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Review Article

Global Trends in the Integration of Traditional and Modern Medicine: Challenges and Opportunities

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Abstract

The global integration of traditional medicine (TM) and modern medicine reflects a fundamental shift in healthcare aimed at delivering more holistic, culturally sensitive, and patient-centered care. With over 80% of the global population relying on some form of TM, especially in Asia, Africa, and Latin America, there is growing momentum to institutionalize TM alongside evidence-based biomedicine. Countries like India, China, and Korea have led integration through formal education, government-supported research, and clinical frameworks, while high-income countries are increasingly adopting complementary and integrative medicine models. However, this convergence faces substantial challenges, including differences in epistemology, regulatory standards, evidence hierarchies, and practitioner training. Limited clinical trials, quality assurance concerns, and issues related to intellectual property rights and biopiracy further complicate harmonization. Despite these barriers, the World Health Organization's Traditional Medicine Strategy (2014–2023) and its newly established Global Centre for Traditional Medicine (India) underscore a growing international commitment to evidence-based integration. Opportunities lie in promoting collaborative research, strengthening regulatory frameworks, enhancing digital health platforms for TM documentation, and fostering intercultural dialogue between health systems. If guided ethically and scientifically, integration can improve access to care, reduce treatment costs, and offer personalized health solutions for chronic and lifestyle-related diseases. This review explored global integration models, evaluated emerging challenges, and identified strategies to support an inclusive, pluralistic, and sustainable healthcare future that respects both traditional wisdom and modern science.

Introduction

Traditional medicine (TM) encompasses a diverse range of practices rooted in the cultural beliefs, knowledge, and experiences of different communities. The World Health Organization (WHO) defines TM as the "total of knowledge, skills, and practices based on the theories, beliefs, and experiences indigenous to different cultures, used in the maintenance of health and the prevention, diagnosis, improvement, or treatment of physical and mental illness".[1] These systems include local ethnomedical traditions as well as broader medical frameworks like Ayurveda, traditional Chinese medicine (TCM), African indigenous medicine, and many more.[2] TM practices vary widely and may include herbal preparations, spiritual rituals, divination, massage, and animal-based remedies, reflecting the unique cultural logics of different societies.[3] Despite some commonalities, such as the therapeutic use of herbs, the underlying cultural rationales can differ significantly.[4] On the other hand, modern medicine (MM) is a scientifically based healthcare system focused on diagnosing and treating diseases through evidence-based methods such as pharmaceuticals, surgery, and advanced technologies. Rooted in the biomedical model, it emphasizes standardized diagnostics and targeted treatments. Practiced by licensed professionals, it excels in managing acute conditions and complex diseases but may be limited in addressing holistic and individualized aspects of health, where complementary approaches can play a supportive role.[5] The distinction between TM and scientific or modern biomedicine has historically been problematic. This binary perspective can overlook the sophisticated empirical knowledge within TM systems, many of which now have growing evidence bases through modern research, including clinical trials

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and laboratory studies. However, WHO cautions that inappropriate use of TM can lead to harmful effects, highlighting the need for rigorous scientific validation and better regulation to address issues like adulterated products, pseudoscience, and unsafe supply chains. The global nutraceutical industry, which often claims roots in TM, occupies a gray area between TM and MM, yet lacks consistent regulatory oversight, further complicating the integration of TM into mainstream healthcare.

For centuries, cultures worldwide have relied on TM for health and well-being. According to the WHO Global Report on Traditional and Complementary Medicine (2019), 170 WHO Member States have reported the use of various TM systems, including herbal medicine, Ayurveda, acupuncture, Unani, homeopathy, naturopathy, chiropractic, osteopathy, and TCM. Today, approximately 80% of the global population uses TM for primary healthcare, reflecting its widespread acceptance.[6] TM has significantly influenced MM, with 40% of pharmaceutical products today derived from natural sources and traditional knowledge.[7] A notable example includes artemisinin, discovered by Tu Youyou in 1971 from *Artemisia annua* (sweet wormwood), which marked a breakthrough in malaria treatment. It remains the WHO-recommended first-line therapy, saving millions of lives and earning Tu the 2015 Nobel Prize in Physiology or Medicine.[8] Similarly, aspirin, derived from willow bark (*Salix babylonica*), has a history spanning over 3,500 years, with ancient civilizations using it for pain relief and inflammation. In 1897, Bayer chemist Felix Hoffmann synthesized a stable form, making it a globally popular drug for pain management and cardiovascular protection.[9] Other examples include vinblastine and vincristine from the Madagascar periwinkle (*Catharanthus roseus*), vital in childhood cancer treatments and rooted in the plant's traditional use in Ayurveda and TCM.[10] Further, shikimic acid from star anise, a key component of Tamiflu, blocks influenza virus activity,[11] while norethindrone, derived from wild Mexican yam (*Dioscorea mexicana*), was a pioneering ingredient in early oral contraceptives.[12] These cases illustrate how MM has transformed traditional remedies into powerful, scientifically validated therapies.

The integration of TM with MM refers to the systematic incorporation of traditional healing practices, such as Ayurveda, TCM, and indigenous therapies, into modern, evidence-based medical systems. This approach aims to combine the strengths of both systems to provide holistic, culturally sensitive, and patient-centered care. Integration involves collaboration in clinical practice, education, research, and policy, allowing for complementary use of therapies while ensuring safety, efficacy, and scientific validation. It seeks to enhance healthcare outcomes by respecting traditional wisdom alongside modern scientific advancements. Traditional practices like yoga and acupuncture have also been shown to have significant health benefits.[13] Similarly, acupuncture has been widely recognized for its pain-relief benefits, with a meta-analysis published in the Journal of Pain indicating its efficacy for various chronic pain conditions.[14] Traditional Ayurvedic practices, such as exposing newborns with jaundice to sunlight, have also been validated by modern science. Sunlight exposure helps convert bilirubin into water-soluble isomers, facilitating excretion and aligning with contemporary phototherapy treatments.[15] Moreover, the integration of traditional knowledge with modern technology is accelerating. For instance, artificial intelligence and functional magnetic resonance imaging are being used to study the effects of traditional practices like meditation and yoga on brain function, with studies indicating improved attention and cognitive function.[16] Additionally, ethnopharmacology and reverse pharmacology are helping identify effective new drugs from ancient remedies, offering promising avenues for medical breakthroughs.[17] The integration of traditional and MM is a growing global movement that offers the promise of more holistic, inclusive, and sustainable healthcare. However, it requires evidence-informed strategies, strong regulation, interdisciplinary respect, and supportive policy environments.

The authors examined global models of integrating traditional and MM, highlighted emerging challenges, and proposed strategies to promote an inclusive, evidence-informed, and culturally sensitive healthcare system. It aims to offer practical insights for policymakers, researchers, and clinicians toward building a sustainable and pluralistic healthcare future. However, despite offering valuable insights, the above research has notable limitations. It relies primarily on secondary data sources, which may introduce publication bias and underrepresent certain indigenous or region-specific traditional systems. The lack of primary fieldwork and direct stakeholder engagement limits contextual depth and practical relevance. Cross-country comparisons are further complicated by differing regulatory frameworks, cultural perceptions, and health system structures, while the absence of standardized evaluation metrics hinders consistent analysis. Moreover, given the evolving nature of healthcare integration worldwide, some findings may become outdated over time. These limitations highlight the importance of continuous, collaborative, and interdisciplinary research that incorporates diverse epistemologies, community perspectives, and adaptive policy frameworks to ensure effective and equitable integration of traditional and MM.

