




Review Article

Addressing the Challenges of Traditional, Complementary, and Integrative Medicine Research: An International Perspective and Proposed Strategies Moving Forward

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ABSTRACT

Traditional, complementary, and integrative medicine (TCIM) encompasses a broad range of healthcare practices beyond conventional Western medicine. Despite its use globally and increased research, many TCIM research challenges persist impeding its progress and integration into clinical practice. Key challenges involve financial constraints, insufficient research training and educational support, and the methodological barriers which arise from a lack of standardization. Financial limitations hinder investment into crucial research limiting both the quantity and quality of TCIM research. Inadequate training in research and educational support limit the development of TCIM research, hindering growth and recognition of TCIM in academic and clinical settings. The inherent dynamic nature of TCIM therapies poses additional challenges for applying standardized biomedical research models. These challenges not only impede the advancement of TCIM research but also perpetuate negative attitudes and biases within the healthcare and research communities. To overcome these challenges, a comprehensive strategy is necessary to increase funding, improve literacy, and the promotion of open science practices in TCIM. Addressing these confounding factors will enable well-informed TCIM research literacy and the development of TCIM skills and facilitate the integration of evidence based TCIM therapies into a more inclusive healthcare domain, ultimately reducing negative attitudes and biases towards TCIM.

Keywords: complementary medicine, integrative medicine, traditional medicine

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Introduction

Complementary medicine is commonly characterized as a collection of diverse medical and healthcare interventions, practices, products, and disciplines that fall outside of the realm of conventional medicine [1]. The World Health Organization (WHO), defines the term “complementary medicine” as “a broad set of health care practices that are not part of that country’s own tradition or conventional medicine and are not fully integrated into the dominant healthcare system. They are used interchangeably with traditional medicine in some countries” [2]. “Traditional medicine” is defined as “the sum total of knowledge, skill, and practices based on the theories, beliefs, and experiences indigenous to different cultures, whether explicable or not, used in the maintenance of health, as well as in the prevention, diagnosis, improvement, or treatment of physical and mental illness” [2]. The National Center for Complementary and Integrative Health (NCCIH) elaborates

on the term “complementary medicine” describing it as a nonmainstream practice used alongside conventional medicine, and links it with “integrative health” which involves the coordinated delivery of both conventional and complementary approaches to health care [3]. For the purposes of this article, these therapies will collectively be referred to as “traditional, complementary, and integrative medicine” (TCIM) henceforth.

TCIM therapies can vary widely in nature, stemming from their diverse origins across distinct global regions, various cultural contexts, and unique traditional medicine systems, each shaped by different philosophical frameworks [4,5]. Despite these variations, multiple types of TCIMs can be categorized into distinct groups, each serving unique purposes in disease prevention, health promotion, and treatment [6]. The NCCIH pragmatically categorizes TCIM according to the following four categories: (1) nutritional approaches; (2) psychological approaches; (3) physical approaches; and (4) combinations of approaches [3].

Nutritional approaches involve special diets, dietary supplements, herbs, and probiotics [3]. Psychological practices are based on the incorporation of techniques such as mindfulness [3]. Physical therapies encompass treatments like massage and spinal manipulation [3]. Combinations of TCIM approaches integrate either psychological and physical elements (including yoga, tai chi, acupuncture, dance, art therapies) or psychological and nutritional components (such as mindful eating) [3].

Globally, the use of TCIM therapies have experienced notable growth in recent years [7]. The WHO estimates that approximately 100 million people in Europe utilize TCIM therapies [8,9]. Findings from the 2022 National Health Interview Survey in the United States show a significant increase in TCIM use among adults, with over 37% incorporating TCIM into their health practices [10]. Other high-income countries including Australia [11], South Korea [12], Singapore [13], and Japan [14] have also shown high rates of TCIM use. Notably, many migrant populations residing within Europe and the United States commonly uphold their traditional health practices including the use of TCIM therapies, contributing to its progressive increase [15-18]. The use of TCIM therapies are also present in numerous lower and middle-income countries, where they may even be regarded as common practice due to cultural factors and notable deficiencies in the local healthcare systems [19,20]. According to the WHO, in lower and middle-income countries, the proportion of the population depending on TCIM therapies as their primary healthcare varies widely, ranging from 40% in Colombia [21], up to 90% in Ethiopia [22]. TCIM therapies are widely used by patients with a variety of illnesses and ailments; among cancer patients globally, multiple studies have reported TCIM use up to 90% in some form [23-25]. Patients use TCIM for a variety of reasons including symptom relief, improved quality of life, augmentation of traditional therapy, reinforcing health philosophies, and gaining control over their health care [26,27]. TCIM consumers value the holistic healthcare approach, addressing functional, mental, emotional, spiritual, economic, and social aspects [3].

Consequently, the growing interest in TCIM, within the context of research, is evident based on the surge of scholarly output on this topic. A commentary published in 2014 [28], identified 175,482 articles using PubMed and the medical subject heading “complementary therapies”. A recent inquiry into the same database with identical parameters, was undertaken more recently in December 2023, and revealed a noteworthy increase in published articles whereby 248,265 results were retrieved (Table 1). This rise in research output underscores the growing attention and exploration of TCIM within the scientific community. Since the 1940s, there has been an upward trajectory in the number of publications on this topic [29]. However, despite this growing interest and expanding research output,

Table 1. Number of Complementary Therapy Related Articles Published which were Identified Using the PubMed Database and using “Complementary Therapies” as the Medical Subject Heading

Article publication (y)	All article types (n)
1990-1980	21,829
2001-1991	33,236
2012-2002	83,192
2023-2013	88,071
No date restrictions	248,265

numerous challenges and obstacles persist in conducting rigorous TCIM research and integrating its findings into clinical practice. This article delves into the challenges associated with TCIM research, specifically addressing impediments to conducting research in this field. These challenges include insufficient financial support, a lack of training in research and educational resources for TCIM students, and the absence of standardization resulting in methodological barriers. Additionally, this article also discusses how inherent negative attitudes and a lack of interest or understanding of TCIM by conventional healthcare practitioners and other biomedical researchers hinders its implementation into clinical practice.

Challenges to Conducting TCIM Research

1. Lack of financial support

The challenges associated with conducting TCIM research are deeply rooted in the lack of financial support and funding, posing impediments to the progress and advancement of this field. This skepticism permeates through various channels, including media coverage, which tends to present TCIM in a more negative manner compared with conventional medicine [30]. Bias has also been reported in medical students who developed a more negative perspective towards TCIM after exposure to and completion of conventional medicine curriculum, despite possessing a positive interest before commencing their education [31,32]. This shift in attitude in medical students observed over the course of their medical degree not only reflects a potential bias in medical education but may also influence research priorities in the future, contributing to the existing publication bias against articles and studies on TCIM therapies [33,34].

