M., Allehyani, A. A., ... & Al Sharif, K. A. (2023). Enhancing Patient-Centered Care IN Primary Nursing Strategies, Cultural Competence, AND Shared Decision-Making; Systematic Review Findings. Journal of Namibian Studies: History Politics Culture, 37, 80-105.

Altalhi, B. R., Shahbal, S., Almalki, A. A., Alzahrani, H. M., Aljuaid, F. A., Althagafi, M. M., ... & Alzahrani, S. O. (2023). Effectiveness of Nurse Education in Infection Control; A Systematic Review of Programs and Knowledge Enhancement. HIV Nursing, 23(3), 2196-2206.

Babu AN, Niehaus E, Shah S, Unnithan C, Ramkumar PS, Shah J, et al. (2019). Smartphone geospatial apps for dengue control, prevention, prediction, and education: MOSapp, DISapp, and the mosquito perception index (MPI). Environ Monit Assess. https://doi.org/10.1007/s10661-019-7425-0

Bempong NE, Ruiz De Castaneda R, Schutte S, Bolon I, Keiser O, Escher G, et al.(2019). Precision Global Health - The case of Ebola: a scoping review. Journal of Global Health.

Brinkel, J.; Krämer, A.; Krumkamp, R.; May, J.; Fobil, J. (2014). Mobile phone-based mHealth approaches for public health surveillance in sub-Saharan Africa: A systematic review. Int. J. Environ. Res. Public Health

Choi, J.; Cho, Y.; Shim, E.; Woo, H. (2016). Web-based infectious disease surveillance systems and public health perspectives: A systematic review. BMC Public Health

Dabla, P. K.; Gruson, D.; Gouget, B.; Bernardini, S.; Homsak, E.,(2021). Lessons Learned from the COVID-19 Pandemic: Emphasizing the Emerging Role and Perspectives from Artificial Intelligence, Mobile Health, and Digital Laboratory Medicine. Ejifcc 32, (2), 224-243

Davies SE. Artificial Intelligence in Global Health. Ethics Int Aff. (2019);33(2):181-92. https://doi.org/10.1017/S0892679419000157

Duda-Sikuła, M.; Kurpas, D. (2023). Barriers and Facilitators in the Implementation of Prevention Strategies for Chronic Disease Patients—Best Practice Guidelines and Policies' Systematic Review. J. Pers. Med. https:// doi.org/10.3390/jpm13020288

Filipp, F. V.(2019). Opportunities for artificial intelligence in advancing precision medicine. Curr. Genet. Med. Rep. **7**, 208–213

Hasana public health surveillance network. (2021). Dubai: Dubai Health Authority (https://www.dha.gov.ae/hasana/Pages/home).

Health facility-based surveillance Healthcare (2023). https://doi.org/10.3390/healthcare11040470 https://www.mdpi.com/journal/healthcare Healthcare

https://doi.org/10.3390/ healthcare1104047

Madoff LC, Woodall, JP. (2005). The Internet and the global monitoring of emerging diseases: lessons from the first 10 years of ProMED – mail. Arch. Meds .Res.36:724-30

MOH launches introductory campaign on HESN program, 6 February (2019). Ministry of Health, Kingdom of Saudi Arabia; https://www.moh.gov.sa/en/Ministry/MediaCenter/News/Pages/News-2019-

Mustafa, U.-k.; Kreppel, K.S.; Brinkel, J.; Sauli, E.(2023). Digital Technologies to Enhance Infectious Disease Surveillance in Tanzania: A Scoping Review. Healthcare.

Noshili, A. I., Almutairi, F. A., Shahbal, S., Alotaibi, F. A., Aldhafeeri, B., Refaei, R. A. A., ... & Alzauri, F. H. (2023). Systematic Review Are We Ready for New Emerging Infection Candida Auris; Review of Preparedness Measure and Strategies for Infection Prevention in the Saudi Arabian Health System. Migration Letters, 20(S1), 678-697.

Noshili, A. I., Almutairi, F. A., Shahbal, S., Alotaibi, F. A., Aldhafeeri, B., Refaei, R. A. A., ... & Alzauri, F. H. (2023). Systematic Review Are We Ready for New Emerging Infection Candida Auris; Review of Preparedness Measure and Strategies for Infection Prevention in the Saudi Arabian Health System. Migration Letters, 20(S1), 678-697.

