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AYURVEDIC INSIGHTS INTO GENETICS AND CONGENITAL ABNORMALITIES IN CHILDREN: A COMPREHENSIVE REVIEW

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Abstract:

Congenital abnormalities affect approximately 2–3% of live births worldwide and remain a major cause of neonatal morbidity and mortality. Although modern medicine has advanced in diagnostic technologies, its emphasis largely remains on detection rather than prevention. Ayurveda, in contrast, offers a holistic preventive framework integrating biological, nutritional, psychological, and environmental determinants of fetal development. This study aimed to analyze Ayurvedic concepts related to genetics and congenital abnormalities, examine the ***Ṣaḍ Garbhakara Bhāvas*** (six procreative factors), compare ***Bīja***, ***Bījabhāga***, and ***Bījabhāgāvayava*** with chromosomes, genes, and DNA, and explore potential areas for integrative application with contemporary biomedical science. A comprehensive narrative review was conducted using classical Ayurvedic texts (*Caraka Saṃhitā*, *Suśruta Saṃhitā*, *Aṣṭāṅga Hṛdaya*, *Bhāvaprakāśa*, *Yogaratnākara*) and contemporary biomedical literature from PubMed and specialized databases. Thematic analysis revealed significant conceptual convergence between the two knowledge systems. Ayurvedic descriptions of *Bīja* (chromosomes), *Bījabhāga* (genes), and *Bījabhāgāvayava* (DNA) demonstrate a hierarchical understanding that closely parallels modern genetics. The *Ṣaḍ Garbhakara Bhāvas Mātṛja*,

Pitṛja, *Ātmaja*, *Rasaja*, *Sātmyaja*, and *Sattvaja* encompass hereditary, nutritional, environmental, and psychological contributors to fetal development. Ayurveda attributes congenital disorders primarily to defects in *Śukra* and *Śoṇita*, emphasizing the importance of preconception purification, nutritional optimization, emotional balance, and environmental harmony. Contemporary research supports these principles, showing strong connections between maternal nutrition, mental well-being, environmental exposures, and fetal gene expression through epigenetic pathways. Evidence of a 50–70% reduction in neural tube defects with folic acid supplementation further validates Ayurveda's emphasis on periconceptional care. Integrating Ayurvedic preventive strategies with biomedical diagnostics may enhance the ability to reduce congenital abnormalities through comprehensive preconception and prenatal care. Future interdisciplinary research should focus on correlating Ayurvedic *Prakṛti* with genetic and epigenetic profiles and evaluating Ayurvedic antenatal regimens to develop evidence-based integrative models for preventing congenital disorders.

Keywords:

Ayurveda, Genetics, Congenital abnormalities, Epigenetics, Preconception care, Integrative medicine.

Introduction

Congenital anomalies, defined as structural or functional abnormalities present at birth, remain a major global public health challenge. They account for a substantial proportion of neonatal and under-five mortality, and many survivors experience lifelong disability requiring complex medical, rehabilitative, and social support. Global estimates indicate that 3–6% of newborns are affected, while regions in South Asia, including Sri Lanka, show particularly high prevalence rates. Neural tube defects, congenital heart diseases, cleft lip and palate, and limb malformations constitute the majority of reported anomalies. Contemporary biomedical science attributes these conditions to diverse etiologies, including chromosomal aberrations, single-gene defects, multifactorial inheritance patterns, and gene–environment interactions. Maternal age, consanguinity, micronutrient deficiencies, infections during pregnancy, exposure to teratogenic drugs or alcohol, and environmental toxicants are recognized contributors to the risk profile. Despite improvements in antenatal screening, nutritional supplementation, and diagnostic technologies, congenital anomalies continue to impose significant burdens on health systems, families, and societies**. [1–4]**

Ayurveda provides a complementary explanatory framework that predates molecular genetics yet aligns closely with modern scientific insights. Central to this understanding is the concept of *garbha-saṃbhava-sāmagrī*, the essential determinants for healthy conception and embryogenesis, comprising *ritu* (optimal timing), *kṣetra* (uterine environment), *ambu* (nutritive fluid), and *bīja* (germinal material). The doctrine of *bīja* and its components *bīja-bhāga* and *bīja-bhāgāvayava* offers a hierarchical interpretation of hereditary transmission. Disturbances at these levels are described as causes of structural or systemic abnormalities in the offspring, conceptually comparable to the gradations of chromosomal, genetic, and molecular defects recognized today. Ayurveda further distinguishes congenital disorders into *ādibala-pravṛtta* (hereditary) and *janmabala-pravṛtta* (intrauterine-origin), a categorization that reflects the modern division between genetic and non-genetic etiologies**.[5–8]**