Despite a noticeable increase in TCIM research in recent decades, [2,35-37], the decisions regarding the allocation of research funding remains imbalanced reflecting differing funding priorities. For instance, in 2022, only 0.17%

(equivalent to \$159.3 million) of approximately \$96.48 billion of the United States' National Institute of Health research funding was allocated to finding the NCCIH research funding [38,39]. Australia's National Health and Medical Research Council observed this disproportionality over 2 decades ago (2001 to 2004) whereby only 0.085% (equivalent to \$850,000) of approximately \$1 billion was allocated to TCIM research [40]. Even in Asian countries, such as South Korea, where TCIM is regulated and integrated within the mainstream healthcare system, statistics from 2021 revealed that only 6.33% of the total research and Development budget in the healthcare sector was allocated to Korean Medicine research [41]. This allocation is not only insufficient but also indicative of a systemic disregard for the potential contributions and insights TCIM researchers offer to the general medical and healthcare community.

Moreover, apprehension surrounding patentability concerns of TCIM products present another challenge in acquiring research funding. Unlike pharmaceutical or technological innovations eligible for patents, various TCIM therapies are ineligible (such as mind-body medicine practices which include meditation, breathing exercises, tai chi, and yoga). Additionally, the incorporation of natural compounds into many TCIM products, such as herbal medicines, varies across countries worldwide. In China, herbal medicines are regulated by the China Food and Drug Administration according to the Provisions of Drugs Registration, specifically adhering to the Supplementary Rules for the registration of Traditional Chinese Medicines [42]. Herbal medicine preparations with a well-established history of use may undergo a simplified registration process that does not require clinical trials [42]. In Japan, herbal medicines are regulated as Health and Medical Foods under the "Food with Health Claims" regulations [42]. To qualify as medicine, both raw compounds and standardized formulations of herbal medicines must be registered, licensed, and comply with regulatory frameworks [42]. These patenting frameworks have enabled over 200 Chinese herbal preparations included in the Essential Drugs List of China and approximately 300 Kampo (traditional Japanese herbal medicine) preparations listed in the "Approval Standards for over the counter Kampo Products" [43]. In contrast, other countries may have patent frameworks that do not neatly align with the incorporation of natural compounds found in many TCIM products. In 2015, the US Patent and Trademark Office introduced guidelines instructing patent examiners to reject claims that sought exclusive rights over all purified natural products [44]. This introduces challenges to patenting natural product compounds that comprise many TCIMs, contributing to a reluctance among financial investors to support research initiatives in this field. This reluctance is further emphasized by the fact that, despite numerous clinical trials, the US Food and Drug Administration has not approved any dietary

supplement or food for cancer prevention or treatment [44]. The resultant lack of patent protection places manufacturers under competitive pricing pressures, making it difficult to generate the necessary profits for extensive Phase III clinical trials [44]. Another challenge to patenting TCIM products emerges when considering the concept of biopiracy, which refers to the unethical appropriation or economic exploitation of Indigenous knowledge and/or biological resources from Indigenous communities without the proper compensation or acknowledgement [45]. In the context of TCIM, many therapies are derived from Indigenous practices and natural products that have been passed down through generations within specific cultural groups. However, when these practices or natural products are commercialized and patented without the consent or involvement of the Indigenous communities, it can lead to various ethical and legal concerns.

2. Lack of training in research and educational support

The challenges associated with conducting TCIM research are exacerbated by a notable lack of training in research and educational support within the TCIM community [8,46,47]. This deficiency stems from varying factors that hinder the fundamental development of research skills, knowledge, and competency among TCIM professionals. Specifically, a considerable proportion of TCIM practitioners, particularly those specializing in disciplines such as naturopathy, homeopathy, and herbal medicine, pursue their education and training within private colleges [28,48]. This preference is primarily driven by considerations of cost and wider accessibility to private colleges in comparison with universities [28]. Additionally, some Western countries such as Canada, do not offer TCIM programs at public universities, resulting in TCIM practitioners obtaining an education from institutes outside of the university educational system [49]. Ultimately, this educational trajectory often results in a lower number of practitioners obtaining a bachelor's degree which may present barriers to their involvement in research endeavours in the future. For instance, a little over half of TCIM professionals in New Zealand (56.6%) and a little under half of TCIM professionals in Australia (49.1%) attained a high school certificate or advanced diploma as their highest level of education [50]. In Canada, 8.1% of TCIM professionals do not have a bachelor's degree [50].

When seeking education and training in research skills, the typical route for a researcher to gain recognition involves the completion of a postgraduate degree with a research focus. As such, applying to study for an advanced degree presents a challenge for the TCIM practitioner who attended a private college and lacks a bachelor's degree. In addition, the need to complete a bachelor's degree as a

prerequisite for admission to postgraduate programs would place time constraints on the professional practice of TCIM by practitioners who decide to return to school.

Additionally, unlike students in other professional health programs such as the Doctor of Medicine program, students may apply for research opportunities offered within or outside of their universities, but typically TCIM students are not offered these research opportunities [48]. This absence of exposure to research does not enable development of research skills for TCIM practitioners or facilitate integration of research into their career paths. Notably, for those practitioners who aspire to engage in research later in their careers, navigating this path is particularly challenging. The lack of prior research experience, combined with the absence of formal connections within the research community, and limited exposure during their education/training period, creates a challenge for TCIM practitioners aspiring to pursue research projects [8]. Navigating this unfamiliar path may require extra effort and support for those seeking to establish themselves and become involved in research opportunities.

The clinical-centric focus of TCIM institutions that does not expose students to research opportunities, combined with the historically marginalized nature of TCIM, makes it challenging to engage practitioners in research endeavors [51]. Some TCIM practitioners may become distrustful towards research, particularly those with nonscientific worldviews [52]. These worldviews often diverge from the principles of scientific inquiry and encompass perspectives that prioritize subjective experiences, intuitions, spiritual beliefs, or holistic approaches. Interestingly, challenges persist in actively involving TCIM practitioners, even when they express support for research. A survey of US American naturopaths revealed that while a substantial portion (40.7%) would recommend patient participation in research projects, only a fraction (25.5%) would support recruiting them from their own clinics [53]. This reluctance may be rooted in the perception that research is more relevant to the public and broader health system's views on TCIM than to the practitioners' day-to-day clinical practice as instilled within their educational training [51]. Findings from a cross-sectional study conducted by Wayne et al on acupuncture and Oriental medicine students in the United States revealed that the initially high interest in research among 1st year students diminished in the subsequent years [54]. Overall, these findings reinforce the need for a re-evaluation of TCIM education, integration of training on research into TCIM courses, and support to bridge the gaps in order to cultivate a more research-informed practitioner community.

3. Lack of standardization and methodological barriers

Conducting TCIM research poses challenges due to

the diverse nature of TCIM therapies, characterized by their dynamic nature [55]. These factors give rise to methodological barriers resulting from the tension between the demand for standardization in scientific research and the personalized nature of TCIM therapies. Whilst efforts have been made to establish a operational definition for TCIM therapies through systematic evidence-based approaches [55], a lack of international consensus persists among experts in the field [56]. This lack of consensus becomes particularly apparent when attempting to categorize certain TCIM therapies due to cultural nuances [5]. For instance, therapies rooted in Buddhist practices may be considered common care practices in some Eastern cultures but are categorized as TCIM in Western contexts [19,20]. While this cultural variation underscores the complexities of TCIM research, it also raises practical questions about the impact of different categorizations on funding priorities and research agendas. Additionally, it also presents challenges concerning competence and cultural respect in research practice. Researchers must navigate cultural differences in understanding health and illness as well as navigating the deeply ingrained beliefs and practices associated with various TCIM therapies. Adapting research methodologies to accommodate cultural differences and preferences is necessary and thereby further highlighting the challenges posed by standardization in research.

