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Review Article

Vata dynamics with special reference to cardiac disorders – A cross-disciplinary approach

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ABSTRACT

Vata is one of the fundamental patho-physiological entities with unique and dynamic properties. All actions inside the body, whether voluntary or involuntary, are governed by *Vayu*. Actions involved during natural physiological calls or urges, are involuntary, but partially under voluntary control. Classical texts from Ayurveda state that such natural urges (NU) should be strictly attended without disturbing their natural flow. Some urges can be intentionally or inadvertently initiated (*Udiran*) or suppressed (*Dhaaran*), redirecting the normal flow of *Vayu*, leaving scopes for severe morbidities in the heart causing cardiovascular disorders (CVD). Since *Vata* has unique attribute of *Vega* (locomotion) that moves in a specific direction, its intensities can be quantified with the help of modern techniques. Few studies have objectively evaluated the intensities of NU like belching, sneezing, expulsion of flatus, etc. during normalcy, which may help us to determine their altered activity during morbidity. In spite of such studies, their relevance to CVD is inadequately explored. Hence, this article addresses details of such NU that lead to CVD alone, from classical texts of Ayurveda, conventional medicines and technology that quantify their intensities. Citing research articles from various journals using keywords were done to understand their mechanism along with their intensities. It was found that objective estimation of few NU was performed extensively whereas some had limitations. Theories from the classical texts confirm that physiological NU, if allowed to flow freely without any impedance, assures good health. It would certainly benefit the mankind if their pathologic state is timely detected so as to prevent disease progression in CVD.

1. Introduction

All actions inside the body, whether voluntary or involuntary, are governed by *Vayu*. Some actions such as digestion, blood circulation, pumping and beating of the heart, etc. are performed uninterruptedly and are not under voluntary control. They come completely within the scope of the autonomous nervous system and work independently to govern all involuntary actions of the body. In spite of recent advancements in neurosciences, integration of voluntary and involuntary motor commands still needs to be better understood [1]; on the contrary, Ayurvedic classical texts present extensive evidences on similar integration. Actions involved during natural physiological calls or natural urges (NU), are involuntary; however, few are partially under voluntary control i.e. heavy breathing during exercise, yawning, coughing, sneezing, belching, vomiting, hunger, sleep, flow of tears, expulsions of flatus, urine, faeces and secretions discharged during orgasm are some of the involuntary actions that are partially under voluntary control.

Performing one's actions, especially natural physiological calls or holding them back voluntarily, has always been a key feature in human beings [2]. Since majority of individuals are striving hard on upgrading their status of living than improving quality of life, the above-mentioned key feature is conveniently manipulated to meet their demands of mundane life. Ayurveda refers to such actions as *Vega Udeeran* (forceful initiations) or *Vega Dhaaran* (suppression), and if with-held repeatedly may lead to severe conditions which are root cause of all diseases [3], collectively termed as *Udaavarta Rogas* [4].

It is extremely challenging to detect morbidities caused due to manipulations of such involuntary actions, as some of them are

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intermittent in nature like belching, sneezing, coughing, etc. and some are performed uninterruptedly like breathing. Since these actions are predominantly governed by *Vata*, they possess unique attributes of *Vega* (locomotion) [5]. They move in a specific direction and their intensities can be quantified using latest technology. Whether naturally expressed (physiologic) or manifested as *Roga Lakshana* (pathologic), this unique attribute of *Vata* is relatively expressed in different speed and frequencies which needs to be determined. Hence, such urges when intermittently or inadvertently manipulated, redirect the normal flow, leaving scope for severe morbidities in the heart leading to cardiovascular disorder (CVD).

CVDs are a leading cause of death in the world and can potentially impede one's development [6]. CVDs have always been a major concern for health globally. United Nations (UN) has initiated well-set plans to prevent such diseases [7]. Moreover, there have been well-established and exhaustive evidences that feature various antecedent factors for CVDs such as inheritance or environmental factors that induce stress, improper diet or lifestyle [8]. In spite of well-established multi-factorial determinants and well set plans by UN, there has not been any decline in CVD cases. There are extensive evidences with references in classical texts of Ayurveda on manipulation of NU leading to CVDs [9–12], but could not get similar attention as a determinant. Few studies have documented that suppression of urine aggravates stress in the heart and is reflected through hypertension [13]. Furthermore, there are documented studies on heart failure patients where majority of them have a strong history of manipulating NU [14]. This led to study on *Vata* dynamics, especially those manipulated urges that bring morbidity in the heart.

