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## Critical analysis of ayurvedic pharmacotherapy in pediatric obesity: Molecular mechanisms, clinical evidence, and safety dynamics- Narrative review

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### ABSTRACT

Pediatric obesity is a chronic, relapsing and multifactorial disease in which pharmacotherapy must improve cardiometabolic risk without compromising nutrition, linear growth, puberty or psychological health. This narrative review critically examines Ayurvedic pharmacotherapy for pediatric obesity through traditional rationale, molecular plausibility, clinical evidence and safety surveillance. In 2022, more than 390 million people aged 5-19 years were overweight and over 160 million were living with obesity. Classical Ayurveda describes Sthaulya/Atisthaulya as excessive Meda accumulation associated with over-nourishing food, inadequate activity, disordered appetite and constitutional susceptibility, and proposes Langhana, Rukshana, Lekhana, Dipana-Pachana, dietary regulation and exercise. Triphala, Guggulu-containing formulations, Navaka Guggulu and Vachaharidradi Gana Vati are frequently discussed, but pediatric efficacy data are extremely limited. A Triphala systematic review included 12 randomized studies and 749 participants, predominantly adults; five studies reported reductions in weight-related outcomes, but heterogeneity and risk of bias restrict certainty. One randomized trial in 130 adolescents reported a between-group BMI difference of approximately -1.4 kg/m<sup>2</sup> after three months with a proprietary plant formulation, whereas a 2025 pediatric comparison of Navaka Guggulu and Vachaharidradi Gana Vati remained a trial protocol rather than definitive outcome evidence. Mechanistic work suggests anti-adipogenic and multi-target metabolic signalling, but laboratory and computational findings cannot establish pediatric clinical benefit. Safety concerns include gastrointestinal reactions, variable composition, developmental pharmacology, herb-drug interactions, contamination and under-reporting of adverse events. Ayurvedic medicines should therefore remain adjunctive to family-based lifestyle treatment, be restricted to quality-assured products under qualified supervision, and be evaluated in adequately powered pediatric trials with growth, pubertal, metabolic and pharmacovigilance outcomes.

**Keywords:** Pediatric obesity; Sthaulya; Triphala; Guggulu; molecular mechanisms; pharmacovigilance.

### INTRODUCTION

Pediatric obesity has moved from an individual lifestyle label to recognition as a chronic disease produced by interactions among genetic susceptibility, neuroendocrine regulation, sleep, medications, family behaviour, psychosocial stress, food systems and the built environment. The World Health Organization reported that, in 2022, more than 390 million children and adolescents aged 5-19 years were overweight and over 160 million were living with obesity; global prevalence in this age group increased from 8% in

1990 to 20% in 2022. The continuing coexistence of obesity and undernutrition in many settings underscores the need for prevention and treatment that are clinically effective, nutritionally safe and socially sensitive.<sup>1</sup>

Diagnosis in children requires age- and sex-specific interpretation rather than adult BMI cut-offs. Indian Academy of Pediatrics guidance recommends WHO standards below five years and IAP BMI charts from 5-18 years, routine waist assessment in overweight or obesity, and evaluation of older children for hypertension, dysglycaemia, dyslipidaemia and metabolic dysfunction-associated steatotic liver disease. Management should be comprehensive and family-centred, with attention to secondary causes, comorbidities, adequate nutritional intake, stigma prevention and longitudinal growth monitoring before any complementary medicine is considered.<sup>2</sup>

Ayurveda offers a culturally embedded framework that links excessive corpulence with *Meda* predominance, impaired functional capacity, excessive hunger and thirst, reduced exercise tolerance and obstruction of physiological pathways. *Charaka Samhita*, *Sutrasthana 21*, describes etiological factors such as heavy, sweet, cold and unctuous food, insufficient activity, daytime sleep and hereditary susceptibility, and recommends controlled under-nutritive strategies, exercise and selected *Medohara* measures. These concepts may support individualized counselling, but *Meda*, *Agni*, *Kapha* and *Srotas* are not literal synonyms for adipocytes, mitochondrial metabolism, inflammatory cytokines or anatomical vessels. The purpose of this review is therefore not to force equivalence between knowledge systems, but to evaluate whether proposed Ayurvedic medicines possess reproducible pharmacology, clinically meaningful pediatric evidence and an acceptable safety framework.<sup>3</sup>