Notably, TCIM practitioners prioritize a comprehensive, individualized, and holistic approach to patient care which is opposed to the reductionist approach commonly associated with conventional biomedical research. Conventional biomedical research refers to the mainstream scientific investigation that typically focuses on isolating specific biological mechanisms or components to understand disease processes or treatment effects [46,57]. Therefore, conventional biomedical research often involves a more focused and mechanistic exploration which often does not neatly align with TCIM. For instance, when investigating naturopathic systems that consider entire plants with multiple constituents rather than isolating single components, many methodological processes become limiting [46]. The holistic nature of TCIM practices pose methodological barriers that challenge the application of conventional research models such as use of a randomized controlled trial [51,58]. Many TCIM therapies target syndromes rather than isolated diseases, focusing on functional relationships between systems in individuals. This departure from the disease-centered model often used by Western biomedicine complicates the development of effective controls for TCIM therapies, especially when the key factors are not well understood or easily assessed, as is the case with certain mind-body therapies (such as qi gong, yoga, tai chi, and meditation) or energetic therapies (such as reiki, therapeutic touch, magnet therapy, and polarity therapy) [58-60]. While the WHO

has made guidelines for methodologies on research and evaluation of traditional medicine [22], and guidelines for clinical research on acupuncture [61], standardizing criteria across TCIM modalities requires careful consideration of cultural, contextual, and philosophical differences. These WHO guidelines, while valuable, highlight the complexity involved in standardizing TCIM research due to their diverse cultural backgrounds and unique approaches to healthcare. The diverse nature of herbal medicines, for example, presents unique challenges in standardization efforts. Herbal medicine practices encompass a vast array of botanical remedies and traditional healing methods, each deeply rooted in cultural beliefs and traditions. Furthermore, the variability in herbal preparations, dosages, and administration methods adds layers of complexity to research standardization, making it essential to address these nuances to ensure robust and meaningful outcomes in TCIM research. Thus, while guidelines serve as a foundation for research standardization, adapting them to accommodate the intricacies of TCIM practices remains an ongoing and essential task.

Furthermore, the emphasis TCIM practitioners place on personalized care not only highlights the importance of tailoring therapies to meet each patient's unique needs and preferences but, also introduces additional challenges for standardizing research practice. Some TCIM practitioners may be hesitant to adopt standardized treatments as it may compromise their capacity to address the diverse needs of patients effectively. Despite these challenges, effort has been made to establish benchmarks and guidelines for the practice of TCIM. The WHO has published benchmarks for various TCIM modalities, including acupuncture [62], Unani medicine [63], and Ayurveda [64], serving as useful resources providing in-depth information on levels of practice, requirements, and safety considerations. Moreover, countries including South Korea and China have taken steps towards promoting standardization of practice by publishing clinical practice guidelines for TCIM therapies. While such guidelines are useful for promoting practice standardization, incorporating them into TCIM requires striking a balance between ensuring consistency and preserving the holistic, patient-centered approach that TCIM practitioners utilize. Although similar issues of research and practice standardization are present in assessments of non-TCIM therapies (such as psychological counselling, exercise, and nutrition), these challenges have not led to dismissing the effectiveness or importance of such therapies. However, within the context of TCIM, negative attitudes and bias have emerged. Overall, the dynamic nature of TCIM, combined with the difficulties of incorporating standardized methods highlight the intricacies involved in conducting rigorous research within this field.

Challenges of Implementing TCIM Research into Clinical Practice

1. Inherent and systemic negative attitudes towards TCIM research

The incorporation of TCIM research findings into clinical practice faces various challenges due to inherent and systemic negative attitudes within the health professional and health researcher community. This pervasive bias not only obstructs the integration of evidence informed TCIM into conventional healthcare but, also fosters negative attitudes towards TCIM practitioners wherein some have reported their research unjustly being labelled as “unscientific” [8,65]. TCIM research is also perceived as less credible when compared with biomedical research, irrespective of scientific validity [46]. For instance, despite evidence supporting the efficacy of TCIM research, such as in the case of herbal medicines, practitioners report experiencing challenges reflecting bias. While safety concerns and potential interactions should always be a priority, it is essential to treat these concerns with equal importance for both TCIM and conventional treatments. However, current reports from TCIM practitioners indicate a disproportionate emphasis on safety concerns and potential interactions, with minimal consideration given to the potential benefits [46]. These negative attitudes and biases highlight the challenges of incorporating TCIM research in clinical practice, emphasizing the need to implement strategies to reduce the biases held by conventional healthcare practitioners.

Language biases pose an additional substantial obstacle to TCIM research integration. The literature on TCIM therapies is disseminated across various languages, with English and Chinese being predominant contributors [66]. Studies published in English-language journals tend to report more negative results associated with TCIM therapies compared with non-English language journals. It was found that when compared with English-language journals, TCIM studies that were published in Chinese, Japanese, Taiwanese, and Russian-language journals report a higher frequency of positive results [67]. Additionally, TCIM research conducted in countries such as China, Japan, Hong Kong, Taiwan, and India conclude greater positive results [67,68]. While the likelihood of publication bias may contribute to an increase in positive results, it is crucial to recognize that the specificities of TCIM research in languages other than English remain largely unexplored; the differences in findings based on language underscore the challenges faced by TCIM research globally [69,70]. These language-related challenges contribute to the reinforcing of negative inherent systemic attitudes towards TCIM research, especially among health professionals who predominantly search for and read literature in the English language. Addressing these

complex challenges requires a strategic approach that involves improving research methods and reporting across all languages to ensure study results are consistent across different language journals to recognize the validity and significance of TCIM research on a global scale.

2. Insufficient interest and understanding of TCIM research

Despite the high rates of TCIM use among patients with varying conditions and illnesses, many patients are reluctant to disclose their use of TCIM therapies to their healthcare professionals (HCPs) [71-73]. It has been found that in order to promote well-informed decision-making, HCPs are advised to inquire about patients' engagement and interest regarding TCIM [74]. Although HCPs could serve as trusted sources of information about TCIM research, their knowledge in this domain often falls short [75,76]. For physicians, this knowledge gap can be attributed to insufficient education or training in TCIM during medical school or residency, coupled with a lack of awareness regarding available evidence-based TCIM resources [77]. Bridging this knowledge gap through education in TCIM is crucial. In spite of efforts made to educate HCPs about TCIM, the most common approach used in the US is voluntary through elective courses as opposed to compulsory courses integrated as part of the curriculum [77,78]. This lack of standardized TCIM healthcare education further exacerbates the challenge of fostering interest and understanding among conventional healthcare providers, hindering the effective incorporation of TCIM research into clinical practice. In addition to the lack of interest and understanding of TCIM research expressed by conventional HCPs, some TCIM practitioners may also exhibit insufficient interest and understanding of TCIM research and may possess distrustful and dismissive attitudes, and perceive TCIM research as inadequate at capturing the subtleties of their TCIM practice [52]. This may stem from the belief that the standardized methodologies used in research fail to sufficiently represent the holistic and individualized nature of TCIM therapies [51,58]. This lack of interest and understanding among TCIM practitioners not only impedes their engagement with research but may also reinforce the perception by other health researchers and HCPs that TCIM studies are less credible, hindering TCIM integration into clinical practice.