Okeleke, K.(2019). Digital Transformation in Tanzania: The Role of Mobile Technology and Impact on Development Goals; Groupe Special Mobile Association: London, UK. https://data.gsmaintelligence.com/api-web/v2/research-file-download?id= 39256224&file=2736-180319-Tanzania.pdf

Pandemic preparedness and response in fragile, conflict and violence (FCV) situations, HNP Knowledge Brief. Washington (DC): World Bank Group; 2019 (http://documents1.worldbank.org/curated/en/302471552972075221/pdf/PandemicPreparedness-and-Response-in-Fragile-Conflict-and-Violence-FCV-Situations.pdf

Pappaioanou, M.; Kane, T. R., (2023). Addressing the urgent health challenges of climate change and ecosystem degradation from a One Health perspective: what can veterinarians contribute? Journal of the American Veterinary Medical Association 261, (1), 49-55

Park, H. A., Jung, H., On, J., Park, S. K., & Kang, H. (2018). Digital epidemiology: use of digital data collected for non-epidemiological purposes in epidemiological studies. Healthcare informatics research, 24(4), 253-262.

Poljak M, Sterbenc A. (2019). Use of drones in clinical microbiology and infectious diseases: current status, challenges and barriers. Clinical Microbiology and Infection: the official publication of the European Society of Clinical Microbiology and Infectious Diseases. https://doi.org/10.1016/j.cmi.2019.09.014

Porta M, ed. **2008**. A Dictionary of Epidemiology. New York: Oxford Univ. Press

R Niakan Kalhori, S.; Bahaadinbeigy, K.; Deldar, K.; Gholamzadeh, M.; Hajesmaeel-Gohari, S.; Ayyoubzadeh, S. M.,(2021). Digital health solutions to control the COVID-19 pandemic in countries with high disease prevalence: literature review. Journal of medical Internet research 23, (3), e19473.

Rana MS, Usman M, Alam MM, Ikram A, Salman M. (2021).Overlapping clinical manifestations of covid-19 with endemic infectious diseases in Pakistan: a looming threat of multiple lethal combinations. https://doi.org/10.1080/20008686.2021.1873494. doi:10.1080/20008686.2021.1873494.

Regional strategy for integrated disease surveillance and response 2020–2030: report of the Secretariat. In: Sixty-ninth session of the Regional Committee for Africa, Brazzaville, Republic of Congo, 19–23 August 2019. Brazzaville: WHO Regional Office for Africa; 2019 https://apps.who.int/iris/handle/10665/332926

Salathe M.(2018). Digital epidemiology. What is it, and where is it going? Life Sci. Soc. Policy 14:1

Sim, S.; Cho, M., (2023).Convergence model of AI and IoT for virus disease control system. Personal and Ubiquitous Computing 27, (3), 1209-1219.

Sworna, N.S.; Islam, A.M.; Shatabda, S.; Islam, S.(2021). Towards development of IoT-ML driven healthcare systems: A survey. J. Netw. Comput. Appl.

WHO EM/RC68/5. October (2021).A regional strategy for integrated disease surveillance – overcoming data fragmentation in the Eastern Mediterranean Region

WHO Regional Office for Africa. Integrated Disease Surveillance and Response Technical Guidelines, Booklet One: Introduction Section; WHO: Brazzavile, Congo, (2019). https://www.afro.who.int/publications/integrated-disease-surveillance-andresponse-technical-guidelines-booklet-one

Wolff, Josephine. (2021). “How Is Technology Changing the World, and How Should the World Change Technology?” Global Perspectives. https://doi.org/10.1525/gp.27353.

Yakout, S. M., Alanazi, S., Jahlan, I., & Shahbal, S. (2023). Assessing the Significance of Pre-and Post-Health Education on the Changes of

Knowledge Levels and Self-Efficacy in Pregnant Women with Urinary Tract Infections. HIV Nursing, 23(3), 1572-1579.

Zuckerberg, Mark. (2019). "The Internet Needs New Rules. Let's Start in These Four Areas." Washington Post,. https://www.washingtonpost.com/opinions/mark-zuckerberg-the-internet-needs-new-rules-lets-start-in-these-four-areas/2019/03/29/9e6f0504-521a-11e9-a3f7-78b7525a8d5f_story.html