PERSPECTIVE

Scientific wellness in China: Innovations and implementation of data- and AI-driven health

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Received: August 24, 2024; Accepted: November 22, 2024; Published Online: November 25, 2024; https://doi.org/10.59717/j.xinn-med.2024.100103

Citation: Liu H. and Ding G. (2024). Scientific wellness in China: Innovations and implementation of data- and AI-driven health. The Innovation Medicine **2(4)**: 100103.

As the measurement and utilization of human biological data continue to advance, the potential of data- and AI-driven Scientific Wellness in disease prevention and health promotion is increasingly being recognized, garnering widespread attention within the academic and medical communities. The implementation of Scientific Wellness promises a revolutionary shift in healthcare from a disease-centered model to a health-centered model, greatly enhancing the well-being of the population. In this study, we undertook a comparative analysis of the health strategic frameworks employed by China and the United States. We outlined policy support, public sentiment, and the current status of the application of Scientific Wellness in China. Additionally. We propose prioritized development directions tailored to address the unique challenges faced by Scientific Wellness initiatives in the country. We aim to contribute to the formulation of effective strategies that harness the transformative power of Scientific Wellness to advance public health outcomes.

INTRODUCTION

Scientific Wellness is a novel healthcare concept that aims to maintain long-term health by longitudinally collecting extensive human biological data and constructing individual and population wellness dashboards to develop personalized and actionable strategies.[1] As a pioneering proponent of this concept, Dr. Leroy Hood demonstrated in a wellness study of 108 individuals that a data-driven approach can detect perturbations in biological data networks and indicate health-to-disease transitions.[2] Implementing personalized strategies achieves optimal goals for disease prevention and health maintenance, potentially extending a healthy lifespan. This concept perceives individuals as active participants in healthcare, rather than passive treatment recipients.

Progress in human phenome research and artificial intelligence has driven the completion of the Scientific Wellness concept. The human phenome, shaped by gene-environment interactions, is a set of measurable traits that include morphology, functions, behaviors, and molecular patterns throughout the lifespan, from embryonic development to birth, growth, aging, and death.[3] Development of human phenotyping technology, the macro-micro multi-dimensional cross-scale mechanisms, and systems biology has provided a holistic view of wellness and disease.

The Chinese academic community is actively engaging in the International Human Phenome Project (IHPP), which employs a distributed approach worldwide and focuses on the detection, analysis, and population application of wellness and disease. Scientists from China released the first human phenome atlas, which enabled the precise identification of personalized wellness and disease interventions.[4]

CURRENT STATUS

The United States of America and China were among the first countries in the world to initiate health strategy planning. In China, strategic initiatives, such as "Healthy China 2030, " emphasize the importance of prevention over treatment, advocating the promotion of health literacy, sensible eating habits, healthy environments, mental well-being, and chronic disease prevention. Health literacy rates among urban and rural residents in China have significantly increased from 16.52% and 8.47%, respectively, in 2016, when the program was introduced, to 31.94% and 23.78%, respectively, by 2022.[5] Since 1990, the United States has implemented a ten-year national health strategy, which shifted its focus after 2010 from reducing mortality rates and promoting health equity towards enhancing quality of life, extending healthy lifespan, and establishing supportive social and physical environments for the public. This shift represents a progression from a focus on survival to a high quality of life. The policy priorities of the two countries differ slightly in terms of their target populations. China has addressed the entire lifecycle from the outset, including the disabled and low-income groups. In contrast, the United States initially concentrated on pregnant women and infants, gradually extending its coverage to the entire life cycle with a dynamic adjustment for priority populations.

There are also differences in the public acceptance of scientific health between China and the United States. In China, 'treating undiagnosed diseases' is deeply rooted in traditional medicine, making Scientific Wellness more widely acceptable. Conversely, due to differences in insurance reimbursements and public health perceptions, companies providing such services in the U.S. still struggle to survive, despite the positive reception of Scientific Wellness in the academic and industrial sectors.

