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Research Article

Quantum Health Policy Readiness: Anticipating the Next Digital Disruption in Public Health A Comparative Policy Analysis and Global Readiness Assessment

*¹Gabriel Dogbanya, ²Bukola Titilayo Fagbemi, ³Bukola Mekuleyi Asorho, ⁴Temitope Emmanuel Alo, ⁵Ayomide Samuel Ogunrinde, ⁶Jude O. Dilioha, ⁷Munachiso Nelson Obiechi, ⁸Ezeamii Patra Chisom, ⁹Chiamaka Pamela Agu

About Article

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About Author

¹ Department of Family Science, University of Maryland, College Park, USA

² Department of Health Sciences, Western Illinois University, Macomb, Illinois, USA

³ Faculty of the School of Medicine, Windsor University School of Medicine, Saint Kitts and Nevis, West Indies

⁴ Department of Medical Laboratory Science, Faculty of Basic Medical Sciences, Ladoko Akintola University of Technology, Ogbomoso, Nigeria

⁵ Department of Political Science, Master of Public Administration, East Carolina University, USA

⁶ Department of Environmental Health, East Carolina University, USA

⁷ Department of Optometry, Federal University of Technology, Owerri, Imo State, Nigeria

⁸ Department of Biostatistics, Epidemiology and Environmental Health Sciences, Jiann-Ping Hsu College of Public Health, Georgia Southern University, USA

⁹ Department of Public Health, University of New Haven, Connecticut, USA

Contact @ Gabriel Dogbanya
gabriel@umd.edu

ABSTRACT

This study evaluates the readiness of public health policy frameworks to integrate quantum technologies, highlighting critical gaps in governance, infrastructure, equity, and workforce preparedness. Despite global investments in quantum research, public health systems are not adequately prepared for the potential disruptions quantum technologies will bring. Key strengths include growing investments in research and recognition of digital health challenges, while significant gaps remain, such as a lack of anticipatory governance, insufficient infrastructure in low- and middle-income countries (LMICs), and inadequate quantum literacy among the workforce. To address these gaps, immediate regulatory reforms are essential. Recommendations include integrating quantum principles into digital health frameworks, improving infrastructure to support quantum applications, and enhancing workforce training. By taking proactive steps, public health systems can ensure the equitable and secure deployment of quantum technologies, mitigating the risks of a widening “quantum divide.”

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1. INTRODUCTION

1.1. Background

The rapid development of quantum technologies is a turning point in the history of science and civilisation. Quantum computing, communication, and sensing—once thought to be only theoretical physics ideas—are now moving into practical fields at an unprecedented rate (Memon *et al.*, 2024). Their ability to handle complex datasets, make better judgments in real-time, and protect data with quantum encryption has a significant impact on medicine and public health. Quantum technologies are expected to transform the way health systems operate over the next few decades (Alrashed & Min-Allah, 2025). They will speed up drug discovery, make disease modelling more accurate, improve pandemic forecasting, and protect health data from future cyber threats. In this context, "quantum health" is emerging as a novel approach that leverages the disruptive potential of quantum technology to address the pressing need to manage the health of large groups of people (Mafu & Senekane, 2023; Memon *et al.*, 2024).

1.2. Rationale

Quantum breakthroughs have considerable potential, but the pace at which they are being applied in public health is faster than the rate at which current policy frameworks can keep up. Current digital health regulations were mostly created for classical computing, AI, and big data systems. They often fail to consider the unique security, ethical, and governance issues that quantum applications present. Quantum encryption could change the way health data is protected, but it could also make present cybersecurity systems useless (Ur Rasool *et al.*, 2023). The use of quantum-enhanced diagnostics or population monitoring systems also raises important questions about fairness, rules, and access worldwide. Suppose policymakers continue to react instead of taking action. In that case, the disparity between what technology can do and what regulations can do might exacerbate unfairness, complicate ethical issues, and erode people's trust in the government. As governments and businesses invest a significant amount of money in quantum research, it's essential to consider whether health systems and policies are prepared for this digital revolution (How & Cheah, 2023; Rashid & Kausik, 2024).