## MATERIALS AND METHODS

A focused narrative review was conducted using PubMed/MEDLINE and authoritative sources from WHO, the Indian Academy of Pediatrics, the American Academy of Pediatrics, the Ministry of Ayush, Ayush Suraksha and the Pharmacopoeia Commission for Indian Medicine and Homoeopathy. English-language literature available up to 31 August 2026 was considered. Search combinations included "pediatric obesity," "childhood obesity," "Ayurveda," "Sthaulya," "Triphala," "Guggulu," "Navaka Guggulu," "Vachaharidradi Gana," "adipogenesis," "molecular mechanisms," "toxicity," "quality control," "herb-drug interaction" and "pharmacovigilance." Priority was given to guidelines, systematic reviews, controlled clinical studies, pediatric protocols, mechanistic experiments and official safety documents. Because formulations, populations and outcomes were heterogeneous, no meta-analysis was attempted; findings were synthesized by evidentiary level and pediatric relevance. The search and synthesis were organized according to accepted principles for transparent narrative literature reviews.<sup>4</sup>

## AYURVEDIC CONCEPTUAL BASIS AND THERAPEUTIC LOGIC

The Ayurvedic description of *Sthaulya* integrates causation, phenotype and management. Excessive intake of *Guru*, *Madhura*, *Sheeta* and *Snigdha* foods, *Avyayama*, *Divasvapna* and constitutional or familial susceptibility are described as promoting *Kapha-Meda* accumulation. The resulting phenotype includes disproportionate abdominal, gluteal and breast fat, heaviness, sweating, odour, weakness, dyspnoea on exertion, excessive appetite and thirst, and impaired longevity or functional capacity. Therapeutic logic emphasizes correction of exposure and behaviour before or alongside medicines: *Nidana-parivarjana*, portion and food-quality control, graded *Vyayama*, sleep regulation, *Langhana*, *Rukshana*, *Lekhana* and *Dipana-Pachana*. This multidimensional logic resembles modern chronic-care models in its attention to diet, movement and sustained habits, but its pharmacological claims require independent testing. In children, aggressive fasting, dehydration-producing procedures or strong purgation are particularly problematic because weight management must preserve height velocity, lean mass, micronutrient sufficiency, schooling and emotional well-being.<sup>5</sup>

## MAJOR AYURVEDIC PHARMACOTHERAPEUTIC CANDIDATES

Triphala is the most frequently studied candidate and combines fruits of *Phyllanthus emblica*, *Terminalia bellirica* and *Terminalia chebula*. A systematic review identified 12 randomized studies involving 749 participants, predominantly adults, and reported signals in anthropometric, lipid and glycaemic outcomes; however, heterogeneous formulations, doses, populations and outcome measures restricted certainty. Guggulu-containing medicines, including *Navaka Guggulu*, and plant-based combinations such as *Vachaharidradi Gana Vati*, *Trikatu-*, *Musta-*, *Vidanga-*, *Amalaki-* and *Haritaki-*centred formulations remain pharmacotherapeutic candidates rather than established pediatric treatments. Their evaluation requires exact botanical identification, standardized manufacturing, transparent dose reporting and child-specific safety monitoring.<sup>6</sup>

**Table 1. Ayurvedic candidates: rationale, evidence and pediatric cautions**

| Candidate                                    | Ayurvedic rationale                                          | Current evidence                                                                               | Pediatric caution                                                                                  |
|----------------------------------------------|--------------------------------------------------------------|------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------|
| Triphala                                     | Traditional Medohara, bowel regulation and metabolic support | Cell, animal and mostly adult clinical evidence; systematic review of 12 RCTs/749 participants | No established pediatric anti-obesity dose; monitor gastrointestinal tolerance and product quality |
| Navaka Guggulu                               | Kapha-Meda reduction, Lekhana and Dipana-Pachana rationale   | Pediatric comparative trial protocol; no definitive pediatric outcome evidence                 | Verify Guggulu identity, complete co-ingredients, dose and laboratory safety                       |
| Vachaharidradi Gana Vati                     | Plant-based Kaphamedohara and Karshana formulation           | Compared with Navaka Guggulu in a pediatric protocol; completed results are required           | Composition, adherence, growth and laboratory safety need prospective reporting                    |
| Agnimanthadi compound and other combinations | Dipana-Pachana, Lekhana and supportive Svedana rationale     | Small adult clinical evidence; pediatric effectiveness is not established                      | Do not extrapolate adult dose or procedural intensity directly to children                         |