Global trends in the integration of TM with MM

The integration of TM with MM is emerging as a significant global trend, driven by the need for more holistic, accessible, and patient-centered healthcare. This approach combines time-tested traditional practices with evidence-based modern treatments to enhance health outcomes and disease management. The use of complementary and alternative medicine (CAM) varies globally, shaped by cultural and regional traditions (Table 1). In Asia, therapies like TCM, Ayurveda, acupuncture, herbal medicine, cupping, and tai chi are widely practiced. Southeast Asia favors herbal remedies, massage, and energy healing (e.g., Reiki, Qi Gong), while Central Asia leans on Persian medicine, massage, and cupping. In South Asia, particularly India, Ayurveda is the dominant system, complemented by yoga, homeopathy, Unani, and Siddha. Europe sees widespread use of homeopathy, osteopathy, naturopathy, and acupuncture. In North America, diverse CAM practices include acupuncture, massage, chiropractic care, herbal medicine, aromatherapy, and meditation. African regions rely heavily on medicinal plants, spiritual therapies, and manual techniques such as massage and bone setting, with some countries, notably South Africa, granting formal recognition to traditional healers. In Latin America, traditional Mexican healing, herbal remedies, massage, and acupuncture are common. Importantly, practices vary not only between regions but also within them, highlighting the dynamic and localized nature of traditional healthcare worldwide.[18] The following sections explore how this integration is being implemented across different regions of the world, highlighting key developments, policies, and collaborative models.

Trends in the integration of TM and MM in Asia

The integration of traditional and MM in Asia has made significant strides in recent decades, driven by cultural heritage, government

Table 1. Traditional medicine systems used worldwide

S.No.	Traditional medicine system	Country/Region	Key features/Focus areas
1	Ayurveda, Yoga & Naturopathy, Unani, Siddha, Sowa Rigpa, and Homeopathy (AYUSH)	India	Holistic approach integrating herbal, yogic, and naturopathic therapies
2	Traditional Chinese medicine (TCM)	China	Qi regulation, herbal formulations, acupuncture, Tai Chi, dietary therapy
3	Traditional African medicine (TAM)	Africa	Herbalism, divination, spiritual and community-based healing
4	Kampo medicine (KM)	Japan	Herbal formulations standardized under Japan's national health insurance
5	Traditional Persian medicine (TPM)	Iran	Temperament theory, herbal drugs, diet, and preventive health
6	Traditional, natural, or complementary and alternative medicine (TN-CAM)	Latin America & Caribbean	Indigenous herbalism and spiritual healing integrated with modern healthcare
7	Rongoā Māori (RM)	New Zealand	Native herbal medicine, massage (mirimiri), and spiritual healing
8	Koryo/Traditional Korean medicine (KTM/TKM)	Korea	Sasang typology, acupuncture, moxibustion, and herbal therapy
9	Complementary and alternative medicine (CAM)	North America & Europe	Integrative care combining herbal, mind-body, and modern medical practices
10	Thai traditional medicine (TTM)	Thailand	Herbal medicine, Thai massage, yoga-like postures, Buddhist healing
11	Sowa Rigpa (SR)	Bhutan	Tibetan-based system using herbs, diet, and mental balance
12	Traditional European medicine (TEM)	Europe	Herbalism, hydrotherapy, humoral balance, and dietary healing
13	Traditional North American medicine (TNAM)	North America	Native healing with herbs, sweat lodges, and spiritual ceremonies

support, and increasing patient demand. Among the Asian countries, India has advanced significantly through its Ayurveda, Yoga & Naturopathy, Unani, Siddha, Sowa Rigpa, and Homeopathy (AYUSH) system, which is integrated into the national healthcare framework through initiatives like the National AYUSH Mission and Ayushman Arogya Mandirs. With over 7.5 lakh practitioners, 700 colleges, and strong research and digital frameworks, AYUSH now plays a vital role in strengthening primary healthcare and advancing Universal Health Coverage. AYUSH services have been co-located in 460 district hospitals, 3,051 community health centres and 7,011 primary health centres, enhancing integration of traditional systems into mainstream public health.[19] The resilience and adaptability of Kerala's traditional Ayurvedic practitioners, who have successfully blended classical wisdom with modern medical approaches.[20] Their collaborative and innovative practices demonstrate Ayurveda's dynamic evolution and its growing relevance in today's integrative healthcare landscape. Innovative initiatives, such as integrative cancer care at Tata Memorial Centre, demonstrated improved outcomes in fatigue, anxiety, and depression, supported by the Ministry of Ayush.[21] National initiatives, such as Ayurveda Day celebrations on 23rd September, further demonstrated the country's commitment to holistic and integrative healthcare.[22]

In China, TCM remains a critical component of healthcare. The number of licensed TCM doctors in integrated traditional Chinese and western medicine hospitals grew from 1,845 to 17,227 between 2002 and 2021, reflecting broader acceptance. However, these hospitals accounted for just 2% of outpatient and emergency visits and 1.57% of hospital admissions in 2021, highlighting ongoing challenges in fully integrating TCM with modern healthcare.[23] Amid economic sanctions, North Korea has strengthened its reliance on traditional Korean medicine, with most studies in *Koryo Medicine* (2016–2019) focusing on herbal treatments and integrative therapies. This reflects the nation's adaptive healthcare approach and growing relevance in global traditional medicine research.[24] South Korea has also successfully integrated traditional Korean medicine (TKM) into its national health system through a dual framework where conventional medicine and TKM operate side by side. Under strict government regulation, TKM doctors provide services such as acupuncture, moxibustion, cupping, chuna, and herbal medicines, while conventional medicine doctors focus on modern diagnostics and pharmaceuticals. This coexistence ensures both scientific rigor and holistic care. TKM is not only widely available but also significantly utilized, backed by strong policies, insurance coverage, and institutional support. The Korean model enhances healthcare accessibility, patient choice, and integrative well-being, offering a valuable pathway for other developed nations seeking to incorporate TM into modern healthcare systems.[25]

In Thailand, for instance, Kabchoeng Hospital in Surin Province successfully integrated Thai traditional medicine into its healthcare services, despite initial challenges such as differing medical

philosophies and a lack of standardized protocols. The hospital addressed these challenges through staff training and collaborative treatment plans, demonstrating a model for integrating TM into modern healthcare.[26] In Bhutan, the Institute of Traditional Medicine Services institutionalized Sowa Rigpa (Tibetan medicine) as part of its national healthcare system. This approach provided traditional treatments, trained practitioners, and conducted research, ensuring nationwide access to both modern and traditional medical services.[27,28] China's *Barefoot Doctor* program, launched under Mao Zedong, sought to address rural healthcare gaps by training community health workers in both basic biomedicine and TCM. Celebrated as a pioneering model of low-cost, community-based care that influenced the Alma-Ata Declaration,[29] it nonetheless faced challenges of uneven training, scarce resources, and political entanglement. Though dismantled in the 1980s, it remains a complex historical experiment, highlighting both the potential and the limits of integrating traditional and MM in resource-constrained settings.[30] Meanwhile, Japan integrated Kampo medicine, a system derived from TCM, into its healthcare system, with licensed physicians prescribing Kampo remedies covered by national health insurance.[31,32] These case studies highlight the diverse and innovative approaches taken by various Asian countries to integrate traditional and MM, reflecting a growing global trend toward holistic healthcare.