1.3. Scope and Objective

This article analyzes the preparedness of public health policy frameworks for incorporating quantum technology, focusing on governance, security, and equality issues. It specifically examines the opportunities and challenges that quantum advances in healthcare present, and identifies gaps in current digital health regulations. It outlines a plan for proactively modifying policies to address these gaps. This study situates quantum health within the broader context of digital transformation, arguing that readiness for quantum disruption is not only a technical requirement but also a strategic necessity for safeguarding public health, ensuring equitable access, and maintaining trust in healthcare systems. The ultimate goal is to create a paradigm that looks to the future and can help policymakers, academics, and practitioners address the complex convergence of quantum innovation and public health governance.

2. LITERATURE REVIEW

2.1. Governance and Regulatory Preparedness

The integration of quantum technologies into public health requires comprehensive governance frameworks that address both regulatory and ethical concerns. Current public health policy frameworks, largely designed for classical computing and AI, lack provisions to manage the unique challenges posed by quantum applications, such as quantum encryption and quantum-enhanced diagnostics (Bajwa *et al.*, 2021; Yeung *et al.*, 2023). Notably, international organizations like the WHO and EU have focused on digital health initiatives, but their strategies overlook the implications of quantum technologies (Lakhotia *et al.*, 2024). The absence of anticipatory governance for quantum health applications raises concerns about liability models, data governance, and ethical oversight, which could hinder effective regulation and oversight as quantum technologies advance (Mennella *et al.*, 2024).

2.2. Infrastructure and Technical Capacity

Infrastructure preparedness for quantum technologies in healthcare is a critical consideration for effective integration. While high-income countries are investing in quantum research hubs (e.g., U.S. National Quantum Initiative, EU Quantum Flagship), there is a noticeable lack of infrastructure in low- and middle-income countries (LMICs) to support quantum-enabled health technologies (Lee *et al.*, 2025). LMICs face significant barriers, including inadequate digital infrastructure and limited technical capacity to handle the demands of quantum technologies, which could exacerbate the global digital divide (Sanders & Scanlon, 2021). Ensuring scalable, flexible infrastructure is key to supporting the secure and effective use of quantum technologies in public health systems (Ghaleb *et al.*, 2021).

2.3. Equity and Accessibility

Equity remains a core issue when considering the deployment of quantum technologies in healthcare. While digital health initiatives strive toward universal health coverage (UHC), they often overlook emerging technologies like quantum computing that could further entrench existing disparities (Mumtaz *et al.*, 2023). The rapid pace of quantum advancement threatens to create a "quantum divide," where high-income countries benefit from these innovations, while LMICs remain excluded from the advantages they offer (Panteli *et al.*, 2025). To mitigate these risks, policies must proactively ensure equitable access to quantum-enhanced health solutions through global collaborations, technology-sharing agreements, and targeted investments (Sanders & Scanlon, 2021).

2.4. Workforce Readiness and Implementation

The readiness of the healthcare workforce to adopt quantum technologies is another key factor in ensuring successful integration. Currently, there are few initiatives aimed at educating healthcare professionals about quantum technologies and their applications in public health (Rouleau *et al.*, 2024). As quantum technologies rapidly evolve, there is a pressing need to build workforce capacity through training programs that enhance quantum literacy among policymakers, healthcare workers, and data scientists. Without adequate preparation,



the workforce will struggle to make informed decisions about the adoption and regulation of quantum technologies in public health settings (Mennella *et al.*, 2024). Building a quantum-ready workforce will be essential for the successful deployment and utilization of quantum health applications.

This review highlights the key challenges and opportunities in preparing public health systems for the integration of quantum technologies. Across the four domains—Governance, Infrastructure, Equity, and Workforce—there are significant gaps in current frameworks that must be addressed to ensure the equitable, secure, and efficient deployment of quantum technologies in public health. These insights directly inform the methodology used to assess the readiness of public health policy frameworks for quantum technologies.

3. METHODOLOGY

3.1. Approach

This study utilised a comparative policy analysis alongside a narrative literature review to evaluate the readiness of public health policy frameworks for the integration of quantum technology. The investigation utilised a multidisciplinary approach, integrating aspects from public health, information governance, cybersecurity, and emerging technology policy. When possible, the results were confirmed by comparing them to the opinions of experts in discussions that included legislators, digital health professionals, and technological experts. This combination strategy made sure that the study was both broad (by being thorough) and deep (by putting policies in context and getting expert viewpoints).