**MOLECULAR MECHANISMS: PLAUSIBILITY AND LIMITS**

Laboratory and computational studies suggest multiple plausible mechanisms, but each remains a hypothesis until linked to standardized exposure and clinical outcomes. Network pharmacology of Triphala has identified candidate compounds including beta-sitosterol, luteolin, quercetin, kaempferol, ellagic acid and phyllanthin, with predicted interactions involving AKT1, PPARG and PI3K-Akt/PPAR pathways. These signals are consistent with possible effects on adipogenesis, lipid and glucose signalling, inflammation and oxidative stress, but docking scores and predicted networks do not establish target engagement, effective dose or clinical benefit in children. Pediatric translation additionally requires attention to developmental differences in absorption, hepatic enzymes, renal clearance, body composition and puberty.<sup>7</sup>

**Table 2. Translational interpretation of proposed molecular pathways**

| Pathway              | Reported signal                                                                                  | Critical interpretation                                                    |
|----------------------|--------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------|
| Adipogenesis         | Lower PPAR-gamma, C/EBP-alpha, GLUT4, fatty-acid synthase and lipid accumulation in 3T3-L1 cells | Shows target engagement in vitro, not weight loss or safety in children    |
| Network targets      | Predicted interactions involving AKT1, PPARG and PI3K-Akt/PPAR pathways                          | Network and docking evidence is hypothesis-generating                      |
| Metabolic signalling | Predicted multi-component effects on lipid, glucose and inflammatory pathways                    | Requires experimental validation with standardized products                |
| Dose and exposure    | Constituent exposure depends on formulation, extraction and developmental pharmacology           | Pediatric pharmacokinetic and dose-finding studies are required            |
| Clinical translation | Mechanistic signals may justify biomarker selection in trials                                    | They cannot independently establish efficacy or prescribe a pediatric dose |

### CLINICAL EVIDENCE WITH EMPHASIS ON CHILDREN AND ADOLESCENTS

The direct pediatric evidence is insufficient for routine therapeutic recommendation. In the best-known adolescent trial, 130 participants with BMI above 25 kg/m<sup>2</sup> were randomized to a plant-based formulation or cellulose placebo for three months. Reported between-group changes favoured treatment for BMI (-1.4 kg/m<sup>2</sup>), total cholesterol (-20.9 mg/dL), triglycerides (-12.9 mg/dL), HDL cholesterol (+7.2 mg/dL), leptin (-8.0 ng/mL), systolic blood pressure (-6.7 mmHg) and diastolic blood pressure (-10.4 mmHg). Interpretation is limited by the adult-style BMI threshold, short follow-up, limited formulation transparency and lack of detailed growth or pubertal outcomes. A single short trial therefore cannot establish pediatric efficacy, optimal dose, long-term safety or generalizability across Ayurvedic products.<sup>8</sup>

**Table 3. Selected clinical evidence relevant to pediatric translation**

| Evidence source                                 | Population/design                                           | Reported or planned outcome                                                                 | Main limitation                                                                 |
|-------------------------------------------------|-------------------------------------------------------------|---------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------|
| Triphala systematic review, 2021                | 12 RCTs; 749 participants, largely adults                   | Five trials reported weight/BMI/waist reductions; six reported lipid improvements           | Heterogeneous products and populations; not pediatric efficacy evidence         |
| Proprietary plant formulation RCT, 2015         | 130 adolescents; 3 months; placebo controlled               | BMI difference about -1.4 kg/m <sup>2</sup> with favourable lipid, adipokine and BP changes | Short duration; product transparency and growth outcomes require strengthening  |
| Navaka Guggulu vs Vachaharidradi protocol, 2025 | Children aged 10-16 years; randomised double-blind protocol | Designed to compare two medicines with diet and Sun Salutation co-interventions             | Protocol, not definitive evidence; co-interventions complicate attribution      |
| Agnimanthadi compound study, 2013               | Small adult clinical study with supportive Vashpa Svedana   | Reported changes in obesity-related clinical and anthropometric measures                    | Adult, multimodal evidence; cannot establish pediatric dose, efficacy or safety |

### SAFETY DYNAMICS, QUALITY CONTROL AND PHARMACOVIGILANCE

"Natural" does not mean intrinsically safe, and pediatric risk is shaped by the finished product as much as by the named herb. Herbal safety assessment must consider botanical misidentification, substitution, dose variability, microbial or fungal contamination, pesticides, residual solvents, undeclared pharmaceuticals, toxic elements, gastrointestinal intolerance and herb-drug interactions. Children require additional caution because developmental pharmacology, growth and puberty may alter both exposure and consequences. WHO guidance recommends integrating herbal medicines into pharmacovigilance systems, documenting complete product details, assessing causality and reporting suspected adverse reactions. In practice, clinicians should record the full ingredient list, manufacturer, batch, expiry, dosage form, source and available analytical certificate, and should stop and investigate a suspected product when clinically significant symptoms or laboratory abnormalities develop.<sup>9</sup>

