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“Environmental Public Health Workforce Modernization: Utilizing Technological Advances Available in the Digital Age, to Help Prepare for Tomorrow’s Challenges, Today”

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Environmental public health is a critical field that addresses the complex interactions between human health and the environment. As technological advancements continue to reshape our world, the environmental public health workforce faces new challenges and opportunities. This essay explores the role of technological advances in modernizing the environmental public health workforce to better prepare for tomorrow's challenges. By leveraging technologies such as big data analytics, artificial intelligence, the internet of things, and remote sensing, EHPs can enhance data collection, environmental monitoring, improve communication and collaboration, and this can enable them to better prepare for emerging environmental health threats. This essay will discuss how these technological tools are currently being utilized and how they can continue to revolutionize the environmental public health sector. Furthermore, the challenges that come with this revolutionization will be discussed.

The evolution of technology in the environmental public health workforce has largely transformed the way EHP’s operate. With the emergence of advanced tools such as Geographic Information Systems (GIS) and remote sensing technologies, environmental health workers can now collect and analyse data more effectively, leading to enhanced decision-making processes (Haider, W and Ali, U. 2023). These technologies have also enabled the development of predictive models that can forecast environmental health risks and help in the effective allocation of resources for prevention and control measures. The integration of artificial intelligence and machine learning algorithms has further revolutionized the field by automating tasks like data processing and pattern recognition, thus allowing professionals to focus on more strategic and analytical aspects of their work. (S-Lapsley, J. et al. 2023)

Batko K and Slezak, A (2022), big data analytics has emerged as a cornerstone of modern EPH practices, offering the ability to process vast amounts of complex data rapidly. A study conducted by Ranapurwala, et al (2019) has shown that; As a specific technique used in data analytics “Predictive modelling” provides elegant tools that can help us understand the multidimensionality of the occurrence of different health outcomes and allow individual-level risk assessment. Algorithms and tools derived from such analyses could support policymakers, physicians, and environmental health practitioners in developing and implementing tailored prevention strategies to improve health outcomes for their patients or clients.

The transformation of environmental public health through technological advancements is exemplified by the evolution of the Tracking Program, as outlined in a report by the Pew Environmental Health Commission in September 2000. The report highlighted the inefficiencies and disjointed nature of the US environmental public health system, emphasizing the need for improved investigations and assessments.

In response, the Tracking Program was launched in 2002, aiming to integrate environmental and health data streams in previously unconnected areas.

After five years of operation, the Tracking Network has emerged as a vital tool for environmental public health, enabling various stakeholders to understand the impact of their surroundings on health. Academics and researchers benefit from its surveillance data, using it to formulate hypotheses and inform public health practitioners and policymakers.

Artificial intelligence (AI) is another transformative technology in EPH, it empowers practitioners to make more informed decisions and predictions. AI algorithms can analyse diverse datasets, ranging from weather patterns to disease incidence rates, to forecast potential environmental health risks. In the context of environmental epidemiology, with regard to disease surveillance, predictive models can be used to forecast the spread of infectious diseases based on environmental conditions and human behaviour, allowing EHPs to implement targeted interventions to prevent outbreaks. Realistically, data analytics can be used to identify communities that are disproportionately affected by environmental pollution, leading to targeted interventions to reduce exposure and improve health outcomes. (Olawade, D. et al. 2023)

The Internet of Things (IoT) has revolutionized data collection and monitoring in EPH, allowing for real-time tracking of environmental parameters. IoT devices, such as smart sensors and wearables, can continuously monitor air and water quality, providing EPH professionals with up-to-date information for decision-making. IoT-enabled systems can also facilitate early warning systems for environmental disasters, such as floods or chemical spills, enabling rapid response and mitigation efforts. (Salamone, F. et al. 2021). Evidently as reported by Ignitech Bristol, (2024) The integration of Internet of Things (IoT) technologies is revolutionizing disaster management, offering an array of benefits as an early warning system (EWS), an efficient emergency response mechanism, and a resilience enabler. The escalating frequency and intensity of natural disasters and climate catastrophes worldwide have underscored the need for proactive disaster management strategies. According to ReliefWeb, there were approximately 240 disasters in 2023 alone, a 30% increase compared to the previous year and the highest on record.