Next Steps

1. Strategies to overcome barriers

The intricate interrelationships among the challenges facing TCIM research (Figure 1), underscores the need for

a comprehensive strategy spanning multiple domains to effectively address them. One crucial aspect is the need for increased funding to propel TCIM research forward. A correlation between funding increments and a rise of both the quantity and quality of published scientific research has been reported [79-81]. The effectiveness of increased funding has been demonstrated by the successes of research across various health fields such as autism [82], cancer [83], dyspnea, and nausea [84]. Increased research funding has led to advancements in the prognosis and treatments of many diseases including ovarian cancer, and has facilitated advancements in screening techniques, early diagnosis, and a broader range of effective treatment options [85]. Crucially, the establishment of diverse funding bodies within and beyond the TCIM community is essential, fostering innovative collaborations and entities that enhance awareness of TCIM.

While navigating barriers arising from funding TCIM research, it is also crucial to overcome the inadequacy in research capability within the TCIM community arising from insufficient training and educational support. To address the shortage of TCIM graduates prepared to perform research, it is essential to incorporate faculty development initiatives aimed to advance research literacy in TCIM education institutions. Effective faculty development programs can play a crucial role in empowering faculty to make impactful changes in the learning environments of students and their outcomes. As a result, the research skills of TCIM students depends heavily on the faculty's ability to teach research methodology courses, offer research opportunities, and support students by effectively and comprehensively answering questions. Previously, the National Institute of Health/NCCIH initiated the "CAM Practitioner Research Education Project Grant Partnership," granting it to nine TCIM institutions [86]. The primary objective of this initiative was to elevate the quality and quantity of research content within the curricula of TCIM institutions across the United States. The program aimed to explicitly increase TCIM practitioners' understanding, exposure, and appreciation of evidence-based research, literature, and methods for advancing scientific knowledge [87]. A distinctive feature of the program was the requirement for TCIM institutions to collaborate with a research-intensive institution in developing and executing research education [87]. Initially, all nine TCIM institutions that had received the grant were provided with foundation training in research literacy [88]. This training assisted each institution's faculty with the incorporation of research literacy into both their teaching and clinical responsibilities to their students. The institutions expressed enthusiasm for instructional approaches that embraced collaborative and small group learning strategies [88]. These methods were perceived as advantageous, offering each faculty member a relatively uncommon yet highly valued chance

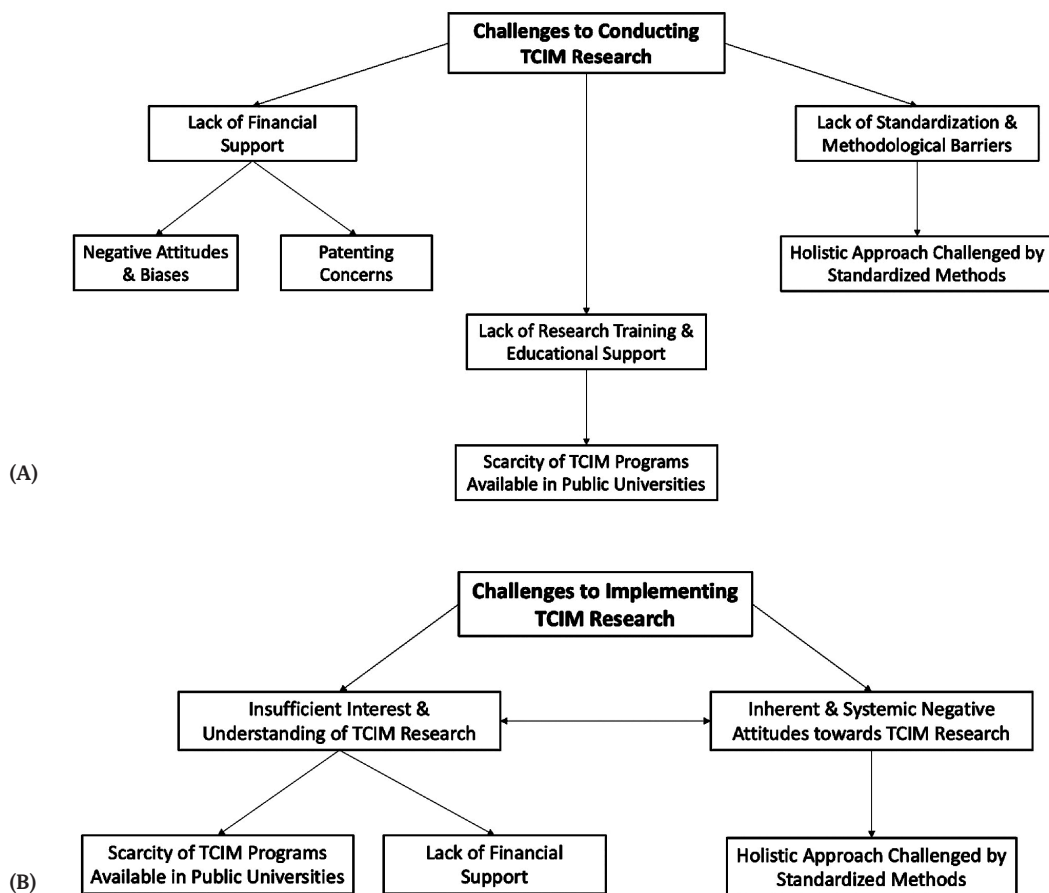


Figure 1. Interrelated challenges in traditional, complementary, and integrative medicine research and its implementation. (A) Challenges in conducting TCIM research. (B) Challenges in implementing TCIM research. TCIM = traditional, complementary, and integrative medicine.

to engage with their colleagues and health educators from diverse disciplines, both within and between institutions. The institutions favored the “multi-hour seminar series” instructional format due to its positive outcomes [89]. These series provided faculty groups with dedicated time to participate in formal presentations and engage in small group guided conversations, reflecting on the integration of new information. TCIM institutions around the world could proactively work towards incorporating similar faculty development initiatives. By providing a faculty with the necessary training and educational support, TCIM education and training institutions can bridge the gap in research capabilities, ensuring that graduates are well-equipped with essential research skills. This strategic initiative aims to increase the number of TCIM graduates with adequate research literacy and skills, thereby empowering TCIM practitioners to critically evaluate biomedical literature, actively participate in research, and in some cases, inspire pursuit of advanced training in research and career development opportunities. Such a comprehensive and collaborative approach not only addresses the challenges

posed by the current lack of research capability in TCIM graduating students but also contributes to the advancement and credibility of TCIM as a field of study and practice.

