

# *Prakriti* and its associations with metabolism, chronic diseases, and genotypes: Possibilities of new born screening and a lifetime of personalized prevention

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## ABSTRACT

Ayurveda is one of the oldest health sciences of the world with concepts of *tridosha* and *prakriti* being core philosophies. These core concepts allow implementation of ways for not only personalized medicine and treatment but also personalized prevention. In the light of modern or current science, evidence has surfaced connecting the concepts of *tridosha* and *prakriti* with metabolic pathways, chronic diseases, and various genotypes. Such evidence has thrown up insights about the universality of Ayurvedic concepts as well as their apparent association with concepts in current science. This review was undertaken to consolidate the evidence of such associations which exist between *prakriti* and metabolic systems, chronic diseases, and genotypes with the objective that a case can be made for drawing out the clear linkages that might exist for *prakritis* being distinct phenotypes representing certain genotypes. A corollary to such discoveries can be the possibility of newborns being screened for their *prakriti* by genetic testing, which will enable the prevention of various chronic diseases for such children via the implementation of various dietary, lifestyle, and habitual changes, as required, from an early age. This implementation of preventive practices from an early age may result in such children leading healthy, disease-free, more productive lives. Thus, eventually, this can be an opportunity to practice personalized preventive health, which is not a possibility in other systems of medicine especially western systems of medicine. Personalized preventive health is one step further than personalized medicine and is a very novel idea with far-reaching implications.

**Key words:** Ayurgenomics, newborn screening, personalized prevention, *prakriti*, *Tridosha*

## INTRODUCTION

Ayurveda is the ancient medical science prevalent for thousands of years in the Indian subcontinent. One of the key fundamental theories of Ayurveda involves

a system of understanding health and disease known as the *tridosha*.<sup>[1]</sup> This concept of *tridosha* involving the three *doshas* of *vata*, *pitta*, and *kapha* is a central doctrine of Ayurveda and follows from the first chapter of the earliest text on Ayurveda, the *Charaka Sambhita*.<sup>[2]</sup> The ancient texts of Ayurveda mention numerous properties of *doshas* and how they affect a human being's physiology or *prakriti* based on the dominance of one or more *doshas*. The *prakriti* of a person is quite capable of providing a fair indication of physiological strengths and weaknesses, mental tendencies, and susceptibility to illnesses of various types [Table 1].<sup>[1]</sup> There exist a number of tools, mainly questionnaires, for ascertaining the *prakriti* of an individual and there have been ongoing attempts of validating such a tool since the 1980s such as investigation into such tools done by Joshi<sup>[3]</sup> and Rastogi.<sup>[4]</sup> At the moment, questionnaires for determining one's *dosha* exist online as well and can be readily used by people to determine their own *prakriti*.<sup>[5]</sup> There also exists the age-old

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method of *nadi vigyan* or pulse diagnosis, through which a skilled Ayurvedic physician can determine *prakriti* among other things.<sup>[6]</sup> However, no literature suggests the presence of standardized techniques for *nadi vigyan* or for the need to standardize it.

In addition to attempts at validating a tool to ascertain *prakriti*, there have also been numerous ongoing attempts at understanding Ayurvedic principles and validating Ayurvedic theories in the light of modern science.<sup>[7]</sup> Of late links have been forwarded about the association of the *tridosha* theory with living systems of all organisms, biological functions in cells and organisms, and genetics.<sup>[7]</sup> The most recent understanding of Ayurvedic *tridosha* theory is related to the fact that *doshas* are concerned with organism regulations involving input/output, turnover, and storage.<sup>[8]</sup> According to this understanding, *doshas* are biologically universal mechanisms regulating functions identified as fundamental by systems theory: input and output (*vata*), throughput or turnover (*pitta*), and storage (*kapha*). As such it has been extrapolated that *doshas* are fundamental to all living systems and organisms and even single cells.<sup>[9]</sup> Thus, of late, there is emerging a full theory in terms of all modern sciences which can be subjected to empirical testing and we await further research that can take the understanding of Ayurveda forward in terms of modern science.

One such area with respect to modern science in which some evidence is being generated is now known as

Ayugenomics.<sup>[10]</sup> The basic concept behind Ayugenomics is the fact that if the system of *tridosha* is prevalent in all organisms then there must be ways in which it is inherited. Stated simply, *prakriti* must be a phenotypic phenomenon arising from a particular genotype. The *doshas* represent different aspect of regulation within an organism and such regulation is a result of metabolic pathways involving multiple enzymes.<sup>[11]</sup> Thus, if protein enzymes are inherited then so are metabolic pathways comprising of multiple enzymes.<sup>[11]</sup> Although there are enormous difficulties in understanding the pattern of inheritance of enzymes involved in complex metabolic pathways, some headway has been made in identifying metabolic pathways of certain diseases as well as certain genes related to *prakriti* types.<sup>[11]</sup>