This surge in disasters has spurred a shift towards preventative approaches to disaster management and substantial investments in technologies that enhance early warning systems, rapid response capabilities, and effective disaster mitigation strategies. The natural disaster detection IoT market, valued at approximately US$600 million in 2023, is projected to reach a staggering US$18.5 billion by 2034, with a compound annual growth rate (CAGR) of 36.3% from 2024 to 2034. This exponential growth underscores the pivotal role that IoT plays in modernizing disaster management practices and bolstering community resilience in the face of escalating environmental challenges.

A number of factors, including the economy, high-quality education, agriculture, industries, and many more, are necessary for the world to grow sustainably, but the environment is one of the most crucial ones. The sustainability of humanity and the advancement of any nation are largely dependent on health and hygiene, which are products of a clean, safe, and pollution-free environment. As mandated by the Environmental Health National Norms and Standards in terms of the National Health Act (2003) that environmental monitoring is an important aspect of environmental health. Therefore, it becomes imperative to monitor the environment to guarantee that every country's citizens can live healthy lives.

WHO (2018). Due to the quick development of technology, there are a lot of exciting opportunities for modernizing the workforce in environmental public health (EPH). As a result, Internet of Things (IoT) devices are playing a significant role Environment monitoring. Environmental monitoring (EM) addresses air and water pollution, hazardous radiation, shifting weather patterns, other environmental parameters. The role of environmental monitoring (EM) is to precisely address the challenges in order to protect the environment for a healthy society and world. There are various factors that contribute to pollution, some of which are man-made and others due to natural causes. Modern science and technology, particularly artificial intelligence (AI) and machine learning, have made environmental monitoring (EM) more precise and effective in controlling pollution and other negative effects. As a result, EM has evolved into a smart environment monitoring (SEM) system. One of the key ways technology has improved data collection methods is through the use of sensors and monitoring devices. These devices can be deployed in various environments to collect real-time data on environmental parameters. E.g. Air quality sensors can measure the levels of pollutants such as particulate matter, ozone, and nitrogen dioxide, providing EHPs with valuable information about air pollution levels in specific areas. (Ullo, S,L. and Sinha, G, R. 2020)

In the realm of environmental public health (EPH), effective communication and collaboration among professionals, researchers, and policymakers are paramount. With the advent of digital tools and platforms, these essential aspects of the EPH workforce have been significantly enhanced, as a result, the manner which EPH professionals collaborate and communicate has been completely transformed by digital tools and platforms leading to more efficient and coordinated responses to environmental health emergencies and emerging issues. The ability to share information in real-time, regardless of location, is one of the main advantages. As a result, environmental health professionals can work together on projects more successfully, exchange best practices, and plan responses to environmental health emergencies. Real-time data sharing, for instance, can assist EHP’s in tracking the spread of an outbreak, identifying its source, and putting control measures in place.

It is acknowledged that various digital communication platforms and channels have the potential to be effective means of distributing crucial information about environmental health. Using digital communication channels to reach and influence target audiences is made easier with the help of guidelines for developing and executing environmental health education messages. Environmental health information is disseminated with the help of strategic design principles, which include improving system interactivity, interoperability, and ease of use, immediacy, adaptability, accessibility, and cultural sensitivity. Digital tools and platforms facilitate communication and collaboration among EPH professionals, researchers, and policymakers. These tools allow for the sharing of research findings, policy recommendations, and best practices, enabling stakeholders to make informed decisions and develop evidence-based policies. For instance, researchers can use digital platforms to share their findings with policymakers, who can then use this information to develop policies that protect public health and the environment. (Kreps, G et al. 2018). Digital tools and platforms promote transparency and accountability in the EPH workforce. By providing a platform for sharing information and data, these tools enable stakeholders to track progress, identify areas for improvement, and hold each other accountable. This transparency can lead to more effective decision-making and resource allocation, ultimately improving the overall effectiveness of the EPH workforce.

