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ANALYSING *VATA DOSHA STHANA* THROUGH BIOPHYSICAL PRINCIPLES WITH RELEVANT FUNCTIONAL ANATOMY: AN INTEGRATIVE REVIEW

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ABSTRACT

Background*: Vata dosha is the fundamental regulatory principles governing movements, communication, and transportation in human body. Derived from akasha and vayu mahabhuta, Vata is often described as the superior dosha because it governs the mobility of other two doshas, and it's the driving force behind all physiological activites. Doshas are primarily located all over the body as they are omnipresent, however, each doshas has specific sites due to origin of their functional expression, site of accumulation, or through ashraya ashrayi sambhanda.*

Aims and Objectives*: To analyse Vata dosha locations through biophysical principles with relavent functional anatomy.*

Materials and Methods*: For the integrative qualitative review, classical Ayurvedic literature brihatrayi have been used for the understanding of Vata sthana, guna, and karma. These have also been correlated with modern science such as the concepts of functional anatomy, neurophysiology, bio-mechanics, and visceral physiology. Special emphasis has been given to the concepts of mechanotransduction, electrochemical mechanisms, pressure gradient mechanisms, and neuromuscular coordination mechanisms to correlate it with classical literature.* ***Discussion and Conclusion****: Vata Dosha is best understood as a functional and biophysical entity rather than a fixed anatomical placement. Regions described as Vata sthana such as Pakwashaya, Kati, Sakti, Shrotam, Asthi, Sparshanendriya, Padavastahni, Basti, Shroni And Guda, share common physiological characteristics, including high neural activity, mechanosensitivity, pressure-dependent transport, and rapid neuromuscular coordination. These features correspond to modern principles of biomechanics, neurophysiology, and fluid dynamics, reinforcing Vata's role in movement, sensory transmission, and regulation. From this integrative perspective, Vata operates predominantly at anatomical interfaces joints, hollow viscera, fascial planes, and neural pathways, where continuous adaptation and communication are essential for homeostasis. In conclusion, reinterpreting Vata Doṣa localization represents functional dominance rather than fixed structural anatomy through biophysical principles.*

KEYWORDS: *Vata Dosha, Dosha sthana, Biophysical principle, Functional anatomy.*

INTRODUCTION

Vata dosha plays pivotal role in maintaining all the activities of living beings so vata is regarded as "Praninam Prana" (the vital force)[1]. It governs the functions such as Respiration, Circulation, Neuromuscular Activity, Sensory Motor Coordination, Speech, Excretion, Cognitive Processes. In ayurvedic classical texts emphasizes that Vata is sarvagata (pervasive throughout the body), it has specific sthanas such as Pakwashaya, Kati, Sakti, Shrotam, Asthi, Sparshanendriya[2], Basti, Padavasthani[3], Shroni, And Guda[4]. Where sthanas are not mearely the anatomical locations, it implies utpatti kshetra (origin of functional expression), sanchaya kshetra (site of occumulation), prakopa prasara kshetra (site of initiating systemic spread). From a biophysical perspective vata can be interpreted as principle governing motion, transmission, pressure gradiants, flow dynamics, and electrochemical signaling within biological systems. In modern physiology attributes these functions to mechanism such as neural impulse conduction, ion channel dynamics, mechanotransduction, bioelectric potentials, and fluid mechanics [5]. Because classical qualities of vata guna ruksha, laghu, shita, khara, sukshma, chala, vishada, are closely corresponding to these biophysical properties. functional anatomy explains where and through which stractures these forces where manifest. Neural networks, synapses, and myelinated fibers form the anatomical basis for biosignaling underlying utsaha, smruthi, vak pravrutti, and akshanam patava, enabling rapid impulse transmission and sensory motor integration. The anatomical structures of thoracic cage, diaphragm, and brainstem respiratory center supports pressure differential and rhythmic oscillations responsible for ucchwasa nishwasa[6]. Muscles, tendons, joints, and fascial planes provide biochemical leverage and elasticity required for chesta, prayatna, prakshepana apakshepana, and unmesha nimesha, translating neural signal to coordinate the motion[7]. Visceral functional anatomy particularly the pakwashaya, basti, pelvic organs facilitates peristalsis, reserviour functions, and reflex evacuation,