Furthermore, to effectively address preconceived biases and negative attitudes towards TCIM research, a strategic approach could involve integrating open science practices. Open science practices play a crucial role in enhancing transparency and reproducibility in research by making the dissemination of knowledge and the research process accessible to everyone. The adoption of these practices within TCIM research can be instrumental in mitigating negative biases associated with the field. A recent audit investigating the nature of open science practices across complementary, alternative, and integrative medicine (CAIM) journals by using the Transparency and Openness Promotion (TOP) Factor reported that CAIM journals provide minimal guidelines to encourage or require that authors adhere to open science practices, as reflected by the average TOP Factor of 2.95, within a range of 0 to 24 [90]. Comparisons of audits assessing open science

practices across various health domains including, health and medical science journals, pain journals, and sleep and chronobiology journals, reveal mean TOP Factors of 7.00, 3.50, and 3.00, respectively [91-93]. These findings underscore the lowest usage of open science practices in the field of TCIM when compared to journals belonging to these other health domains. In a recent study assessing barriers and the incorporation of open science practices among CAIM researchers, findings indicated that while most researchers were actively engaging in open access publishing, registering study protocols, and adhering to reporting guidelines, about 75% of respondents emphasized insufficient funding as the primary barrier hindering further integrating of open science practices into their work [94]. Among the CAIM researchers participating in the study, there was a notable lack of formal training in open science practices [94].

Moreover, to effectively overcome barriers in implementing TCIM research into clinical practice, an essential strategy involves incorporating principles of implementation science. Implementation science offers valuable methodologies for translating evidence-based TCIM interventions into real-world practice settings by utilizing a comprehensive approach that seeks to understand the complexities of the implementation by employing determinant frameworks. These frameworks categorize various determinant factors into barriers or facilitators, encompassing five interconnected domains: (1) the effectiveness of implementation strategies; (2) the characteristics of the implemented service, including its perceived complexity and compatibility with existing services; (3) the attributes of adopters, such as their attitudes, beliefs, and motivation toward the implemented service; (4) the characteristics of patients or recipients of the implemented practice, including their preferences and values; and (5) contextual influences, such as cultural and collective factors affecting adopters [95]. By focusing on understanding the factors influencing successful implementation, dissemination, and sustainability of TCIM interventions, implementation science provides a systematic approach to bridging the gap between TCIM research and practice. Embracing implementation science principles can enhance the integration of evidence-based TCIM interventions into healthcare systems.

Considering that TCIM training has predominantly been reported to occur in private colleges rather than universities, TCIM researchers may lack exposure to research practices in comparison with those in conventional biomedical fields [28,48]. This can lead to poorer research practices such as not incorporating international research reporting standards into their work [8]. Approximately 50% of the respondents expressed that practical support from their institutions, coupled with clearer communication highlighting the benefits and importance of open science, would serve as motivating factors to incorporate more open

science practices into their research [94]. It is thus essential for TCIM institutions to actively support such practices. This can be achieved through the implementation of faculty development programs, as discussed above, that educate and train faculty members to integrate research literacy and open science practices into the curricula. By doing so, institutions can not only empower faculty to embrace open science but also foster an environment that supports students in adopting these practices. By incorporating open science practices into TCIM research, guidelines for transparency and reproducibility can be established, fostering a more robust and credible research environment. This is particularly noteworthy in addressing concerns about the efficacy and safety of TCIM practices, which are often subjected to skepticism. Transparent and reliable research, guided by open science principles, becomes a powerful tool to validate or refute concerns surrounding TCIM practices, thereby contributing to the reshaping of perceptions and dispelling negative biases associated with TCIM research.

In addition, overcoming preconceived biases and negative attitudes toward TCIM practices presents another layer of complexity that requires a strategic and collaborative approach within professional healthcare programs. It is crucial to recognize the variability of academic TCIM institutions and degrees, acknowledging that they may be limited or nonexistent in several regions [49]. An essential element in this process involves the integration of comprehensive TCIM content and research into conventional medical and professional healthcare curricula. Integrating TCIM research and education into these conventional settings not only fosters interdisciplinary collaboration but also expands the reach, impact, and interest in TCIM from various HCPs within their respective fields/areas of expertise. Furthermore, this incorporation will not only provide future HCPs with the essential knowledge to confidently integrate TCIM advancements and research findings into clinical practice but will also encourage them to act as a catalyst for fostering open communication with future patients about their use of TCIM [96,97]. Institutions must proactively support these changes, both financially and logistically, to ensure the effective implementation of TCIM integration [98]. This commitment involves not only the financial investment necessary for curriculum development but also the organizational support to ensure these changes are substantive and meaningful in healthcare education. For example, program evaluations could serve as an important measure in assessing the impact of integrating TCIM into educational curricula, ensuring it goes beyond a symbolic gesture and rather it becomes a substantive change [98]. These changes may lay the foundation for a healthcare education system that fosters more informed HCPs capable of reducing the negative attitudes and biases associated with TCIM in a knowledgeable and supportive manner. Current HCPs are strongly encouraged to regularly update

their TCIM knowledge through published literature, such as TCIM recommendations in clinical practice guidelines [99-104]. This reframing of biases, when combined with enhanced education, provides the foundation for addressing the challenges associated with integrating TCIM research into clinical practice.

Conclusion

The widespread global use of TCIM therapies and the growing body of research surrounding its diverse therapeutic modalities highlights the field's increasing popularity. However, financial constraints, a deficiency in research training and educational support, and a lack of standardization and methodological barriers, pose hurdles for prospective TCIM researchers. Financial barriers inhibit the necessary investment for robust research initiatives, limiting the scope and depth of TCIM investigations. The lack of training in research and educational support impedes the development of TCIM researchers, hindering the growth and acceptance of TCIM within academic and healthcare settings. Additionally, a lack of standardization and methodological barriers caused by the dynamic nature of TCIM therapies pose challenges when applying biomedical research models to holistic TCIM practices. These challenges not only impede the progression of TCIM research but also reinforce negative biases. Language biases in TCIM research, evident in the disparities between the findings reported in English-language and non-English-language journals reinforce negative attitudes towards TCIM making the translation of research findings into clinical practice difficult. In navigating these challenges, a comprehensive approach is essential, encompassing increased funding, enhanced research literacy, strategic efforts to increase open science practices, and integrate TCIM content in professional healthcare programs to reduce negative biases and attitudes. Addressing these barriers collectively opens up a more inclusive, informed, and integrative healthcare domain that recognizes and incorporates the benefits of evidence-based TCIM therapies.

Author Contributions

Co-drafted the project outline and original draft of the manuscript with substantial contributions to all revisions: MR. Provided critical feedback, suggestions, and edits: HC, MSL, and LSW. Conceived the project, co-drafted the outline and original draft of the manuscript providing supervision, critical feedback, suggestions, and edits: JYN. All authors have read and approved the final version of this manuscript.

Conflicts of Interest

The authors have no conflicts of interest to declare.

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Data Availability

All relevant data are included in this manuscript.