3.2. Data Sources

This study utilised data from three principal sources:

1. Policy and Regulatory Documents: Major global organisations, like the WHO, OECD, EU Commission, and national ministries of health, have developed national and international health policy frameworks, digital health programs, and cybersecurity regulations.
2. Published Literature: Peer-reviewed articles, policy briefs, and grey literature on quantum technologies, digital health readiness, and policy adaption methodologies from sites like PubMed, Scopus, Web of Science, and Google Scholar.
3. Expert Insights: Casual conversations with professionals in quantum computing, public health governance, and health information systems. These findings were employed to contextualise shortcomings and highlight emerging difficulties that have yet to be addressed in the formal literature.

3.3. Analysis

A structured readiness assessment approach was created to find out how well current policies are prepared for the use of quantum technologies. The framework underwent evaluation in four domains and was adapted from established digital health readiness models:

1. Governance and Regulatory Preparedness: the creation of rules that take into account the future, moral standards, and ways for governments to work together (Ghaleb *et al.*, 2021).
2. Infrastructure and Technical Capacity: the existence of cybersecurity measures, data systems, and digital infrastructure

that can be utilised in quantum environments (Lee *et al.*, 2025).

3. Equity and Accessibility—policies that make sure that quantum-enabled health improvements are fairly shared, especially in nations with low or moderate incomes (Mumtaz *et al.*, 2023).

4. Workforce Readiness and Implementation: initiatives for training the workforce, getting stakeholders involved, and building adoption capacity (Rouleau *et al.*, 2024).

The results were categorised topically to identify the strengths, shortcomings, and deficiencies in existing policy. A comparison analysis across areas and institutions was utilised to highlight the variability in preparation, while expert opinions were qualitatively coded to discern emerging challenges and practical considerations.

4. RESULTS AND DISCUSSION

4.1. Current Policy Landscape and Readiness Gaps

A review of the existing digital health and technology policy frameworks indicates that most national and international initiatives focus on traditional technologies like AI, big data, and classical computing (Bajwa *et al.*, 2021; Yeung *et al.*, 2023). Although global frameworks, such as the WHO Global Strategy on Digital Health (2020–2025), acknowledge critical issues like cybersecurity, equality, and data interoperability, they largely neglect the integration of quantum technologies (Lakhota *et al.*, 2024). This oversight stems from a perception among policymakers that quantum technologies are still far from practical application, leading them to view these developments as long-term rather than urgent issues. This mindset results in a reactive rather than proactive approach to regulation, which fails to address the anticipated disruption of quantum technologies in public health systems (Smith III, 2020).

The reluctance to prioritize quantum technologies in health policy may also be rooted in political and economic factors. Quantum research is complex and costly, requiring significant investments in infrastructure, workforce training, and international collaboration. In many countries, there is a lack of political will to allocate resources for quantum policy development when the immediate needs of existing health systems (e.g., managing AI, big data, and cybersecurity issues) take precedence. Furthermore, economic constraints in LMICs exacerbate this issue, as these countries struggle with underfunded healthcare systems and digital infrastructure, which impedes their ability to invest in cutting-edge technologies like quantum computing (Sanders & Scanlon, 2021).

4.2. Analysis of Readiness Scores and Global Disparities

The readiness assessment reveals a stark contrast in preparedness between HICs and LMICs. In high-income countries, there is considerable investment in quantum research hubs, such as the U.S. National Quantum Initiative and the EU Quantum Flagship. These countries have made notable strides in integrating quantum principles into broader technological and digital health strategies (Lee *et al.*, 2025). However, even in HICs, the integration of quantum technologies into public health policy is limited. Although these countries have invested in quantum research, most are still in the early stages of developing the necessary infrastructure and regulatory



frameworks. For instance, while cybersecurity policies in these regions are beginning to include provisions for post-quantum cryptography, there is little focus on how quantum technologies can enhance health applications, such as secure telemedicine or quantum-enabled drug development platforms (Weekly Digest on AI and Emerging Technologies, 2025).

