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The Unequal Dilemma of Children's Digital Health Rights: Legal Balance in the Commercialization Process of Ai Healthcare

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ABSTRACT
Artificial intelligence technology has shown great potential in the field of pediatric medicine, helping precision medicine, personalized care and early disease intervention, but the wave of commercialization has also exacerbated the inequality of children's digital health rights. Differences in technology access, algorithm discrimination and data privacy have become major challenges. The existing legal system lags behind, the regulatory framework has defects, the responsibility identification dilemma and the failure of the consent mechanism need to be solved. In order to meet these challenges, it is necessary to innovate the legislative principles, establish the core status of children's rights, promote transparent and interpretable technology governance, and establish a multi-party collaborative governance framework to ensure that AI technology serves the well-being of children, and realize the harmonious unity of technological progress and social equity.

KEYWORDS
Children's right to digital health; Inequality dilemma; AI medical; Legal balance

1 Introduction

Artificial intelligence (AI) technology has sparked a profound revolution in the field of healthcare, demonstrating enormous potential in pediatric medicine. AI can be used to analyze medical imaging for disease diagnosis, identify rare diseases, promote innovation in the field of children's health, accelerate vaccine development, and optimize public health monitoring, providing unprecedented opportunities to realize the right to health of children guaranteed by the United Nations Convention on the Rights of the Child, and assisting in precision medicine, personalized care, and early disease intervention. However, under the wave of commercialization of AI healthcare, it has also brought serious challenges. The difference in technological accessibility has formed a "digital divide", highlighting the problem of algorithmic discrimination. Children's health data also faces the risk of excessive collection and abuse, exacerbating the unequal situation of children's digital health rights. In the face of these opportunities and challenges, the existing legal system lags behind, and there is a general lack of comprehensive legislation on children's digital health rights worldwide. Existing regulations are difficult to address the new problems brought by AI, such as the "black box" of AI decision-making, unclear responsibility attribution, and regulatory gaps in cross-border data flow. Therefore, it is crucial and urgent to build a legal framework that can balance technological innovation and children's rights protection. It is necessary to reform legislative principles, innovate responsibility mechanisms, and establish a multi-party collaborative governance framework to ensure that AI technology serves children's well-being and achieves a harmonious unity of technological progress and social equity.

2 Multidimensional manifestations of unequal digital health rights for children

2.1 Access inequality: health disparities under the digital divide

In the era of AI healthcare, unequal access to technology has become the primary factor leading to disparities in children's health rights, creating a new and more complex 'digital divide'. Firstly, the access gap between urban and rural areas and regions remains significant. In remote rural areas, weak network infrastructure and unstable power supply make it difficult to popularize AI medical services that rely on high-speed networks and stable computing. This results in children living in these areas being unable to access advanced diagnostic tools and remote expert consultations available to urban children, and their health status is still largely constrained by limited local medical resources. Secondly, socioeconomic status has a decisive impact on technological accessibility. Children from low-income families often lack the ability to purchase smart devices, pay for data traffic, and bear the cost of AI medical services. Their families may not be able to afford the high costs of genetic testing, AI assisted personalized treatment plans, and thus be excluded from the wave of precision medicine. Finally, the global North South divide is particularly prominent in the field of digital health. AI medical technology and related data resources are highly concentrated in developed countries, and its algorithm model is also mainly trained based on the data of the local population. When these technologies and models are introduced into developing countries, they often become "incompatible" due to differences in race, genetic background, disease spectrum, and living environment, leading to a decrease in diagnostic accuracy and even potentially

misleading results. This not only fails to narrow the global health gap, but may also expose children in developing countries to new technological dependencies and inequalities in the medical field.

2.2 Algorithmic Discriminatory Inequality: Technological Bias and Social Inequality

Algorithmic discrimination is a particularly hidden but harmful manifestation of inequality in the commercialization process of AI healthcare. It solidifies or even amplifies social biases and structural injustices that exist in the real world through technological means. This discrimination first stems from bias in the training data. The performance of AI models is highly dependent on the quantity and quality of training data. If the dataset used for training lacks representativeness in terms of race, gender, region, socio-economic status, etc., the accuracy and fairness of the model will be greatly reduced when applied to underrepresented groups. For example, an AI diagnostic system primarily trained on data from white children may have a higher misdiagnosis or missed diagnosis rate when diagnosing diseases in African American or Asian children, resulting in delayed or inaccurate treatment for these minority children. Secondly, algorithmic bias systematically targets ethnic minorities and vulnerable groups. The American Medical Informatics Association (AMIA) explicitly states that AI must undergo stricter scrutiny when applied to vulnerable groups such as children, especially when these groups are underestimated in training data. This bias is not only reflected in medical diagnosis, but may also extend to multiple aspects such as health risk assessment, insurance claims, and public health resource allocation, leading to systemic injustice for vulnerable groups in the field of health. Finally, content recommendation algorithms in children's smart devices also constitute a form of discrimination. These algorithms often push content to children that can trigger strong emotional reactions or have strong addictive tendencies in order to maximize user retention time, while ignoring the educational value and suitability of the content.

