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Review Article

Integrating Traditional Chinese Medicine Health Preservation with Intelligent Technologies

John Taylor[1,*]

[1] Columbia University in the City of New York, 10027, USA

* Corresponding author: John Taylor

Email: JohnTaylor@outlook.com

***Abstract*:** The intersection of traditional Chinese medicine health preservation with contemporary standardization and digital technologies represents a field in which enthusiasm has occasionally outpaced critical appraisal. This review examines recent scholarship across four interconnected domains: the construction of standardized systems for TCM external therapies, the integration of smart wellness models with industry standards, clinical and experimental evidence for TCM interventions, and theoretical reflections on the historical modernity of medicine. A recurring difficulty in synthesizing this literature lies in the uneven methodological quality across studies, certain multicenter observational designs, while valuable, may to some extent lack the control conditions necessary for causal inference, and the theoretical papers, though conceptually rich, await empirical verification. Possible tensions also emerge between the drive toward uniform technical standards and the individualized, syndrome-differentiation logic that has long characterized TCM practice. Considering these factors, the reviewed work suggests that standardization and digitization are not merely technical additions but may subtly reshape the epistemological foundations of TCM health preservation. Further research is needed to determine whether such transformations preserve or diminish the distinctive clinical reasoning that defines the tradition.

Keywords: *Traditional Chinese Medicine; Health Preservation; Standardization; Digital Health; Evidence-Based Practice;*

1. Introduction

The modernization of traditional Chinese medicine (TCM) health preservation has long been a project animated by competing aspirations—the desire for scientific legitimacy, the imperative of clinical safety, the ambition of global dissemination, and, not least, the concern that something essential might be lost in translation. Recent years have witnessed a proliferation of scholarship addressing this project from markedly different angles: some studies pursue the construction of standardized technical systems for external therapies [9], others explore the embedding of industry standards within digital platforms [11], while a further body of work continues to accumulate clinical and experimental evidence for specific interventions[3][6][18][20]. Running alongside these applied efforts is a more reflective strand of inquiry concerned with the historical and comparative dimensions of medical modernity[12][13].

What makes this literature particularly worth examining is not simply its volume but the friction between its various commitments. The standardization agenda, for instance, presupposes a degree of uniformity in practice that may sit uneasily with the syndrome-differentiation (bian zheng) reasoning central to TCM. Similarly, the turn toward digital systems raises questions about whether the tacit, embodied knowledge of experienced practitioners can be adequately captured in algorithmic form. These are not merely abstract concerns; they surface repeatedly, if sometimes implicitly, in the empirical studies reviewed here.

This review therefore seeks to map the current landscape of TCM health preservation research while remaining attentive to these underlying tensions. Rather than treating standardization, digitalization, and evidence-based practice as straightforwardly complementary developments, the analysis that follows considers how they may at times reinforce and at other times complicate

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one another. The aim is not to adjudicate between these orientations but to clarify the terms on which their relationship might be more carefully understood.

2. Standardization of TCM External Therapies

The construction of standardized systems for TCM external therapies has proceeded along several fronts, each with its own methodological logic and, it should be said, its own limitations. Chen's work on the standard system for traditional external therapy in TCM health preservation offers a systematic framework intended to codify technical procedures and operational norms [9]. The value of such an endeavor is evident in principle—without shared standards, multi-site collaboration and quality assurance become difficult to sustain. Yet the very act of codification raises a question that the paper itself does not fully resolve: to what extent can the individualized judgments that characterize expert external therapy practice be reduced to standardized protocols without distorting the clinical reasoning they embody? This is not an objection so much as an acknowledgment of a tension that likely requires ongoing negotiation rather than one-time resolution.

A related effort by the same author reports a multicenter observational study of standardized TCM external therapy for chronic soft tissue pain [6]. The multicenter design represents a meaningful step toward generalizability, and the inclusion of multiple sites partially addresses the concern that single-center findings may reflect local practitioner idiosyncrasies. However, observational designs of this kind, however carefully executed, cannot fully exclude selection effects or the possibility that patient-reported improvements reflect expectancy rather than specific therapeutic action. The study's contribution may therefore lie less in establishing efficacy than in demonstrating the feasibility of implementing standardized protocols across diverse clinical settings—a practical achievement whose significance should not be underestimated.