Few productive studies have been done on actions such as belching, sneezing, coughing, expulsion of flatus, faeces, and spermatic fluid, which objectively quantifies its intensity and frequencies during normalcy, but their relevance to CVDs is not adequately explored and studied as systematically as done in willful retention of urine and heart failure [13,14]. Indeed, several established and exhaustive studies are documented on dyspnea on exertion (DOE), as an important cardinal symptom but not as a main cause. Moreover, even though they are popularly evaluated under functional class criteria, studies on heavy breathing during exercise could not get similar attention. Authors from classical Ayurvedic literature, *Bruhat Trayi- Charaka Samhita, Susruta Samhita and Ashtanga Hrdayam*, have addressed these NU, when manipulated, can become an important source of morbidity, especially CVDs. There is an absolute need to address these issues from the etio-pathological point of view so as to decelerate the disease progression. Moreover, it is also necessary to spread awareness on attending to one's physiological call more urgently than any other jobs in life [15].

Focusing on review of literature, we aim to highlight all those natural urges that bring morbidity in the heart when manipulated. Their mechanisms during normalcy and influencing factors that disrupt their normal mechanism have been correlated to CVDs from both, modern and Ayurvedic disciplines of medicine. Their dynamic nature has been studied from the available data that objectively quantifies their peak performance using modern technology.

2. Strategies to review the concept of NU

Information on details of NU was collected from *Bruhat Trayi-Charaka Samhita, Susruta Samhita and Ashtanga Hrdayam.* Literature search was performed using key words *Vega Dhaaran, Udeerana, Udaavarta Roga, Adhaaraniya Vega* etc. Urges when suppressed that lead to CVDs alone were elucidated and their mechanisms during normalcy were cited from various journals using the following keywords - mechanisms, techniques and intensity of flow impedance on: belching, sneezing, coughing, breathing, expulsion of flatus, faeces and semen etc. along with their subtypes. The influencing factors that disrupt normal kinesis were understood from both disciplines of science Ayurveda and conventional stream and finally incorporating them with reference to CVDs through Ayurvedic concept.

3. Elucidation of manipulated urges with special reference to CVDs

There are more than 13 urges mentioned by authors from classical texts out of which only nine have direct impact on *Hrdaya* (Heart) leading to CVDs [9–12,16] (Table 1). Some of these urges have been quantified and technically elucidated during normalcy.

3.1. Belching

Belching is a physiological release of accumulated gastric air from the stomach. This phenomenon is a result of a coordinated response by the receptors in the gastric wall, which initiates the relaxation of the lower esophageal sphincter, and this excess air from the distended stomach is vented out towards the upper esophageal sphincter and finally releasing it through the mouth. This comes out as an audible sound as a belch. They are of two types of belching: gastric belch and supra-gastric belch [17].

Susrutha explains *Udgar* (belch) as a *lakshana* (symptom) where *Vayu* is expelled out through mouth making a varied sound. *Shuddha Udgar* (*pure* belches) are considered to be normal when arises without any foul smell, or food regurge especially having sweet, sour or pungent tastes [18]. It is in fact an indication of the normal digestion process [19].

There are studies that have evaluated the frequency of belches to be considered normal and becomes pathological and bothersome if occurred more than 20–30 times per day [17].

Esophageal electrical impedance monitoring is a useful tool that objectively quantifies the intensity of a gastric belch. It measures the resistance/impedance on the movement of air in the esophagus. According to a study conducted by Bredenoord, an increase in impedance of air by $\geq$ 1000 Ω that moves in the oral direction is a characteristic of a gastric belch. Conversely, supra-gastric belching, moves in an abnormal direction, followed by a return to baseline moving in the opposite direction with a similar impedance value [20].

A high-resolution manometer is another instrument, widely used to access the pressure from pharynx to stomach. Sun et al. studied esophageal and gastric functions through this method and found that a normal value of lower esophageal sphincter was 9–27 mmHg [21]. It is also an important diagnostic tool for achalasia and dysphagia too.