Since *prakriti* is related to certain physical and mental tendencies that determine susceptibility to diseases, the ancient texts of Ayurveda also provide guidelines for maintaining lifestyles in accordance with one's *prakriti* for continued healthy living in a personalized manner.<sup>[11]</sup> Although numerous publications exist in all the above mentioned topics, on assessing the present literature we felt the need for synthesizing the current state of evidence regarding Ayurvedic *prakriti*, its relation to metabolism, chronic disease, and genotypes, and the future direction. In this review we have attempted to collate evidence with regards to the relation of *prakriti* with metabolism, chronic disease and genotypes known so far. We also take this knowledge further to predict a future where it will be possible to screen newborns using their genotype

**Table 1: Characteristic features of the three extreme *prakriti* types: *Vata*, *pitta*, and *kapha* and their susceptibility to diseases**

Features	<i>Vata</i>	<i>Pitta</i>	<i>Kapha</i>
Body frame	Thin	Medium	Broad
Body build and musculature	Weakly developed	Moderate	Well-developed
Skin	Dry and cracked	Soft, thin, with tendency for moles, acne and freckles	Smooth and firm, clear complexion
Hair	Dry, thin, prone to breaks	Thin, oily, early greying	Thick, smooth, and firm
Weight gain	Recalcitrant	Fluctuating	Tendency to obesity
Food and bowel habits	Frequent, variable, and irregular	Higher capacity for food and water consumption	Low digestive capacity and stable food habits
Movements and physical activities	Excessive and brisk	Moderate	Less mobile and slow
Tolerance for seasonal weather	Cold intolerant	Heat intolerant	Tolerant to both heat and cold
Disease resistance and healing capacity	Poor	Good	Excellent
Metabolism of toxic substances	Moderate	Quick	Poor
Communication	Talkative	Sharp, incisive communication with analytical abilities	Less vocal with good communication skills
Initiation capabilities	Quick, responsive, and enthusiastic	Moderate, upon conviction and understanding	Slow to initiate new things
Memory	Quick at grasping but poor retention	Moderate grasping and retention	Slow grasping but good retention
Ageing	Fast	Moderate	Slow
Disease predisposition/poor prognosis	Developmental, neurological, dementia, movement and speech disorders, arrhythmias	Ulcer, bleeding disorders, skin diseases	Obesity, diabetes, atherosclerotic conditions

and thus determine their *prakriti*, which can then help us decide the type of most healthy and suitable lifestyle for such newborns to lead a disease free and productive life. This will be a novel step towards personalized preventive medicine for humans.

