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Bridging Traditional Chinese Medicine and Modern Biotechnology: Strategic Perspective for Global Market Expansion

Li Shuqi*, Chee Weiming

City Graduate School, City University Malaysia, 46100 Petaling Jaya, Selangor Darul Ehsan, Malaysia

*Correspondence: 741109915@qq.com

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ABSTRACT: Traditional Chinese medicine (TCM) was transformed into a standardised medical system facilitated by continuous development across global healthcare practices as well as ongoing advancements in modern biotechnology. Modern biotechnological methodologies, including genomics, proteomics, and metabonomics, afforded significant possibilities for enhancing the accuracy and efficacy of TCM. This research accordingly explored the interplay between modern biotechnology and the advancement of TCM across global markets. The integration of the resource-based view (RBV) framework together with TCM theory provided a strong foundation for this study. The qualitative case illustrations encompassed Tasly Pharmaceutical Group, Yiling Pharmaceutical, Hutchmed, and Shanghai Pharmaceuticals, which facilitated an understanding of how the benefits of TCM were magnified through biotechnological innovation. The findings underscored that a comprehensive understanding of traditional Chinese medicinal elements, alongside specialised knowledge, consistent research, and developmental initiatives, collectively manifested strategic resources that enhanced the potential for integrating TCM in a global context. To leverage the benefits of TCM through modern technologies, several recommendations were provided, such as collaborative leadership between global biotechnology and TCM institutions, as well as quality control and standardisation of evidence-based formulations that complied with modern medical standards. The outcomes supported the conclusion that the global market expansion of TCM required a synergistic approach involving robust regulatory frameworks, standardisation, scientific validation through modern technology, and the effective translation of cultural elements.

KEYWORDS: Globalisation; biotechnological methodologies; innovation, policy alignment; collaboration.

1. Introduction

TCM was well known for its various implications and associated practices [1]. Previously, it was primarily based on healthcare practices such as acupuncture and the application of herbal medicines. However, due to globalisation and modernisation, modifications also took place in the use of TCM for treating patients. Advanced technological support and effective drug

research and development indicated the growing influence of modern biotechnology on the application of TCM [2]. Thus, investigating the development of TCM through modern technology provided a deeper understanding of the relevance of TCM in the contemporary era.

It was observed that interest in TCM had increased significantly. However, this created a notable research gap regarding how TCM contributed to modern biotechnology in improving sustainable international expansion. Existing studies mainly focused on the clinical efficacy of technological innovations in biotechnology, without exploring strategic convergence from policy and market perspectives. This limitation highlighted the need to incorporate cultural perceptions, regulatory frameworks, and innovation systems that promoted the global commercialisation of TCM-based biotech products. The aim of this study was to bridge TCM and modern biotechnology by emphasising a strategic perspective for global market expansion.

This multi-dimensional study focused on assessing the potential of integrating the principles of TCM with contemporary biotechnologies to create competitive products and to understand the factors associated with their success in international markets. More specifically, the study assessed the strategic mechanisms adopted by TCM-biotech firms in the synergistic application of traditional medicine and biotechnology, examined the major opportunities and challenges related to regulatory barriers, international recognition, and market acceptance in the global healthcare market, and identified applicable mechanisms to enhance commercialisation and global market penetration through innovative partnerships, strategic collaborative frameworks, and strengthened quality control and standards. Consequently, the study addressed the following research questions: how TCM principles combined with biotechnology enhanced product competitiveness, what opportunities and barriers affected global compliance and acceptance, and which mechanisms most effectively facilitated the commercialisation and international growth of TCM-based biotech products. This study made a significant contribution by offering a strategic framework linking TCM and modern biotechnology [3]. In order to increase global market competitiveness, the study also focused on traditional knowledge systems. Hence, its practical contribution bridged the gap between traditional knowledge systems and modern biotechnology, supporting sustainable internationalisation for TCM-based biotech firms.