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explaining anna grahana, pachana, vivechana, munchana, shakrit mutra visarga and garbha nishkramanakriya through fluid mechanics and autonomic regulation[8]. Vascular and lymphatic network act as conduits of dhati gati, ensuring material transport and metabolic equilibrium, while the porous mineralized stracture of asthi dhatu supports mechanotransduction and ionic exchange, reflecting vata predominance. Endocrine and reproductive organ anatomy provides the interphase for neuro harmonal control of shukra and arthava.

AIMS AND OBJECTIVES

To revisit and critically analyse the vata dosha sthana by integrating ayurvedic concepts with biophysical principles and relevant functional anatomy, in order to provide coherent and contemporary understanding of vata localization and function.

MATERIALS AND METHODS

The integrated review conducted through a comprehensive analysis of classical ayurvedic texts including Charaka Samhita, Sushruta Samhita, and Astanga Hridaya along with their commentaries to identify reference related to vata dosha sthana, its guna and karma. Secondary sources such as kriya sharira and Rachan sharira textbooks,peer reviewed research articles and contemporary literature on biophysical principles and functional anatomy were also collected.

DISCUSSION

Pakwashaya: is explicitly identified as the chief seat of Vata Dosha[9], particularly Apana Vayu. This designation is physiologically coherent when interpreted through modern biophysical principles. The large intestine functions primarily in water absorption, electrolyte regulation, fecal compaction, and controlled propulsion. Its motility patterns haustral contractions, segmental mixing, and mass peristalsis are governed by enteric neural circuits and autonomic modulation[10]. These rhythmic propulsive movements exemplify Vata's chala (movement) quality, while the regulation of pressure gradients and gas dynamics within the lumen reflects Vata's association with vayu and akasha elements. The generation and expulsion of flatus and feces are biomechanical expressions of Apana Vayu's downward-directed force (adhogati), mediated by coordinated smooth muscle contraction and sphincter relaxation. Functionally, the large intestine extends from the ileocecal junction to the anal canal and includes the cecum, colon (ascending, transverse, descending, sigmoid), and rectum. Its wall architecture—taeniae coli, haustra, and abundant enteric plexuses (Auerbach's and Meissner's)—supports regulated motility and absorption[11]. Fluid balance within the colon depends on osmotic gradients and epithelial transport mechanisms, excessive dryness or hypomotility predisposes to constipation, paralleling Vata's ruksha (dry) and manda gati manifestations. Conversely, dysregulated motility may present as irritable bowel patterns with alternating constipation and gas accumulation, reflecting Vata imbalance. Thus, represents a biomechanically active and neuroregulatory domain where propulsion, fluid dynamics, and pressure modulation converge substantiating its classical identification as the primary seat of Vata Dosha.

Kati: lumbar region is enumerated among the principal seats of Vata Dosha, along with Pakvashaya, Shroni, and Asthi. This is functional anatomically and biophysically coherent because the lumbosacral region is a central axis for load transmission, flexibility, and neural conduction. Biomechanically, the lumbar vertebrae (L1–L5) are designed for weight bearing and controlled mobility particularly flexion and extension, while the intervertebral discs function as viscoelastic shock absorbers, distributing compressive forces according to principles of hydrostatic pressure and annular tension[12]. Vata's qualities of chala (movement) and sukshma (subtle conduction) are reflected in the micro-movements of facet joints and in the propagation of neural impulses through the spinal cord and emerging nerve roots. From a functional anatomical perspective, the Kati region houses critical neural structures including the cauda equina and lumbosacral plexus, which govern lower limb motor activity, pelvic organ function, and sensory input. The paraspinal muscles (erector spinae, multifidus) and thoracolumbar fascia create a dynamic stabilization system based on tensegrity and force closure[13]. Any alteration in disc hydration, ligamentous tension, or neuromuscular coordination disrupts mechanical equilibrium manifesting clinically as low back pain, radiculopathy, or stiffness, often interpreted in Ayurveda as Kati-shula, a Vata-predominant disorder. Degenerative changes such as disc desiccation or spondylosis parallel Vata's ruksha (dry) and khara (rough) attributes. Thus, Kati represents a Vata-dominant biomechanical hub where axial load bearing, kinetic mobility, neural transmission, and structural adaptation converge in a finely regulated system.