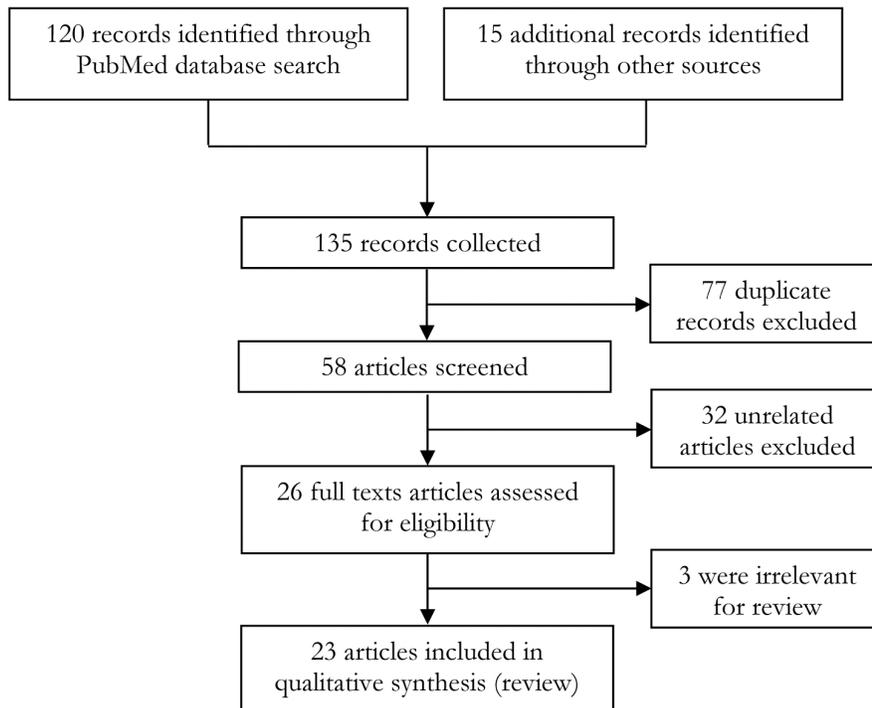
## MATERIALS AND METHODS

A search was undertaken in MEDLINE (www.pubmed.com) or the PubMed database, using keywords like *prakriti*, *dosha*, *prakriti* genotypes, *prakriti* chronic disease, *prakriti* metabolism, *prakriti* personalized medicine, Ayurveda *prakriti*, Ayurveda *dosha*, Ayurveda *prakriti* genotypes, Ayurveda *prakriti* chronic disease, Ayurveda *prakriti* metabolism, and Ayurveda *prakriti* personalized medicine with their corresponding mesh terms in combination like OR, AND. The following are the process and eligibility criteria for the inclusion of articles in this review: The search was limited to only English literature including those studies which were published from 1980 to 2013. This search yielded a total of 120 articles from the PubMed source and 15 articles from other sources such as Google Scholar, OVID, MEDSCAPE, CABI, BMC, and Science Direct [Figure 1]. Fifty-eight articles were selected after removing all the duplicates. After screening all these articles, 26 articles were included as other 32 articles were unrelated to the topic concerned. Out of these 26 articles, three more

articles were excluded as these did not have the relevant information related to our review objectives. A total of 23 articles fulfilled the inclusion criteria [Table 2]. This search was undertaken in February, 2013.

### *Prakriti* and metabolism

We discovered a total of seven articles related to *prakriti* and metabolism in our review (Articles 1, 10, 12, 15, 16, 17, and 21) [Table 2]. *Prakriti* literally meaning constitution or nature, and consists of the *tridoshas* (*vata*, *pitta*, and *kapha*).<sup>[11]</sup> The three striking constitutions of *prakriti* (*vata*, *pitta*, and *kapha*) present a set of metabolic tendencies which help in determining the reaction of body and mind when confronted by a stimulus. Each *dosha* has its distinct properties and functions which are universal to living systems and are present in all organisms.<sup>[12]</sup> In Ayurveda, the three *doshas* are understood to have their regions within the body where they predominate; *vata* below the navel, *pitta* between the clavicle and navel, and *kapha* above the clavicle.<sup>[11]</sup> Generally there is a natural predominance of one or more *doshas* in an individual. In human body, functions like cell division, movement, and excretion of wastes are mainly governed by *vata prakriti*; while anabolism, growth, maintenance of structure, storage, and stability are contributed by *kapha*; and *pitta* is primarily responsible for metabolism, thermal regulation, and homeostasis.<sup>[12]</sup> Each *prakriti* has specific physical, physiological, and psychological attributes (*gunas*) which



**Figure 1:** Flow of information in terms of number of articles through different phases of literature search for this review

