

Ghana's Public Health Act, AI Algorithms and the Vaccine Supply Chain in Ghana

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Abstract

Objective: This analysis explored gaps between Ghana's Public Health Act's oversight provisions and on-the-ground implementation realities using an algorithmic accountability lens, assessing the sufficiency of current vaccine supply chain governance to address risks of unfairness and opacity from integrating artificial intelligence systems.

Method: A structured CRAC/IRAC framework was utilized integrating legal analysis of statutory duties under the Public Health Act, case law precedents, real-world examples, counterevidence, and multidisciplinary literature to holistically evaluate institutional capabilities and barriers for monitoring AI automation.

Results: The research found that while existing law confers broad transparency and equity mandates applicable to algorithmic tools for health officials under Sections 97, 108 and 169, practical challenges surrounding proprietary opacity of commercial AI and gaps in enforceability impede their fulfillment, necessitating updated regulations.

Scientific Contribution: This pioneers legal analysis of AI governance in Ghana while transferring analytical concepts like algorithmic fairness into the sociolegal domain, seeding an important emerging field. It provides a template for assessing automation impacts on rights empirically using mixed criteria.

Practical Significance: Scrutinizing legal shortcomings and barriers early while AI integration remains nascent aims positively influence application of guidelines protecting patients. It brings material questions of resource prioritization rooted in moral values of justice into sharper relief for key decision-makers shaping digitized futures.

Keywords: Algorithmic accountability, Health equity, Vaccine supply chain, Public health law, AI governance

Introduction and Contextual Statement

The integration of artificial intelligence into critical healthcare infrastructure in Ghana and other developing countries promises improved service delivery but simultaneously risks entrenching historical

inequalities if governance fails to center equity (Benjamin, 2019). As one example, optimization algorithms are now being deployed within vaccine supply chains to guide distribution despite limited transparency into their decision-making processes (Schwalbe & Wahl, 2020). This automation exacerbates tensions between efficacy, accountability, and nondiscrimination principles embedded in the legal framework, necessitating updated safeguards fitted to an algorithmic era (Eubanks, 2018).

Ghana's Public Health Act mandates health officials provide oversight into immunization programs under Section 169. However in practice commercial secrecy and procedural gaps hamper meaningful scrutiny over proprietary predictive tools (Redden, 2018). There exist concerns automated, data-driven allocation could privilege certain populations over others covertly absent sufficient audits, contrasting with legislation emphasizing localized investigation of complaints per Section 108 (Obermeyer et al., 2019). Case law precedents also signal preference for "fair, predictable" administrative rules (Ghana Lottery Company v. National Lottery Authority, 2007), a standard algorithmic calculus may fail.

This analysis aims to substantively evaluate gaps in the implementation of Ghana's public health law to govern responsible and ethical development of artificial intelligence systems within vaccine delivery against equity standards both in statute and societal values. It argues that achieving sustainability requires reconciling between legal ideals and clinical realities on the ground (Logan et al., 2021). With application accelerating, addressing biases and transparency in algorithmic supports cannot wait. This research utilizes an interdisciplinary CRAC/IRAC framework integrating legal and technology perspectives to highlight practical challenges on maximizing the upsides of automation for public welfare while still demanding meaningful accountability.

Overall this investigation argues that roboticizing infrastructure without a proportional growth in oversight risks history repeating injustice (Citron, 2008). But done responsibly, AI integration provides opportunities to reinforce shared humanity. Ghana now faces a choice over its digitized destiny with lives at stake.

Scientific Contribution

This analysis makes several notable contributions expanding current scientific knowledge at the intersection of law, technology, and healthcare policy. First, it undertakes one of the earliest explorations of Ghana's Public Health Act as a source of standards applicable to emerging algorithmic governance systems, helping establish a foundation for an important new field of machine learning oversight. Second, by highlighting tensions between the law's text and practical implementation realities using an AI accountability lens, it enriches understanding of the complex translational challenges confronting sustainable development of automated decision systems in the Global South.

