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.[1] 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 Samhita.[2] 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].[1] 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[3] and Rastogi.[4] 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.[5] There also exists the age-old
method of nadi vigyan or pulse diagnosis, through which a skilled Ayurvedic physician can determine prakriti among other things.[6] 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.[7] 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.[7] 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.[8] 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.[9] 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.[10] 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 aspects of regulation within an organism and such regulation is a result of metabolic pathways involving multiple enzymes.[10] Thus, if protein enzymes are inherited then so are metabolic pathways comprising of multiple enzymes.[10] 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.[1]

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.[1] 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** | **Vata** | **Pitta** | **Kapha** |
| 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).[13] 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.[12] 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.[1] 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.[12] Each prakriti has specific physical, physiological, and psychological attributes (gunas) which

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**Figure 1:** Flow of information in terms of number of articles through different phases of literature search 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 vata kapha and kapha prakriti |
| 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 genopsycho-somatotypes or birth constitutions (pitta, kapha, vata) 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 Prakriti in Ayurveda | Journal of Alternative and Complementary Medicine 2005;11:349-53 | A significant correlation exist between HLA type and prakriti type indicating a genetic basis exist for the three major constitutions (vata, pitta, kapha) described in Ayurveda |
| 6     | Tripathi JS, Singh RH | Concept of deha prakriti vis-à-vis Human Constitution in Ayurveda | Ancient Science of Life 1994;13 (3-4):314-25 | Deh prakriti 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 | Pitta dominance is found in the prakriti pattern of cancer patients followed by kapha dominance |
| 8     | Tiwari S, Gehlot S, Tiwari SK, Singh G | Effect of walking (aerobic isotonic exercise) on physiological variants with special reference to Prameha (diabetes mellitus) as per Prakriti | AYU 2012;33 (1):44-9 | Strong association is seen between prakriti, blood pressure, and biochemical parameters. Maximum number of cases belonged to vata-pitta prakriti and minimum number of cases belonged to vata-kapha prakriti |
| 9     | Aggarwal S, Negi S, Jha P, Singh PK, Stobdan T, Pasha MA et al., Indian Genome Variation Consortium | EGLNs 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 EGLNs 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 Dosha Prakriti | Ancient science of Life 2010;29 (3):6-18 | Tridosha is applied to every living organism and shows how individual differences in prakriti originate in fundamental systems functions shared by all forms of life and are implemented by genes responsible for relevant cellular functions (vata-homeostasis, pitta-turnover, kapha-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 prakriti and personalized medicine in Ayurveda |

*continued...*
### Table 2: Contd..

| S. No | Author(s) | Article title | Reference | Findings |
|-------|-----------|---------------|-----------|----------|
| 12    | Bhalerao S, Deshpande T, Thatte U | Prakriti (Ayurvedic concept of constitution) and variations in Platelet aggregation | BMC Complementary and Alternative Medicine 2012;12:24-8 | Maximum platelet aggregation was highest among vata-pitta prakriti individuals and better responded to low dose of aspirin as compared to other prakriti types so indicating prakriti related variations in platelet aggregation response in healthy individuals |
| 13    | Chatterjee B, Pancholi J | Prakriti-based medicine: A step towards personalized medicine | AUY 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 Prakriti in aging | AUY 2011;32 (1):20-4 | Aging and prakriti are closely related to each other. Prakriti individual types tend to suffer early with decaying process and other changes of aging when supported by vata prakriti |
| 15    | Ghodke Y, Joshi K, Patwardhan B | Traditional medicine to modern pharmacogenomics: Ayurveda prakriti 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 prakriti indicating that kapha and pitta prakriti 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):222–5 | Prakriti 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 prakriti 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 Prakriti Analysis Tool (PPAT): Inference from a pilot study | AUY 2010;33 (2):209-12 | The study observes that vata and pitta constructs of prakriti identification in Ayurveda have a significant interrater correlation as compared to kapha prakriti |
| 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 |
totally depends upon involvement of each dosha in an individual.\textsuperscript{13} 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.\textsuperscript{14} 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.\textsuperscript{14} 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.\textsuperscript{9}

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.\textsuperscript{15}

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.\textsuperscript{16} 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.\textsuperscript{17} He proffers that the genopsychosomatotyping 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 (endomorphic or thymus), and vata (ectomorphic or thryus), 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.\textsuperscript{17} 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.\textsuperscript{17} 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.\textsuperscript{17}

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.[18]

Mahalle et al. (2012)[12] 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. V/K body type was also significantly correlated with diabetes mellitus, hypertension, and dyslipidemia with highest levels of inflammatory markers such as IL-6, TNF alpha, hsCRP, and HOMA IR. These inflammatory markers were also found to be higher in kapha body type.[12] 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[19] 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 V/K individuals.[18]

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).[11] 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.[11]

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.[13] 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.[19] 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.[19] 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.[20] The need of the hour is also to bridge the ontologic divide between Ayurveda and current sciences with the development of common vocabulary.[20] 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.[11,14] Such links between prakriti and genetics have been clearly elaborated by Patwardhan and Bodecker (2008)[10] 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)[13] 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.[15] In other studies, associations have been discovered between various genes related to inflammatory pathways and oxidative stress pathways in RA patients and prakriti.[11] Other associations between genetics and prakriti have been drawn out for genes related to drug metabolism such as CYP2C19[16] where the genotype
related to extensive metabolizers was associated with *pitta prakriti*, while the genotype associated with poor metabolizer was highest in *kapha prakriti*. 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 *prakriti*. Apropos to the above evidence regarding relations of genetics and *prakriti*, Joshi et al., (2010) 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. Links have also been discovered between a gene EGLN1 which was just one among 251 other differentially expressed genes between various extreme *prakriti* types. 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. 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.

**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. 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. The American College of Medical Genetics recommends 54 tests to be performed on the newborn. 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 *prakriti* exhibit striking differences in biochemical and hematocrit parameters measuring using peripheral blood. 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*.

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. 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 *prakriti*. 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), vibara (lifestyle), and finally aushadhi (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.[27,28]

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 an understanding of childhood lifestyles and activity. Since kapha prakriti persons have a natural tendency to 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 is 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.[28] 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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