In contrast, LMICs are far behind in terms of both infrastructure and workforce preparedness. These countries face significant barriers, including limited digital health infrastructure, poor internet connectivity, and a lack of financial resources to invest in quantum research or quantum-specific policy development (Lee *et al.*, 2025). As a result, their readiness scores in areas such as infrastructure and workforce preparedness are markedly lower than those of HICs. For example, while HICs have initiated workforce training programs to familiarize public health professionals with quantum technologies, LMICs lack similar initiatives. The absence of these programs leaves healthcare workers in LMICs ill-prepared to manage or regulate quantum health applications, which could delay or even prevent the adoption of quantum technologies in these regions (Rouleau *et al.*, 2024).

4.3. Implications of Global Disparities

The disparities in readiness between HICs and LMICs have significant implications for global health equity. In the absence of targeted policies to address these gaps, the rapid development of quantum technologies could exacerbate the "quantum divide." High-income countries with well-developed infrastructure and regulatory frameworks will likely be able to deploy quantum health technologies first, reaping the benefits of faster, more accurate diagnostics, improved disease modeling, and enhanced data security. Meanwhile, LMICs could be left behind, unable to leverage these innovations to improve their healthcare systems, widening existing health disparities (Panteli *et al.*, 2025).

Moreover, the lack of international cooperation on quantum health technologies could further entrench these inequities, leaving vulnerable populations without access to quantum-enhanced healthcare solutions (Mumtaz *et al.*, 2023).

4.4. Root Causes and Path Forward

The root causes of these disparities are multifaceted. Politically, there is a general underestimation of quantum technologies' immediate relevance in healthcare, particularly in low-resource settings. Economic challenges further complicate the situation, as LMICs are often unable to allocate funds for long-term quantum policy planning when pressing issues like healthcare access and infrastructure remain unresolved. Furthermore, there is a lack of awareness about the specific risks and opportunities that quantum technologies present in healthcare, both in high- and low-income countries. Addressing these issues will require a shift in perspective: from reactive, long-term planning to proactive, short-term actions that ensure quantum readiness is integrated into health policy frameworks now, before the technologies become widespread.

Recommendations for closing these gaps include:

- Governance reforms: Establishing clear policies on quantum health technologies, addressing ethical, liability, and data privacy concerns.
- Infrastructure development: Investing in scalable digital infrastructure that can support quantum computing, especially in LMICs.
- Workforce training: Developing quantum literacy programs for healthcare professionals, policymakers, and technologists to ensure an informed and prepared workforce.
- International collaboration: Strengthening global alliances to ensure equitable access to quantum technologies, particularly for LMICs.

A summary of the readiness assessment is presented in Table 1

Table 1. Readiness of Public Health Policy Frameworks for Quantum Technologies

Domain	Strengths	Vulnerabilities / Blind Spots
Governance & Regulation	Increasing global focus on digital health ethics	No explicit frameworks for quantum health; unclear liability models
Infrastructure & Technical	Investment in quantum research hubs (HICs)	LMICs are under-resourced; lack of scalable infrastructure
Equity & Accessibility	Emphasis on universal health coverage (UHC) in digital health	No mechanisms to prevent 'quantum divide'
Workforce & Implementation	Early digital health workforce training programs	Lack of quantum literacy and preparedness initiatives

Experts also noted that trust and ethics are significant issues. Quantum instruments might make things more accurate and secure, but their lack of clarity and complexity could make it harder to be open about decisions. Policymakers warned that if communities weren't involved early on, people might be just as sceptical of AI in healthcare as they were of AI in other areas. A readiness scorecard was created to highlight the relative

strengths and weaknesses of public health policy frameworks in four key areas, in addition to the comparative findings presented in Table 1. Figure 1 illustrates that readiness remains uneven. Governance and regulatory measures have made some progress, but fairness, infrastructure scalability, and worker capacity are still lagging (The Ethics Of Quantum Computing: Considerations And Challenges, n.d.).