References

- [1] Ventola CL. Current issues regarding complementary and alternative medicine (CAM) in the United States. *P T* 2010;35(8):461-8.
- [2] Traditional, complementary and integrative medicine [Internet]. [cited 2023 Nov 19]. Available from: <https://www.who.int/health-topics/traditional-complementary-and-integrative-medicine>.
- [3] NCCIH [Internet]. Complementary, alternative, or integrative health: what's in a name? [cited 2023 Nov 19]. Available from: <https://www.nccih.nih.gov/health/complementary-alternative-or-integrative-health-whats-in-a-name>.
- [4] World Health Organization [Internet]. WHO global report on traditional and complementary medicine 2019. World Health Organization; 2019 [cited 2023 Nov 19]. Available from: <https://iris.who.int/handle/10665/312342>.
- [5] Petri RP, Delgado RE, McConnell K. Historical and cultural perspectives on integrative medicine. *Med Acupunct* 2015;27(5):309-17.
- [6] Hawk C, Adams J, Hartvigsen J. The role of CAM in public health, disease prevention, and health promotion. *Evid Based Complement Alternat Med* 2015;2015:e528487.
- [7] Frass M, Strassl RP, Friehs H, Müllner M, Kundi M, Kaye AD. Use and acceptance of complementary and alternative medicine among the general population and medical personnel: a systematic review. *Ochsner J* 2012;12(1):45-56.
- [8] Veziari Y, Leach MJ, Kumar S. Barriers to the conduct and application of research in complementary and alternative medicine: a systematic review. *BMC Complement Altern Med* 2017;17(1):166.
- [9] NCCIH [Internet]. Statistics from the national health interview survey. [cited 2023 Nov 19]. Available from: <https://www.nccih.nih.gov/health/statistics-from-the-national-health-interview-survey>.
- [10] Nahin RL, Rhee A, Stussman B. Use of complementary health approaches overall and for pain management by US adults. *JAMA* 2024;331(7):613-5.
- [11] Commonwealth of Australia [Internet]. Statistics - Complementary therapies. Commonwealth of Australia; Australian Bureau of Statistics; 2008 [cited 2023 Nov 19]. Available from: <https://www.abs.gov.au/AUSSTATS/abs@.nsf/Lookup/4102.0Chapter5202008>.
- [12] Kwon S, Heo S, Kim D, Kang S, Woo JM. Changes in trust and the use of Korean medicine in South Korea: a comparison of surveys in 2011 and 2014. *BMC Complement Altern Med* 2017;17(1):463.
- [13] Lim MK, Sadarangani P, Chan HL, Heng JY. Complementary and

- alternative medicine use in multiracial Singapore. *Complement Ther Med* 2005;13(1):16-24.
- [14] Hori S, Mihaylov I, Vasconcelos JC, McCoubrie M. Patterns of complementary and alternative medicine use amongst outpatients in Tokyo, Japan. *BMC Complement Altern Med* 2008;8(1):14.
- [15] Medeiros PM, Soldati GT, Alencar NL, Vandebroek I, Pieroni A, Hanazaki N, et al. The use of medicinal plants by migrant people: adaptation, maintenance, and replacement. *Evid Based Complement Alternat Med* 2012;2012:e807452.
- [16] Shewamene Z, Dune T, Smith CA. Use of traditional and complementary medicine for maternal health and wellbeing by African migrant women in Australia: a mixed method study. *BMC Complement Med Ther* 2020;20(1):60.
- [17] Babar ZUD, Pengelly K, Scahill SL, Garg S, Shaw J. Migrant health in New Zealand: exploring issues concerning medicines access and use. *J Pharm Health Serv Res* 2013;4(1):41-9.
- [18] González-Vázquez T, Pelcastre-Villafuerte BE, Taboada A. Surviving the distance: the transnational utilization of traditional medicine among Oaxacan migrants in the US. *J Immigr Minor Health* 2016;18(5):1190-8.
- [19] Braun LA, Tiralongo E, Wilkinson JM, Spitzer O, Bailey M, Poole S, et al. Perceptions, use and attitudes of pharmacy customers on complementary medicines and pharmacy practice. *BMC Complement Altern Med* 2010;10(1):38.
- [20] Obadia L. The economies of health in western buddhism: a case study of a Tibetan Buddhist group in France. *Emerald insight*; 2007. p. 227-59.
- [21] Traditional medicine [Internet]. [cited 2023 Dec 17]. Available from: <https://www.who.int/news-room/questions-and-answers/item/traditional-medicine>.
- [22] WHO traditional medicine strategy 2002-2005 [Internet]. [cited 2023 Dec 17]. Available from: <https://www.who.int/publications-detail-redirect/WHO-EDM-TRM-2002.1>.
- [23] Savas P, Robertson A, Beatty L, Hookings E, McGee M, Marker J, et al. Patient preferences on the integration of complementary therapy with conventional cancer care. *Asia Pac J Clin Oncol* 2016;12(2):e311-8.
- [24] Adams M, Jewell AP. The use of complementary and alternative medicine by cancer patients. *Int Semin Surg Oncol* 2007;4(1):10.
- [25] Oh B, Butow P, Mullan B, Beale P, Pavlakis N, Rosenthal D, et al. The use and perceived benefits resulting from the use of complementary and alternative medicine by cancer patients in Australia. *Asia Pac J Clin Oncol* 2010;6(4):342-9.
- [26] Kristoffersen AE, Stub T, Musial F, Fønnebo V, Lillenes O, Norheim AJ. Prevalence and reasons for intentional use of complementary and alternative medicine as an adjunct to future visits to a medical doctor for chronic disease. *BMC Complement Altern Med* 2018;18(1):109.
- [27] McCaffrey AM, Pugh GF, O'Connor BB. Understanding patient preference for integrative medical care: results from patient focus groups. *J Gen Intern Med* 2007;22(11):1500-5.
- [28] Steel A, McEwen B. The need for higher degrees by research for complementary medicine practitioners. *Aus J of Herb Med* 2014;26(4):136-40.
- [29] Ng JY. Insight into the characteristics of research published in traditional, complementary, alternative, and integrative medicine journals: a bibliometric analysis. *BMC Complement Med Ther* 2021;21(1):185.
- [30] Bubela T, Boon H, Caulfield T. Herbal remedy clinical trials in the media: a comparison with the coverage of conventional pharmaceuticals. *BMC Med* 2008;6(1):35.
- [31] Jeffries WB. A fourth-year elective course in alternative medicine. *Acad Med J Assoc Am Med Coll* 2001;76(5):525-6.
- [32] Halterman-Cox M, Sierpina VS, Sadoski M, Sanders C. CAM attitudes in first- and second-year medical students: a pre- and post-course survey. *Integr Med* 2009;7(6):34-42.
- [33] Resch KI, Ernst E, Garrow J. A randomized controlled study of reviewer bias against an unconventional therapy. *J R Soc Med* 2000;93(4):164-7.
- [34] Caulfield T, DeBow S. A systematic review of how homeopathy is represented in conventional and CAM peer reviewed journals. *BMC Complement Altern Med* 2005;5(1):12.
- [35] NCCIH [Internet]. Complementary and alternative medicine funding by NIH institute/center. [cited 2023 Nov 19]. Available from: <https://www.nccih.nih.gov/about/budget/complementary-and-alternative-medicine-funding-by-nih-institutecenter>.
- [36] Lewith G, Verhoef M, Koithan M, Zick SM. Developing CAM research capacity for complementary medicine. *Evid Based Complement Alternat Med* 2006;3(2):283-9.
- [37] Cyranoski D. Why Chinese medicine is heading for clinics around the world. *Nature* 2018;561(7724):448-50.
- [38] NCCIH [Internet]. NCCIH funding: appropriations history. [cited 2024 Jan 8]. Available from: <https://www.nccih.nih.gov/about/budget/nccih-funding-appropriations-history>.
- [39] National Institutes of Health (NIH) [Internet]. Direct economic contributions. 2023 [cited 2024 Jan 8]. Available from: <https://www.nih.gov/about-nih/what-we-do/impact-nih-research/serving-society/direct-economic-contributions>.
- [40] Bensoussan A, Lewith GT. Complementary medicine research in Australia: a strategy for the future. *Med J Aust* 2004;181(6):331-3.
- [41] Korean Institute of Oriental Medicine [Internet]. 2021 yearbook of traditional korean medicine. Daejeon (Korea): Korean Institute of Oriental Medicine; 2021. Available from: https://www.kiom.re.kr/gallery.es?mid=a1020400000&bid=0003&list_no=43&act=view.
- [42] Enioutina EY, Salis ER, Job KM, Gubarev MI, Krepkova LV, Sherwin CMT. Herbal medicines: challenges in the modern world. Part 5. Status and current directions of complementary and alternative herbal medicine worldwide. *Expert Rev Clin Pharmacol* 2017;10(3):327-38.
- [43] Teng L, Zu Q, Li G, Yu T, Job KM, Yang X, et al. Herbal medicines: challenges in the modern world. Part 3. China and Japan. *Expert Rev Clin Pharmacol* 2016;9(9):1225-33.
- [44] Paller CJ, Denmeade SR, Carducci MA. Challenges of conducting clinical trials of natural products to combat cancer. *Clin Adv Hematol Oncol* 2016;14(6):447-55.
- [45] Brody BA. Intellectual property, state sovereignty, and biotechnology. *Kennedy Inst Ethics J* 2010;20(1):51-73.
- [46] Veziri Y, Kumar S, Leach MJ. An Exploration of barriers and enablers to the conduct and application of research among complementary and alternative medicine stakeholders in Australia and New Zealand: a qualitative descriptive study. *PLoS One* 2022;17(2):e0264221.
- [47] Leung B, Seely D [Internet]. Guidelines to case report writing for naturopathic doctors. 2012 [cited 2023 Nov 19]. Available from: <https://intjnm.com/guidelines-to-case-report-writing-for-naturopathic-doctors/>.
- [48] Wardle J, Steel A, Adams J. A review of tensions and risks in naturopathic education and training in Australia: a need for regulation. *J Altern Complement Med N Y N* 2012;18(4):363-70.
- [49] Xue P, Zhan T, Yang G, Farella GM, Robinson N, Yang AW, et al. Comparison of Chinese medicine higher education programs in China and five Western countries. *J Tradit Chin Med Sci* 2015;2(4):227-34.
- [50] Leach MJ. Profile of the complementary and alternative medicine workforce across Australia, New Zealand, Canada, United States and United Kingdom. *Complement Ther Med* 2013;21(4):364-78.
- [51] Adams J, Andrews G, Barnes J. Traditional, complementary and integrative medicine: an international reader. Bloomsbury Publishing; 2017.
- [52] Boon H. Canadian naturopathic practitioners: holistic and scientific world views. *Soc Sci Med* 1998;46(9):1213-25.
- [53] Weber W, McCarty RL. Interest of naturopathic physicians in pediatric research. *J Altern Complement Med N Y N* 2008;14(4):445-8.
- [54] Wayne PM, Hammerschlag R, Savetsky-German J, Chapman TF. Attitudes and interests toward research among students at two colleges of acupuncture and oriental medicine. *Explore N Y N* 2010;6(1):22-8.
- [55] Ng JY, Dhawan T, Dogadova E, Taghi-Zada Z, Vacca A, Wieland