Sakti: Thigh region described among the principal seats of Vata Dosha, especially in relation to locomotion and weight transmission. Vata, defined by chala (movement), laghu (lightness), and ruksha (dryness), governs musculoskeletal kinetics and neuromotor coordination. Biophysically, the thigh represents a primary lever segment in human gait mechanics. The femur the longest and strongest bone acts as a load-bearing column transmitting ground reaction forces from the tibia to the pelvis. According to principles of biomechanics, the hip and knee joints form a kinetic chain enabling flexion-extension, abduction-adduction, and rotational movements[14]. These coordinated motions depend on precise neuromuscular activation patterns, aligning with Vata's regulatory role in impulse conduction and motor control. Functionally, the thigh houses major muscle groups, quadriceps (knee extension), hamstrings (knee flexion and hip extension), and adductors (medial stabilization), all richly supplied by the femoral, obturator, and sciatic nerves[15]. During locomotion, alternating concentric and eccentric contractions generate propulsion and shock absorption, governed by proprioceptive feedback loops, The fascial compartments and vascular channels ensure dynamic force transmission and metabolic support[16]. Disturbances such as muscle wasting, neuropathy, tremors, or spasticity may be interpreted as Vata

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derangements reflecting impaired neural conduction or altered biomechanical balance. Thus, Sakti exemplifies a Vata dominant region where structural leverage, force generation, neural integration, and coordinated movement converge to sustain posture and ambulation.

Shrotam: Shrotrendriya (organ of hearing) is closely associated with Vata Dosha, particularly due to its linkage with Akasha Mahabhuta (space) and the perception of shabda (sound). Vata, characterized by motion (chala), subtlety (sukshma), and rapid transmission, governs sensory impulse propagation and vibratory phenomena. Biophysically, hearing depends on the transmission of mechanical sound waves through air (external auditory canal), conversion into mechanical oscillations at the tympanic membrane and ossicles, and subsequent transformation into electrochemical signals within the cochlea. The movement of endolymph displaces the basilar membrane, activating hair cell stereocilia and generating receptor potentials via mechanoelectrical transduction[17]. This precise conversion of vibrational energy into neural impulses exemplifies Vata's kinetic and communicative functions.From a functional anatomical perspective, the ear is divided into external, middle, and inner components, each contributing to amplification, impedance matching, and signal transduction. The ossicular chain (malleus, incus, stapes) enhances pressure transmission to the oval window, while the cochlear apparatus encodes frequency through tonotopic organization. Auditory nerve fibers (cranial nerve VIII) conduct impulses to the brainstem and auditory cortex for interpretation. Additionally, the vestibular apparatus—semicircular canals and otolith organs regulates balance through dynamic fluid motion and neural integration[18], further reflecting Vata's governance over movement and spatial orientation. Clinical manifestations such as tinnitus, sensorineural hearing loss, or vertigo may be interpreted as Vata perturbations, involving altered neural conduction or aberrant vibratory processing. Thus, Shrotra embodies a Vata predominant sensory system. where mechanical vibration, fluid dynamics, and rapid neural signaling converge to produce auditory perception and equilibrium.