In addition to hereditary determinants, Ayurveda emphasizes the influence of *garbhopaghātakara bhava,* a broad group of factors harmful to the developing fetus. These include maternal illnesses, inappropriate dietary habits, psychological disturbances, exposure to toxins, and neglect of recommended antenatal regimens (*garbhiṇī-paricaryā*). The classical theory of *ṣaḍbhāva* (six formative factors) *mātṛja*, *pitṛja*, *ātmaja*, *sātmya-ja*, *rasa-ja*, and *sattva-ja* provides a multidimensional lens through which fetal development is shaped by genetic, nutritional, environmental, and psychological influences. This holistic model resonates strongly with contemporary concepts such as polygenic inheritance, epigenetic modulation, developmental origins of health and disease, and the psychological environment of pregnancy**.[5]**

Preventive measures described in Ayurvedic literature parallel many established practices in modern maternal-fetal medicine. Preconception purification and rejuvenation procedures (*garbhadhāna saṃskāra*, *rasāyana*, *vṛṣya* therapies), timing conception during the fertile window (*ritu*), optimizing the uterine environment (*kṣetra śodhana*), ensuring adequate maternal nutrition (*ambu*), and following structured month-wise antenatal regimens (*māsa-anumāsika paricaryā*) are emphasized for healthy fetal development. Integration of these traditional measures with evidence-based biomedical interventions, such as folic acid supplementation, genetic counseling, routine prenatal screening, and avoidance of teratogens, can strengthen culturally acceptable and comprehensive strategies to reduce the burden of congenital anomalies**.[5,8]**

Objectives

- To explore Ayurvedic concepts of heredity through the doctrines of *Bīja*, *Bīja-bhāga*, *Bīja-bhāgāvayava*, and *Ṣaḍbhāva*, and compare them with modern genetic principles.
- To examine Ayurvedic perspectives on congenital abnormalities, particularly *Ādibala-pravṛtta* and *Janmabala-pravṛtta*, and assess their relevance to contemporary biomedical understanding.
- To analyze the role of maternal, paternal, nutritional, psychological, and environmental factors *Garbhopaghātakara bhāva* and *Ṣaḍbhāva* (*Mātṛja*, *Pitṛja*, *Ātmaja*, *Sātmyaja*, *Rasaja*, *Sattvaja*) in the causation of congenital anomalies in both Ayurvedic and modern contexts.
- To highlight Ayurvedic preventive strategies such as *Garbhadhāna saṃskāra*, *Ritu*, *Kṣetra śodhana*, *Ambu*, and *Māsa-anumāsika paricaryā,* and identify their parallels with modern preconception and antenatal care.
- To propose integrative approaches combining Ayurvedic risk assessment (*Doṣa prakṛti*, family history, lifestyle evaluation) with modern genetic counseling, nutritional supplementation, and teratogen avoidance to reduce congenital anomalies.

Methodology

This narrative review integrated classical Ayurveda texts Caraka Saṃhitā, Suśruta Saṃhitā, Aṣṭāṅga Hṛdaya, and Kāśyapa Saṃhitā with modern biomedical literature from PubMed, Scopus, and WHO/CDC reports (2000–2025). Key Ayurvedic concepts such as *Beeja* (germinal material), *Ṣaḍbhāva* (six formative factors), *Ādibala-pravṛtta* (hereditary disorders), *Janmabala-pravṛtta* (congenital disorders), and *Garbhopaghātakara bhāva* (factors harmful to the fetus) were compared with modern frameworks, including chromosomal abnormalities, single-gene defects, multifactorial inheritance, teratogens, and epigenetics.