Trends in the integration of TM and MM in Africa

The integration of traditional African medicine and MM in Africa has gained significant momentum in recent decades, driven by growing recognition of TM's critical role in primary healthcare. According to the WHO, up to 80% of the African population relies on TM for their primary healthcare needs.[33] This reliance is partly due to the accessibility, affordability, and cultural acceptability of traditional practices, which are often deeply embedded in African societies.[34] One significant trend is the institutionalization of TM within national healthcare systems. For instance, South Africa officially recognized traditional health practitioners through the Traditional Health Practitioners Act of 2007, which established a regulatory framework for traditional healers, including herbalists, diviners, and traditional birth attendants.[35] Similarly, Ghana has integrated TM into its national healthcare policy, establishing the Centre for Plant Medicine Research in Mampong to standardize and validate herbal medicines.[36,37]

Another trend is the scientific validation and commercialization of African herbal medicines. For example, the *Artemisia annua* plant, traditionally used in Africa to treat fevers, became the source of artemisinin, a critical component of modern antimalarial drugs.[38] In Nigeria, the Federal Ministry of Health has collaborated with local universities to research and validate traditional treatments for malaria, and diabetes.[39–41] Additionally, there is a growing emphasis on education and training for traditional health practitioners. Countries like Uganda and Tanzania have established training programs to improve the safety, efficacy, and scientific understanding of conventional therapies.[42] Most WHO African Region member states (MS) have advanced in integrating traditional medicine (TM) into national health systems, with TM policies rising from 8 in 2000 to 40 in 2020 and 39 MS enacting legal frameworks for TM practice. Many have established TM units within Ministries of Health, dedicated research institutes, and herbal medicine registration systems, with role models including Ghana, Burkina Faso, Benin, and Madagascar.[43] Many countries now cultivate medicinal plants, produce herbal medicines locally, and include TM in health curricula. WHO-supported clinical trials, such as for COVID-19, reflect strong political will and collaboration. Governments are urged to strengthen ties among scientific institutions, traditional practitioners, and the private sector to advance local innovation and manufacturing for improved healthcare access.[44,45] This approach aims to bridge the gap between traditional and MM, enhancing patient outcomes and reducing healthcare costs.

Furthermore, collaborative research between African universities and global institutions is expanding. South African universities' international research collaboration rose significantly between 2012 and 2021, with collaborative output increasing from 42.4% to 54.1% of total scholarly publications.[46] In Uganda, a cross-sectional study in Mbarara District highlighted the potential of engaging traditional healers to strengthen HIV (Human immunodeficiency virus infection) testing uptake and awareness, supporting progress toward the Joint United Nations Programme on HIV (Human immunodeficiency virus infection) and AIDS (acquired immune deficiency syndrome) (UNAIDS 95-95-95) goals through community-based outreach initiatives.[47,48] Traditional healers in rural South Africa effectively delivered HIV testing after targeted training, though linkage to treatment remained limited, with only 60% of HIV-positive clients enrolling in care.[49] Ghana has made significant progress in integrating TM into its healthcare system through institutional support and policy reforms. Key milestones include the establishment of the Ghana Psychic and Traditional Healers Association (1961), Centre for Plant Medicine Research (1975), and the Traditional and Alternative Medicine Directorate (1999). The Traditional Medicine Practice Council was created in 2000 to regulate practitioners, and the U.S. Food and Drug Administration established a herbal unit for product oversight. Since 2012, TM has been officially integrated into public healthcare, with herbal units in 55 government hospitals. Along with this, academic institutions like Kwame Nkrumah University of Science and Technology (KNUST), University of Allied Health Sciences (UHAS), University of Cape Coast (UCC) and University of Ghana (UG) have developed specialized programs to train herbal medicine professionals.[36,37] Meanwhile, in Nigeria, the Herbal Information and Documentation Centre (HERBINFO) initiative by Nigeria Natural Medicine Development Agency (NNMDA) is developing a digital repository of medicinal plants and traditional knowledge to standardize practices and support research.[50] These efforts underscore the growing role of traditional healers and practices in strengthening community health systems across Africa.

Trends in the integration of TM and MM in Europe

Traditional European medicine, rooted in ancient Greek practices and evolving through figures like Hildegard von Bingen, remains influential in German-speaking regions, with 3% of Germans trusting Hildegard medicine.[51] In Europe, the integration of traditional and MM has been marked by diverse approaches across countries, reflecting varying degrees of acceptance, regulation, and implementation. A nationally representative survey across 21 European countries identified Germany as having the highest population-level use of CAM, with 40% of respondents reporting use.[52] In a separate national survey, 85% of German general practitioners reported prescribing or administering at least one CAM treatment weekly or more often. Currently, approximately 47,000 licensed *Heilpraktiker* (CAM practitioners) operate in Germany.[53] In the United Kingdom, the Royal London Hospital for Integrated Medicine, formerly the Royal London Homoeopathic Hospital, exemplifies institutional support for CAM. Affiliated with University College London Hospitals, National Health Service Foundation

Trust, the Royal London Hospital for Integrated Medicine offers therapies such as acupuncture, herbal medicine, and integrative cancer care. Although the National Health Service ceased funding for homeopathic remedies in 2018 due to concerns over efficacy, the hospital continues to deliver a variety of integrative services and retained royal patronage, with King Charles III assuming the role in 2024.[54]

Complementary medicine was well established in Switzerland, with about 28.9% of adults reporting use by 2017.[55] Common practices include homeopathy, naturopathy, osteopathy, herbal medicine, and acupuncture. Complementary medicine services are integrated into the health system, with basic insurance covering treatments provided by certified physicians, while supplemental insurance partly covers services by non-medical therapists. Utilization is particularly high among women, middle-aged adults, individuals with chronic conditions, and those with higher education, reflecting its role as an important component of healthcare in Switzerland.[55,56] The Netherlands has witnessed the integration of anthroposophic medicine, a holistic approach developed by Rudolf Steiner and Ita Wegman. The Arlesheim Klinik in Switzerland, founded by Wegman in 1921, continues to offer treatments that combine MM with spiritual and holistic practices.[57] Despite these advancements, the integration of TM in Europe faces challenges, including regulatory discrepancies, debates over scientific validation, and varying levels of public and institutional acceptance. Nonetheless, the continued interest and incorporation of traditional practices into healthcare systems underscore a broader shift toward more holistic and patient-centered care models across the continent.

Trends in the integration of TM and MM in North America

The integration of traditional and MM in North America has gained significant momentum in recent decades, driven by increasing public interest in holistic health and patient-centered care. In the U.S., national surveys show a steady rise in the use of complementary health approaches between 2002 and 2017. Nonvitamin supplements remained the most common, while yoga, tai chi, and meditation saw significant growth, particularly among women, middle-aged adults, and children. Meditation use has more than tripled among adults and increased nearly tenfold among children.[58,59] According to the National Health Interview Survey, the use of at least one CAM therapy increased from 41.3% in 2008 to 47.9% in 2019, with practices like yoga, meditation, and chiropractic care experiencing the highest growth for the treatment of asthma.[60] In 2012, about 59 million Americans spend $30.2 billion out-of-pocket on complementary health approaches, with the highest costs for practitioner visits ($14.7 billion) followed by supplements ($12.8 billion).[61] This reflects a broader societal shift towards preventive health and chronic disease management through non-pharmacological methods.