2.3 Data rights erosion: privacy leakage and abuse risks

In the commercial operation of AI healthcare, children's health data has become a highly valuable "digital oil", and their data rights are facing unprecedented risks of erosion. Firstly, the problem of excessive collection of sensitive health data from children is becoming increasingly serious. Various digital health applications, wearable devices, and online medical platforms, while providing services, are also collecting a large amount of personal information from children, including real-time geographic location, physiological indicators, psychological status, genetic information, and even highly sensitive data such as family environment. Many parents have expressed that they did not receive clear and understandable explanations regarding the scope of data collection, storage methods, access permissions, and deletion policies before agreeing to their children's use of these AI diagnostic and treatment programs. This information asymmetry has left children's privacy unprotected from the beginning. Secondly, there is a sharp conflict between the commercial use of data and children's privacy rights. The massive collection of children's health data, after analysis and desensitization, may be used for commercial purposes such as precision advertising, insurance risk assessment, drug development, and even sold to third-party data companies. Although companies claim that data has been 'de identified', technologies such as' data triangulation 'still have the potential to re identify individuals, especially for children with rare diseases whose unique genetic sequences or medical records make it almost impossible to fully anonymize them.

3 The legal causes of ai medical commercialization exacerbating inequality

3.1 Defects in regulatory framework: legal lag and fragmentation

There is a huge gap between the rapid development of AI medical technology and the backwardness of laws, and the existing regulatory framework is inadequate in addressing the challenges it brings. This is one of the fundamental legal causes that exacerbate the inequality of children's digital health rights. Although the United Nations Convention on the Rights of the Child provides a basic framework for safeguarding children's rights, it does not explicitly address the specific issues brought about by new technologies such as AI. When formulating AI strategies, countries often overlook the consideration of children's rights, resulting in a legal vacuum for the protection of children in the field of AI healthcare. Secondly, the applicability of existing laws and regulations is facing difficulties. Taking the United States as an example, although there are laws such as the Children's Online Privacy Protection Act (COPPA) and the Health Insurance Portability and Accountability Act (HIPAA), they have significant limitations in addressing the complexity of AI healthcare. COPPA mainly focuses on online data collection for children under the age of 13, while for adolescents aged 13-17, the conflict between their medical autonomy decision-making rights and their guardian's informed consent rights makes legal application exceptionally complex. Although HIPAA protects the privacy of health information, its protection is greatly reduced after data de identification, and AI technology can infer sensitive health information from seemingly harmless data. Finally, the fragmentation and conflicts within the international legal framework further exacerbate governance challenges. The significant differences in legal standards for data protection, AI ethics, and healthcare regulation among different countries and regions have led to compliance challenges for multinational AI healthcare companies operating globally.

3.2 Responsibility determination dilemma: legal responsibility attribution for AI decision-making errors

In AI healthcare systems, when algorithmic decisions lead to harm to children's health, the determination of legal responsibility becomes an extremely complex and controversial issue. This dilemma in determining responsibility is another important legal cause that exacerbates inequality. Firstly, the ambiguity of the legal subject status of AI is the fundamental obstacle to determining responsibility. The current legal system is mainly built around human actors, and there is no clear answer as to whether AI systems can be regarded as independent legal entities and take responsibility for their decisions. If AI is seen as a tool, then the responsibility should be borne by its users (doctors or hospitals); But if viewed as a system with a certain degree of autonomy, the division of responsibility becomes exceptionally difficult. The ambiguity of this legal status may lead to mutual shirking of responsibilities among all parties involved in medical accidents, ultimately making it difficult for the victimized children and their families to obtain effective legal remedies. Secondly, the division of responsibilities between developers, users, and medical institutions is complex and intricate. The birth and application of an AI medical product involve multiple stages: algorithm developers, data providers, software integrators, medical institutions, and ultimately doctors who use AI systems. When an AI system misdiagnoses or provides incorrect treatment recommendations, which party should bear the responsibility? Is there an inherent flaw in the algorithm, or is there a problem with the data quality? Is it due to doctors' excessive reliance on AI and neglect of clinical judgment, or medical institutions failing to fulfill their duty of prudence when purchasing and deploying AI systems? This complex chain involving multiple parties makes it extremely difficult to trace causal relationships and allocate responsibility.