**Table 2: Detailed list of articles used for this review**

S. No	Author(s)	Article title	Reference	Findings
1	Mahalle NP, Kulkarni MV, Pendse NM, Naik SS	Association of constitutional type of Ayurveda with cardiovascular risk factors, inflammatory markers and insulin resistance	Journal of Ayurveda and Integrated Medicine 2012;3 (3):150-7	There is strong relation of risk factors (diabetes, hypertension, and dyslipidemia), insulin resistance and inflammatory markers with <i>vata kapha</i> and <i>kapha prakriti</i>
2	Nayak J	Ayurveda research: Ontological challenges	Journal of Ayurveda and Integrated Medicine 2012;3 (1):17-20	For a collaborative research to occur at required levels, a mutually acceptable vocabulary should be developed between Ayurveda, modern biomedical, as well as other sciences belonging to different ontology
3	Rizzo-Sierra CV	Ayurvedic genomics, constitutional psychology, and endocrinology: The missing connection	Journal of Alternative and Complementary Medicine 2011;17 (5):465-8	Three basic extreme genopsyo - somatotypes or birth constitutions ( <i>pitta, kapha, vata</i> ) have different nuclear receptors which are expected to regulate the expression of specific genes, thereby controlling embryonic development, adult homeostasis, and metabolism of the human organism in a very profound way
4	Patwardhan B, Bodecker G	Ayurvedic genomics: Establishing a genetic basis for mind-body typologies	Journal of Alternative and Complementary Medicine 2008;14 (5):571-6	The findings suggest a commonality exist between Asia's medical traditions in their diagnostic typologies and genetic basis for medicines theory of discrete and discernable groups of psycho-physiologic differences
5	Patwardhan B, Joshi K, Chopra A	Classification of Human population based on HLA Gene Polymorphism and the Concept of <i>Prakriti</i> in Ayurveda	Journal of Alternative and Complementary Medicine 2005;11:349-53	A significant correlation exist between HLA type and <i>prakriti</i> type indicating a genetic basis exist for the three major constitutions ( <i>vata, pitta, kapha</i> ) described in Ayurveda
6	Tripathi JS, Singh RH	Concept of deha <i>prakriti vis-à-vis</i> Human Constitution in Ayurveda	Ancient Science of Life 1994;13 (3-4):314-25	Deh <i>prakriti</i> is a psychosomatic constitution of an individual which genetically determines the pattern of susceptibility of an individual to different diseases, prognosis, course, and complications
7	Venkatraghavan S, Sundaresan TP, Rajagopalan V, Srinivasan K	Constitutional study of cancer patients – its prognosis and therapeutic scope	Ancient Science of Life 1987;7 (2):110-5	<i>Pitta</i> dominance is found in the <i>prakriti</i> pattern of cancer patients followed by <i>kapha</i> dominance
8	Tiwari S, Gehlot S, Tiwari SK, Singh G	Effect of walking (aerobic isotonic exercise) on physiological variants with special reference to <i>Prameha</i> (diabetes mellitus) as per <i>Prakriti</i>	AYU 2012;33 (1):44-9	Strong association is seen between <i>prakriti</i> , blood pressure, and biochemical parameters. Maximum number of cases belonged to <i>vata-pitta prakriti</i> and minimum number of cases belonged to <i>vata-kapha prakriti</i>
9	Aggarwal S, Negi S, Jha P, Singh PK, Stobdan T, Pasha MA <i>et al.</i> , Indian Genome Variation Consortium	EGLN1 involvement in high- altitude adaptation revealed through genetic analysis of extreme constitution types defined in Ayurveda	Proceedings of Natural Academy of Science USA 2010;107 (4):18961-6	The study shows that EGLN1 polymorphisms are associated with high-altitude adaptation and expressions and genetic analysis of healthy individuals phenotyped could uncover genetic variations that are associated with adaptation to external environment and susceptibility to diseases
10	Hankey A	Establishing the scientific Validity of Tridosha Part 1: Doshas, Subdoshas and Dosh <i>Prakritis</i>	Ancient science of Life 2010;29 (3):6-18	<i>Tridosha</i> is applied to every living organism and shows how individual differences in <i>prakriti</i> originate in fundamental systems functions shared by all forms of life and are implemented by genes responsible for relevant cellular functions ( <i>vata</i> -homeostasis, <i>pitta</i> -turnover, <i>kapha</i> -storage)
11	Juyal RC, Negi S, Wakhode P, Bhat S, Bhat B, Thelma BK	Potential of ayurgenomics approach in complex trait research: Leads from a pilot study on rheumatoid arthritis	PLOS One 2012;7 (9):e45752	This exploratory study supports that conditions associated studies on prior risk, predictable in Ayurveda, thereby validating the concepts of <i>prakriti</i> and personalized medicine in Ayurveda

continued...

**Table 2: Contd..**

S. No	Author(s)	Article title	Reference	Findings
12	Bhalerao S, Deshpande T, Thatte U	<i>Prakriti</i> (Ayurvedic concept of constitution) and variations in Platelet aggregation	BMC Complementary and Alternative Medicine 2012;12:248	Maximum platelet aggregation was highest among <i>vata-pitta prakriti</i> individuals and better responded to low dose of aspirin as compared to other <i>prakriti</i> types so indicating <i>prakriti</i> related variations in platelet aggregation response in healthy individuals
13	Chatterjee B, Pancholi J	<i>Prakriti</i> -based medicine: A step towards personalized medicine	AYU 2011;32 (2):141-6	The Golden Triangle of Ayurveda, modern science, and modern medicine can pave the path to personalized medicine and offer remedies to challenging health issues
14	Purva MC, Meena MS	A review on role of <i>Prakriti</i> in aging	AYU 2011;32 (1):20-4	Aging and <i>prakriti</i> are closely related to each other. <i>Prakriti</i> individual types tend to suffer early with decaying process and other changes of aging when supported by <i>vata prakriti</i>
15	Ghodke Y, Joshi K, Patwardhan B	Traditional medicine to modern pharmacogenomics: Ayurveda <i>prakriti</i> type and CYP2C19 gene polymorphism associated with metabolic variability	Evidence Based Complementary and Alternative Medicine 2011:2011:249528	A significant correlation was found between CYP2C19 genotypes and <i>prakriti</i> indicating that <i>kapha</i> and <i>pitta prakriti</i> being low and fast metabolizer groups are likely to require low and high doses of CYP2C19 substrates
16	Prasher B, Negi S, Aggarwal S, Mandal AK, Sethi TP, Deshmukh SR, et al., Indian Genome Variation Consortium	Whole Genome expression and biochemical correlates of extreme constitutional types defined in Ayurveda	Journal of Translational Medicine 2008;6:48	Individuals from the three constitutional types exhibit striking differences with respect to biochemical, hematological parameters, and at genome wide expression levels which ultimately can help in differential disease predisposition
17	Hankey A	The scientific value of Ayurveda	The Journal of Alternative and Complementary Medicine 2005;11 (2):221-5	<i>Prakriti</i> of an individual depends on the inheritable properties of encoded proteins and their identifiable alleles in the genome thus making them interrelated
18	Joshi RR	A biostatistical approach to ayurveda: Quantifying the tridosha	The Journal of Alternative and Complementary Medicine 2004;10:879-89	Statistical validation on a large scale shows the accuracy of this study estimates with confidence level above 90%, suited for prognosis applications and systematic drug response analysis of Ayurvedic medicines
19	Patel K	Ayurveda: A study of Eastern Philosophy of Medicine	Thesis-Miami University May 2008	Ayurvedic holistic approach emphasizes the individual patient having particular constitution not the disease and combining this philosophy with other schools of treatment can help in devising a more effective treatment
20	Joshi K, Ghodke Y, Shintre P	Traditional medicine and genomics	Journal of Ayurveda and Integrative Medicine 2010;1 (1):26-32	The paper revealed that human <i>prakriti</i> can be empirically validated at the genomics level and layout scientifically validated approaches to preventive medicines, chronic diseases, and treatments
21	Hankey A	A test of the systems analysis underlying the scientific theory of Ayurveda's Tridosha	The Journal of Alternative and Complementary Medicine 2005;11 (3):385-90	The universality of coenzyme A implies that it is evolutionary invariant with its identified role and supports the system analysis identifying the doshas
22	Rastogi S	Development and Validation of a Prototype <i>Prakriti</i> Analysis Tool (PPAT): Inference from a pilot study	AYU 2010;33 (2):209-12	The study observes that <i>vata</i> and <i>pitta</i> constructs of <i>prakriti</i> identification in Ayurveda have a significant interrater correlation as compared to <i>kapha prakriti</i>
23	Mukherji M, Prasher B	Ayurgenomics: A new approach in Personalized and Preventive Medicine	Science and Culture	This study has provided a novel molecular framework for integration of predictive and personalized medicine and highlighted that Ayurgenomics approach can accelerate/assist predictive marker discovery