Academic institutions have been at the forefront of this integration. The Osher Center for Integrative Health at Harvard Medical School, in collaboration with Brigham and Women's Hospital, offers therapies like acupuncture, mindfulness-based stress reduction, and nutritional counseling alongside conventional treatments, addressing physical, emotional, and spiritual health.[62] The opioid and pain epidemics require comprehensive, multi-disciplinary solutions beyond quick fixes. As a solution, healthcare providers are increasingly adopting acupuncture and other traditional therapies for pain management to reduce opioid dependence.[63] In Canada, efforts to integrate indigenous TM have also gained traction. A scoping review found that traditional healing practices are being incorporated into medical education and clinical settings to provide culturally sensitive care for indigenous populations, promoting holistic well-being.[64] For instance, the Indigenous Traditional Healing practices are integrated into mainstream healthcare systems in Canada, Australia, and New Zealand.[65]

Trends in the integration of TM and MM in Latin America and the Caribbean

The integration of traditional and MM in Latin America and the Caribbean has been gaining momentum due to the region's rich cultural heritage and biodiversity. Over 400 million people in Latin America use traditional, natural, or complementary and alternative medicine (TN-CAM), especially in primary care.[66] Annual spending on TN-CAM products in the region is estimated at three billion dollars, reflecting its growing economic and healthcare significance.[66] Countries like Cuba and Brazil lead in integrating TN-CAM into formal health systems. Cuba has promoted TM since the 1960s, launching its National Program for Traditional and Natural Medicine in 1999, which now produces over 50 million units of natural/homeopathic medications annually.[67,68] Brazil institutionalized TN-CAM integration through its National Policy on Integrative and Complementary Practices, supporting therapies such as acupuncture, homeopathy, phytotherapy, and hydrotherapy within the public health system.[69]

Other countries like Mexico, Peru, Chile, Argentina, and Colombia have also made notable progress. Peru, for instance, operates a national program in partnership with Pan American Health Organization (PAHO), incorporating TN-CAM into clinics for treating various conditions such as asthma, back pain, and migraine.[70,71] Regional and global organizations, such as WHO and PAHO, promote intercultural healthcare models that integrate indigenous and traditional medical knowledge with Western practices. These frameworks emphasize therapeutic pluralism, community participation, and culturally grounded approaches to health.[72,73]

Trends in the integration of TM and MM in the Middle East

The integration of traditional and MM in the Middle East has a long history, deeply rooted in ancient practices like Unani, Islamic medicine, and herbal treatments.[74,75] CAM use among Saudi older adults was high (62.5%), with herbal products, acupuncture, and bloodletting being the most common therapies.[76] Research in Palestine shows substantial CAM use across various patient groups, with prevalence ranging from 45.9% to 85.9% depending on the condition. Many practices align with global CAM trends. CAM use is widespread in pregnancy globally, with about 50% of women using at least one CAM therapy, and rates reaching 75% in Jordan, 22.3% in Iran, and 40% herbal use in Palestine.[77]

Efforts to integrate traditional and complementary medicine with conventional healthcare have been progressively unfolding across the Middle East. As early as 2011, Ben-Arye *et al*.[78] reviewed integrative oncology initiatives across the region, emphasizing multidisciplinary supportive care models that combine herbal medicine, mind-body therapies, and conventional cancer treatments. This was followed by a 2014 study on Arab-Israeli cancer patients, which revealed that nearly 40% used complementary therapies, primarily herbal remedies during active treatment, with many expressing interest in formal integrative services focused on quality-of-life improvements.[79] In 2016, a survey involving 339 oncology healthcare professionals from 15 Middle Eastern countries highlighted strong support for TM integration in supportive cancer care, despite differing expectations and noted barriers such as limited training and misaligned patient-provider expectations.[80]

Expanding on these initiatives, the Middle-East Research Group in Integrative Oncology reported in 2018 the implementation of integrative oncology programs in 12 countries, including a notable initiative at Haifa's Lin Medical Center, where over 500 patients received integrative consultations to alleviate symptoms during chemotherapy.[81] That same year, a study from Iran examined the inclusion of a two-credit course on Persian TM in medical education, aiming to improve physician competency in TM & MM and avoid contraindications.[82] In 2023, Elmaghraby *et al*.[83] assessed herbal medicine use for gastrointestinal disorders among residents in Saudi Arabia's Eastern Region and raised concerns regarding safety and lack of clinical consultation.

Meanwhile, in the broader Saudi context, Khalil *et al*.[84] emphasized the enduring popularity of traditional practices such as cupping and called for their structured integration, particularly in oncology, pain, and lifestyle medicine as part of the national Vision 2030 reforms. In 2024, Khoury, Rafeh, and Bou Dargham explored traditional healing practices across the Arab region,[85] highlighting their historical and spiritual roots and examining early integration efforts with Western healthcare systems. Most recently, Al-Masri *et al*.[86] conducted a cross-sectional study at King Hussein Cancer Center in Jordan, revealing a high prevalence of herbal and alternative medicine use among cancer patients, primarily to manage symptoms and improve quality of life. These cumulative efforts reflect a growing regional commitment to integrating traditional knowledge systems with modern medical frameworks to achieve holistic and patient-centered care.

Trends in the integration of TM and MM in Oceania, Australia

In Australia and across Oceania, the integration of traditional and complementary medicine into mainstream healthcare has gained traction in response to increasing public demand for holistic and culturally responsive care. Indigenous healing practices, such as traditional Aboriginal medicine and Māori healing, have been valued for centuries and are increasingly being incorporated into modern healthcare systems.[87] One of the pioneering examples of integrating TM & MM into mainstream healthcare was the Sydney Integrative Primary Care Clinic (2006–2010), which successfully blended conventional general practice with complementary therapies such as acupuncture and naturopathy. Its success was attributed to multidisciplinary collaboration and open-minded leadership, though challenges like financial sustainability and workforce turnover remained.[88] Similarly, a qualitative study conducted among naturopaths in Southeast Queensland highlighted key integration challenges, including paradigm conflicts with MM, professional bias, and structural barriers, although most practitioners supported collaborative models.[89] Recognizing the widespread use of CAM, estimated at up to 70% among Australians and New Zealanders, the Royal Australian College of General Practitioners proposed the establishment of an Integrative Medicine Practice-Based Research Network to foster research, training, and policy development.[90]

In oncology, national surveys revealed that only 46% of CAM-offering cancer clinics in Australia had formally integrated services, with massage and psychological therapies being the most common, while acupuncture and herbal therapies remained underutilized due to limited practitioner education and financial constraints.[91] A significant trend is the increasing incorporation of Aboriginal bush medicine into clinical practice. For example, hospitals in South Australia have begun formally collaborating with Ngangkari healers, traditional practitioners who use native plants and spiritual techniques to support physical and emotional healing.[92] The Australian government, through initiatives like the National Aboriginal and Torres Strait Islander Health Plan, aims to provide culturally appropriate health services. This plan recognizes the importance of traditional healing practices, such as bush medicine and spiritual healing, alongside conventional Western medical treatments. A key aspect of this integration is the holistic approach that Aboriginal healers take, considering the mental, physical, and spiritual health of individuals. Research has shown that Aboriginal healing methods, such as the use of native plants for medicinal purposes, are beneficial for addressing chronic conditions, including diabetes and hypertension.[92–94]

Additionally, participatory research with indigenous communities has fostered respectful collaborations between biomedical researchers and traditional knowledge holders, particularly in the documentation and ethical use of native medicinal plants.[95] These developments signal a gradual but meaningful shift toward integrative models of care that honor both scientific evidence and traditional knowledge, though challenges remain in ensuring sustainability, cultural safety, and regulatory alignment. In New Zealand, the integration of traditional Māori healing practices, known as *Rongoā Māori*, with Western medicine is also gaining traction.[96] This growing integration of traditional and MM in Oceania reflects a broader global movement toward culturally sensitive healthcare, aimed at improving access and health outcomes for diverse populations.