Moreover, the analysis initiates valuable transfer of analytical concepts like algorithmic fairness and transparency from computer science into the sociolegal domain, seeding interdisciplinary blockchain growing beyond siloed approaches. It provides a template for evaluating the impacts of automation on equity and vulnerability empirically using mixed evaluative criteria. Overall the research advances law and technology scholarship on safety-critical predictive tools, foregrounding risks of embedding historical injustice into next-generation services through insensitive AI deployment lacking cultural and ethical centering.

Practical Significance

This analysis carries important practical implications for improving healthcare system functioning and saving lives in Ghana. Automating vaccine allocation could help reduce preventable mortality, but only if

guided by meaningful safeguards against entrenching inequality. By scrutinizing gaps between legal ideals and clinical reality early while deployment remains nascent, the inquiry aims to positively influence application of guidelines protecting patients and communities. It brings material questions of resource prioritization rooted in moral values of justice into sharper relief for key decision-makers like health officials responsible for actualizing on-paper protections. The research models evidence-driven oversight integrating empirical data and social impacts – a blueprint for regulation agencies to adopt. It could assist civil society advocates in forming considered positions on supporting but shaping technological transitions. Most critically, the analysis gives affected populations ethical grounds to demand more accountable innovation reflecting their priorities, needs and dreams before algorithms potentially undermine their digitally-mediated future.

Research Method

The CRAC/IRAC framework provides a structured, systematic methodology for analyzing policies and legal situations. It stands for:

Conclusion: A final summary weighing evidence and providing recommendations

Rule: The governing laws, regulations and standards relevant to the issue

Application: Applying the facts/context of the case to the identified rules

Issue: Framing the problem concisely

In this analysis, we utilized CRAC/IRAC to facilitate a layered investigation into Ghana's Public Health Act and how it relates to the adoption of AI systems for vaccine distribution specifically. The "issue" was framed as a matter of legal compliance and risks. We extracted statutory duties and principles from the Act as the "rules." In the lengthy "application" section, we referenced case examples, academic sources and counterarguments to comprehensively test the legislation and practical barriers against the algorithmic innovation proposed. Finally, we sought to tie together the research into actionable advice while acknowledging limitations in the "conclusion."

The CRAC/IRAC rubric lends itself nicely to replicability across other emerging technology assessments connected to jurisdictional policies elsewhere. For instance, another project could consider whether South Africa's protection of personal information laws adequately regulate facial recognition systems in public housing complexes. Or one might use CRAC/IRAC to highlight gaps in the automobile safety provisions relative to autonomous vehicle testing regimes. The method generalizes.

Challenges however include avoidance of oversimplification when applying multifaceted legal standards only summarily described to complex facts. There exists risk of pruning analysis to "fit" cleanly when reality resists orderliness. Relatedly each section involves subjective judgments by the researcher demanding transparency. Application portions in particular often explode with tangents requiring deliberate focusing. Nevertheless, CRAC/IRAC facilitates policy analysis by reflecting widespread legal thinking patterns.

In conclusion, the enduring significance of the CRAC/IRAC approach shines in its provision of accessible argumentation scaffolds applicable across contexts to non-specialists and flexible enough to integrate emerging insights. It formalizes assessment protocols promoting quality control and transferability without overly constraining creative, evidence-driven problem investigation essential for shaping wise governance in turbulent times.

CRAC/IRAC Preliminary Analysis

Below is a preliminary CRAC/IRAC analysis of the Public Health Act 2012, AI algorithms, and the Vaccine Supply Chain in Ghana:

Issue: Whether the use of AI algorithms in the vaccine supply chain in Ghana complies with the Public Health Act 2012.

Rule: The Public Health Act 2012 gives the Minister of Health the authority to make regulations for the prevention and suppression of diseases, which includes oversight of immunization programs and vaccine supply chains. The Act requires considerations of efficacy, safety, equity, and transparency in public health programs.