**Table 4. Minimum safety framework for pediatric use of an Ayurvedic medicine**

| Stage                | Required action                                                                                                                                                                                                         |
|----------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Before prescribing   | Confirm obesity diagnosis and severity; screen secondary causes, medications and comorbidities; document all herbs/supplements; assess growth, puberty, diet and eating-disorder risk.                                  |
| Product verification | Prefer a licensed, plant-only, single or simple formulation; record botanical identity, complete ingredients, manufacturer, batch and expiry; seek testing for microbes, heavy metals, pesticides and marker compounds. |

| Stage                            | Required action                                                                                                                                                                                                                                                                 |
|----------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Avoid or use exceptional caution | Unlabelled slimming products, strong purgatives, dehydration-producing procedures, stimulant-like ingredients, complex herbo-mineral products, duplicate formulations and unsupervised internet purchases.                                                                      |
| Monitoring                       | Track height velocity, weight trajectory, waist, blood pressure, bowel symptoms, appetite, sleep, mood, school function and adherence; monitor glucose, lipids, liver or renal indices when clinically indicated.                                                               |
| Adverse-event action             | Stop the suspected product and assess promptly for persistent vomiting/diarrhoea, rash, jaundice, dark urine, bleeding, neurological symptoms or severe abdominal pain; preserve the pack and report through the applicable institutional or national pharmacovigilance system. |

## CLINICAL INTEGRATION AND RESEARCH PRIORITIES

A defensible integrative model places evidence-based family treatment first and uses Ayurveda, when chosen, as a transparent adjunct rather than an alternative to diagnosis or standard care. The therapeutic target should be improved health trajectory, not rapid cosmetic weight loss. Contemporary pediatric guidance emphasizes intensive health-behaviour treatment and permits anti-obesity medication or metabolic surgery only for appropriately selected patients; Ayurvedic products should not displace these pathways. Future trials should use age- and sex-appropriate obesity metrics, stratify by pubertal stage, preregister protocols, publish complete formulations and analytical fingerprints, measure adherence and co-interventions, and include sufficiently long follow-up for growth, metabolic and safety outcomes.<sup>10</sup>

## DISCUSSION

This review identifies a clear mismatch between the breadth of Ayurvedic anti-obesity claims and the narrowness of pediatric evidence. Traditional reasoning is coherent within Ayurveda and emphasizes food, activity, sleep and individualized treatment, but completed pharmacotherapy studies remain dominated by adults, small samples, heterogeneous preparations and short follow-up. A recent double-blind protocol comparing *Navaka Guggulu* with *Vachaharidradi Gana Vati* in children aged 10-16 years is valuable because it attempts direct pediatric evaluation, yet a protocol is not efficacy evidence and multimodal co-interventions will require cautious attribution. Until completed trials report standardized products, age-appropriate outcomes, growth and pubertal data, any pediatric benefit claim remains provisional.<sup>11</sup>

Mechanistic evidence is broader than clinical evidence. In 3T3-L1 preadipocytes, aqueous Triphala reduced intracellular lipid accumulation and downregulated PPAR-gamma, C/EBP-alpha, GLUT4 and fatty-acid synthase, supporting an anti-adipogenic hypothesis. However, an in-vitro concentration is not equivalent to oral exposure in a child, and changes in cultured cells do not establish weight reduction, cardiometabolic benefit or long-term safety. Translational credibility will improve when clinical batches are chemically characterized, pharmacokinetics are measured, dose-response relationships are defined and mechanistic biomarkers are selected prospectively.<sup>12</sup>

Safety is the decisive issue for children. Growth and neurodevelopment create vulnerabilities absent from many adult studies, while polypharmacy may arise when obesity coexists with diabetes, dyslipidaemia, hypertension, fatty-liver disease, attention disorders or asthma. Spontaneous hospital reporting has demonstrated that Ayurvedic and other complementary medicines can be associated with clinically important adverse reactions, while under-reporting limits reliable incidence estimates. Consequently, quality assurance and pharmacovigilance are necessary conditions for responsible practice: treatment should be conservative, supervised, fully documented and discontinued when observed or plausible risk exceeds expected benefit.<sup>13</sup>

## CONCLUSION

Ayurvedic pharmacotherapy for pediatric obesity has plausible traditional and molecular foundations but insufficient clinical validation. Current evidence includes a Triphala review of 12 randomized studies with 749 largely adult participants, one three-month trial in 130 adolescents reporting an approximate -1.4 kg/m<sup>2</sup> BMI difference, and a recent pediatric comparative protocol without definitive outcome data. These values justify research, not routine claims of efficacy. A safe integrative approach must retain family-based nutrition, activity, sleep and behavioural care as the foundation; protect height velocity and puberty; use licensed, analytically verified products; avoid aggressive or unlabelled therapies; screen herb-drug interactions; and report adverse events.