BMC = BioMed Central, AYU = An International Quarterly Journal of Research in Ayurveda, PLOS = Public Library of Science

totally depends upon involvement of each *dosha* in an individual.<sup>[13]</sup> Every individual must maintain their balance of *doshas* as determined by their *prakriti* in order to remain healthy.

*Prakriti* is believed to be determined at the time of conception and remain unaltered during the lifetime with contributions from environmental factors including maternal diet and lifestyle.<sup>[14]</sup> Every individual can be categorized into various combinations of *vata*, *pitta*, and *kapha prakriti* depending upon the predominance of each *dosha* and is independent of race, ethnicity, language, and geography, which will be specific for each individual. The susceptibility to different diseases depends upon the type of *prakriti* constitution in an individual. Therefore, assessment of *prakriti* analysis will not only help in understanding the physical and mental constitution of patient, but also plays a vital role in prognosis, diagnosis, treatment, and prevention of many complex diseases.

*Vata*, *pitta*, and *kapha prakriti* are found to have unique metabolic activities. According to Ayurveda, *kapha* is slow, *pitta* is fast, and *vata* is considered to have variable metabolism. Various studies have tried to establish correlation between specific *prakriti* types and different metabolic activities occurring in the body. Recently, a study reported that body mass index (BMI) in *vata-pitta prakriti* was significantly less as compared to *kapha-pitta prakriti* and the *vata-pitta prakriti* individuals were found to be having maximum platelet aggregation.<sup>[14]</sup> One of the associations of *tridoshas* has been hypothesized by Hankey (2005) in which it was suggested that the peptide coenzyme A, which occurs in all cells across all species-preserved through evolution and is associated with lipid metabolism, is linked with the *tridoshas* at the cellular level.<sup>[9]</sup>

One more study describes the concept of *prakriti* in aging stating that the *pitta* predominance *prakriti* type individuals have high basal metabolic rate (BMR) and energy consumption leading to tissue destruction and premature aging and average life span, while *kapha* predominance *prakriti* type have a tendency to delayed manifestation of aging and longer life span.<sup>[15]</sup>

Ghodke *et al.*, (2011) demonstrate a probable genomic basis for metabolic differences attributed by *prakriti* and concluded that *pitta prakriti* are fast metabolizers and *kapha* ones are slow and are influenced by different doses of CYP2C19 substrates.<sup>[16]</sup> Thus it was apparent from this study that fast and slow metabolism was one of the major differentiating phenomena with respect to correlations between CYP2C19 genotypes and *prakriti*. Evidence from other studies also indicates probable differences in other biomarkers related to the *tridosha* system. Sierra (2011)