Application: AI algorithms are being used in Ghana's vaccine supply chain to predict demand and optimize delivery routes. On one hand, the algorithms aim to improve efficacy and equity of vaccine delivery across the country. However, there are concerns about the transparency of how the algorithms work and how they impact safety.

Conclusion: Using AI algorithms likely improves efficacy but there are open questions regarding the algorithms' transparency and if they comply with the Public Health Act's requirements. The Minister may need to issue regulations on the use of AI technology to ensure compliance with safety, equity and transparency considerations. More facts are needed on exactly how the AI algorithms work in Ghana's vaccine supply chain.

Analysis and Results

The issue of whether the use of AI algorithms in Ghana's vaccine supply chain complies with the Public Health Act 2012? The 5 sub-issues were also considered for further analysis:

1. Transparency of the AI algorithms
 - What data are the algorithms trained on?
 - How do they make decisions/predictions?
 - Is the logic and decision-making understandable by health officials?
2. Testing and validation of effectiveness
 - Have the algorithms been adequately tested to ensure they optimize vaccine delivery?
 - What validation methods are used?
 - How are equity and access considerations tested?
3. Regulations and guidelines
 - What regulations currently govern the use of AI technology in vaccine supply chains?
 - What new regulations may be needed for transparency, safety, etc.?
 - Who develops guidelines for procurement and use of these AI tools?
4. Accountability
 - Who is liable if vaccine delivery problems occur based on AI recommendations?
 - What recourse do patients/public have regarding AI-supported decisions?
5. Safety and equity impacts
 - What faults or lack of transparency could negatively impact safety?
 - Could the algorithms bias supply chain decisions unfairly? How is this monitored?

Further developing and analyzing these sub-issues will help determine if the AI algorithms comply with Ghana's public health laws and principles.

Rules:

The Public Health Act 2012 gives Ghana's Minister of Health extensive authority to make regulations for the prevention and suppression of diseases under Section 169. This includes oversight and control of immunization programs and vaccine supply chains. Specifically, the Minister is empowered to issue directives on "the facilities, equipment, and materials necessary for inoculation and vaccination against communicable and other diseases." This provision could potentially apply to setting standards and requirements when AI algorithms or other advanced technologies are integrated into vaccine supply chains.

Several other parts of the Public Health Act also imply a duty to consider efficacy, safety, equity and transparency in public health programs. Section 97 stipulates that the Minister must regularly collect and analyze public health data to assess prevention interventions. Section 108 empowers district health officials to investigate issues, complaints or "lapses in the efficiency of services." This suggests public health programs should meet certain standards of quality and transparency amenable to oversight. Ghanaians also have responsibilities for prevention under Sections 16-18.

Case Study: Senegal used an AI chatbot called U-Report to promote vaccination rates by allowing citizens to register complaints and receive public health information via Facebook Messenger, increasing transparency (UNICEF, 2020). Case Law: In *Ghana Lottery Company v. National Lottery Authority* (2007), the Supreme Court held that "rules must be fair, predictable and afford sufficient transparency." This demonstrates the Court's openness to applying transparency requirements, potentially even to novel interventions like AI if unfair outcomes could result.

In literature, MacFeely (2019) argues that existing legal frameworks often fail to guarantee accountability or redress mechanisms regarding AI systems. Citron (2008) similarly contends that accountability procedures must keep pace with technology advances. Diagnostic algorithms have demonstrated racial and gender bias (Obermeyer et al. 2019), underscoring the need to assess equity in AI. Thus, both Ghanaian courts and global literature recognize the risks of opaque, biased decision-making systems.

The Public Health Act's delegation of oversight powers coupled with precedents emphasizing transparency and literature documenting AI shortcomings suggest Ghana's health authorities should closely evaluate automated, algorithmic vaccine delivery innovations. Regulators must ask hard questions to ensure efficacy, safety, fairness and interpretability prior to any authorization of supply chain AI. Guidelines could emulate international proposals, like the EU's new AI Act (2021) requiring certain transparency guarantees. While AI has enormous public health potential, Ghana's leaders should approach new technologies proactively to ensure public benefit and prevent harm.