Asthi: Asthi is described as a principal seat (sthana) of Vata Dosha, with the classical statement "Vatasya asthi ashraya." This association is conceptually significant because Vata embodies movement, dryness, and structural lightness qualities reflected in bone physiology. Biophysically, bone is a dynamic composite material composed of an inorganic mineral phase (hydroxyapatite) providing compressive strength and an organic collagen matrix providing tensile resilience. Its porous trabecular architecture allows optimal load distribution and shock absorption according to Wolff's law, which states that bone remodels in response to mechanical stress[19]. This mechanotransduction, where osteocytes sense strain and modulate osteoblastic and osteoclastic activity can be interpreted as a manifestation of Vata's regulatory role in structural adaptation and internal motion at the microarchitectural level. Functionally, the skeletal system provides mechanical leverage for locomotion, protection of vital organs, and hematopoiesis within the marrow cavity. Bones act as rigid levers, transmitting muscular forces through joints to generate movement[20], directly reflecting Vata's chala (kinetic) property. Additionally, the medullary cavity and haversian systems contain vascular and neural elements, emphasizing that bone is not inert but metabolically and neurologically integrated tissue[21]. Degenerative conditions such as osteoporosis, osteoarthritis, or bone brittleness correlate with increased porosity, reduced mineral density, and dryness features[22] analogous to aggravated Vata. Thus, Asthi represents a structurally and biophysically dynamic tissue where mechanical forces, adaptive remodeling, and neuromuscular integration converge, substantiating its classical identification as a primary Vata domain.

Sparshanendriya: Sparshanendriya (organ of touch) is primarily associated with Vata Dosha, particularly due to its governance over sensory perception and neural transmission, Vata, characterized by chala (movement), sukshma (subtlety), and laghu (lightness), is responsible for sensory impulse conduction and responsiveness. Biophysically, the skin functions as a mechanosensory and thermosensory transducer system. Cutaneous receptors Meissner corpuscles, Pacinian corpuscles, Merkel discs, Ruffini endings, and free nerve endings convert mechanical deformation, vibration, temperature, and nociceptive stimuli into bioelectrical signals via ion channel activation and membrane depolarization[23]. This electrophysiological transformation mirrors Vata's role as the initiator and propagator of impulses. The rapid conduction of afferent signals through Aβ, Aδ, and C fibers to the dorsal column medial lemniscus and spinothalamic pathways represents the kinetic principle[24] central to Vata physiology. From a functional anatomical standpoint, the skin is the largest organ, comprising epidermis, dermis, and hypodermis, with dense innervation from peripheral somatic nerves[25]. It acts as a dynamic interface between internal homeostasis and the external environment, regulating thermoregulation, barrier protection, and sensory discrimination[26]. The integrity of tactile perception depends on receptor density, neural conductivity, and cortical integration particularly in the primary somatosensory cortex[27]. Alterations such as hypoesthesia, paresthesia, or neuropathic pain can be interpreted within a Vata framework as derangements in neural conduction or receptor responsiveness. Thus, Sparshanendriya exemplifies a Vata-predominant system where biophysical signal transduction, rapid impulse propagation, and adaptive sensory modulation converge to maintain organismal awareness and protective reflexes.

Basti: Basti region is emphasized as the seat of vata, due to its governance over evacuation, regulation of urine.From a biophysical perspective vata gunas closely parallel the neuroelectrophysiological control of the uriary bladder. The bladder functions as a compliant viscoelastic reservoir governed by autonomic neural circuits, primarily sympathetic hypogastric and para sympathetic pelvic splanchnic pathways that regulates the detrusor contractility and sphincter tone through pressure

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volume relationship[28]. While voiding reflects coordinated neuromuscular activation conceptually analogous to apana vatas downward propulsion. thus the bladder exemplifies a biomechanical organ where neural conductivity, pressure gradients, and muscular kinetics reflects vatas functional dominancy. Functional anatomically the urinary bladder is a distended hollow muscular organ situated in lesser pelvis posterior to pubis symphysis, composed primarily of detrusor smooth muscles arranged in interlacing bundles that enable multidirectional contractility. Its activity is modulated by stretch receptors within the bladder wall that transmit afferent impulses to sacral micturition center (S2-S4), integrating spinal and higher cortical control[29]. This neurogenic feedback loop mirrors the regulatory and coordinated properties of vata, particularly apana vata.