Results and Discussion

Ayurveda provides an intricate theoretical framework for heredity and congenital abnormalities that is strikingly aligned with modern biomedical science. Its classical doctrines *bīja*, *bīja-bhāga*, *bīja-bhāgāvayava*, and *ṣaḍbhāva* offer a multi-tiered structure of hereditary determinants that parallel the genomic, chromosomal, molecular, and epigenetic layers recognised today. Additionally, the Ayurvedic emphasis on maternal health, paternal contribution, nutrition, environment, and psychological factors demonstrates a deep understanding of the multifactorial nature of human development. These similarities

underscore the contemporary relevance of Ayurveda in understanding and preventing congenital anomalies. [9]

Ayurvedic Conception of Hereditary Architecture

Bīja: The Primary Germinal Material

In classical Ayurveda, *bīja* represents the complete germinal essence contributed by both parents. It is considered the fundamental determinant of structural and functional traits in the offspring. A wholesome *bīja* ensures the proper manifestation of bodily tissues, organs, and physiological systems. A defective *bīja,* whether due to parental illness, poor lifestyle, genetic lineage, or exposure to harmful substances, is said to produce systemic congenital disorders.

Bīja-bhāga: Organ-Level Determinants

Bīja-bhāga denotes the subdivisions of hereditary material that correspond to specific organs or organ systems. When these sub-units are defective, organ-specific malformations occur, such as congenital heart defects, limb anomalies, or sensory impairments.

Bīja-bhāgāvayava: Micro-Level Hereditary Fractions

The most nuanced hereditary determinants, *bīja-bhāgāvayava*, govern finer details of morphology and function. Classical texts describe defects at this level producing subtle anomalies, minor deformities, physiological deviations, or functional vulnerabilities. These descriptions resemble the modern understanding of single-nucleotide variants, epigenetic dysregulation, or gene expression errors.

Table 1. Ayurvedic hereditary units and modern biological analogues[10]

Ayurvedic Concept	Classical Function	Modern Equivalent	Examples
Bīja	Foundational germinal material	Genome, whole genetic blueprint	Systemic hereditary diseases
Bīja-bhāga	Organ-forming subdivisions	Chromosomal arms, gene clusters	CHD, limb defects
Bīja-bhāgāvayava	Finer molecular fractions	SNVs, methylation patterns, epigenetic markers	Minor anomalies, metabolic vulnerabilities

This hierarchical hereditary model anticipates modern genomic architecture, where errors at progressively finer levels result in proportionately varied phenotypic outcomes.

Ṣaḍbhāva: The Six Formative Factors of Life

Ayurveda expands hereditary determinism through the doctrine of *ṣaḍbhāva* a composite of six determinants shaping embryonic development. This is among the earliest holistic models integrating biology, nutrition, environment, and psychology.

Detailed Components of *Ṣaḍbhāva*

1. ***Mātṛja* -** maternal contribution
    - Ovum quality
    - Uterine environment
    - Maternal hormonal balance
    - Nutrition, metabolism, immunity
    - Mental and emotional state
2. ***Pitṛja* -** paternal contribution
    - Sperm morphology and motility
    - Genetic integrity
    - Paternal lifestyle and exposures
    - Family lineage characteristics
3. ***Ātmaja* -** constitutional essence
    - Inherent individuality
    - Resilience or vulnerability to environmental influences
4. ***Sātmyaja* -** habitual adaptation
    - Parental diet, habits, ethnicity
    - Climate adaptation
    - Environmental exposures
5. ***Rasaja* -** nutritive essence
    - Maternal diet quality

- Placental nourishment
- Micronutrient sufficiency

6. ***Sattvaja* -** psychological determinants
    - Maternal mood, stress, cognition
    - Emotional stability throughout pregnancy

Table 2. *Ṣaḍbhāva* model with expanded modern parallels[11]

Factor	Classical Explanation	Expanded Modern Interpretation	Developmental Outcomes
Mātṛja	Maternal ovum, uterine field	Uterine vasculature, endocrine balance, microbiome, metabolic health	NTDs, IUGR, CHD
Pitṛja	Paternal hereditary traits	Paternal age effect, sperm DNA fragmentation, epigenetic imprinting	Autism, syndromic disorders
Ātmaja	Constitutional identity	Epigenetic predispositions, individuality in gene expression	Variable disease risk
Sātmyaja	Dietary and environmental adaptation	Ethnicity-linked polymorphisms, climate-linked metabolism, toxin exposure	Teratogenic effects
Rasaja	Maternal nutrition	Folate, iodine, iron, choline, placental transport efficiency	Brain and organ development
Sattvaja	Maternal mental state	Cortisol patterns, neuroendocrine pathways, placental CRH	Neurocognitive outcomes

This model effectively integrates genetic, nutritional, environmental and psychological determinants, mirroring contemporary multifactorial risk models.