The scientific landscape in China is shifting towards disease prevention and health management. In 2018, China's key project, Precision Medicine, proposed precise classification and disease intervention to achieve precise prevention. It also supports disease risk prediction and health management consulting using big data. China is actively developing innovative methods for detecting human biological data and has established a multi-dimensional, cross-scale, one-stop deep phenotyping platform in Shanghai with the highest detection capabilities globally.[6] Aside from "diseases-centered" AI applications on diagnosis and prevention, AI screening models like OvaRePred[7] and PCOSt[8] have already been developed for fertile women and are utilized in female reproduction, endocrine metabolism, and mental health. Tools such as Makizako Social Frailty Index, neonatal pain response variable set, and standardized Motoric Cognitive Risk Questionnaires have been used in populations to personalize and enhance health management outcomes in China.[9,10]

PROSPECTS

Despite establishing a solid foundation in policy frameworks, public support, and technological reserves, China faces challenges that hinder the widespread benefits of scientific well-being for its entire population. First, obtaining systematic data is challenging. Individuals can gather data through annual physical examinations, medical interventions, wearable devices, etc. However, it is difficult to merge personal data generated from these varied sources into a cohesive biological dataset. The terminology, measurement, and storage of biological data produced by various methods differ, making it difficult to consolidate them, even if they pertain to the same individual, owing to a lack of standardization and quality control. Additionally, Personal biological data raise concerns related to privacy and data security, necessitating stringent regulatory oversight. Secondly, the application of artificial intelligence in healthcare requires further improvement. Despite the significant advancements in AI in language models and autonomous driving, its application in the medical field is still relatively restricted. Current artificial intelligence imaging tools are often restricted to single-modality datasets. Large-scale applications of AI in medical decision making are yet to be realized. Third, healthcare practitioners often lack an awareness of Scientific Wellness and its associated tools. The prevailing disease-centered healthcare model makes it difficult for individuals to receive guidance on wellness improvement from clinical institutions when no clinical symptoms are evident. Furthermore, the absence of AI applications and related tools has left profes-