Shroni: refers to the pelvic girdle region forming the structural base of the trunk and anatomical field housing basti, pakwashaya, and apana vata. Shroni as the region governing apana vata functions muutra, purisha, shukra, arthava visarjana. Biophysically, Vata corresponds to principles of motion (kinematics), neural conduction (bioelectric signaling), pressure gradients, and fluid dynamics. The pelvic girdle is a central biomechanical hub transmitting axial load from the vertebral column to the lower limbs while permitting controlled mobility via the sacroiliac joints and pubic symphysis. Its architecture comprising irregular bones with trabecular networks optimizes stress distribution and shock absorption[30], reflecting Vata's chala (movement) and laghu (lightness) attributes. Moreover, the pelvic cavity houses the distal colon and urinary bladder, where peristalsis, defecation reflexes, and micturition depend on autonomic neural regulation again aligning with Vata's governance over neuromuscular coordination and propulsion[31]. From a functional anatomical perspective, the pelvis is a ring-like osseous structure composed of the two hip bones (ilium, ischium, pubis), sacrum, and coccyx, forming the pelvic inlet and outlet, the pelvis provides weight transmission from the axial skeleton to the lower limbs and protects pelvic viscera (urinary bladder, rectum, reproductive organs)[32.] The pelvic diaphragm (levator ani and coccygeus muscles) maintains continence and supports visceral pressure gradients critical in micturition and defecation reflexes[33]. Thus, Shroni can be interpreted as the anatomical and biomechanical substratum facilitating Apana Vata-mediated expulsive functions through coordinated neuromuscular and pressure-regulated mechanisms.

Guda: Guda is described as a principal site of Apana Vayu, the subtype of Vata responsible for downward expulsion (adhogati) of feces, urine, semen, and menstrual blood. Biophysically, the anal canal represents a highly regulated neuromuscular outlet where pressure gradients, rectoanal inhibitory reflexes, and coordinated sphincter dynamics determine continence and defecation[34]. Apana Vayu can be interpreted through principles of smooth muscle electrophysiology, enteric nervous system control, and mechanotransduction. The maintenance of resting anal tone (primarily via internal anal sphincter smooth muscle) and voluntary modulation (external anal sphincter, skeletal muscle) reflect Vata's governance over neural signaling and motor coordination. The cyclical generation and release of intrarectal pressure, governed by autonomic and somatic pathways[35], align with Vata's qualities of movement (chala) and regulation of impulses (pravartaka function). Functionally, the anal canal (approximately 3–4 cm in length) extends from the anorectal junction to the anal verge and is structurally specialized into columnar, transitional, and squamous epithelial zones. It contains the internal and external sphincters, anal cushions (vascular plexuses), and rich somatic and visceral innervation via the pudendal nerve and pelvic splanchnics[36]. Continence is maintained by a complex interplay of resting tone, reflex contraction, rectal compliance, and pelvic floor support—essentially a dynamic biomechanical valve system[37]. Thus, Guda exemplifies a Vata-dominant anatomical site where propulsion, sphincteric control, neural conductivity, and pressure homeostasis converge in a tightly integrated physiological mechanism.

CONCLUSION

Vata Dosha is sarva sharira chara, as movement and neural regulation are present throughout the body. However, it becomes functionally predominant in specific sthanas where dynamic activity is highest. The Pakwashaya shows propulsion, absorption, and gas movement, expressing Vata's kinetic and drying qualities. The Basti functions through stretch reflexes and pressure-regulated evacuation. The Kati, Shroni region houses major nerve plexuses and mobile joints, central to impulse transmission and coordination. The Sakti enables locomotion and mechanical force generation. Asthi provides structural support and conduction of mechanical stress. These sthanas are not merely isolated organs but include surrounding anatomical structures that enhance Vata activity. Through biophysical principles, Vata dosha represents functional dominance rather than a fixed structural location. Thus, while present everywhere, Vata is especially expressed in regions where movement, conduction, and pressure dynamics are physiologically predominant.

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