makes the connection between Ayurveda *tridosha* system with psychological and endocrinological components of a human being and suggests possible biomarkers related to the three body types.<sup>[17]</sup> He proffers that the genopsycho-somatotyping of humans as comprised by the *tridosha* theory of Ayurveda is mediated by certain nuclear receptors; mainly those related to androgen, T-cells, and thyroxine which are related to *pitta* (mesomorphic or andrus), *kapha* (endomorph or thymus), and *vata* (ectomorph or thyrus), respectively. These receptors regulate the expression of certain genes and thus have an overall control over embryonic development, adult homeostasis, and finally the metabolism of an organism. Androgens are not referred to only as male hormones but as a broader term consisting of various steroid hormones which determine the physical constitution of humans. Such steroid hormones have been known to modify brain structures in various species and also between genders with implications for various behaviors such as aggression, dominance, courage, and libido and can be first marker for *tridosha* system.<sup>[17]</sup> Another component is that of cell-mediated immunity which acts independent of antibodies or complements and can thus be a second biomarker related to the *tridosha* system. Last but not the least is the thyroid hormones which are primarily responsible for a body's rate of metabolism; how quickly a body uses energy, makes proteins, and controls sensitiveness of body to other hormones. Given the importance of thyroid hormones in creating essential metabolic difference between humans, this has been suggested as a third marker related to the *tridosha* system.<sup>[17]</sup> Finally, the pituitary and the melanocyte-stimulating hormone (MSH) can modify the effects of the above three markers to produce further nuanced differences between the three body types.<sup>[17]</sup>

Thus a number of studies have demonstrated or hypothesized the links of the Ayurvedic *tridosha* theory with various metabolic systems and biomarkers among which some have even demonstrated the genomic linkages as well. However, a number of these associations need to be further verified by more direct evidence.

### **Prakriti and chronic disease**

We have listed a total of five articles related to *prakriti* and chronic diseases in this review (articles 1, 7, 8, 11, and 14) [Table 2]. *Prakriti* or a person's constitution of his/her *tridoshas* also has a clear link to the susceptibility one has for chronic diseases. This is quite widely known in Ayurveda, but is also now becoming more apparent in the wider knowledge scape of health in the light of recent evidence from modern or current health science. Based on the properties of the three body types, the predominance of *kapha* body types for gaining weight is quite well known [Table 1]. This propensity to gain

weight and for obesity is in turn linked with a number of chronic diseases such as heart disease, hypertension, and diabetes; all of which are increasingly viewed collectively as metabolic syndrome. Similarly looking at the properties of *pitta* body type it can be predicted that such individuals can have a propensity to develop ulcers, bleeding disorders, and skin disorders more common [Table 1]. *Vata* body types can have propensity to develop neurological problems, dementia, movement and speech disorders, arrhythmias, and related chronic diseases as well [Table 1]. However, of the three body types, classical texts suggest that *vata* type individuals will have maximum propensity for chronic disease.<sup>[18]</sup>

Mahalle *et al.* (2012)<sup>[12]</sup> have discovered in their study that biomarkers of coronary artery disease (CAD) such as very low-density lipoprotein (VLDL) and low-density lipoproteins (LDL) were significantly higher; while high-density lipoprotein (HDL) was significantly lower among CAD patients who were *vata kapha* (*VK*) when compared to other body types. *VK* body type was also significantly correlated with diabetes mellitus, hypertension, and dyslipidemia with highest levels of inflammatory markers such as IL6, TNF alpha, hsCRP, and HOMA IR. These inflammatory markers were also found to be higher in *kapha* body type.<sup>[12]</sup> Thus, the patterns of association that might be expected from Ayurvedic *tridosha* theory have been shown to have clear links with certain chronic disease conditions. As a part of another study which looked at the effect of walking on various markers<sup>[18]</sup> it was noted that there was a favorable change in multiple markers related to blood pressure and blood glucose among *vata-pitta* (*VP*) and *pitta-kapha* (*PK*) individuals due to exercise. Similarly, favorable effects of exercise to some extent was also true for *VK* individuals.<sup>[18]</sup>

In addition to obesity and related disorders of heart, blood pressure, and diabetes; *doshas* have been linked to other types of chronic disease as well such as rheumatoid arthritis (RA).<sup>[11]</sup> Juyal *et al.*, (2012) discovered that inflammatory genes were more associated with *vata* subgroup of patients, while oxidative stress pathway genes were more observed in *pitta* and to some extent *kapha* subgroup. This study delineated the fact that there were discreet pathways for the same disease for RA etiology in different *prakriti*-based subgroups which according to them took us closer to validating concepts of *prakriti* and personalized medicine as defined by Ayurveda.<sup>[11]</sup>