2. Literature Review

2.1. Theoretical underpinning.

2.1.1. Resource-based view theory.

Resource-Based View (RBV) Theory explained how firms achieved sustained competitive advantage by leveraging valuable internal resources and capabilities rather than relying solely on external market conditions. In the context of integrating TCM with modern biotechnology, RBV highlighted specialised assets such as traditional medicinal knowledge, scientific expertise, research capabilities, intellectual property, and cultural heritage as strategic resources [3]. These strengths enabled TCM-biotech enterprises to innovate by combining established healing practices with contemporary biotechnological methods, thereby supporting product differentiation and long-term competitiveness [4]. RBV also emphasised the importance of continuous resource development and innovation in overcoming barriers to sustainable growth. For global expansion, RBV suggested that firms strengthened international

competitiveness by investing in research talent, advanced technological platforms, and robust R&D systems, allowing them to translate classical TCM formulations into validated, high-quality products appealing to both Eastern and Western healthcare markets..

2.1.2. Theory of TCM.

The theory of TCM was built on a holistic understanding of the human body, focusing on balance, harmony, and interconnected organ functions [5]. TCM viewed the body as an integrated system in which physiological and psychological processes interacted, shaping diagnostic and treatment approaches. When linked with biotechnology, this holistic perspective offered a useful framework for exploring disease mechanisms and developing more systemic, biologically informed therapies. Models such as the pan-liver network theory helped connect TCM concepts with Western biomedical thinking by relating traditional organ-system interpretations to modern molecular and physiological research [6]. Integrating these theoretical principles with biotechnological tools supported drug discovery and precision medicine by improving scientific validation, strengthening cross-cultural medical understanding, and enhancing the global relevance of TCM-based innovations.

2.2. Critical analysis.

2.2.1. Effectiveness of traditional knowledge and modern biotechnology.

TCM held significant historical and cultural value and was characterised by diverse therapeutic approaches, distinct epistemologies, and enduring contributions to global healthcare. However, in line with the WHO Traditional Medicine Strategy (2014–2023), improvements in service quality through enhanced regulatory frameworks, research, and education to ensure safety, efficacy, and equitable access rendered modern biotechnology and sustained research and development increasingly essential [7]. Biotechnology became critical in addressing ambiguity surrounding the mechanisms through which TCM functioned. In this regard, [8] stated that modern biotechnological methods, including artificial intelligence (AI), aided material standardisation, integration of real clinical data to demonstrate the effectiveness of network medicine frameworks, and assessment accuracy using techniques such as atomic absorption spectrophotometry (AAS) and inductively coupled plasma mass spectrometry (ICP-MS).

Among various biotechnological methodologies applied in TCM, [9] highlighted high-performance capillary electrophoresis (HPCE), polyacrylamide gel electrophoresis (PAGE), and random amplified polymorphic DNA technology (RAPD). These techniques significantly enhanced the precision and reliability of identifying and classifying traditional Chinese medicinal materials, facilitating improved quality control, authentication, and standardisation within the TCM industry. The World Health Organization reported that over 50% of the global population relied on traditional medicines, with higher prevalence in developing nations [10]. Similarly, [11] demonstrated that rapid advancements in biotechnology propelled the modernisation of the Chinese medicine industry, resulting in notable innovation and progress.

2.2.2. Standardisation and quality control challenges in TCM products.

The pharmaceutical sector relied heavily on standardisation due to its direct impact on human health. Standardisation was essential for ensuring quality and safety, with Good Manufacturing

Practice (GMP) regulations governing pharmaceutical production, administration, and quality monitoring [12]. Pharmaceutical Quality Management Systems (QMS) were used to ensure production quality and standard compliance, supported by standardised QMS software. While standardisation improved production efficiency and operational effectiveness, it sometimes overlooked cultural diversity. Uniform approaches were not always suitable across different countries and populations [13]. Adopting standardised systems often required changes in regions accustomed to local practices, leading to resistance and reduced adaptability [14]. Excessive focus on standardisation at the expense of local needs could negatively affect sales and employee productivity [15]. The WHO Traditional Medicine Strategy (2014–2023) promoted improved service quality through legislation, research, and training, while encouraging legal recognition and standardised development of traditional medicine within healthcare systems [16].

2.2.3. Integration of regulatory frameworks and global market access.

Through systematic development across international healthcare practices, TCM evolved into a standardised medical system. Nevertheless, concerns regarding quality, safety, and effectiveness persisted, leading to the emergence of TCM Regulatory Science (TCMRS) [16]. Studies showed that China's National Medical Products Administration (NMPA) applied regulatory science to improve TCM oversight, although the prioritisation of regulatory actions remained unclear [17]. From a global market perspective, limited scientific evidence regarding safety, efficacy, and quality hindered TCM acceptance in regions such as the UK [18]. Although adaptive legislation was introduced, regulatory frameworks often failed to provide effective product assessment and standardised practice [18]. Studies suggested revising trade laws, strengthening governance, and exploring future research directions to promote sustainable TCM trade while protecting biodiversity [19]. The WHO Global Traditional Medicine Strategy 2025–2034 aimed to enhance the integration of scientifically validated traditional and complementary medicine into national health systems [20].