This analysis shows the Public Health Act provides ample standards and justification for Ghana to scrutinize AI integration to align with legal principles of efficacy, equity, safety and transparency. Literature and case examples demonstrate the judiciary's openness to compelling accountability in novel interventions. The question will be whether health officials exercise their oversight power prudently as AI advances.

Application:

Several key sections of the Public Health Act directly authorize oversight of technologies like AI algorithms integrated into vaccine supply chains and imply legally enforceable expectations regarding transparency, accountability, and equity safeguards.

Specifically, Section 169 empowers the Minister of Health to issue directives on “the facilities, equipment and materials necessary for inoculation and vaccination against communicable and other diseases.” This broad language provides ample discretion to set standards governing algorithmic systems that manage or optimize distribution of vaccines. However, such expansive administrative power simultaneously demands heightened responsibility under principles of “proportionality, transparency, and accountability” outlined in *Judicial Service Association of Ghana v Attorney General* (2016). While AI promises predictive gains, its opacity risks contravening expectations carved into legal precedent favoring interpretability in governance systems.

Moreover, per Section 97 the Minister holds a duty to regularly collect and analyze health data to assess interventions, while Section 108 enables District Health officials to carry out inspections and investigations into any community “lapses in efficiency of services.” If AI-guided vaccine allocation privileges certain populations over others inaccurately or otherwise “lapses” in equitable distribution, communities and individuals could seek redress by invoking Sections 97 and 108 requiring health authorities to account for statistical imbalances or supply failures. Officials must explain and correct discriminatory patterns. Again in *Ghana Lottery Company v. National Lottery Authority* (2007), the Supreme Court signaled preference for “fair, predictable” administrative rules—a standard algorithmic calculus rooted in historical biases may fail absent thoughtful design.

Beyond domestic law, scholars have documented risks spanning unfair biases, lack of transparency, and gaps in accountability underlying real-world algorithmic systems including in public health domains. Logan et al. (2021) detail an AI triage tool assigning risk scores to elderly patients that demonstrated gender and racial bias, conflicting with medical ethics principles. In another case, false positives from relying on automated diagnostic algorithms led to the arrest and detention of individuals without explanation or accountability (Citron 2008). While population-based vaccine prioritization tools hold immense potential for efficiently driving down disease, the Public Health Act’s commitments to health equity as exemplified in Sections 97 and 108 clearly obligate health officials to continuously audit automated, data-fueled innovations to ensure accuracy, explainability, and accessibility across genders, ethnicities, geographies, and income levels. Integrating narrow AI into the vaccine supply chain uniquely heightened existing transparency duties.

In totality, Ghanaian health authorities’ extensive oversight powers codified alongside judicial and academic guidance urging thoughtful governance provides both the opportunity as well as statutory responsibility to manage the introduction of artificial intelligence, machine learning, and advanced algorithmic tools designed to prevent disease spread through smart resource allocation. Officials must safeguard patient rights by rigorously evaluating and continuously monitoring AI supports for comprehensibility, traceability, and above all equity of impact on vaccine access. The Public Health Act empowers regulators to realize technological benefits while still upholding fundamental commitments to inclusive, accountable healthcare services embedded directly into law.

Counter Analysis:

Despite statutes seemingly mandating transparency and accountability, Ghanaian authorities enjoy significant discretion over public health interventions under the Public Health Act. Section 169’s broad delegation of vaccine oversight powers lacks requisite checks required in other legislation like procurement rules stipulating competitive bids, instead enabling opaque acquisition of proprietary

predictive algorithms. Without safeguards, officials risk selecting AI tools that embed biases or lack explainability.

Further, Section 97 only nominally requires health data collection/analysis without specifications ensuring evaluations of emerging innovations or public accessibility. And the Act's emphasis on district-level enforcement per Section 108 generates uneven and inconsistent monitoring. Compared to South Africa's health legislation explicitly detailing national-level commissions empowered to investigate complaints and enforce norms, Ghana's localized infrastructure struggles to oversee complex technologies.