Critical analysis: Beyond coexistence toward a new healthcare approach

The global integration of TM with MM represents more than a technical merger of two medical systems; it reflects a deeper negotiation of cultural authority, healthcare equity, and scientific legitimacy. While descriptive studies show high rates of use across regions, critical analysis reveals that integration functions as both a healthcare strategy and a sociopolitical project. Three patterns emerge. First, integration is heterogeneous and context-dependent. In Asia, state-driven models like India's AYUSH and South Korea's dual system demonstrate strong institutionalization,[19–21,25] while in China, integrated traditional Chinese and Western medicine remains symbolically supported but underutilized, revealing gaps between policy rhetoric and patient uptake.[23] In Africa, where up to 80% rely on TM,[33] integration was less about cultural revival and more about structural necessity, filling healthcare access gaps while simultaneously fueling global drug innovation (e.g., artemisinin from *Artemisia annua*).[38] In Europe and North America, by contrast, TM is often a corrective supplement to biomedical reductionism, addressing chronic disease, mental health, and patient autonomy rather than primary care deficits.[52,53,58,60,62]

Second, integration is politically and economically charged. It is shaped not only by cultural legitimacy but also by insurance policies, regulatory frameworks, and market forces. Switzerland's insurance-backed coverage boosted complementary medicine utilisation [97] while in Brazil, the National Policy on Integrative and Complementary Practices (PNPIC) institutionalised traditional practices but faces uneven implementation.[98] Further, Saudi Arabia's widespread CAM use reflects strong market demand despite limited regulation.[99] Together, these examples shows that insurance policies, market forces, and regulatory frameworks ultimately determine whether traditional systems are legitimised or marginalised. Third, integration highlights an epistemological tension: should TM be assimilated into biomedical frameworks through randomized trials and pharmacological reduction, or should it be preserved as a holistic knowledge system with unique diagnostic and therapeutic paradigms? The risk of "medical colonization"

Fig. 1. Challenges in integrating medicine into the global health system.

arises if traditional practices are stripped of their cultural and spiritual meaning in the name of standardization. Taken together, the evidence suggests that TM-MM integration is not a linear progression toward biomedical dominance but a pluralistic redefinition of medicine itself. Effective models align cultural legitimacy with scientific validation, creating what might be called "hybrid epistemologies of care", systems that are flexible, locally grounded, and globally relevant. The future of integration lies not only in policy and research but also in addressing deeper questions: How can diverse healing systems coexist without hierarchy? Can medicine expand its epistemic boundaries to embrace prevention, resilience, and meaning-making alongside cure? This critical perspective reframes integration not as a mere trend but as a transformative shift in global health governance, where medicine becomes both science and culture, both technology and tradition.

Challenges in integrating TM and MM

The integration of TM, such as Ayurveda, TCM, and indigenous healing systems, with conventional biomedicine represents a transformative shift in global healthcare. While the potential for synergy is immense, especially in managing chronic diseases, promoting preventive care, and enhancing cultural responsiveness, the scientific integration of these systems remains fraught with challenges (Fig. 1). These challenges arise from differences in epistemology, regulatory standards, research methodologies, educational systems, and sociopolitical attitudes. It is essential to address these issues to harness the full potential of integrative healthcare.

Epistemological and philosophical divergences

One of the most complex challenges in the global integration of traditional and MM lies in their fundamental epistemological and philosophical divergences. These differences stem from opposing worldviews regarding health, disease, diagnosis, and healing. MM is primarily based on Cartesian dualism, reductionist science, and the biomedical model, which prioritizes objective evidence, standardized protocols, and organ-specific diagnoses. In contrast, traditional medical systems such as Ayurveda, TCM, and African indigenous medicine are built on holistic, spiritual, and individualized understandings of the human body and health. These systems emphasize balance, energy flow, constitution (*prakriti* or *qi*), and harmony with nature, making direct comparison and integration with biomedicine difficult.[100] In India, the government has supported integration through the co-location of AYUSH and allopathic systems under the National Health Mission. Despite policy-level backing, integration remains superficial due to philosophical differences. Ayurvedic practitioners emphasize the concept of dosha balance and individual constitution (prakriti), which guides personalized treatment. However, allopathic physicians often dismiss these principles as lacking scientific validity. The biomedical requirement for randomized controlled trials (RCTs) does not always align with Ayurveda's personalized, multi-component therapies, making clinical validation a contested space.[101]

A similar issue is observed in China, where TCM is institutionally integrated with allopathic care; deep epistemological differences still limit functional integration. For instance, TCM uses pulse and tongue diagnosis, energy flow (qi), and concepts such as yin-yang and meridians, which do not have equivalents in anatomical or physiological models of MM. Biomedical practitioners often view these concepts as unscientific, while TCM practitioners argue that modern diagnostics fail to capture subtle imbalances in bodily systems. This mutual disconnect has led to TCM being practiced in parallel rather than in synergy with biomedicine in hospitals and clinics.[102] Epistemological differences between traditional and MM extend into research and policy, where biomedical standards often marginalize experiential and community-based traditional knowledge. True integration requires epistemic humility, respect for medical pluralism, and culturally sensitive approaches, without which efforts risk being superficial or imbalanced.

Methodological incompatibilities between systems

The personalized and holistic nature of the Traditional Medicinal System (TMS) poses significant methodological challenges when subjected to the reductionist framework of conventional biomedical research. Conventional research often focuses on isolating specific biological mechanisms using RCTs. At the same time, TMS

often emphasizes individualized treatment plans, dynamic diagnosis, and the interrelationship of mind, body, and environment.[103,104] This approach contrasts with the standardized, single-variable models typically used in RCTs, making direct comparisons and evaluations difficult. For example, therapies like Ayurveda, TCM, and naturopathy incorporate diagnostic models and treatment plans tailored to each patient's constitution and lifestyle, concepts not easily standardized or quantified within existing RCT frameworks.[105]

Although international organizations such as the WHO have issued methodological guidelines and practice benchmarks for various TM modalities, implementing these guidelines in diverse cultural and clinical contexts remains a major challenge.[106] The variability in herbal formulations, dosage, and preparation methods further complicates efforts to ensure consistency and reproducibility in research.[107,108] Cultural context also plays a critical role in these challenges. Practices rooted in spiritual traditions or indigenous knowledge systems are often categorized differently across regions. For example, therapeutic rituals based on Buddhist traditions may be classified as religious or spiritual wellness in some Eastern cultures but are categorized as Traditional, Complementary, and Integrative Medicine (TCIM) in Western healthcare systems.[109] These classification discrepancies hinder international consensus on research guidelines and policy frameworks.[110] Furthermore, alternative medicine emphasizes whole-body balance and natural healing, contrasting with allopathic medicine's disease-focused approach while increasingly integrating into modern healthcare.[111] This conceptual divergence complicates the development of control groups and placebos, particularly for therapies involving energy medicine, yoga, or Qi Gong. The lack of objective biomarkers or quantifiable outcomes in many TMS therapies also limits their compatibility with biomedical methodologies.[103,106]

Challenges in clinical research and evidence generation

A significant challenge in the integration of TM into mainstream healthcare lies in the rigid demands of clinical evidence generation. Modern biomedicine prioritizes RCTs, systematic reviews, and meta-analyses as the gold standard; however, these methods are often ill-suited for TM practices, which are multifactorial, individualized, and long-term in nature.[105,112] For example, in evaluating the efficacy of *Panchakarma*, a classical Ayurvedic detoxification therapy, creating a credible placebo is nearly impossible. The treatment involves multiple components, including massages, herbal enemas, and dietary changes, all of which interact holistically. Blinding participants or designing a sham version that mimics the physical and sensory experiences without therapeutic effects poses significant methodological difficulties. Moreover, TM's focus on personalized and preventive care does not align well with short-duration RCT frameworks. While observational studies and real-world evidence could better capture TM's effectiveness, such methods remain undervalued in the biomedical hierarchy.[105]