A phenomenal belch with increased intensity can also arise as a result of habitual use of lozenges, chewing of tobacco/gum, swallowing of air along with saliva or a random gulping of food/liquid in large volumes. It becomes very difficult to measure their intensities if they are already being treated for the same by antacids, carbonated drinks or beer to release an excessive amount of accumulated air, as they give a false measurement on impedance [22].

Belching is predominantly seen in inferior wall myocardial ischemia [23]. It has been established as an enhanced autonomic response to ischemic heart disease [24]. Bulimia nervosa can influence belching to turn pathologic leading to CVDs [25]. Lack of taste, tremors, feeling of obstruction in the heart and other regions of chest, flatulence, cough, and hiccups are some of the consequences caused by forceful initiation or suppression of belching [9]. Natural human exhalation flows such as sneezing, coughing and

Table 1
Morbidities in the Heart (*Hrday*) caused due to suppression of natural urges according to *Bruhat Trayi*.

Sr. No.	Natural Urges	*Ashtang Hrday* [8]	*Charaka Samhita* [9,10]	*Sushrut Samhita* [11]
1	Heavy breathing (*Shrama Shwas*)	Heart disease (*Hrdrog*)	Heart disease (*Hrdrog*)	Heart disease (*Hrdrog*)
2	Belching (*Udgar*)	Cardiac arrhythmia (*Hrdvibandha*)	Cardiac arrhythmia (*Hrdvibandha*), dysnea (*Shwas*)	Cardiac arrhythmia (*Hrdvibandha*)
3	Semen (*Retas*)	Pain in cardiac region or angina (*Hrdvyatha*)	Pain in cardiac region or angina (*Hrdvyatha*)	Pain in cardiac region or angina (*Hrdpida*)
4	Thirst (*Trushna*)	Heart disease (*Hrdrog*)	Pain in cardiac region or angina (*Hrdvyatha*)	Pain in cardiac region or angina (*Hrdvyatha*)
5	Flatus (*Adhovatta*)	Heart disease (*Hrdrog*)	–	Ectopic beats of heart (*Hrdayoparodha*), dysnea (*Shwas*), cough (*Kas*)
6	Tears (*Ashru*)	Heart disease (*Hrdrog*)	Heart disease (*Hrdrog*)	–
7	Faeces (*Purisha*)	Ectopic beats of heart (*Hrdayoparodha*)	–	–
8	Cough (*Kas*)	Dysnea (*Shwas*), cardiac disorder (*Hrdrog*)	–	–
9	Sneezing (*Kshavathu*)	–	–	Obstruction in inhalation (*Utshwasavarodh*)
10	Vomit (*Chhardi*)	Dysnea (*Shwas*), cough (*Kas*)	–	–
11	Urine (*Mutra*)	–	–	–
12	Yawning (*Jrumbha*)	–	–	–
13	Hunger (*Kshudha*)			
	Sleep (*Nidra*)	–	–	–

breathing are actually produced from a single exhalation effort and can be considered as 'jet-like' airflows [26].

3.2. Sneezing

Sneezing is an explosive exit of air, washing out mucosal debris and irritants through mouth and nose. A phenomenal sneeze is a biphasic, coordinated and protective respiratory reflex that involves nasal as well as respiratory passages [27].

Susrutha says *Kshavathu* (sneeze) is an audible sound of *Vayu* being released through nasal passage. These are aggravated *Praana* and *Udaana Vayus* situated in the pathways of head regions [28].

Sneezing is difficult to investigate due to the dearth of available studies on estimating sneeze flow velocity. Tang et al. [26] objectively evaluated the intensity of sneezing using a shadowgraph imaging technique. It was found that within 0.5–2.5s, the maximum visible distance over which the sneeze plumes (or puffs) travelled, was 0.6 m, with a maximum derived velocity from this measured distance of 4.5 m/s. However, sneeze velocities vary depending on the velocities of the airflows or droplets expelled with them. Xie et al. cited a velocity of up to 100 m/s based on earlier estimates by Wells assuming the droplet size to be 10μm in diameter [29].