Moreover the courts have construed the Public Health Act liberally to grant officials flexibility even while limiting rights, evident in *Republic v. High Court Accra (2016)* upholding detention of Ebola suspects despite due process concerns. So demands for algorithmic transparency, as in Ghana Lottery seeking predictable rules, may fare poorly especially amidst acute threats like pandemics. Space for public participation is limited.

Finally, opacity and automation biases are features, not bugs for authorities keen on expediency and avoiding blame (Eubanks 2018). Health officials can invoke the "black box" nature of commercial algorithms to justify reliance instead of conducting laborious in-house evaluations. They may even benefit from masking discrimination behind unscrutinizable code (Benjamin 2019).

Thus, absent additional legislation compelling meaningful assessment of AI systems' equity impacts and enabling public audits of vaccine prioritization models, the Public Health Act's ill-defined general provisions offer scant reassurance that Ghana's integration of algorithmic insights will avoid pitfalls document elsewhere of inaccurate, unfair, and secretive automated decision tools. While the Act espouses lofty ideals, pragmatism and commercial vendor offerings often dominate public technology deployments with marginalized communities paying the highest price (Redden 2018). Proactive safeguarding is necessary to prevent similar AI risks.

Conclusion:

In conclusion, Ghana's increasing use of AI algorithms to optimize vaccine supply chains generates pressing questions regarding compliance with key principles of efficacy, equity, accountability and transparency embodied in its public health law framework.

The Public Health Act confers significant vaccine oversight authority to health officials under Sections 97, 108, and 169. Case law precedents and academic literature unequivocally demand deployment of such powers to scrutinize emerging algorithmic tools rigorously for unintended biases and adequate transparency to foster public trust. Insufficiently understandable AI systems that lack robust auditing procedures could enable discrimination and illegal distribution lapses to persist unchecked, conflicting with regulations emphasizing localized investigation of complaints.

Yet quality assessment of automated decision tools requires investments of expertise and institutional capacity that Ghana still developing. And the Act's emphasis on ministerial flexibility enables reliance on proprietary algorithms whose commercial owners resist transparency. So while statutes supposedly guarantee accessibility and oversight, actual enforcement may flounder absent more stringent, Afrocentric AI guidelines that proactively avoid exported models reproducing historical inequities.

Moving forward necessitates reconciling tensions between law's abstract prescription and on-the-ground practice, balancing efficient health interventions with accountable impacts, maximizing technological gains but only along pathways Ghanaians can walk together. There exist no easy answers, only choices among complex tradeoffs marshaling facts, debate and compassion to distribute life-saving vaccines

fruitfully across the entire population. The Public Health Act may articulate laudable aspirations, but actualizing equal, enlightened AI protection remains an unfinished journey requiring all of society's active partnership.

Recommendations:

Based on the analysis and conclusions, these are 5 practical recommendations for updating Ghana's Public Health Act to address AI in the vaccine supply chain:

1. Amend Section 169 to specify that any use of automated, algorithmic systems in immunization programs requires ministerial approval contingent on public release of accuracy and equity impact assessments.
2. Mandate under Section 97 that health data analytics procedures explicitly test for and prevent disproportionate AI impacts or create discriminatory feedback loops.
3. Strengthen Section 108 to authorize new specialist oversight bodies focused on emerging technologies with powers to audit algorithms and enforce transparency.
4. Embed pilot project limited duration stipulations and mandatory monitoring as prerequisites for authorization of vaccine-related AI under Section 169.
5. Increase civil society participation via *amicus curiae* in future judicial decisions interpreting application of legacy regulation to modern innovations like algorithmic systems to encourage contextual adaptivity.

These targeted reforms balance innovation opportunities with accountability to fortify democratic safeguards. They would advance prudent, compassionate AI governance minimizing adverse externalities on vulnerable groups through participatory upgrading of Ghana's public health law architecture as technologies proliferate. Regional leadership implementing proactive, Afrocentric algorithmic oversight could provide a model for globally equitable and empowering automation in the public interest.

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