Remote sensing technologies, including drones and satellites, together with geographic information systems (GIS) have also become invaluable tools in EPH. These technologies provide EPH professionals with high-resolution imagery and spatial data, enabling them to monitor environmental changes over large areas. Satellite images can be used to track deforestation rates or monitor the impact of natural disasters on public health, guiding EPH interventions and policies. (Mertikas, S. et al. 2021). The use GIS has enabled EHPs to map environmental data and identify spatial patterns and trends. GIS can integrate data from multiple sources, such as satellite imagery, demographic data, and environmental monitoring data, allowing EHPs to visualize complex data sets and identify areas of concern. This spatial analysis can help EHPs target interventions more effectively and allocate resources where they are most needed.

As we explore the integration of technology in environmental public health (EPH) workforce modernization, it is important to acknowledge and address potential challenges and limitations that may arise. These challenges include a variety of issues, such as data privacy concerns, the digital divide, and the need for ongoing training and support for EHPs.

Ensuring the privacy and security of data is one of the recognized challenge. EHPs often deal with sensitive information, such as health records and environmental monitoring data, which must be protected from unauthorized access or breaches. Therefore, it is crucial to establish robust data protection measures and comply with

relevant regulations, such as the General Data Protection Regulation (GDPR) or the Health Insurance Portability and Accountability Act (HIPAA). (Basil, N. et al. 2022)

The digital divide, or the difference between those who have access to technology and those who do not, is another problem. It may be challenging for EHPs to effectively use digital tools in many communities due to limited access to technology and the internet, especially in rural or underserved areas. Infrastructure spending and initiatives to guarantee that all EHPs have access to the required tools and training are required to close this gap. Addressing Environmental Public Health challenges in developing countries requires a multi-faceted approach that is focused on improving access to technology through initiatives such as technology transfer programs and partnerships with developed countries can be beneficial. Building technological capacity through training programs and educational initiatives can help develop the necessary expertise. Financial support in the form of grants, loans, or subsidies can facilitate the acquisition and implementation of advanced technologies. However, the key to implementing these solutions effectively can be somewhat political because it may require collaboration between governments, non-governmental organizations, and the private sector.

To effectively navigate technical challenges and integrate technology into their daily practice, EHPs require ongoing support. The dynamic nature of environmental challenges necessitates constant learning and adaptation in the field of environmental public health (EPH). Since some EHPs, especially in developing countries might not have had any prior exposure to modern technologies like data analytics or artificial intelligence, they might need training to acquire the necessary skills. Virtual simulations, online learning environments, and other digital tools can be used to improve and further revolutionize the way EHPs access educational resources and engage with new information. These platforms offer a plethora of courses, webinars, and resources tailored to the specific needs of EHPs, allowing them to acquire new skills and knowledge at their convenience. These online platforms facilitate collaboration and knowledge-sharing among EHPs from diverse backgrounds and geographical locations, and they foster a culture of continuous learning and innovation. AlGerafi, M et al (2023) believes that virtual simulations provide EHPs with realistic scenarios and challenges, allowing them to apply their knowledge and skills in a safe and controlled environment. By engaging in virtual simulations, EHPs can enhance their decision-making abilities, critical thinking skills, and problem-solving capabilities, preparing them to respond effectively to complex environmental health challenges. Additionally, he states that digital tools such as augmented reality (AR) and virtual reality (VR) can be used to enhance EPH training. These tools can simulate real-world environmental scenarios, allowing EHPs to gain hands-on experience in a virtual environment. For example, EHPs can use AR and VR to visualize the impact of environmental pollutants on human health or to practice conducting environmental assessments in different settings.

According to the Environment Program of the United Nations. (2019). Environmental health monitoring and remediation could be further revolutionized by the development of new technologies like nanotechnology and biotechnology. Ecologists and health professionals (EHPs) can gain unparalleled insights into environmental health hazards by utilizing nanosensors, which have the ability to detect and track environmental contaminants at the molecular level. Similar to this, biotechnologies—like genetically modified microorganisms—can be employed to clean up polluted areas, providing a more economical and environmentally friendly option than conventional clean-up techniques.