- LS, et al. Operational definition of complementary, alternative, and integrative medicine derived from a systematic search. *BMC Complement Med Ther* 2022;22(1):104.
- [56] Gaboury I, April KT, Verhoef M. A qualitative study on the term CAM: is there a need to reinvent the wheel? *BMC Complement Altern Med* 2012;12(1):131.
- [57] Ijaz N, Rioux J, Elder C, Weeks J. Whole systems research methods in health care: a scoping review. *J Altern Complement Med* 2019;25(5):S21-51.
- [58] Giordano J, Engebretson J, Garcia MK. Challenges to complementary and alternative medical research: focal issues influencing integration into a cancer care model. *Integr Cancer Ther* 2005;4(3):210-8.
- [59] Kottow MH. Classical medicine v alternative medical practices. *J Med Ethics* 1992;18(1):18-22.
- [60] Kleinman A. Explanatory models in health-care relationships: a conceptual frame for research on family-based health-care activities in relation to folk and professional forms of clinical care. Cambridge (MA): The MIT Press; 1987. p. 273-83
- [61] Pacific WHORO for the Western guidelines for clinical research on acupuncture [Internet]. WHO Regional Office for the Western Pacific; 1995 [cited 2024 Apr 6]. Available from: <https://iris.who.int/handle/10665/207013>.
- [62] WHO benchmarks for the practice of acupuncture [Internet]. [cited 2024 Apr 6]. Available from: <https://www.who.int/publications-detail-redirect/978-92-4-001688-0>.
- [63] WHO benchmarks for the practice of Unani medicine [Internet]. [cited 2024 Apr 6]. Available from: <https://www.who.int/publications-detail-redirect/9789240042698>.
- [64] WHO benchmarks for the practice of Ayurveda [Internet]. [cited 2024 Apr 6]. Available from: <https://www.who.int/publications-detail-redirect/9789240042674>.
- [65] Polich G, Dole C, Kaptchuk TJ. The need to act a little more 'scientific': biomedical researchers investigating complementary and alternative medicine. *Sociol Health Illn* 2010;32(1):106-22.
- [66] Wieland LS, Manheimer E, Sampson M, Barnabas JP, Bouter LM, Cho K, et al. Bibliometric and content analysis of the cochrane complementary medicine field specialized register of controlled trials. *Syst Rev* 2013;2:51.
- [67] Vickers A, Goyal N, Harland R, Rees R. Do certain countries produce only positive results? A systematic review of controlled trials. *Control Clin Trials* 1998;19(2):159-66.
- [68] Cramer H, Lauche R, Langhorst J, Dobos G. Are Indian yoga trials more likely to be positive than those from other countries? A systematic review of randomized controlled trials. *Contemp Clin Trials* 2015;41:269-72.
- [69] Pham B, Klassen TP, Lawson ML, Moher D. Language of publication restrictions in systematic reviews gave different results depending on whether the intervention was conventional or complementary. *J Clin Epidemiol* 2005;58(8):769-76.e2.
- [70] Wu XY, Tang JL, Mao C, Yuan JQ, Qin Y, Chung VCH. Systematic reviews and meta-analyses of traditional Chinese medicine must search Chinese databases to reduce language bias. *Evid Based Complement Alternat Med* 2013;2013:e812179.
- [71] Walsh MC, Trentham-Dietz A, Schroepfer TA, Reding DJ, Campbell B, Foote ML, et al. Cancer information sources used by patients to inform and influence treatment decisions. *J Health Commun* 2010;15(4):445-63.
- [72] Sansevere ME, White JD. Quality assessment of online complementary and alternative medicine information resources relevant to cancer. *Integr Cancer Ther* 2021;20:15347354211066081.
- [73] Foley H, Steel A, Cramer H, Wardle J, Adams J. Disclosure of complementary medicine use to medical providers: a systematic review and meta-analysis. *Sci Rep* 2019;9:1573.
- [74] Ng JY, Raja M, Tahir U, Thakar H, Balkaran SL. Assessing the quality of complementary, alternative, and integrative medicine website information for cancer: a cross-sectional survey and analysis. *Eur J Integr Med* 2023;64:102309.
- [75] Akeeb AA, King SM, Olaku O, White JD. Communication between cancer patients and physicians about complementary and alternative medicine: a systematic review. *J Integr Complement Med* 2023;29(2):80-98.
- [76] Keene MR, Heslop IM, Sabesan SS, Glass BD. Knowledge, attitudes and practices of health professionals toward complementary and alternative medicine in cancer care - a systematic review. *J Commun Healthcare* 2020;13(3):205-18.
- [77] Patel SJ, Kemper KJ, Kitzmiller JP. Physician perspectives on education, training, and implementation of complementary and alternative medicine. *Adv Med Educ Pract* 2017;8:499-503.
- [78] Karpa K. Development and implementation of an herbal and natural product elective in undergraduate medical education. *BMC Complement Altern Med* 2012;12(1):57.
- [79] Reed DA, Cook DA, Beckman TJ, Levine RB, Kern DE, Wright SM. Association between funding and quality of published medical education research. *JAMA* 2007;298(9):1002-9.
- [80] Ebadi A, Schiffauerova A. How to boost scientific production? A statistical analysis of research funding and other influencing factors. *Scientometrics* 2016;106(3):1093-16.
- [81] Beaudry C, Allaoui S. Impact of public and private research funding on scientific production: the case of nanotechnology. *Res Policy* 2012;41(9):1589-606.
- [82] Singh J, Illes J, Lazzeroni L, Hallmayer J. Trends in US autism research funding. *J Autism Dev Disord* 2009;39(5):788-95.
- [83] Eckhouse S, Lewison G, Sullivan R. Trends in the global funding and activity of cancer research. *Mol Oncol* 2008;2(1):20-32.
- [84] Bradshaw DH, Empy C, Davis P, Lipschitz D, Nakamura Y, Chapman CR. Trends in funding for research on pain: a report on the national institutes of health grant awards over the years 2003 to 2007. *J Pain* 2008;9(12):1077-87.e8.
- [85] Baugh E. Ensuring Canada's competitiveness through an investment in ovarian cancer research [Internet]. [cited 2024 Jan 10]. Available from: <https://www.ourcommons.ca/Content/Committee/421/FINA/Brief/BR10005209/br-external/OvarianCancerCanada-e.pdf>.
- [86] PAR-04-097: CAM practitioner research education project grant [Internet]. [cited 2024 Jan 10]. Available from: <https://grants.nih.gov/grants/guide/pa-files/PAR-04-097.html>.
- [87] Kreitzer MJ, Sierpina VS. NCCAM awards grants to CAM institutions to enhance research education. *Explore* 2008;4(1):74-6.
- [88] Long CR, Ackerman DL, Hammerschlag R, Delagran L, Peterson DH, Berlin M, et al. Faculty development initiatives to advance research literacy and evidence-based practice at CAM academic institutions. *J Altern Complement Med* 2014;20(7):563-70.
- [89] Evans R, Delagran L, Maiers M, Jo Kreitzer M, Sierpina V. Advancing evidence informed practice through faculty development: the Northwestern health sciences university model. *Explore N Y N* 2011;7(4):265-8.
- [90] Ng JY, Lin B, Parikh T, Cramer H, Moher D. Investigating the nature of open science practices across complementary, alternative, and integrative medicine journals: an audit. *PLoS One* 2024;19(5):e0302655.
- [91] Schroeder SR, Gaeta L, El AM, Chow JC, Borders JC. Evaluating research transparency and openness in communication sciences and disorders journals. *J Speech Lang Hear Res* 2023;66(6):1977-85.
- [92] Cashin AG, Bagg MK, Richards GC, Toomey E, McAuley JH, Lee H. Limited engagement with transparent and open science standards in the policies of pain journals: a cross-sectional evaluation. *BMJ Evid-Based Med* 2021;26(6):313-9.
- [93] Nosek BA, Ebersole CR, DeHaven AC, Mellor DT. The preregistration revolution. *Proc Natl Acad Sci* 2018;115(11):2600-6.
- [94] Ng JY, Santoro LJ, Cobey KD, Steel A, Cramer H, Moher D. Complementary, alternative, and integrative medicine researchers' practices and perceived barriers related to open science: An international, cross-sectional survey. *PLoS One* 2024;19(5):e0301251.
- [95] Chung VC, Ho FF, Lao L, Liu J, Lee MS, Chan KW, et al. Implementation science in traditional, complementary and integrative medicine: an overview of experiences from China and the United States.