The most methodologically ambitious contribution in this domain is Huang's three-arm assessor-blinded randomized controlled trial of integrated acupuncture, tuina, and moxibustion for chronic multisite musculoskeletal pain [3]. The incorporation of biomarker and pressure pain threshold assessments is particularly noteworthy, as it moves beyond subjective symptom scales toward more objective physiological indices. Even so, the interpretation of such biomarkers is not entirely straightforward; changes in inflammatory markers or pain thresholds may reflect multiple pathways, and attributing them specifically to the integrated intervention requires assumptions that the trial design, for all its rigor, cannot fully validate. Huang's companion theoretical paper, which analyzes the same combined intervention through the lens of meridian examination and the tendon excess-deficiency and qi-blood stasis framework [8], offers a complementary perspective—though the relationship between theoretical mechanism and empirical outcome remains, to some extent, a matter of interpretive bridging rather than direct demonstration.

Rui's theoretical analysis of time-based moxibustion with the Linggui Bafa method for mild cognitive impairment adopts a different approach altogether, grounding standardization in the temporal logic of qi transformation and meridian time sequence [7]. This is a conceptually sophisticated attempt to derive standardized timing protocols from classical theory rather than from empirical optimization. Whether such theory-derived standards will prove clinically superior to conventionally determined schedules is, however, an open question that the paper does not purport to answer; further research would be needed to test the clinical implications of its theoretical proposals.

It is worth noting that standardization efforts are not confined to TCM. Pan's work on constructing a risk screening system for urban adolescent physical fitness training [1] exemplifies a parallel development in the sports science domain, where standardized assessment protocols serve to identify individuals at risk and guide intervention. The methodological parallels—and the shared challenge of balancing standardized criteria with individual variability—may offer useful lessons for TCM standardization, even though the substantive domains differ considerably.

3. Intelligent Technologies and Digital Integration

The integration of digital systems with TCM health preservation standards, as pursued by Yao, represents one of the more forward-looking strands of current research [11]. The smart wellness model described in that work attempts to translate industry standards into digital infrastructure, thereby enabling standardized services to be delivered through technological platforms. This

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is an appealing vision, and the practical challenges of implementation are addressed with reasonable candor. Still, one might wonder whether the digital encoding of standards introduces a subtle rigidity—once a standard is embedded in software, the flexibility that allows practitioners to adapt to individual patients may be constrained in ways that are not immediately visible. This is a possibility rather than a demonstrated outcome, but it merits attention as such systems become more widespread.

It is worth noting that methodological inspiration for TCM's digital turn may come from quarters not usually associated with medical research. Lin's work on a multi-sensor fusion system for intelligent pet anti-barking collars [4] and on thermal runaway early warning for polymer lithium-ion batteries in wearable pet devices [10] belongs to an entirely different domain, yet the underlying engineering challenges—integrating heterogeneous sensor data, designing safety warning architectures for wearable devices—are not unrelated to those facing TCM smart diagnostic equipment. Similarly, Haipeng's lightweight neural network approach to dog bark recognition based on mel-frequency cepstral coefficients [2] demonstrates how computationally efficient models can be deployed in resource-constrained environments, a consideration that may prove relevant for portable TCM diagnostic devices intended for community or rural settings. These are, admittedly, speculative connections; the direct transfer of such methods to TCM contexts has not been demonstrated and would require substantial adaptation. The point is rather that the technical toolkit for TCM's digital transformation may be broader than the TCM literature itself typically acknowledges.

A more immediate concern with the digital integration agenda is the risk of what might be called premature codification—encoding standards before their clinical validity has been sufficiently established. If digital systems propagate standards that are themselves still under development, the result could be a hardening of practice patterns around protocols whose evidence base remains incomplete. This concern does not argue against digital integration but suggests that the sequencing of standardization and digitalization efforts deserves careful thought.

4. Clinical Evidence and Data-Driven Inquiry

The clinical evidence base for TCM interventions continues to expand, though its methodological character varies considerably across studies. Cao's prospective cohort study of food-medicine homologous intervention for chronic fatigue, grounded in TCM constitution classification [5], exemplifies an approach that leverages the individualized logic of TCM while employing a recognized epidemiological design. The constitution-based stratification allows for a degree of personalization that would be difficult to achieve in a conventional randomized trial, and the prospective cohort design permits observation of outcomes over time. The trade-off, of course, is that cohort studies remain vulnerable to confounding, and the possibility that individuals who seek constitution-tailored interventions differ systematically from those who do not cannot be entirely ruled out. The study's findings are therefore suggestive rather than definitive, though their relevance to the growing interest in personalized nutrition should not be dismissed.