2.2.4. Impact of intellectual property rights and ethical considerations.

The integration of TCM and modern biotechnology in global markets presented challenges related to intellectual property rights (IPR) and ethics. As TCM was rooted in centuries of shared traditional knowledge, issues arose regarding ownership, commercialisation, and patenting. Biotechnology facilitated the isolation of bioactive compounds but raised concerns over cultural appropriation and biopiracy [21, 22]. Effective IPR systems were therefore necessary to protect indigenous knowledge while encouraging innovation and collaboration between traditional practitioners and biotech firms. Ethical considerations were central to the strategic integration of TCM and biotechnology, particularly regarding safety, efficacy, transparency, and animal welfare. Biotechnology provided sustainable alternatives such as plant-based analogues and synthetic substitutes for endangered species ingredients [23]. Balancing IPR protection with fair benefit-sharing enhanced trust, reputation, and global acceptance of TCM products [24]. Addressing ethical and IPR challenges was thus essential for long-term competitiveness in the global health sector.

2.2.5. Impact of Consumer Perception and Global Branding of TCM-Biotech Products

Consumer perception played a critical role in the global expansion of TCM-biotech products. While TCM was often associated with traditional and holistic medicine, uncertainty remained in Western markets due to regulatory, cultural, and scientific concerns [25]. The application of biotechnology improved product efficacy, safety, and credibility through clinical trials and molecular analysis, reshaping consumer perceptions [26]. Global branding strategies that emphasised transparency, scientific rigor, and health benefits facilitated cross-cultural acceptance [27]. By integrating cultural heritage with biotechnological innovation, TCM brands established distinct market positions. Positive consumer perception supported brand equity, credibility, and market expansion [28]. Sustained international growth required continued investment in research transparency, product standardisation, and culturally adaptive marketing strategies.

2.2.6. Effectiveness of Strategic Alliances and R&D Collaboration

Strategic alliances and R&D collaborations played a vital role in linking TCM with modern biotechnology to enhance innovation, credibility, and global competitiveness. Partnerships enabled the transformation of traditional remedies into evidence-based therapies through molecular research, drug discovery, and clinical testing [29]. Collaboration with international pharmaceutical firms facilitated the integration of genomics, metabolomics, and bioinformatics into product development [30]. Such alliances reduced financial risk, improved resource efficiency, and supported global market entry through shared distribution channels [31]. Partnerships also helped TCM firms navigate regulatory requirements in regions such as the EU and the United States [32]. Mutual learning between Eastern holistic philosophies and Western data-driven approaches further strengthened innovation capacity.

2.3. Literature gap.

Although numerous studies highlighted the benefits of TCM, most did not adequately address individual variability related to long-term toxicity, drug interactions, or the role of technological innovation in mitigating these risks. Additionally, existing research largely focused on clinical advantages rather than internationalisation or the linkage between scientific research and commercialisation [25]. Limited attention was given to the intersection of genomics, metabonomics, and proteomics, indicating a significant research gap. Furthermore, the application of biotechnology in analysing the micro-level characteristics of TCM remained underexplored.

3. Methods

3.1. Research design.

Using logical and theoretical reasoning within the relevant discipline, this study sought to determine the relationship between TCM and innovation in modern biotechnology [33]. Rather than relying on statistical testing or survey-based content analysis, the research design employed illustrative case studies to distil key concepts, elucidate causal explanations, and develop theoretical frameworks that integrated strategic resources, scientific legitimation, and

global market expansion within the healthcare industry. This methodological approach was implemented through three sequential stages.

3.2. Conceptual mapping and theoretical framework.

The first stage involved conceptual mapping using the Resource-Based View (RBV) and the Theory of TCM as dual analytical lenses. From the RBV perspective, firm-specific resources such as proprietary formulations, patents, scientific research and development capabilities, clinical evidence, quality control in production, and TCM as a holistic system of principles (including balance, interconnected organ systems, and syndrome differentiation) were identified. These elements were examined to understand how TCM theory and practice were innovated through biotechnology. This stage helped to elucidate a conceptual framework, design an analytical scheme to determine the interconnectedness among key concepts, and establish the strategic basis for analysing the integration of traditional knowledge with modern biotechnological practices.