- Phytomedicine 2023;109:154591.
- [96] Joyce P, Wardle J, Zaslowski C. Medical student attitudes towards complementary and alternative medicine (CAM) in medical education: a critical review. *J Complement Integr Med* 2016;13(4):333-45.
- [97] Yildirim Y, Parlar S, Eyigor S, Sertoş OO, Eyigor C, Fadiloglu C, et al. An analysis of nursing and medical students' attitudes towards and knowledge of complementary and alternative medicine (CAM). *J Clin Nurs* 2010;19(7-8):1157-66.
- [98] Wetzel MS, Kaptchuk TJ, Haramati A, Eisenberg DM. Complementary and alternative medical therapies: implications for medical education. *Ann Intern Med* 2003;138(3):191-6.
- [99] Ng JY, Liu H, Wang MC. Complementary and alternative medicine mention and recommendations in inflammatory bowel disease guidelines: systematic review and assessment using AGREE II. *BMC Complement Med Ther* 2023;23(1):230.
- [100] Ng JY, Hilal A, Maini I. What traditional, complementary, and integrative medicine recommendations exist across osteoporosis clinical practice guidelines? A systematic review and quality assessment. *Integr Med Res* 2022;11(2):100803.
- [101] Ng JY, Hanna C. Headache and migraine clinical practice guidelines: a systematic review and assessment of complementary and alternative medicine recommendations. *BMC Complement Med Ther* 2021;21:236.
- [102] Ng JY, Nazir Z, Nault H. Complementary and alternative medicine recommendations for depression: a systematic review and assessment of clinical practice guidelines. *BMC Complement Med Ther* 2020;20:299.
- [103] Ng JY, Azizudin AM. Rheumatoid arthritis and osteoarthritis clinical practice guidelines provide few complementary and alternative medicine therapy recommendations: a systematic review. *Clin Rheum* 2020;39(10):2861-73.
- [104] Ng JY, Mohiuddin U. Quality of complementary and alternative medicine recommendations in low back pain guidelines: a systematic review. *Eur Spine J* 2020;29(8):1833-44.