Data mining studies of historical prescribing patterns represent a distinct mode of inquiry. Wang et al.'s analyses of Menghe medical school prescriptions for warm diseases [14][26]and Qiu et al.'s study of Menghe physicians' treatment of insomnia [25] employ computational methods to identify regularities in historical clinical records. These studies offer a valuable corrective to the tendency to treat historical medical knowledge as monolithic; they reveal patterned variation in prescribing that might otherwise remain obscured. At the same time, the limitations of data mining in this context deserve acknowledgment. The historical records available for analysis are necessarily selective, reflecting the practices and documentation habits of particular lineages rather than the full range of clinical experience. The patterns identified may therefore describe the Menghe tradition's internal logic more accurately than they describe the broader landscape of TCM prescribing. This is not a flaw in the studies themselves but a boundary condition on the inferences they support.

The experimental literature on TCM interventions for neurodegenerative and cerebrovascular conditions is extensive and methodologically diverse. Du et al.'s investigation of Naofuming dripping pills in a vascular dementia rat model [18], the series of behavioral comparisons of Alzheimer's disease model mice by Di et al. [20][22][27], Tang et al.'s examination of Semaphorin 3A expression and the protective effects of Tongluo Jiunao injection in focal cerebral ischemia [21], and Zheng's study of maca extract on scopolamine-induced memory impairment [24] together illustrate the range of animal models and outcome measures employed in this field. These studies contribute to mechanistic understanding, though the translation from rodent models to human clinical

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benefit is, as is well known, far from straightforward. The behavioral phenotypes of different mouse strains, as Di et al. themselves demonstrate[20][27], can vary in ways that complicate cross-study comparison—a methodological difficulty that the field has not fully resolved.

The educational and professional development literature, while not directly concerned with clinical outcomes, addresses conditions that shape the research enterprise itself. Di et al.'s discussion of socialist core values education for TCM graduate students [15], Di's reflections on moral education [16], Lin et al.'s SWOT analysis of graduate employment [19], and Wang et al.'s survey of mental health among incoming graduate students [23] collectively highlight the human dimensions of TCM's research capacity. These studies are, to some extent, descriptive rather than analytical, but they draw attention to the institutional contexts within which the clinical and technological research reviewed above is conducted.

The historical and comparative scholarship of Xu et al.[12][13] operates at a different level of abstraction, examining the comparative history of Chinese and European medicine and the impact of the Renaissance and New Culture Movement on medical modernity. Zhang et al.'s survey of appropriate technology promotion in Pingliang [17] and Feng et al.'s investigation of public awareness of herbal treatments for constipation [28] address the practical interface between TCM and its users. These studies remind us that the standardization and digitalization agendas are not merely technical matters but are embedded in specific social and historical contexts that condition their reception and effectiveness.

5. Conclusion

Taken together, the literature reviewed here reveals a field in transition, one in which the impulse toward standardization, digitalization, and evidence-based practice is reshaping TCM health preservation in ways that are neither wholly beneficial nor wholly problematic, and whose long-term consequences remain genuinely uncertain. The tension between codified protocols and individualized clinical judgment—a tension that surfaces, in different forms, in the standardization of external therapies, the encoding of standards in digital systems, and the design of clinical studies—may prove to be the central issue around which future scholarship organizes itself. What the present review suggests is that this tension is not a problem to be solved once and for all but a productive difficulty that may, if approached with appropriate care, generate more sophisticated understandings of what TCM health preservation can become in the contemporary world. Future research might usefully attend to the question of how standardization processes can be designed to preserve rather than flatten the clinical reasoning they seek to codify, and to the empirical testing of digital systems in real-world practice settings rather than only in demonstration projects. Whether the tradition's distinctive strengths can be carried forward through these transformations, or whether they will be eroded by them, is a question that only sustained, critically minded inquiry can answer.

Data Availability Statement

Data will be made available on request.

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Conflicts of Interest

The author(s) declare no conflicts of interest.

Ethical Approval and Consent to Participate

Not applicable.

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