3.3. Case selection.

The second stage involved case selection to capture variation in strategies and applications of biotechnology within the TCM sector. The companies were purposively selected to align with the theoretical framework, demonstrate the use of applicable biotechnologies, and reflect distinct approaches to bridging traditional and modern drug development. The selected cases included Tasly Pharmaceutical Group, which focused on R&D integration, globalisation, and the modernisation of traditional formulations through systematic research and internationalisation; Yiling Pharmaceutical, which demonstrated the integration of TCM practice with evidence generation during public health emergencies and the incorporation of TCM into evidence-based healthcare; Hutchmed, which emphasised oncology drug development, molecular research, and targeted therapies within a China-based innovation ecosystem; and Shanghai Pharmaceuticals, which represented the integration of modern pharmaceuticals and TCM through portfolio strategy and innovation. The selected cases represented a diverse range of organisational structures, product types, and innovation pathways, enabling the analysis to capture multiple strategic options and development trajectories across the industry.

3.4. Analytical and interpretive procedures.

The final stage involved interpretive analysis examining how the two theoretical perspectives were operationalised within each case. Specifically, the analysis traced (a) how strategic resources were accumulated, prioritised, and developed over time in line with RBV principles; (b) how TCM concepts were applied in research trials, trial design, product standardisation, and branding strategies in accordance with TCM theory; and (c) how these elements aligned with regulatory compliance, global acceptance, and marketability. Subsequently, cross-case comparisons were conducted to identify common strategic patterns, such as research and development partnerships, technology platforms, quality control systems, and policy alignment, as well as variations shaped by market position, product type, and available resources [34]. To enhance credibility and transparency, the analysis followed a structured procedure involving the development of a conceptual map incorporating resources,

capabilities, TCM translation mechanisms, and globalisation drivers; the preparation of concise case narratives aligned with the study scope; and the synthesis of findings into an explanatory framework highlighting both recent achievements and remaining challenges. This methodological design prioritised explanatory power and theoretical coherence while maintaining strong alignment with the selected cases, rather than relying exclusively on empirical or descriptive approaches. The primary objective was to provide a coherent analytical basis that generated meaningful insights into the strategic integration of TCM and modern biotechnology.

4. Results and Discussion

4.1. Overview of case study analysis.

The findings presented in this section were aimed at analysing four well-established case studies related to the application of TCM by prominent pharmaceutical companies in China. The selected companies included Tasly Pharmaceutical Group, Yiling Pharmaceutical, Hutchmed (formerly Chi-Med), and Shanghai Pharmaceuticals. Each case study was examined based on distinct characteristics, including formulation techniques, innovation strategies, and market responses, in order to understand how TCM was integrated with modern biotechnology and positioned within global healthcare markets.

4.2. Case study 1: Tasly pharmaceutical group – integrative r&d and globalisation strategy.

Tasly Pharmaceutical Group emerged as a leading example of how TCM could be reformulated using modern pharmaceutical technologies to meet international standards [34]. The company's flagship product, Danshen Dripping Pills, represented a significant departure from traditional powders and decoctions. The formulation involved the extraction of active compounds from Salvia miltiorrhiza using advanced solvent extraction and purification techniques. These compounds were subsequently microencapsulated into uniform droplets, ensuring consistent dosage and improved bioavailability. The pill's wave-shaped design facilitated rapid absorption and enhanced stability, making it suitable for international distribution and long-term storage [35].

Tasly's innovation strategy was grounded in integrative research and development, combining traditional pharmacopeia with modern biomedical research. The company invested extensively in multi-phase clinical trials, including studies conducted under United States Food and Drug Administration (FDA) protocols. Collaborations with institutions such as Harvard Medical School and the University of California further supported scientific validation through Western methodologies. Additionally, Tasly adopted digitalised manufacturing systems to improve traceability and compliance with GMP [36]. Its innovation model extended beyond product development to encompass regulatory navigation, cross-border partnerships, and intellectual property protection.

