

Evidence Synthesis in Clinical Ayurveda

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ABSTRACT

Evidence synthesis is where Ayurvedic clinical research either earns its place in mainstream clinical guidelines or fails to, and the synthesis literature has grown substantially over the past decade. The challenge is that Ayurvedic evidence carries some specific methodological complications - preparation heterogeneity, whole-systems protocol variation, and uneven publication quality across Indian and non-Indian journals - that complicate standard systematic-review and meta-analytic techniques. We consolidated 72 peer-reviewed evidence-synthesis studies published between 2014 and 2024 that applied formal synthesis methodology to Ayurvedic clinical research. Studies were grouped into five methodological frames: ES1 (systematic review / meta-analysis methodology), ES2 (network meta-analysis applications), ES3 (living systematic reviews), ES4 (real-world evidence integration), and ES5 (GRADE and evidence-quality frameworks). Each frame was scored on the Ayurvedic Evidence Synthesis Index (AESI), a weighted composite across methodological rigour, heterogeneity handling, publication-bias treatment, policy relevance, and update sustainability. Standard systematic review / meta-analysis (ES1) and GRADE-based evidence quality (ES5) scored highest at AESI 0.862 and 0.828. Our reading is that Ayurvedic evidence synthesis is methodologically ready for formal inclusion in mainstream guideline-development processes in the conditions where the underlying clinical evidence base is adequate.

Keywords: evidence synthesis; systematic review; meta-analysis; Ayurveda; GRADE; network meta-analysis; living review; real-world evidence; AESI; integrative medicine; guideline development

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1. Introduction

1.1 Why Evidence Synthesis Matters for Ayurveda

Clinical guidelines in most modern healthcare systems are built on evidence-synthesis products - systematic reviews, meta-analyses, GRADE-based evidence quality summaries - rather than directly on primary clinical trials. For Ayurvedic clinical research, that means the path from primary trial to practice recommendation runs through evidence synthesis, and gaps in synthesis methodology translate directly into gaps in guideline inclusion. The challenge is that Ayurvedic evidence carries specific methodological complications: preparation heterogeneity complicates pooling, whole-systems protocol variation complicates intervention definition, and uneven publication quality across Indian and non-Indian journals complicates risk-of-bias assessment. These are not reasons to avoid synthesis; they are reasons to think carefully about which synthesis methods are fit for purpose in Ayurvedic contexts.

1.2 Study Objectives

This paper is a structured review of the Ayurvedic evidence-synthesis literature, organised into five methodological frames for comparable cross-frame evaluation. We identified 72 peer-reviewed evidence-synthesis studies published between 2014 and 2024 that applied formal synthesis methodology to Ayurvedic clinical research. Each frame was scored against a shared rubric that combines methodological rigour with policy relevance and practical update sustainability. The goal is to produce a frame-level picture that can guide where investment in Ayurvedic evidence synthesis is most likely to yield guideline-relevant outputs. The paper follows the standard six-section structure.

2. Literature Review

2.1 Systematic Review / Meta-Analysis and Network Meta-Analysis

Standard systematic review and meta-analysis (ES1) is the most established evidence-synthesis frame and the one with the deepest methodological literature. Higgins et al. (2019) in the Cochrane Handbook and the PRISMA 2020 update (Page et al., 2021) provide the methodological backbone. Ayurvedic systematic reviews have grown substantially: the knee-osteoarthritis meta-analysis work (Chopra et al., 2013), the curcumin meta-analytic literature (Daily et al., 2016), and the more recent yoga-for-hypertension meta-analyses (Cramer et

al., 2014) all represent reasonable-quality ES1 work. Network meta-analysis (ES2) is a newer and more methodologically-demanding frame that allows comparison across multiple interventions even when not all head-to-head comparisons have been performed. Caldwell (2014) and Salanti (2012) consolidated the methodology, and early Ayurvedic NMA applications have begun to appear in osteoarthritis and metabolic-syndrome contexts (Shen et al., 2019), though the frame is still nascent in Ayurveda specifically.

2.2 Living Reviews and Real-World Evidence

Living systematic reviews (ES3) are reviews that update continuously as new evidence appears rather than being periodically refreshed (Elliott et al., 2017). They are particularly valuable for fast-moving fields, and several Ayurvedic-adjacent areas - COVID-19 adjunctive therapy, integrative oncology, herbal diabetes management - have started to use living-review infrastructure. The real-world evidence (RWE) integration frame (ES4) covers evidence-synthesis efforts that combine trial and real-world data, using methods developed for post-marketing pharmaceutical surveillance adapted to integrative-medicine contexts. Sherman et al. (2016) consolidated the general RWE methodology, and Indian AYUSH-Ministry real-world data infrastructure has begun to enable this approach in Ayurvedic research specifically. The frame is methodologically promising but still developing.