Studies have confirmed that chronic sneezing, exceeding normal intensity may lead to aortic dissection [30]. Consequences of manipulation of sneezing include headache, debility of sense organs, stiffness of the neck, facial paralysis and obstruction during inhalation [9].

3.3. Cough

Normally, cough consists of inspiratory, compressive and expiratory phases [31]. It begins with a deep breath with a fully opened glottis [32] followed by a compressive phase of the closure of glottis and contraction of expiratory muscles. This suddenly opens the glottis causing an explosive release of trapped extra thoracic air as an expiratory phase. The term laryngeal competence is often used to imply a well-coordinated upper airway and an adequate cough response [33].

Doshas in pathologic state release *Praana Vayu* along with *Udaana Vayu* causing a peculiar sound as that of a sound generated from an empty brass vessel [28].

Tussometry is a new non-invasive technique for objectively assessing laryngeal function by analysis of the airflow waveform produced by a maximum effort voluntary cough maneuver [34]. This allows measurement of the peak airflow generated, cough peak flow rate (CPFR) and the time taken to achieve this, peak velocity time (PVT).

The first publication that considered cough peak flow (CPF) in normal volunteers was published by Leiner et al. They observed that the average CPF was higher than 300 L/min in healthy Caucasian European individuals. Additionally, the researchers stated that the CPF must be higher than 160 L/min for an effective cough [35]. An effective cough must be preceded by the inhalation of a sufficient air volume, and strong expiratory muscles for generating high thoraco-abdominal pressures [36]. A cough is an essential protective reflex that keeps debris out of airways and clears excessive secretions during respiratory tract infections thereby, preventing airway or pulmonary diseases such as pneumonia, atelectasis and acute respiratory failure [37].

A chronic cough persisting for months or years can eventually lead to myocardial infarction through pulmonary infection or inflammation. But usually, an acute cough lasts for less than three weeks and is caused by upper respiratory tract infection [38]. Several previous studies have examined various aspects of the airflow dynamics of coughing with human volunteers using particle image velocimetry, but had some limitations since it was designed to evaluate in a closed environment [39].

Environmental pollution, disease conditions such as pulmonary edema can retain cough in chronic state, leading to increase in pulmonary artery pressure. Suppressing the natural act of cough increases its intensity, brings difficulty in breathing, loss of taste, heart diseases, emaciation, and hiccups [9]. It is seen that chronic cough increases pulmonary artery pressure causing pulmonary hypertension leading to dyspnea on exertion (DOE) bringing morbidity in the heart [40].

3.4. Breathing

Breathing, or ventilation, consists of two phases, inspiration and expiration. During inspiration, the air travels in, through the body's conducting airway - nostrils, throat, larynx and trachea into the alveoli of the lungs. The diaphragm moves downwards and the external intercostal muscles contract. There is an increase in chest volume with lowering of air pressure as compared to atmospheric air. During a resting expiration, the diaphragm and external intercostal muscles relax, restoring the thoracic cavity to its original (smaller) volume, and forcing air out of the lungs into the atmosphere [41].

Heavy breathing, shortness of breath and exertional dyspnea are the terms commonly used for altered breathing during exercise i.e. *Shrama Shwas.* There is no mention of the suppression of breathing at rest in the literature since it is an uninterrupted activity occurring throughout one's life, but its frequency is certainly altered during exercise.

Even though spirometry and echocardiography are widely used to quantify exertional dyspnea, they are performed in a resting state and may correlate poorly during exercise. Hence, cardiopulmonary exercise testing provides a comprehensive assessment of the exercise response and reflects the influences (including interactions) of the cardiac, respiratory, musculoskeletal and hematological systems [42]. This testing provides data on respiratory gas exchange, including oxygen uptake (VO_2), and carbon dioxide output (VCO_2), tidal volume (V_T), minute ventilation (VE), and other variables such as electro and echocardiography, blood pressure and oxygen saturation. Testing can be done incrementally or at a constant work rate. Silverman et al., Kaufman et al. provides established baseline ventilation data under varying conditions of work [43].

Tang et al. used shadowgraph imaging system for breathing modalities and found the maximum visible propagation distance and derived exhalation velocities to be 0.6 m and 1.4 m/s respectively for nasal breathing, and that for mouth breathing, were 0.8 m and 1.3 m/s, respectively [26].