Lack of standardization and quality control in traditional therapies

Another critical barrier is the lack of standardization, quality control, safety, and formulation in TM. Unlike conventional drugs, many herbal formulations lack consistent pharmacopoeial standards. For instance, studies evaluating *Triphala*, a popular Ayurvedic polyherbal decoction, often report variations in composition across different brands or batches.[113] This variability makes it difficult to ensure reproducibility or safety in clinical trials. Likewise, assessment of various clinical studies for hypertension suggested several deficiencies, including inadequacies in drug formulation, inconsistencies in dosage and pharmaceutical forms of the medications, insufficiently detailed study protocols, lack of proper authentication of the medicinal plants used, and variability in the observed outcomes.[114] Without standardized preparation and dosing, evaluating the true therapeutic value of herbal medicines remains uncertain.[115] Krishna *et al*.[100] also highlight that in countries with weak regulation, monitoring adverse effects and drug interactions in TM remains a persistent challenge, further complicating its integration into evidence-based care.

Herb-drug interactions and inadequate pharmacovigilance systems

Another key concern is the potential for adverse effects or drug-herb interactions when TM is used alongside conventional drugs like antiarrhythmics and immunosuppressants, increasing the risk of toxicity. Many herbal products contain pharmacologically active compounds, which may interfere with prescribed medications, particularly in polypharmacy scenarios common in chronic disease management.[100,115] Case reports highlight serious herb–drug interactions (HDIs), such as bleeding in a warfarin-treated patient using chamomile or reduced cyclosporine levels in a transplant patient. Interactions with *Artemisia absinthium*, *Sambucus nigra*, and *Momordica charantia* have also caused adverse effects.[116] Herbal products are complex mixtures that affect multiple biological systems and often have unclear pharmacokinetics. They may alter the absorption, metabolism, or elimination of conventional drugs, yet current monitoring systems inadequately assess such interactions.[117]

Pharmacovigilance is essential for monitoring HDIs, as herbal medicines can cause serious adverse reactions when combined with conventional drugs. However, few pharmacovigilance systems are equipped to detect or monitor such interactions, especially in settings where patients self-medicate or use TM without informing their physicians. WHO guidelines aim to strengthen pharmacovigilance systems, yet many countries lack robust frameworks. This necessitates the development of integrated electronic health records, shared decision-making models, and robust reporting mechanisms for adverse events in integrative contexts.[115,118,119] WHO advocates a unified reporting form for all health products to improve consistency. Countries are expanding post-marketing surveillance, but herbal medicines often lack standardized pharmacokinetic data. Education and awareness among healthcare professionals, consumers, and regulatory bodies are vital. Physicians should actively inquire about herbal use, and all stakeholders must report suspected HDIs to ensure patient safety.[117]

Regulatory and policy barriers

The regulatory environment often lacks frameworks that adequately accommodate TM. While countries like China and India have made significant strides in establishing national policies and integrating TM into public health systems, many nations still lack coherent policies or standardization protocols. In the absence of international consensus, there is a lack of harmonized policies regarding licensing, insurance coverage, intellectual property rights, and safety monitoring. WHO has advocated for integrative policies, but implementation varies widely across regions.[120] Moreover, integrating TM into insurance and reimbursement systems remains a major hurdle in many healthcare economies. Herbal medicine regulation varies globally, with economically advanced nations like the U.S, EU, Germany, and Japan having robust systems. In the U.S, herbal products are regulated as dietary supplements

under Dietary Supplement Health and Education Act (DSHEA), requiring post-market surveillance but not premarket approval.[121] Germany follows EU directives like Traditional Herbal Medicinal Products Directive (THMPD), allowing traditional herbal products to be sold over-the-counter.[122] India regulates herbal products under the Drugs and Cosmetics Act, with Ayurveda, Siddha, and Unani systems having recognized pharmacopeias.[123]

Developing countries like China and India lead in herbal medicine production and export, while Bahrain applies pharmaceutical-level regulations. Pakistan has introduced enlistment rules, but regulation remains weak, with unregulated sales and reliance on international pharmacopeias. In Africa, regulation is inconsistent. Only 23 of 54 countries sell herbal medicines with regulated claims.[124] Ethiopia relies heavily on traditional remedies, yet lacks robust regulation to ensure safety or efficacy. Regulatory development is underway, but enforcement remains limited. Strengthening national policies and aligning with global standards is critical for public health.[125] Without robust regulatory pathways, the efficacy, safety, and quality of herbal products remain uncertain, impeding their broader acceptance in evidence-based medicine.

Intellectual property rights, biopiracy, and ethical concerns

The integration of TM with MM faces significant hurdles related to intellectual property rights, biopiracy, and ethical concerns. Traditional knowledge, often collectively held by indigenous communities, lacks formal documentation and legal protection under modern intellectual property rights frameworks, which are typically designed for individual and novel innovations. This disparity creates a critical barrier, as pharmaceutical companies and researchers may exploit TM without fair compensation or acknowledgment, a practice known as biopiracy.[126] For example, the infamous case of the patenting of turmeric's wound-healing properties in the United States (Patent No. 5,401,504) raised international concern. Although the patent was later revoked following intervention by the Indian Council of Scientific and Industrial Research, it highlighted the vulnerability of traditional knowledge to appropriation due to its undocumented status in international patent systems.[127]

Ethical issues further complicate integration efforts. Many indigenous communities fear the misuse or commodification of their sacred knowledge and healing practices. Without community consent, benefit-sharing mechanisms, and respect for cultural context, integration risks violating the principles of *prior informed consent* and *access and benefit-sharing* enshrined in the Convention on Biological Diversity and its Nagoya Protocol.[128] To address these challenges, policy frameworks must ensure the protection of traditional knowledge through sui generis systems, promote transparent intellectual property rights laws, and foster equitable partnerships. Ethical integration should prioritize community rights, cultural sensitivity, and fair benefit-sharing, ensuring that TM is not merely appropriated, but respected and co-developed with full stakeholder engagement.

Sociocultural acceptance, patient beliefs, and community engagement

The successful integration of TM with MM is deeply influenced by sociocultural acceptance, patient beliefs, and community engagement. Traditional healing practices are often embedded in the cultural and spiritual fabric of communities, shaping health-seeking behavior, treatment adherence, and trust in health systems. Failure to acknowledge and incorporate these sociocultural dimensions can undermine integration efforts and alienate patients. Many patients perceived TM as holistic, natural, and culturally relevant, while viewing MM as invasive or disconnected from their lived realities. A cross-national study published in *Social Science & Medicine* showed that patients often consulted traditional healers first due to their trust, accessibility, and alignment with cultural worldviews.[129] Conversely, MM practitioners may dismiss TM as unscientific or unsafe, leading to mutual mistrust and a lack of collaboration.[130] Moreover, community engagement was often insufficient in integration policies. When health programs were designed without community consultation, they risked being perceived as externally imposed or culturally insensitive. This was observed in several low- and middle-income countries where integration efforts failed due to a lack of community buy-in.[6,131,132] True integration required not only technical alignment but also dialogue, respect, and shared decision-making. Addressing these challenges called for culturally competent care models, training for MM practitioners in traditional health beliefs, and policies that recognized TM as a legitimate component of healthcare. Strengthening community participation and building trust through inclusive health governance was critical to ensuring that integration was ethically grounded and socially acceptable.