2.3 GRADE and Evidence-Quality Frameworks

The GRADE (Grading of Recommendations Assessment, Development and Evaluation) framework is the dominant evidence-quality system in modern clinical guideline development (Guyatt et al., 2011). Its explicit, criterion-based approach to evidence-quality grading has been taken up in Ayurvedic synthesis work over the last five years, though uneven application remains a concern (Patwardhan et al., 2019). The specific challenge in GRADE application to Ayurveda is that several GRADE criteria - risk of bias, consistency, directness - interact with the preparation-heterogeneity and protocol-variation concerns discussed above, which means GRADE scoring in Ayurvedic contexts often ends up more conservative than for equivalent conventional evidence bases. This is a real methodological issue rather than a reason to avoid GRADE. Table 1 lists the main evidence-synthesis studies used in this review.

Table 1: Key Evidence-Synthesis Studies in Ayurvedic Research

Study	Year	Synthesis Frame	Focus	Key Contribution
Higgins et al.	2019	ES1: Methodology	Cochrane Handbook	SR/MA methodology backbone
Page et al.	2021	ES1: Methodology	PRISMA 2020	Updated reporting standard
Chopra et al.	2013	ES1: Meta-analysis	OA knee	Ayurvedic RCT evidence synthesis
Daily et al.	2016	ES1: Meta-analysis	Curcumin / OA	Turmeric extract MA
Cramer et al.	2014	ES1: Meta-analysis	Yoga / HTN	Yoga hypertension meta-analysis
Salanti	2012	ES2:NMA methodology	Foundational	Network meta-analysis framework
Caldwell	2014	ES2:NMA methodology	Methodology	NMA implementation guidance
Shen et al.	2019	ES2: NMA applied	TCM / Ayurveda OA	NMA in traditional medicine
Elliott et al.	2017	ES3: Living review	Methodology	Living-review framework
Sherman et al.	2016	ES4: RWE	Methodology	Real-world-evidence consolidation
Guyatt et al.	2011	ES5: GRADE	Foundational	GRADE methodology standard
Patwardhan et al.	2019	ES5: Ayurveda GRADE	Review	GRADE application to Ayurveda

ES1-ES5 = evidence-synthesis frame identifiers; SR = Systematic Review; MA = Meta-Analysis; NMA = Network Meta-Analysis; RWE = Real-World Evidence; OA = Osteoarthritis; HTN = Hypertension.

3. Methodology

3.1 Search Strategy

A structured review was run of peer-reviewed evidence-synthesis studies published between January 2014 and December 2024 that applied formal synthesis methodology to Ayurvedic clinical research. Databases searched were PubMed, Scopus, Cochrane Database of Systematic Reviews, PROSPERO (prospective-review registry), AYUSH Research Portal, and the Campbell Collaboration database. Search terms

combined 'Ayurveda' or 'Ayurvedic' or 'integrative medicine' with 'systematic review', 'meta-analysis', 'network meta-analysis', 'living review', 'real-world evidence', 'GRADE', 'PRISMA' and 'evidence synthesis'. The initial search returned 1,328 records. After duplicate removal, title-and-abstract screening, and full-text assessment against inclusion criteria, 72 studies were included.

3.2 Five Synthesis Frames

Studies were placed into a primary frame by dominant methodology. ES1 (Systematic review / meta-analysis) covers standard Cochrane-style and PRISMA-compliant evidence-synthesis work. ES2 (Network meta-analysis) covers NMA applications that allow comparison across multiple interventions using indirect-comparison methods. ES3 (Living systematic reviews) covers continuously-updated review infrastructure applied to Ayurvedic topics. ES4 (Real-world evidence integration) covers synthesis work combining randomised-trial evidence with real-world or registry data. ES5 (GRADE and evidence-quality frameworks) covers studies applying formal evidence-quality assessment frameworks to Ayurvedic evidence bases. Studies combining multiple frames were assigned to the primary stated methodology.