Quantum Health Policy Readiness Scorecard

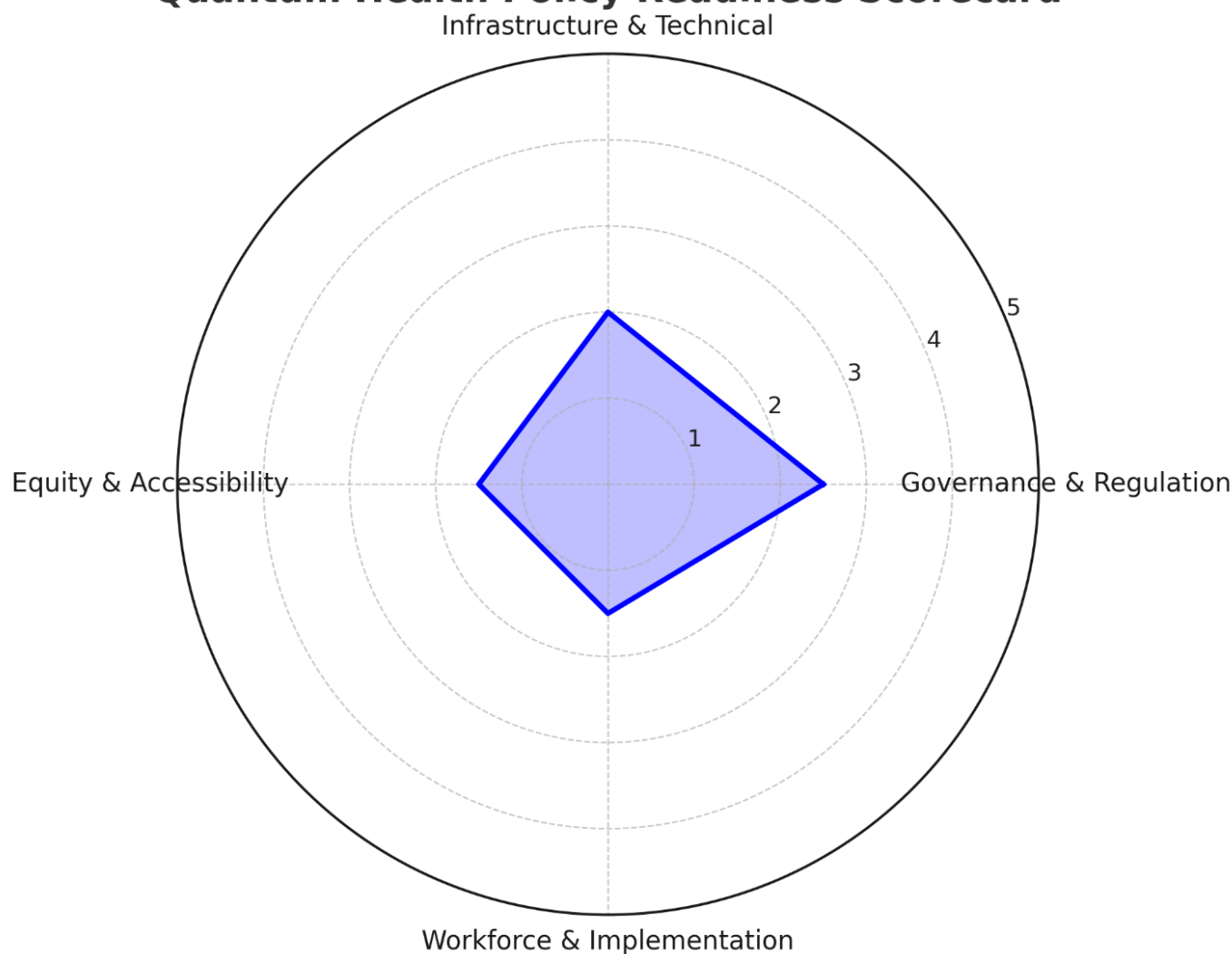


Figure 1. Quantum Health Policy Readiness Scorecard

This radar graphic illustrates the readiness of public health policy frameworks in four key areas: governance and regulation, infrastructure and technical capability, fairness and accessibility, and workforce implementation. Scores (on a scale of 1–5) show that global digital health ethics and investments in research hubs are strong. Still, they also reveal significant issues, particularly with equity, infrastructure scalability, and the workforce's quantum literacy. The graphic illustrates that readiness is not evenly distributed, highlighting the need for swift legislative changes before quantum technologies become widely adopted in public health.