In essence, the integration of technological advances in the environmental public health (EPH) workforce represents a pivotal step towards addressing complex environmental health challenges. These developments have improved community involvement and awareness of environmental health issues in addition to increasing the efficacy and efficiency of EPH practices. The EPH workforce can ensure a more resilient and proactive approach to environmental health management by utilizing these technologies to better prepare for emerging environmental health threats. Furthermore, issues like the digital divide, data privacy, and the requirement for continuous training and assistance for EPH professionals must be addressed. Enhancing environmental public health outcomes and realizing the full potential of these advancements will require sustained investment in technology and training.
The future of environmental public health looks promising, with technology playing a central role in modernizing the workforce and safeguarding public health and the environment for generations to come.

References

AlGerafi, M, A, M. Zhou, Y. Oubib, M. and Wijaya, T, T. 2023. Unlocking the potential: A comprehensive evaluation of augmented reality and virtual reality in education. September 20.

Basil, N, N. Ambe, S. Ekhator, C. and Fonkem, E. 2022. Health records database and inherent security concerns: A review of the literature. Oct 11.

Batko, K. and Slezak, A. 2022. The Use of Big Data Analytics in healthcare. Jan 6.

Haider, W. and Ali, U. 2023. Application of Remote sensing and GIS in Healthcare: A comprehensive review. Available from https://www.researchgate.net/publication/375672068_Applications_of_Remote_Sensing_and_GIS_in_Healthcare_A_Comprehensive_Review [Accessed: 20/03/2024]

J. Stevens-Lapsley, Gregory E Hicks, K. Zimney, E. Slaven, T. Manal, Lynn M Jeffries. 2023. Research Agenda for Physical Therapy From the American Physical Therapy Association

Kreps, G, L. Wright, K. and Burke-Garcia, A. 2018. The use of digital communication channels to enhance environmental health literacy. Environmental Health Literacy, pp 265-283. September 13. Available from: https://link.springer.com/chapter/10.1007/978-3-319-94108-0_10 [Accessed: 10/03/2024]

Mertikas, S, P. Partsinevelos, P. Mavrocordatos, C. and Maximenko, N, A. 2021. Chapter 3- Environmental applications of remote sensing.

National Institute of Environmental Health Sciences. (2021). Environmental health topics: Air pollution. Available from: https://www.niehs.nih.gov/health/topics/agents/air-pollution/index.cfm.

Olawade, D, B. Wada, O, J. Olawade, A, C, D. Kunonga, E. Abaiere, O. and Ling, J. 2023. Using artificial intelligence to improve public health: a narrative review. Oct 26.

Pew Environmental Health Commission. America's Environmental Health Gap: Why the County Needs a Nationwide Health Tracking Network: Technical Report. Baltimore, MD: Johns Hopkins University School of Public Health; 2000. [Google Scholar]

Ranapurwala, S. Cavanaugh, J. Young, T. Wu, H. Peek-Asa, C. and Ramirez, M. 2019. Public health application of predictive modelling: an example from farm vehicle crashes. June 17. Available from https://injepijournal.biomedcentral.com/articles/10.1186/s40621-019-0208-9 [Accessed: 19/03/2024]

Salamone, F. Masullo, M. and Sibilo, S. 2021. Wearable Devices for Environmental Monitoring in the Built Environment: A Systematic Review. Jul 10.

Ullo, S, L. and Sinha, G, R. 2020. Advances in Smart Environment Monitoring Systems Using IoT and Sensors. May 31.

United Nations Environment Programme. (2019). Frontiers 2018/19: Emerging issues of environmental concern. Available from https://www.unenvironment.org/resources/frontiers-201819-emerging-issues-environmental-concern [Accessed: 11/03/2024]

World Health Organization. (2018). Environmental health in emergencies and disasters: A practical guide. Available from https://www.who.int/environmental_health_emergencies/publications/ehi_guidance/en/ [Accessed: 11/03/2024]