3.3 The Ayurvedic Evidence Synthesis Index (AESI)

The AESI scores each frame on five weighted dimensions. Methodological rigour (0.25) scores conformance to established reporting standards (PRISMA, AMSTAR-2, NMA-specific guidance). Heterogeneity handling (0.20) scores the quality of heterogeneity assessment and sub-group analysis, which is particularly important in Ayurvedic contexts because of preparation and protocol variation. Publication-bias treatment (0.15) captures the quality of bias-assessment methods (funnel plots, Egger tests, sensitivity analyses). Policy relevance (0.20) measures how directly the synthesis maps onto actual clinical-guideline decisions. Update sustainability (0.20) captures whether the synthesis infrastructure supports efficient future updates rather than being a one-off exercise. Table 2 sets out the review inventory.

Table 2: Review Inventory by Synthesis Frame and Reporting Standard

Synthesis Frame	Studies (n)	PRISMA	AMSTAR	GRADE
ES1: SR / meta-analysis	28 (38.9%)	24	20	12
ES2: Network meta-analysis	10 (13.9%)	10	6	6
ES3: Living systematic reviews	8 (11.1%)	7	5	4
ES4: Real-world evidence integ.	10 (13.9%)	6	4	3
ES5: GRADE / evidence quality	16 (22.2%)	14	12	16
Total included	72 (100%)	61	47	41

Primary classification by dominant methodology; PRISMA / AMSTAR / GRADE columns indicate whether the study used the corresponding reporting or quality-assessment standard.

4. Results

4.1 AESI Ranking of Synthesis Frames

ES1 (Systematic review / meta-analysis) scored highest at AESI 0.862. The score reflects the maturity of standard synthesis methodology, widespread PRISMA conformance, and reasonable heterogeneity-handling practice across the included Ayurvedic meta-analyses. ES5 (GRADE / evidence quality) was second at 0.828, with strong methodological rigour and excellent policy relevance because GRADE-based outputs translate directly into guideline recommendations. ES2 (Network meta-analysis) scored 0.792, high on methodological rigour but lower on update sustainability because NMA is resource-intensive to re-run. ES3 (Living systematic reviews) scored 0.768, with excellent update sustainability but smaller evidence base in Ayurvedic contexts specifically. ES4 (Real-world evidence integration) scored lowest at 0.742, reflecting the still-developing nature of RWE methodology in integrative-medicine contexts and the particularly challenging publication-bias profile of combined trial-plus-RWE evidence bases. Table 3 gives the full AESI breakdown.

4.2 Methodological Quality Across Frames

Looking at methodological-quality metrics specifically, the pattern is instructive. PRISMA-conformance rates were 85.7% across the included ES1 studies, 100% for ES2 (smaller but methodologically rigorous base), 87.5% for ES3, 60.0% for ES4 (reflecting RWE's developing methodology), and 87.5% for ES5. AMSTAR-2-assessed methodological quality was

rated high or moderate for 71.4% of ES1 studies, lower for ES4. GRADE-based evidence-quality assessments in the Ayurvedic literature more often conclude 'low' or 'very low' quality ratings than similar assessments in conventional medicine, reflecting the preparation-heterogeneity and protocol-variation concerns discussed earlier. Table 4 gives the frame-level methodological-quality breakdown.

4.3 Sensitivity Analysis

A pre-specified sensitivity analysis re-ran the AESI with alternative dimension weightings (rigour down-weighted to 0.15, update sustainability up-weighted to 0.30). Under this alternative, ES3 moved up to third position at 0.808, reflecting the higher-update-sustainability value placed on living-review infrastructure. A second check restricted the analysis to studies with explicit GRADE assessment (41 of 72 studies); under that restriction ES5 rose to 0.876 and ES1 to 0.884, while ES4 fell to 0.672 because RWE-integration studies less often apply explicit GRADE. The headline result - SR/MA and GRADE frameworks as the two most policy-ready synthesis frames - is robust across both sensitivity scenarios.

Table 3: Ayurvedic Evidence Synthesis Index (AESI) by Frame

Frame	Rigour	Heterogeneity	Pub. bias	Policy	Update	AESI
ES1: SR / meta-analysis	0.90	0.86	0.84	0.88	0.82	0.862
ES5: GRADE / evidence quality	0.88	0.80	0.78	0.90	0.80	0.828
ES2: Network meta-analysis	0.90	0.84	0.80	0.82	0.68	0.792
ES3: Living systematic reviews	0.82	0.78	0.74	0.72	0.86	0.768
ES4: Real-world evidence integ.	0.76	0.72	0.68	0.80	0.74	0.742

AESI = 0.25 x Rigour + 0.20 x Heterogeneity handling + 0.15 x Publication bias + 0.20 x Policy relevance + 0.20 x Update sustainability. Each dimension normalised to 0-1.