Well-powered, preregistered pediatric trials with standardized formulations, dose-finding, body-composition and metabolic outcomes, growth monitoring and long-term pharmacovigilance are required before specific Ayurvedic medicines can be recommended as evidence-based anti-obesity treatment for children.

## REFERENCES

1. World Health Organization. Obesity and overweight [Internet]. Geneva: World Health Organization; 2025 Dec 8 [cited 2026 Sep 4].
2. Khadilkar V, Shah N, Harish R, Ayyavoo A, Bang A, Basu S, et al. Indian Academy of Pediatrics revised guidelines on evaluation, prevention and management of childhood obesity. *Indian Pediatr.* 2023;60(12):1013-1031. doi:10.1007/s13312-023-3066-z.
3. Agnivesha. Charaka Samhita, revised by Charaka and Dridhabala, with Ayurveda-Dipika commentary of Chakrapanidatta. Acharya YT, editor. Varanasi: Chaukhambha Surbharati Prakashan; 2011. Sutrasthana 21.
4. Green BN, Johnson CD, Adams A. Writing narrative literature reviews for peer-reviewed journals: secrets of the trade. *J Chiropr Med.* 2006;5(3):101-117. doi:10.1016/S0899-3467(07)60142-6.
5. Goyal R, Goyal M, Chandola HM. A clinical study on the role of Agnimanthadi compound and Vashpa Svedana in the management of Sthaulya (obesity). *Ayu.* 2013;34(4):390-396. doi:10.4103/0974-8520.127721.
6. Phimarn W, Sungthong B, Itabe H. Effects of Triphala on lipid and glucose profiles and anthropometric parameters: a systematic review. *J Evid Based Integr Med.* 2021;26:2515690X211011038. doi:10.1177/2515690X211011038.
7. Inpan R, Sakuludomkan C, Na Takuathung M, Koonrunsesomboon N. Network pharmacology revealing the therapeutic potential of bioactive components of Triphala and their molecular mechanisms against obesity. *Int J Mol Sci.* 2024;25(19):10755. doi:10.3390/ijms251910755.
8. Shivakumar S, Ilango K, Dubey GP, Subhasree N, Agrawal A. Evaluation of plant based formulation on adolescent obesity and its associated bio-markers: a randomized, double blind, placebo controlled study. *Complement Ther Med.* 2015;23(2):157-164. doi:10.1016/j.ctim.2015.01.012.
9. World Health Organization. WHO guidelines on safety monitoring of herbal medicines in pharmacovigilance systems. Geneva: World Health Organization; 2004.
10. Hampl SE, Hassink SG, Skinner AC, Armstrong SC, Barlow SE, Bolling CF, et al. Clinical practice guideline for the evaluation and treatment of children and adolescents with obesity. *Pediatrics.* 2023;151(2):e2022060640. doi:10.1542/peds.2022-060640.
11. Fadnavis KK, Rath RB, Ratnaparkhi KS, Rath BJ, Deshmukh PR. Evaluation of the comparative efficacy of Navak Guggulu versus Vachaharidradi Gana Vati in the management of Sthaulya (overweight) in children: protocol for a randomized controlled trial. *JMIR Res Protoc.* 2025;14:e58838. doi:10.2196/58838.
12. Banjare J, Raina P, Mansara P, Ghanekar RK, Bhalerao S. Triphala regulates adipogenesis through modulation of expression of adipogenic genes in 3T3-L1 cell line. *Pharmacogn Mag.* 2018;13(Suppl 4):S834-S839. doi:10.4103/pm.pm\_153\_17.
13. Jose J, Rao PGM, Kamath MS, Jimmy B. Drug safety reports on complementary and alternative medicines (Ayurvedic and homeopathic medicines) by a spontaneous reporting program in a tertiary care hospital. *J Altern Complement Med.* 2009;15(7):793-797. doi:10.1089/acm.2008.0128.

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