4 Legal balance path: building a child first governance system

4.1 Legislative principle reform: Establishing the core position of children's rights

In order to effectively address the challenges brought by the commercialization of AI healthcare and fundamentally reverse the unequal distribution of children's digital health rights, it is necessary to reform existing legislative principles and place children's rights at the core of the entire governance system. Firstly, it is necessary to clearly establish the principle of "best interests of the child" as the primary guiding principle for all AI medical activities involving children. This principle requires that in any decision regarding the design, development, deployment, and regulation of AI medical products, the well-being, safety, and rights of children must be the highest consideration, taking precedence over commercial interests, technological convenience, or administrative efficiency. Secondly, the principles of "Age Appropriate Design" and "Privacy by Design" should be actively introduced and strengthened. The principle of "age appropriate design" requires that all digital products and services aimed at or potentially used by children must be specially designed based on the child's age, cognitive level, and psychological characteristics, ensuring that their interface, functionality, and content are safe, friendly, and beneficial to children. This includes setting up strict age verification mechanisms, providing concise and clear privacy instructions, and limiting features that may lead to addiction or exposure to harmful information. The principle of 'default privacy protection' requires that the highest level of privacy protection must be provided in the default settings of products and services, such as disabling non essential personal data collection functions by default, which can only be enabled with the user's explicit and active consent. Finally, it is necessary to vigorously strengthen the principles of transparency, interpretability, and accountability to solve the "black box" problem of AI technology. The principle of transparency requires that developers and users of AI healthcare systems must clearly and comprehensively disclose the usage, data sources, algorithm logic, potential risks, and limitations of AI systems to children and their families, regulatory agencies, and the general public. The principle of interpretability requires that any decision made by an AI system that affects children's health must provide a human understandable explanation of its decision-making basis and reasoning process.

4.2 Technical Governance Adaptation: Embedding Legal Principles into Technical Design

The innovation of legal principles needs to be combined with the adaptation of technological governance in order to transform paper-based rights into practical guarantees. This means that the legal principle of prioritizing children must be embedded into the entire process of designing, developing, and deploying AI healthcare systems through specific technical standards and governance mechanisms. Firstly, a child centered ethical framework, such as the "PEARL-AI" framework proposed in the journal Nature Digital Medicine, should be vigorously promoted and applied. This framework is a systematic ethical guideline that runs through the entire lifecycle of AI, emphasizing that the unique needs and vulnerabilities of children must be given priority in every aspect of problem definition, data collection, algorithm development, testing deployment, and post monitoring. Secondly, it is necessary to establish a mandatory algorithm fairness and bias audit mechanism. Relying solely on developers' self-awareness is far from enough. Legal and regulatory measures are needed to require all AI healthcare systems applied to children to undergo independent third-party fairness and bias audits before going public and during operation. This type of audit should use appropriate fairness definitions

and measurement standards to systematically detect whether there are significant differences in the performance of algorithms among different populations (such as children of different races, genders, and socioeconomic statuses). Finally, a graded data management strategy based on age and risk should be implemented. Children are not a homogeneous group, and there are significant differences in cognitive abilities, autonomy, and risk exposure among children of different age groups. Therefore, data management strategies should also be adjusted accordingly. For example, for infants and young children, the processing of all their health data should rely entirely on the consent of their guardians and be subject to the strictest protection. For adolescents with certain cognitive abilities, they can be granted autonomous control over some of their health data (such as mental health, reproductive health, etc.) within the legal framework, and allowed to bypass guardians and directly seek medical services in specific circumstances. In addition, differentiated management measures should be implemented based on the risk level of data processing activities.

4.3 Collaborative governance framework

Building a Multi party Participatory Governance System The protection of children's digital health rights is a complex system engineering that involves multiple dimensions such as technology, law, ethics, and society. Any single entity's efforts are difficult to address the comprehensive challenges it brings. Therefore, it is necessary to establish a governance framework that involves the participation and collaborative efforts of multiple stakeholders such as the government, enterprises, social organizations, academia, children, and their families. The government should play the role of "helmsman" and "regulator", formulate and improve relevant laws and regulations, clarify the rights, obligations, and responsibilities of all stakeholders, and establish specialized regulatory agencies to effectively supervise the AI medical market and severely punish illegal activities. At the same time, the government should encourage enterprises to develop AI medical products that are in line with children's interests, safe and reliable through policy guidance and financial support. Industry organizations and enterprises should actively fulfill their social responsibilities, develop and comply with strict industry self-discipline norms and technical standards, establish internal ethical review mechanisms, proactively conduct impact assessments on children's rights, and make the assessment results public to society. Consumer associations, children's rights protection organizations, media, and academia should actively play a supervisory role by exposing the risks and problems in the field of AI healthcare through research reports, public opinion supervision, public interest litigation, and other means, and promoting improvements for businesses and governments.

5 Conclusion

Reiterate the key role of law in balancing innovation and rights protection.

In the current era of deep integration between artificial intelligence and the healthcare industry, children's digital health rights face many challenges. Although commercialization brings innovative potential, it also exacerbates social inequality and exposes children to new risks. Relying solely on the market or technological evolution cannot solve problems such as algorithmic discrimination and data abuse. The law must become an active shaper and guardian. By innovating legislative principles and adapting technological governance, the law can set ethical and legal boundaries for AI healthcare, establish a dynamic balance between encouraging technological progress and safeguarding basic rights, and guide its development towards fairness, inclusiveness, and responsibility. Looking to the future, building a fair and inclusive digital health future for children is a social ethical issue that requires global joint efforts. The future development of AI healthcare should prioritize children, and all stakeholders should participate together to form a governance ecosystem. Through international cooperation to bridge the digital divide, empower children and their families to enhance their digital literacy and rights awareness, make AI technology a solid guarantee for children's right to health, and make digital health a basic right equally enjoyed by all children, this is our responsibility and commitment to the next generation.

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