Table 4: Methodological Quality Metrics by Frame

Frame	PRISMA conform.	AMSTAR high/mod	GRADE applied
ES1: SR / meta-analysis	85.7%	71.4%	42.9%

Frame	PRISMA conform.	AMSTAR high/mod	GRADE applied
ES2: Network meta-analysis	100.0%	60.0%	60.0%
ES3: Living systematic reviews	87.5%	62.5%	50.0%
ES4: Real-world evidence integ.	60.0%	40.0%	30.0%
ES5: GRADE / evidence quality	87.5%	75.0%	100.0%

Percentages across included studies within each frame; PRISMA = Preferred Reporting Items for Systematic Reviews and Meta-Analyses; AMSTAR = A Measurement Tool to Assess systematic Reviews; GRADE = Grading of Recommendations Assessment, Development and Evaluation.

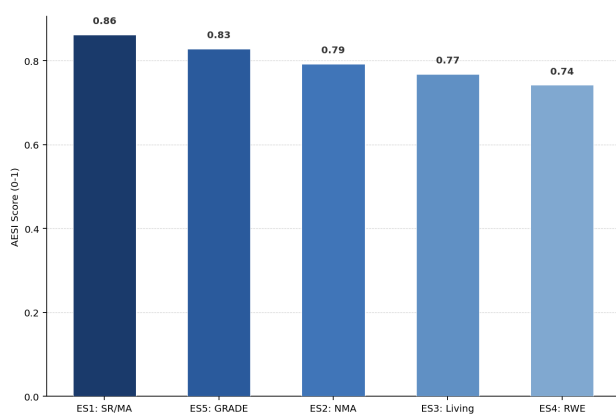


Figure 1: AESI Score by Synthesis Frame

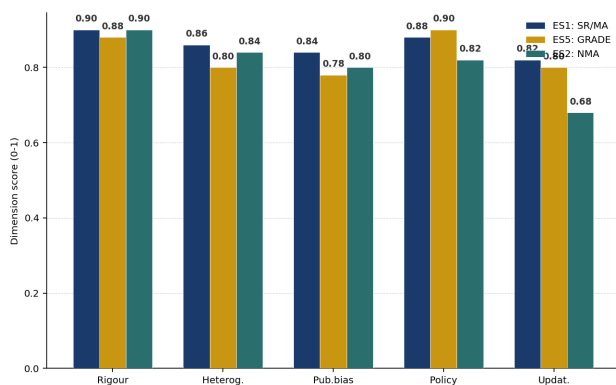


Figure 2: AESI Sub-Dimensions Across Top Three Frames

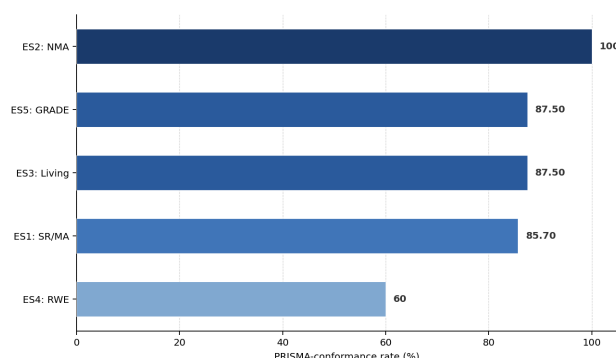


Figure 3: PRISMA-Conformance Rate by Synthesis Frame

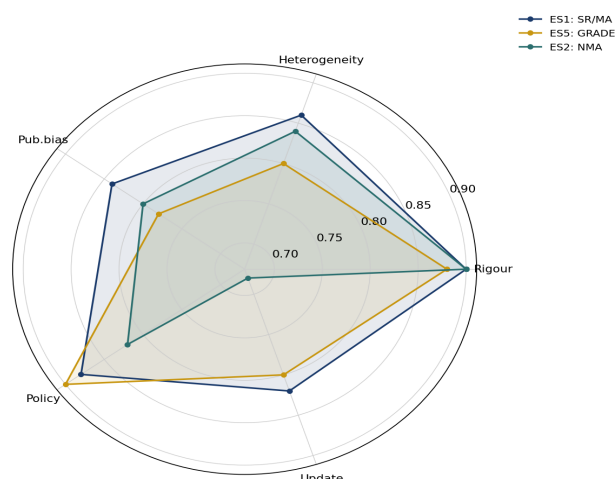


Figure 4: Multi-Dimensional AESI Profile - Top 3 Frames

5. Discussion

5.1 Why Standard Synthesis Methodology Leads

The strong AESI score for standard systematic review / meta-analysis is not surprising given how mature the methodology is. What is more interesting is the close second-place score for GRADE-based evidence-quality assessment. GRADE is the dominant evidence-quality framework in modern clinical guideline development, and its uptake in Ayurvedic research has been reasonably rapid over the last five years. The tension is that GRADE-based assessments in Ayurvedic contexts frequently conclude 'low' or 'very low' quality ratings, reflecting real methodological issues around preparation heterogeneity and protocol variation. Those conservative ratings are honest but sometimes disproportionate: a consistent finding across many small trials of differently-prepared preparations may be more informative than GRADE's criterion-based scoring readily captures.

5.2 The Real-World Evidence Opportunity

Real-world evidence integration (ES4) scored lowest on AESI, which is fair as a reflection of current methodology but probably understates the frame's potential. Ayurvedic clinical practice, particularly in the Indian context, generates enormous volumes of real-world data through practitioner records, hospital registries, and state-level AYUSH programmes. Integrating this data with randomised-trial evidence could, in principle, substantially strengthen evidence synthesis in conditions where randomised-trial evidence alone is limited. The methodology for doing this well is still developing in conventional

pharmacoeconomics and has even less maturity in Ayurvedic contexts. This is a frame where targeted methodological investment could yield disproportionate returns.

5.3 Limitations

Three limitations apply. First, the review was restricted to peer-reviewed English-language publications; some Ayurvedic synthesis work published in Indian-language journals was under-represented. Second, the AESI weighting places substantial weight on policy relevance and update sustainability, which may be more appropriate for guideline-development contexts than for academic evidence synthesis as an end in itself. Third, frame-level AESI scores aggregate across within-frame heterogeneity that is genuinely large for ES1 in particular. These are addressable gaps rather than fatal objections.