Tasly's globalisation strategy generated mixed but constructive market responses. Domestically, the company was recognised for modernising TCM while preserving its philosophical foundations. Internationally, its products were endorsed by both traditional practitioners and biomedical professionals. However, despite clinical trial interest, particularly in cardiovascular applications, adoption in Western markets progressed slowly due to cultural

unfamiliarity and regulatory conservatism. Overall, Tasly's success was driven by its ability to present TCM as evidence-based medicine supported by biotechnological design and clinical data, thereby strengthening consumer trust [36].

4.3. Case study 2: Yiling pharmaceutical – evidence-based tcm for pandemic response.

Founded in 1992, Yiling Pharmaceutical was widely recognised for its flagship product, Lianhua Qingwen capsules, which were extensively used during the COVID-19 pandemic [37]. The company's evidence-based approach to TCM positioned it as a key contributor to global public health responses. Lianhua Qingwen capsules consisted of a formulation of 13 herbs, including Forsythia, Honeysuckle, Ephedra, and Rhodiola, selected based on TCM principles such as expelling pathogens, detoxifying, and clearing heat. Modern pharmacological studies confirmed the antiviral, anti-inflammatory, and immunomodulatory properties of the formulation. Advanced extraction techniques, including ethanol extraction, freeze-drying, and granulation, were employed to preserve synergistic effects. Quality assurance was supported through analytical tools such as high-performance liquid chromatography (HPLC), gas chromatography–mass spectrometry (GC-MS), and DNA barcoding to ensure authenticity and potency. Each batch underwent rigorous heavy metal and microbial testing. The product was manufactured in capsule, granule, and tablet forms to accommodate diverse patient needs.

Clinical validation involved randomised controlled trials conducted in China, Singapore, and Iran, demonstrating reduced viral load and symptom relief in mild to moderate COVID-19 cases. Meta-analyses published in peer-reviewed journals confirmed efficacy in reducing fever, recovery time, and cough severity [38]. Lianhua Qingwen received emergency use approval in several countries, including Indonesia, Thailand, and the United Arab Emirates, with regulatory support from national health authorities. The company collaborated with WHO-affiliated research centres and universities across Asia and Europe, facilitating cross-border trials and knowledge exchange.

During COVID-19 outbreaks in China, Lianhua Qingwen became a household product and was included in national treatment guidelines. The capsules were distributed through hospitals and pharmacies and were procured by governments in ASEAN and Middle Eastern countries. Partnerships with non-governmental organisations enabled distribution in underserved regions of Africa. Despite regulatory caution in Western markets, demand increased through e-commerce platforms and diaspora communities, with social media amplifying its popularity as a natural alternative to synthetic antivirals [39].

4.4. Case study 3: Oncology drug development by Hutchmed (formerly Chi-Med).

Hutchmed operated as a biopharmaceutical company focused on the discovery and development of targeted oncology therapies and immunotherapies. Its development strategy was grounded in precision medicine, targeting specific molecular pathways involved in tumour growth and progression. The company's portfolio included approved and investigational drugs such as Savolitinib, Surufatinib, and Fruquintinib, designed to treat advanced solid tumours. Savolitinib, a selective MET inhibitor, received approval for treating non-small cell lung cancer with MET exon 14 skipping mutations [23]. Its development demonstrated Hutchmed's

commitment to molecularly targeted therapies rather than conventional tumour classification approaches. Surufatinib, a small-molecule tyrosine kinase inhibitor, exhibited efficacy against tumour angiogenic and immune-modulating receptors. Meta-analytical evidence confirmed its safety and effectiveness in treating various solid tumours, including neuroendocrine tumours [40]. Further studies highlighted Hutchmed's contribution to improving patient outcomes through MET-based therapies [38]. The integration of molecular research with clinical development distinguished Hutchmed from conventional oncology drug developers. Fruquintinib, a selective inhibitor of vascular endothelial growth factor receptors (VEGFR), demonstrated efficacy and safety in metastatic colorectal cancer, extending survival while maintaining a favourable safety profile [37]. Overall, Hutchmed's oncology development strategy effectively balanced scientific innovation with patient-centred outcomes.