4.5. Discussion

4.5.1. Interpretation

The results of this study indicate that, despite digital health policy gaining traction, quantum technologies are still largely absent from current regulatory and strategic frameworks. Policymakers and global health organisations are getting ready for problems with AI, big data, and cybersecurity (Lawal *et al.*, 2025). But quantum-enabled apps like encryption and

advanced analytics are still considered as risky. This increases the likelihood of quantum disruption in health systems lacking adequate protections, ethical oversight, or governance frameworks, when legislation fails to keep up with the rapid pace of technological advancement (Mumtaz *et al.*, 2023).

4.5.2. Implications

Problems with governance, infrastructure, equity, and workforce preparation have direct effects on public health. If regulators don't make laws, quantum instruments could be used without any rules, making privacy and liability problems much worse. Infrastructure gaps, especially in low- and middle-income countries (LMICs), could make the "quantum divide" worse. This would mean that only high-income areas get the benefits, and vulnerable groups are left out. The absence of workforce education also jeopardises public health specialists' ability to adequately assess, regulate, or employ quantum technology. If politicians don't respond soon, these problems might make people less trusting of digital health systems and make health disparities worse around the world (Panteli *et al.*, 2025).



4.6. Opportunities

There are certain gaps, but the rise of quantum health technology gives health systems a chance to look over their digital policy frameworks again before the disruption spreads. Taking action early can mean:

- Making anticipatory governance by adding quantum ideas to current digital health plans.
- Making infrastructure that can handle post-quantum cryptography and data processing that can grow.
- Supporting fair systems, like technology-sharing agreements, global collaborations, and subsidies, to keep LMICs from being left out.
- Putting money into workforce development, such as training programs that combine public health, data science, and quantum literacy.

By taking these steps, health systems can convert a potential problem into an opportunity to gain an advantage (Saberikamarposhti *et al.*, 2024).

4.7. Comparison

We can learn from other countries and industries that are already getting ready for quantum disruption. For instance, the European Union Quantum Flagship and the United States National Quantum Initiative have started looking into how quantum technologies may be used in health, but mostly at the research and infrastructure level. Regulators in the financial industry are getting ready for post-quantum encryption standards to secure global banking networks. This shows how preemptive regulation can lower systemic risks. These examples indicate that public health may similarly implement proactive, cross-sectoral strategies, utilizing international collaboration and common standards to ensure readiness (Gutorov *et al.*, 2025).

5. CONCLUSIONS

This study highlights significant gaps in public health policy frameworks regarding the integration of quantum technologies, particularly in the domains of governance, infrastructure, equity, and workforce preparedness. The findings reveal that while high-income countries (HICs) are making strides in quantum research, low- and middle-income countries (LMICs) are facing considerable challenges in preparing their healthcare systems for quantum advancements. These disparities, if left unaddressed, could exacerbate existing health inequities and hinder the global adoption of quantum technologies in public health. The recommendations provided in this study are practical and logically derived from the findings, offering clear, actionable steps to bridge these gaps across the four domains of the readiness framework (Lawal *et al.*, 2025).

i. Governance and Regulatory Preparedness: Establishing anticipatory governance frameworks that explicitly address quantum health technologies is crucial. This includes developing regulations for quantum encryption, data governance, and ethical considerations specific to healthcare applications.

ii. Infrastructure and Technical Capacity: Investment in scalable digital infrastructure, especially in LMICs, is essential to ensure that quantum technologies can be effectively integrated into health systems. This will involve upgrading

current infrastructures to handle the computational demands of quantum applications and ensuring the deployment of quantum-resilient cybersecurity measures.

iii. Equity and Accessibility: Proactive measures are needed to ensure equitable access to quantum-enhanced health solutions. This includes fostering international collaborations, technology-sharing agreements, and policies that prioritize inclusivity to prevent the "quantum divide" from widening existing global health disparities.

iv. Workforce Readiness and Implementation: Building Workforce capacity through targeted quantum literacy and training programs for healthcare professionals, policymakers, and technologists is critical. This will ensure that the workforce is equipped to manage, regulate, and effectively utilize quantum technologies as they are deployed in public health systems.

By implementing these recommendations, policymakers can ensure that public health systems are not only prepared for the digital disruption posed by quantum technologies but are also able to leverage these innovations to enhance healthcare delivery, improve equity, and protect sensitive health data. The proactive integration of quantum technologies into public health governance will help transform potential challenges into opportunities, ensuring that healthcare systems are future-proof and resilient in the face of digital disruption (Fagbenle, 2025).

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