Links of *prakriti* has also been made with aging and cancer. Purva and Meena (2011) in their paper outlined the fact that the aging process was associated with the *prakriti* of an individual with the *pitta* predominant individuals supported by *vata* being prone to premature aging since they have

increased BMR and this tends to destroy the tissues faster compared to the other two *doshas*.<sup>[15]</sup> However, the overall understanding is that it is *vata* predominant individuals who age at the fastest rate [Table 1]. In another article by Venkatraghavan *et al.*, (1987), in a study with a small sample size, it was inferred that cancer patients had primarily *pitta* dominance followed by *kapha* dominance compared to normal controls.<sup>[19]</sup> *Vata* is associated with bone, *pitta* with blood, while *kapha* is associated with other tissues related to structure and storage such as adipose tissue. As such, it is difficult to treat when people with *vata prakriti* develop bone cancer, people with *pitta prakriti* develop leukemias, and people with *kapha prakriti* develop cancer of soft tissues according to Ayurveda.<sup>[19]</sup> Also, it has been suggested that in treatment of cancer it will serve well to reduce *pitta* and *kapha doshas*, both physically and psychologically, in all patients of cancer with modifications based on a person's *prakriti* and the type of cancer.

### Prakriti and genotypes

On searching for links of *prakriti* and genetics or genomics or genotypes, we discovered a total of nine articles (articles 3, 4, 5, 9, 11, 15, 16, 20, 23) [Table 2]. Joint research being carried out with Ayurveda and current sciences is entering novel territory every day. One such initiative has been by the Department of Science and Technology (DST) with the ASIIA (A Science Initiative in Ayurveda) project which has begun studies of Ayurveda *prakriti* and genetics.<sup>[20]</sup> The need of the hour is also to bridge the ontologic divide between Ayurveda and current sciences with the development of common vocabulary.<sup>[20]</sup> The gap is closing fast and so far we have discovered the various ways in which *prakriti* is associated with metabolic systems within the body and also with chronic disease conditions. Evidence is present and mounting regarding the links between *prakriti* and various genes through which these associations work.<sup>[11,16]</sup> Such links between *prakriti* and genetics have been clearly elaborated by Patwardhan and Bodecker (2008)<sup>[10]</sup> which have now become the basis for scientific investigation related to "Ayurvedic biology" and "Ayugenomics". The basis for this was an earlier work done by Patwardhan *et al.*, (2005)<sup>[13]</sup> in which they demonstrated a significant correlation between various alleles of human leukocyte antigen (HLA) genotype and *prakriti* providing rationale and preliminary experimental support for the concept of an association between HLA alleles and Ayurvedic *tridosha* theory of individual *prakriti* types.<sup>[13]</sup> In other studies, associations have been discovered between various genes related to inflammatory pathways and oxidative stress pathways in RA patients and *prakriti*.<sup>[11]</sup> Other associations between genetics and *prakriti* have been drawn out for genes related to drug metabolism such as CYP2C19<sup>[16]</sup> where the genotype

related to extensive metabolizers was associated with *pitta prakriti*, while the genotype associated with poor metabolizer was highest in *kapha prakriti*.<sup>[16]</sup> Other studies looking at genome wide expression differences between the three *prakriti* types have discovered significant enrichment of housekeeping, disease-related, and hub genes associated with the three extreme *prakritis*.<sup>[21]</sup> Apropos to the above evidence regarding relations of genetics and *prakriti*, Joshi *et al.*, (2010)<sup>[22]</sup> have provided a comprehensive review of such studies which have investigated the basis of the *tridosha* theory of Ayurveda in light of modern scientific genetic studies. They have reviewed not only genetic studies related to Ayurveda, but also those related to other traditional forms of medicine from Korea, China, and Japan.<sup>[22]</sup> Links have also been discovered between a gene EGLN1 which was just one among 251 other differentially expressed genes between various extreme *prakriti* types.<sup>[23]</sup> EGLN1 gene variations are responsible for high altitude adaptation in humans and the TT genotype of this gene was more frequent in the *kapha prakriti*, which was associated with higher expression of EGLN1 and higher incidence of pulmonary edema, while this genotype was significantly lower in *pitta prakriti* type.<sup>[23]</sup> Accumulating findings have in recent times led to proposals by certain researchers that this joint field of genetics and Ayurveda, which has now been named Ayugenomics, can be utilized to create a system of predictive, preventive, and personalized medicine so that instead of a generalized symptomatic approach, the practice of medicine takes an individual approach based on one's genetic makeup.<sup>[22]</sup>

### **Prakriti, newborn genetic screening, and personalized prevention: Possibilities for the future**

Newborn genetic screening has its history in 1960s in the United States where it was started as a public health program.<sup>[25]</sup> The first genetic disorder to be detected by newborn genetic screening was phenylketonuria. With time, the list of disorders that can be detected by newborn genetic screening has expanded with different countries having different list of disorders that they screen for.<sup>[25]</sup> The American College of Medical Genetics recommends 54 tests to be performed on the newborn.<sup>[25]</sup> Most of the tests involve using heel prick blood samples or testing for hearing, sight, or congenital heart defects. However, the kind of newborn genetic screening that we envisage in this review differs from just testing for possible genetic disorders.