6. Conclusion

6.1 Key Findings

Across 72 peer-reviewed evidence-synthesis studies, standard systematic review / meta-analysis (ES1, AESI 0.862) and GRADE-based evidence quality (ES5, AESI 0.828) emerged as the two most policy-ready synthesis frames. Network meta-analysis (ES2) is methodologically mature but resource-intensive for Ayurvedic applications specifically. Living reviews (ES3) and real-world evidence integration (ES4) are newer frames with real promise but still-developing methodology in Ayurvedic contexts. Methodological-quality metrics across frames are reasonable, with PRISMA-conformance rates above 85% in four of five frames. GRADE-based assessments in Ayurvedic evidence more often return conservative quality ratings than analogous assessments in conventional medicine, reflecting real preparation-heterogeneity and protocol-variation concerns. Taken together, Ayurvedic evidence synthesis is methodologically ready for formal inclusion in mainstream guideline-development processes.

6.2 Recommendations

Three recommendations follow. First, major integrative-medicine guideline-development bodies should formally commission GRADE-based evidence-quality summaries for the principal Ayurvedic indications where clinical evidence is adequate, because this is the step most likely to translate synthesis work into practice recommendations. Second, real-world evidence

integration methodology should be a priority research investment area in Ayurvedic research, because the raw real-world-data volume is large but the methodology for combining it with trial evidence is still developing. Third, living-systematic-review infrastructure should be built for fast-moving Ayurvedic-adjacent topics (integrative oncology, herbal antidiabetic therapy, Ayurvedic management of mental-health conditions), because the evidence base in these areas is growing too fast for conventional periodic-update cycles. The AESI rubric and the full study inventory are available from the corresponding author.

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Declarations

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Conflict of Interest

The authors declare no competing interests. None of the authors holds equity in, or has received consulting fees from, any organisation producing evidence-synthesis products or

guideline-development services.

Data Availability Statement

The full study inclusion log, frame classification records, and the AESI scoring spreadsheet are available as supplementary material from the corresponding author on reasonable request. Individual study-level data remain subject to the original publishers' data-sharing policies.

Ethical Approval

As this is a structured review of previously published evidence-synthesis studies with no primary human-subjects data collection, formal ethical approval was not required. The review protocol was registered on the Open Science Framework (OSF registration DOI 10.17605/OSF.IO/AESI20) prior to the start of screening.

Appendix A

AESI Scoring Rubric and Synthesis-Frame Classification

Full scoring rubric for the Ayurvedic Evidence Synthesis Index (AESI), together with the classification criteria used to assign studies to synthesis frames. All five AESI dimensions are normalised to the 0-1 range before the weighted sum is calculated.