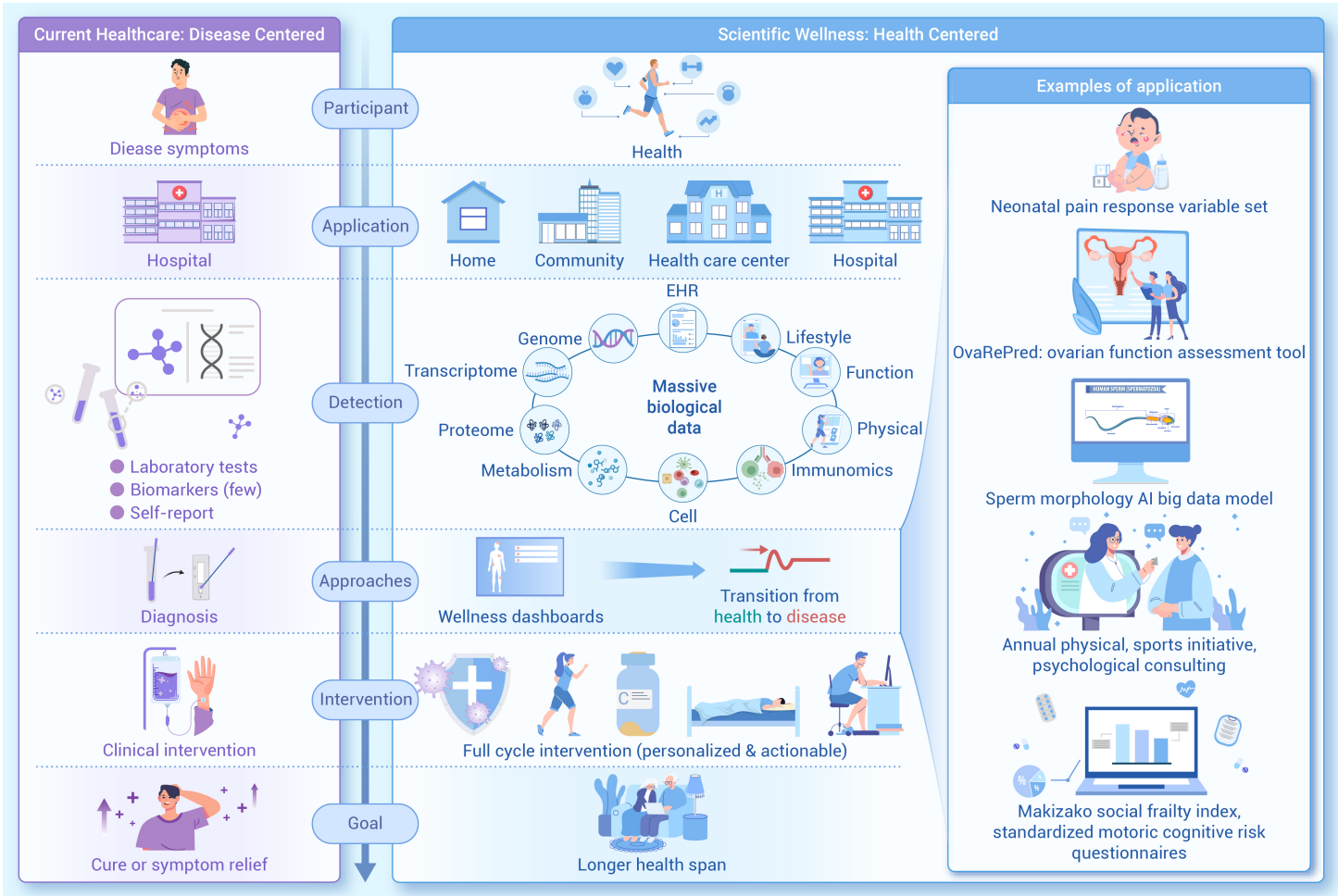

Figure 1. Revolutionary changes under the Scientific Wellness concept and examples of health management applications in China.

sionals ill equipped to handle big data effectively. Scientific Wellness introduces a novel approach to health maintenance that involves a broad range of stakeholders. This has created new opportunities and challenges. Strengthening the construction of the following aspects will accelerate the Scientific Wellness integration process and enhance public health.

Data-rich and systematic biological data for individuals

The accumulation of biological data requires extensive microdata, such as genomics, transcriptomics, proteomics, and metabolomics. Additionally, it requires accessing individual medical data dispersed in various hospitals and long-term dense data on personal daily activities, such as steps, pulse rate, heart rate, oxygen levels, and sleep. When developing technologies for measuring population biological data, it is imperative to establish methodologies and criteria for constructing high-caliber biological datasets, cultivate common phenome data elements, institute standardized protocols for the generation of population biological data, and intensify quality assurance measures throughout the process. In addition to technological challenges, this study also confronts personal data security and ethical issues.

Currently, China has made attempts at standardization of human biological data life cycle. The Standardization Working Group 34 on Biological Phenotypes (Phenomics) of Standardization Administration of China, and other national Standardization Administration have initiated the work of formulating standards regarding the format, governance, management, circulation, processing, and security of human biological data. More than 10 national standards have been completed or are in the process of being developed.

Accelerating health understanding with AI

Generating interpretable and iterable large-scale health knowledge graphs using big data and AI will provide actionable insights for extending healthy lifespans. The digital twin of populations and individuals based on multimodal models is accelerating the understanding of life and health, and achieving personalized assessment and decision-making by simulating a variety of interventions and predicting their effects. The accumulation of population biometric data coupled with AI will expedite the establishment of digital twins and reduce costs, enabling broader and more rapid applications across diverse populations.

Healthcare staff training to adapt to the era of AI

Applying cutting-edge technologies represented by artificial intelligence across various industries will bring new challenges to wellness-promoting work and create new employment opportunities. Careers in nursing, behavioral guidance, and other fields that demand expertise and strong communication skills will play an increasingly crucial role in addressing the needs of an aging population.

Promoting Diverse Stakeholders Join in Biological data Collaboration

Big Data is the most crucial factor in healthcare transformation. Ensuring that high-value health big data meets the needs of both data producers and users while maintaining information security has become a significant challenge for practitioners. Engaging academic societies and industry associations to facilitate the circulation of health big data is another challenge. The key issues that need to be addressed include biological data security, healthcare payments, and the valuation of circulating data. Currently, the fourth-generation medical education centered on health, interdisciplinary, integrated, and empowered by AI, has been proposed and is being implemented in Chinses medical education reforms, with the potential to trigger a paradigm shift.

CONCLUSION

China has entered an era of aging, which has led to a growing demand for

health management and elderly care. Advancements in Scientific Wellness are poised to create new job opportunities and catalyze economic growth. This future reinforces our conviction that China, along with other developing nations, has the potential to improve the wellness of its larger population through avenues such as scientific research, professional training, and innovative approaches during the era of healthcare reform (Figure 1).

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FUNDING AND ACKNOWLEDGMENTS

This project was supported by the Shanghai Municipal Science and Technology Major Project (Grant No. 2023SHZDZX02) and the Shanghai Science and Technology Innovation Project (Grant No. 24DZ2307700). We appreciate the support of Academicians Jin Li from Fudan University and Leroy Hood from the Institute for Systems Biology. We also thank Prof. Renli Deng's team at Zunyi Medical University and Mr.Guangping Jiang from Shanghai Morgan Tan for their generous support. The funders had no role in study design, data collection and analysis, decision to publish or preparation of the manuscript.

AUTHOR CONTRIBUTIONS

Dr. Han Liu contributed the main ideas and wrote the original manuscript. Dr. Guohui Ding provided the concepts and collected the data.

DECLARATION OF INTERESTS

The authors declare no competing interests.