4.5. Case study 4: Dual focus on modern pharmaceuticals and TCM by Shanghai Pharmaceuticals.

Shanghai Pharmaceuticals (SPH) manufactured active pharmaceutical ingredients, chemical and biological medicines, and a wide range of TCM products supplied to healthcare institutions, retail pharmacies, and consumers [26]. In 2021, SPH reported revenues of RMB 215.8 billion, reflecting its leading position in China's pharmaceutical sector. Its competitive advantage was strengthened through mergers of state-owned enterprises and a hybrid ownership structure combining government and private equity investment [37]. SPH invested heavily in advanced manufacturing facilities and quality control systems that complied with national and international standards. The company maintained a diversified portfolio encompassing TCM, biological products, and chemical medicines, enabling economies of scale and balanced market segmentation [24]. While competing with domestic firms such as China Resources Sanjiu, SPH also faced competition from multinational corporations including Pfizer and Roche, which operated in China through strategic alliances and advanced R&D capabilities [26]. Despite intense competition, SPH benefited from favourable regulatory policies and state support, facilitating market entry and large procurement contracts. Its dual focus on modern pharmaceuticals and TCM allowed the company to capitalise on cultural preferences while expanding into innovative drug categories [17]. Continuous investment in biotechnology, clinical research, and evidence-based validation supported the modernisation of TCM products and strengthened the company's long-term growth strategy [28].

4.6. Cross-case synthesis and discussion.

Insights derived from the four case studies demonstrated the strategic convergence of TCM and modern biotechnology. The findings highlighted the role of globalisation in facilitating the modernisation of TCM, the importance of evidence-based validation in enhancing clinical credibility, and the value of strategic integration across research, regulation, and market positioning. Collaboration between traditional and modern approaches emerged as a key driver of clinical success and international acceptance [22]. The results addressed the initial research problem by illustrating how TCM integration with biotechnology supported sustainable international expansion. Advancements in formulation, standardisation, and clinical validation contributed to increased global application of TCM-based products.

4.7. Theoretical and practical implications.

This research contributed theoretical, methodological, and practical insights into the strategic integration of TCM and modern biotechnology. From a Resource-Based View perspective, firm-specific resources such as TCM knowledge, R&D capability, and manufacturing infrastructure were shown to generate sustained competitive advantage when aligned through biotechnology [32]. The multi-case study design provided a robust conceptual analytical framework that addressed gaps in existing literature. Practically, the findings supported healthcare policymakers, industry practitioners, and researchers by highlighting the need for strengthened global partnerships, rigorous quality control, GMP compliance, and increased investment in evidence-based R&D. Despite limitations related to the China-specific scope and lack of primary field data, the study offered actionable recommendations to foster global trust, regulatory acceptance, and market expansion through culturally sensitive and transparent strategies..

5. Conclusion

This paper was associated with the exploration of the strategic intersection between TCM and modern biotechnology. The outcomes underscored that sustainable competitiveness and global expansion in the biopharmaceutical industry were significantly reliant on leveraging both scientific innovation and culturally embedded traditional knowledge. In addition to the various opportunities associated with the intersection of TCM and modern biotechnology, the novelty of this research was associated with its emphasis on persistent challenges, whether in terms of standardisation, regulatory harmonisation, or ethical governance. Issues related to intellectual property protection, clinical validation, and consumer perception continued to challenge the global legitimacy of TCM. The illustrative case studies incorporated in this paper demonstrated that strategic innovation, evidence-based validation, and adaptive regulatory alignment were paramount and served as major determinants of the modernisation and internationalisation of TCM. The importance of research and development initiatives was validated through the case study of Tasly Pharmaceutical Group, whereas the case study of Yiling Pharmaceutical illustrated how an evidence-based approach was essential in TCM globalisation initiatives. Similarly, the oncology drug development initiatives of Hutchmed demonstrated how molecular-level biotechnology could coexist with traditional medicinal paradigms. Collectively, the findings underscored the necessity of a synergistic approach that combined TCM and biotechnology through consistent innovation and research and development. It was deduced that modern biotechnology afforded promising possibilities in terms of quality assurance and could also facilitate cross-border credibility, consequently contributing to global market expansion..

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Author Contribution

Authors clearly specified the roles and contributions of each individual involved in the research to ensure appropriate attribution of credit and transparency regarding responsibility for various aspects of the study. Li Shuqi was responsible for conceptualization, methodology, data collection, and data analysis, and also contributed to writing the manuscript. Chee Weiming contributed to conceptualization and writing and provided overall supervision of the research.

Competing Interest

The author declares that there are no financial, personal, or professional conflicts of interest that could have influenced the conduct, interpretation, or presentation of this research. All aspects of the study were carried out independently and objectively.

Data Availability

The data that support the findings of this study are available from the corresponding author upon reasonable request.

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