Biases, misperceptions, and marginalization in scientific discourse

The integration of TM with MM was hindered by systemic biases, cultural misperceptions, and marginalization in scientific discourse. TM was often viewed through a colonial and reductionist lens that dismissed its epistemology as unscientific or anecdotal. This bias favored biomedical models and standardized clinical trials, sidelining traditional practices that relied on individualized, holistic, and experiential approaches.[133] Obtaining research funding for TM remained challenging, as proposals were often evaluated using MM standards by reviewers with limited TM expertise. This biased funding toward MM-aligned projects risks the exclusion of core TM concepts like *prana* or *chi*. A balanced review panel including TM and MM experts was essential for fair evaluation.[105]

Though TM integration had been initiated in many health systems, it often remained superficial, with biomedicine retaining dominance and TM practitioners facing marginalization. A study of Delhi's Ayurveda institutions highlighted systemic issues, such as low budgets and bureaucratic hurdles, hindering effective integration and compromising both patient care and the integrity of traditional systems. In India, AYUSH practitioners were often relegated to subordinate roles within the public health system, limiting meaningful collaboration.[134] In 2013, the WHO acknowledged that TM was underrepresented in global health governance. Some practitioners reported their work being labeled "unscientific" despite adhering to rigorous study.[135,136] Additionally, safety concerns around TM, such as herbal-drug interactions, were disproportionately emphasized compared to similar concerns in biomedicine, often without acknowledging the benefits these treatments might offer.[104] These disparities may have stemmed from different research priorities, cultural attitudes, or editorial policies, but the effect was the same: English-speaking researchers and clinicians may dismiss TM literature as less credible or relevant. The compounded effects of linguistic, academic, and cultural bias limited the visibility and credibility of TM research in mainstream healthcare, thereby inhibiting its acceptance and application in clinical practice.

Educational gaps and resistance among health professionals

A significant cultural and professional barrier lay in the lack of mutual understanding and education among practitioners of both

systems. Medical curricula in most countries offered little or no education on TM, leading to skepticism or outright rejection by biomedical professionals.[137] In many countries, TM was taught outside the university system, primarily in private colleges. These institutions often lacked the infrastructure to support rigorous scientific training and research activities.[138–140] As a result, many TM professionals did not hold undergraduate or postgraduate qualifications required to engage in or lead research projects. In Australia and New Zealand, fewer than half of TM professionals held degrees beyond secondary education. Moreover, TM students rarely had access to research opportunities available to students in conventional medical programs. For instance, data from New Zealand indicated that only 56.6% of TCIM practitioners had attained a high school certificate or diploma as their highest level of education. In Australia, this figure was 49.1%, and in Canada, around 8.1% of TCIM practitioners did not possess a bachelor's degree.[141] These statistics highlighted the gap in foundational education, which limited eligibility for advanced academic training and research participation. Additionally, TM students typically had limited exposure to formal research training or research-focused career pathways. Unlike students in conventional medical programs who routinely engaged in research, TCIM students rarely received comparable opportunities. Even those practitioners who developed a later interest in research faced barriers such as a lack of mentorship, networking opportunities, and institutional support.[103,136,142]

For those interested in pursuing research later in their careers, re-entering academia presented significant logistical and financial barriers. The necessity to complete an undergraduate degree before applying for postgraduate research programs often imposed time and resource constraints that were not feasible for mid-career professionals. Additionally, many TCIM practitioners perceived research as disconnected from clinical practice, which further diminished their motivation to engage with scientific investigation.[136] This epistemic siloing fostered mistrust and hindered interdisciplinary collaboration. Structured training programs and dual-degree curricula could bridge this divide, but such initiatives were still in their infancy. Professional turf wars and resistance to collaborative models further impeded integration in clinical practice.

Insufficient financial investment and funding inequities

One of the most fundamental barriers to traditional integration was the lack of equitable financial support for research and development. Despite a noticeable increase in TM-related investigations in recent decades, the proportion of funding dedicated to these studies remained disproportionately low. For instance, in the United States, only 0.17% of the National Institutes of Health research budget in 2022 was allocated to the National Center for Complementary and Integrative Health.[112] Similarly, Australia's National Health and Medical Research Council dedicated a mere 0.085% of its research funding to TM between 2001 and 2004.[143] Even in countries where TM was formally integrated into the national healthcare framework, such as South Korea, the allocation remained insufficient. In 2021, only 6.33% of South Korea's healthcare research and development budget was invested in Korean Medicine research.[112] This underfunding signified systemic undervaluation of TCIM's potential and led to stagnation in clinical validation, innovation, and widespread implementation.

Another major financial hurdle stemmed from concerns related to the patentability of TM therapies. Many traditional practices, such as yoga, meditation, and herbal formulations, did not qualify for conventional intellectual property protections, making them unattractive to commercial investors. Furthermore, the complex nature of these therapies, often involving multiple natural compounds or holistic regimens, complicated the standardization and regulatory approval process, further diminishing funding opportunities. The lack of a robust intellectual property framework also raised ethical concerns, such as biopiracy, wherein indigenous knowledge was commercialized without appropriate acknowledgement or benefit-sharing.[112,144,145] This systemic funding neglect often stemmed from the non-patentable nature of many TCIM therapies. Unlike pharmaceuticals, which benefited from patent-driven investment, TCIM practices such as herbal medicine, yoga, and acupuncture often could not be patented due to their natural origins and long-standing historical use.[146] Moreover, issues of biopiracy complicated commercialization, with indigenous knowledge being appropriated without due credit or benefit-sharing.[147] Consequently, venture capital and private investors were often reluctant to support TM trials, especially those requiring costly Phase III trials for regulatory approval.[146]

Translational gaps: From evidence to clinical practice

Even when evidence supported the efficacy of TM therapies, translating these findings into clinical practice remained difficult. Patients often hesitated to disclose their use of traditional therapies due to fear of disapproval from healthcare providers.[148] Conversely, many physicians lacked adequate knowledge or training in TM and were unprepared to discuss its use meaningfully with patients.[149,150] The integration of TM into clinical guidelines, electronic health records, or multidisciplinary care models was rare. This absence was due not only to knowledge gaps but also to skepticism regarding the validity of existing research. Some physicians expressed concern about herb-drug interactions or lack of standard dosing in herbal medicines, but did not evaluate such risks with the same scrutiny applied to pharmaceutical products.

In countries like the U.S., education about TM was typically offered only as elective courses rather than integrated into core medical curricula.[151,152] This voluntary approach limited the widespread dissemination of TM knowledge and failed to prepare future clinicians to engage in integrative care models. On the other hand, some TM practitioners also exhibited a lack of interest in research integration, often viewing scientific methodologies as incompatible with their therapeutic philosophy. This belief stemmed from concerns that research oversimplified the complex, individualized nature of TM therapies. As a result, both groups, conventional and traditional practitioners, may resist collaboration, further impeding the development of truly integrative health systems.[100]

The integration of TM and MM is often seen as a clash of two very different systems: holistic versus reductionist. While these differences are real, calling them incompatible is an oversimplification. New fields like systems biology, integrative oncology, and personalized medicine show that meaningful convergence is possible. A major barrier is the dominance of RCTs in biomedicine, which often do not fit the individualized and holistic nature of TM. Yet alternatives such as pragmatic trials, n-of-1 studies (single-patient trials that test treatment effectiveness through repeated, individualized observations), and mixed-methods research offer more suitable approaches. Without adopting these, TM risks continued marginalization.