### **Newborn genetic screening for prakriti**

As a part of this review, it has been apparent that *prakriti* types as described in Ayurveda, can be considered as phenotypes that have distinct links with various metabolic pathways, disease susceptibility especially that with chronic diseases and last but not the least, with differing genotypes.

As these links of *prakriti* become further defined it is not difficult to imagine a time in the near future when it will be possible to identify specific genotypes that are linked to any given *prakriti* type. Not only genotypes, but studies so far have also shown that normal healthy individuals from the three most contrasting *prakritis* exhibit striking differences in biochemical and hematocrit parameters measuring using peripheral blood.<sup>[21]</sup> These include lipid profiles, uric acid, hemoglobin, blood clotting time, and serum zinc levels. At the expression level there is enrichment in core biological processes such as transport, immune response, blood coagulation, etc., Also, higher levels of markers for metabolic syndrome such as triglyceride (TG), total cholesterol, LDL, VLDL, HDL, etc., were seen in persons with *kapha prakriti*. Similarly, higher levels of expression of hemoglobin genes were observed in *pitta* compared to *kapha* or *vata*.<sup>[24]</sup>

Ayurvedic method of *prakriti* classification has thus led scientists to identify biochemical and gene expression differences among normal individuals—something which is not possible in western system of medicine. Thus, it can be anticipated that in near future genotype ascertainment can be used a predictive markers for *prakriti*. This opens the door for an idea that has not been proposed before. It is quite possible that in near future, newborns can be screened right at the time of birth for their *prakriti* using their genetic profile which is further correlated by other biochemical parameters. Thus, specific set of criteria using genetic markers and biochemical markers can be set up not only to identify extreme *prakriti* types, but even mixed *prakriti* types.

### **A lifetime of personalized prevention**

The concepts of Ayurveda are not India specific and can apply to all of human population in the world. We are also well aware that a person's *prakriti* is considered to be normal for that person and any derangement of the *doshas* of the person's constitution leads to diseases. As such, the job of an Ayurvedic physician is to detect the extent of derangement and bring back the *doshas* to the normal state which can be done using drugs, diet, lifestyle changes, or environmental changes.<sup>[24]</sup> As a part of Ayurveda the various traits that each *prakriti* type has in terms of their body structure, mental makeup, tolerance to various types of food and environment, and susceptibility to various diseases including the prognosis is well-established [Table 1]. In addition, also well-established is the knowledge regarding the effects that various diet, lifestyle, environment, and treatment will have on different *prakritis*.<sup>[26]</sup> Also, we know by now that western allopathic medicine excels when it is required for treating acute disorders. Chronic disorders on the other hand cannot be managed well by allopathic medicine and Ayurveda is more effective in treating such chronic noncommunicable

diseases, mainly by *ahara* (diet), *vihara* (lifestyle), and finally *ausbadhi* (medication). The above three pillars of Ayurvedic medicine in conjunction with the *tridosha* theory provide a different paradigm to medical practitioners for understanding a disease and make Ayurveda capable of delivering personalized medicine for everyone.<sup>[27,28]</sup>

As such, detecting the screening newborns to detect their *prakriti* right after the time of their birth can have very significant and far-reaching implications. Knowing the *prakriti* of a newborn can lead to inculcation and adoption of lifestyles of a newborn that will result in prevention of chronic diseases and more healthy high quality life for an individual.<sup>[26]</sup> For example, if it is known that a newborn has *kapha prakriti* then right from the beginning the child can be encouraged to participate in sports and physical activity. Since *kapha prakriti* persons have a natural tendency for reduced movement, inculcation of habits that leads a *kapha prakriti* person to participate in sports from childhood will lead to a healthier life and will prevent most of the chronic diseases related to obesity that a *kapha* person is otherwise susceptible to. Similarly, if it known that a child has *pitta prakriti*, steps can be taken right from childhood to make sure such a child inculcates habits that make him more patient and not loose one's anger. In addition, spicy or acidic food may not be served to such a child since *pitta prakriti* individuals have more propensities to develop gastric ulcers and related disorders.

Thus, in conclusion, it is apparent that multiple linkages of Ayurvedic *tridosha* principle with modern scientific biochemical and genetic markers are being unearthed. This is a very significant step towards integrating Ayurvedic theories with modern scientific findings and it is quite likely that linking the *tridosha* theory of Ayurveda with current medical practices can improve health outcomes.<sup>[28]</sup> As a step further, it can be envisaged that in future newborns can be screened for various *prakriti* types which will open up possibilities of creating lifestyles and environments that lead to prevention of diseases that particular *prakriti* types are prone to. This takes the concept of personalized medicine further and enters the arena of personalized preventive health or personalized preventive medicine. Such personalized preventive health will result in healthy and more productive lives for such children, which has also the potential to reduce the burden of disease as well as increasing costs faced by health systems due to rising incidence of chronic diseases.

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