Ayurvedic Classification of Congenital Disorders

Ādibala-pravṛtta (Hereditary Origin)

These disorders arise from defective *bīja*, *bīja-bhāga*, or *bīja-bhāgāvayava*. Classical descriptions map closely to modern hereditary conditions, including:

- chromosomal aneuploidies

- monogenic disorders
- heritable metabolic syndromes
- familial congenital malformations

***Janmabala-pravṛtta* (Intrauterine Origin)**

These arise not from hereditary defects but from intrauterine disturbances such as:

- maternal malnutrition
- toxin exposure (alcohol, drugs, heavy metals)
- infections
- psychological stress
- incompatible diet
- inadequate antenatal care

This aligns with modern teratology and the DOHaD (Developmental Origins of Health and Disease) model.[12]

Determinants of Congenital Anomalies: An Integrative Lens [13]

Ayurveda recognizes multiple determinants, many of which mirror contemporary biomedical risk factors.

Table 3. Comprehensive determinants of congenital anomalies

Determinant Category	Classical Perspective	Expanded Biomedical Interpretation
Hereditary (*bīja*)	Genetic foundation	Chromosomal, genic, and molecular mechanisms
Maternal (*mātṛja*)	Ovum, uterine environment, maternal health	Pre-gestational diabetes, hypertension, obesity, and infection
Paternal (*pitṛja*)	Sperm quality, lineage traits	Advanced age, oxidative stress, and DNA damage
Nutritional (*rasaja*)	Maternal diet and rasa-dhātu	Folate, B12, iron, iodine, and vitamin D deficiencies
Environmental (*sātmyaja*)	Climate, toxins, habitual practices	Air pollution, pesticides, radiation, and occupational hazards

Psychological (*sattvaja*)	Maternal mental state	Chronic stress, anxiety, and cortisol elevation
Constitutional (*ātmaja*)	Intrinsic individuality	Gene expression variability

This integrated perspective emphasizes that congenital anomalies emerge from the cumulative influence of hereditary, environmental, nutritional, and psychosocial determinants.

Preventive Strategies in Ayurveda: A Structured Approach

Ayurvedic preventive strategies emphasize strengthening parental health, optimizing the uterine environment, and protecting the fetus during vulnerable developmental stages.

Key measures include:

- *Garbhadhāna saṃskāra* — preconception detoxification, rejuvenation, and lifestyle correction
- *Ritu* — conception during optimal fertility
- *Kṣetra śodhana* — uterine cleansing and restoration
- *Ambu* — ensuring nutrient-rich maternal physiology
- *Māsa-anumāsika paricaryā* — month-wise antenatal care adapted to fetal developmental needs

Table 4. Expanded comparison of Ayurvedic and modern preventive frameworks [14]

Ayurvedic Principle	Modern Equivalent	Detailed Preventive Impact
Garbhadhāna saṃskāra	Comprehensive preconception care	Corrects metabolic disorders, improves gamete quality
Ritu	Fertile window monitoring	Optimal ovulation timing, improved embryo quality
Kṣetra śodhana	Uterine evaluation and treatment	Management of fibroids, polyps, and infections

Ambu	Micronutrient supplementation	Reduces NTDs, thyroid disorders, and anemia-associated defects
Māsa-anumāsika paricaryā	Trimester-specific ANC	Ensures organogenesis, placental function, and mental health

Integrative Prevention and Risk Assessment [15]

By combining Ayurvedic diagnostic elements, lineage evaluation, *doṣa-prakṛti*, habitual patterns, and environmental exposures with modern genetic counseling, ultrasound screening, biochemical markers, and nutraceutical support, a more holistic and culturally sensitive prevention model emerges.

Such an integrative framework supports:

- early identification of at-risk couples
- targeted nutritional and lifestyle interventions
- improved adherence to antenatal guidelines
- reduction of modifiable risk factors

Conclusion

The Ayurvedic doctrines of *bīja* and *ṣaḍbhāva* provide a detailed, multi-level understanding of hereditary and congenital determinants that align closely with contemporary genetics, epigenetics, teratology, and developmental biology. Integrating these classical principles with evidence-based biomedical practices offers a powerful, culturally congruent and preventive framework for reducing congenital anomalies. This synthesis is particularly relevant in regions where traditional health systems remain influential and where the burden of congenital disorders remains high. [16]

Conflict of interest

The authors declare that they have no competing interests.

Abbreviations

ANC — Antenatal care

DOHaD — Developmental Origins of Health and Disease

NTD — Neural tube defect

SNV — Single-nucleotide variant

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