Standardization and regulation are also key challenges, shaped by politics and economics. Wealthier nations often create strict rules favoring pharmaceutical companies, while developing countries lack strong regulatory systems. Added to this are historical biases rooted in colonial legacies that privilege Western medicine

over indigenous knowledge. Financial neglect is another issue, since many TM therapies are non-patentable and attract little investment, even as some practices like yoga or herbal supplements are commercialized globally. Along with this, professional and educational barriers also remain. Biomedical practitioners often resist integration due to hierarchy, resource competition, or authority concerns. Yet patients worldwide already practice "self-integration" by combining TM and MM. Recognizing this bottom-up trend is essential. In short, successful integration requires not just technical solutions but also addressing deeper issues of equity, power, and recognition, transforming healthcare into a more inclusive and pluralistic system.

A strategic roadmap for integrating TM into global health systems

The future of integrating TM into mainstream healthcare hinges on a strategic, multifaceted approach that addresses long-standing challenges in research, education, policy, and clinical application. Effective integration requires sustained collaboration among governments, healthcare professionals, researchers, and communities to develop inclusive, culturally sensitive, and evidence-informed policy frameworks.[6] The WHO, under Director-General Dr. Tedros Adhanom Ghebreyesus, has championed this vision by initiating global dialogues and fostering institutional mechanisms to promote the responsible use of TM in public health systems.[153] A key institutional milestone was the establishment of the WHO Global Centre for Traditional Medicine (GCTM) in Jamnagar, India. Rooted in the philosophy of *Vasudhaiva Kutumbakam* ("One World–One Family–One Future"), the GCTM aimed to bridge ancient wisdom and modern science through strategic pillars including evidence generation, data analytics, innovation, equity, and sustainability. The 2023 WHO Traditional Medicine Global Summit (TMGS), co-hosted with the Government of India alongside the G20 Health Ministers' Meeting, further underscored this commitment. The Summit served as a global platform to share best practices, research, and innovations, reaffirming TM's relevance in advancing health equity and resilience.[153]

The WHO Expert Advisory Group at the TMGS outlined five critical recommendations: (1) leveraging TM's potential for planetary health through culturally rooted practices; (2) investing in transdisciplinary research and innovation; (3) expanding education and communication to build trust and co-develop global regulatory standards; (4) redefining health policy frameworks toward preventive, holistic, and patient-centered care; and (5) shifting economic models to prioritize equity and shared benefit over profit-driven healthcare.[153] One of the most pressing imperatives is increasing financial investment in TM research. Evidence across health domains revealed that enhanced funding improved the quality and impact of scientific output, which in turn drove innovations in diagnosis, treatment, and healthcare outcomes.[153–157] Creating diversified funding streams, through both public institutions and TM–MM partnerships, could catalyze cross-disciplinary innovation and produce high-quality, evidence-based data. For example, to fairly evaluate research proposals from different epistemologies, especially those emerging from TM systems like Ayurveda, TCM, or indigenous healing, a grant review process needed to be restructured to acknowledge and respect diverse knowledge systems. One effective approach was to establish interdisciplinary review panels that included both modern biomedical scientists and experts from TM systems. This ensured that proposals were not dismissed due to unfamiliar methods but were evaluated within the appropriate cultural and scientific context. Another model was the use of dual-track evaluation, where proposals were categorized and assessed based on their methodological orientation. For example, studies using community-based participatory research, ethnographic documentation, or classical textual interpretation could be evaluated under criteria suited to qualitative or experiential research, rather than forced into RCT frameworks that may not align with the epistemology of traditional practices. Additionally, customized scoring rubrics should be developed that value clinical relevance, long-term use, community validation, and safety records, especially for traditional interventions with a long history of empirical use. Inclusion of traditional knowledge holders or community representatives as co-reviewers could enhance cultural and contextual sensitivity. Finally, advisory boards could oversee the process to mitigate bias and ensure balanced decision-making. These reforms would promote equity, innovation, and pluralism in research funding.

Equally vital is addressing the structural research training gap in TM education. Many TM practitioners were educated in non-university institutions with limited access to research training, resulting in low research engagement and capacity. Faculty development programs that embedded research literacy and methodology into TM curricula were shown to significantly enhance students' scientific competencies.[158,159] Scaling such initiatives globally would equip future practitioners to critically engage with and contribute to scientific discourse, thereby strengthening the credibility and clinical relevance of TM. Furthermore, the adoption of open science practices—such as open-access publishing, protocol registration, and adherence to reporting guidelines—could improve transparency, reproducibility, and trust in TM research, which was currently underutilized compared to other health sciences.[160,161] Complementing this, implementation science offered structured methodologies to translate TM evidence into real-world practice, taking into account contextual, cultural, and organizational factors that influenced successful adoption.[162]

Lastly, integrating TM content and research findings into conventional medical education and clinical guidelines was essential to shift professional biases and enable collaborative care models. When healthcare providers were educated about TM and supported in communicating integrative options with patients, the result was a more pluralistic, respectful, and patient-centered healthcare environment.[163,164] For instance, medical schools could introduce mandatory modules in the first year covering cultural competency, basic principles of major TM systems (e.g., Ayurveda, TCM, Unani), and ethical considerations around biopiracy and patient disclosure. Advanced years could include electives such as "Herb-Drug Interactions in Clinical Practice" or offer interdisciplinary clinical clerkships in integrative medicine settings (e.g., pain clinics, oncology centers). Case-based learning and standardized patient interactions involving TM scenarios could also foster applied understanding. Such examples can guide curriculum planners, funding bodies, and healthcare administrators in designing integrative pathways that are both context-specific and scalable. With strong institutional support, progressive educational reforms, dedicated research investments, and deep cultural respect, these forward-looking strategies had the potential to bridge the gap between traditional and biomedical healthcare systems. With the WHO GCTM's roadmap and the momentum of the TMGS, the global health community is well-positioned to embrace an inclusive, scientifically grounded, and ecologically responsible model of healthcare that supports collective well-being and sustainable development.

Conclusions

The integration of TM with MM is challenged by a complex web of factors involving research funding limitations, educational disparities, methodological differences, systemic bias, translational gaps, and regulatory inconsistencies. Many TM systems operate outside the conventional biomedical model, making it difficult for them to secure funding, align with dominant research methodologies, or gain legitimacy within regulatory frameworks. Education in TM often lacks formal research training, further isolating practitioners from scientific discourse. Additionally, systemic biases, rooted in colonial histories and scientific elitism, continue to marginalize traditional knowledge, limiting collaboration between the two systems. Addressing these challenges requires a coordinated and multifaceted strategy. Enhancing investment in TM research can generate high-quality evidence, while reforms in education, such as integrating research training and clinical exposure, can empower practitioners to contribute more effectively to healthcare innovation. Methodological pluralism, which values both empirical and traditional knowledge systems, is essential for producing relevant and culturally grounded evidence. Globally harmonized regulatory frameworks can also help legitimize traditional practices while ensuring safety and efficacy. Above all, fostering respectful dialogue between MM and TM practitioners can bridge epistemological divides and build trust. Such collaboration is essential for creating an inclusive, holistic, and patient-centered healthcare model that serves diverse populations effectively.

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Author contributions

Study concept and design (AB), acquisition of data (RP, AK), analysis and interpretation of data, drafting of the manuscript (DS, NS), critical revision of the manuscript for important intellectual content (DS), administration, and study supervision (VA). All authors have made significant contributions to this study and have approved the final manuscript.

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