Breathlessness caused due to exertion, or DOE when left unattended or untreated, leads to severe shortness of breath even without exertion. The presence of dyspnea predicts long-term mortality and characterizes high-prevalence of diseases like congestive heart failure, ischemic heart disease, chronic obstructive pulmonary disease (COPD), and asthma [44]. *Shrama Shwasa* is one of the symptoms of vitiated *Praanavaha Srotas* caused due to irregular meals, injury to vital organ like the heart or *Hrdaya Marma,* leading to *Hridroga* [11,14]. Dust, smoke, wind, residing in cold places, intake of untimely and dry food, debility, severe dehydration, fever, vomiting, coryza, chest injury or any other internal hemorrhage, wasting, *Udaavarta Rogas*, anemia and intoxication are some of the factors that lead to an altered breathing pattern [19].

3.5. Expulsion of flatulence

Flatulence is flatus or gas expelled through the anus and the scientific study of this area of medicine is flatology. Out of 99% of intestinal gas only two (nitrogen and oxygen), are present in the atmosphere in appreciable amounts whereas the other three (methane, hydrogen, and carbon dioxide) result from the metabolic processes of bacterial flora in the colon [45]. In humans, the production of methane is confined to the colon, where the partial pressure of this gas reaches as high as 200 mm Hg [22].

Flatus is brought to the rectum and pressurized by muscles in the intestines. It is normal to pass flatus, though volume and frequency vary greatly among individuals. The normal range of volumes of flatus in normal individuals varies hugely between 476 −1491 ml/24 h [46].

Ayurveda refers to flatus as *Adhovayu*, where its obstruction causes bloating of gases in the abdomen as *Adhmaanam* [47]. Frequent impedance on its expulsion may lead severe cough, dyspnea on exertion, arrhythmia [48] and severe conditions like heart failure [14].

3.6. Expulsion of faeces

Human defecation is resultant of a synchronized activity that involves sensory-motor functions and is regulated by central, spinal, peripheral and enteric neural activities in a well-coordinated manner. Even though the systems involved in this mechanism initially are involuntary in nature, the concluding maneuver of an attempt to defecate is under voluntary control. Palit et al.unfolded this physiological response in four distinct phases, wherein the entire mechanism is well-coordinated, right from the basal phase to expulsive phase through pre-defecatory phase [49]. Inability to perform a coordinated movement till the phase of defecation leads to dissynergic defecation.

A trained maneuver where an adult attempting to defecate with a frequency of minimum three per day and a maximum of three per week is considered normal [50].

Ayurveda refers to this inability as *Anaha*, which is a result of excess accumulation of undigested food or faecal matter disrupting its usual downward flow redirecting it upwards causing *Hrullas* (nausea), *Hridvibandha* (arrhythmia) and obstruction in belching [51]. Suppressing the urge of feacus gives rise to *pindikodweshtana* (cramps in the leg muscles) and oppression in the heart [9].

3.7. Expulsion of secretions during orgasm (Retas)

A healthy and prolonged life expectancy lies in a secure sexual relationship whereas a chaotic sexual lifestyle, on the contrary, can lead to its adverse consequences [52].

As of date, the technology for calibrating the velocity of female orgasmic spurt/discharge has not been established. Moreover, there is an understanding that this velocity is negligible as compared to the velocity of male ejaculate. Sperm velocity and the fraction of sperm moving at that velocity can be measured objectively with a turbidimetric technique. The average sperm velocity in normal semen analysis is 96.5 mu/sec [53].

Contributors to flow impedance in the expulsion of sperm are atherogenic, high fat diet, stress factors resulting from insufficient rest or sleep. Consumption of drugs such as Sildenafil or Viagara that are popularly used for enhancing the sexual desire are found to have a serious impact on impairment of the penile vasculature or erectile failure consequently leading to severe arrhythmia. Stable, unstable angina and de-compensated heart failure are some of the consequences caused due to suppression in expulsion of spermatic fluid [54].

According to *Bruhat Trayi*, obstruction in micturation, cutting pain in the body, inguinal and scrotal hernia, urinary stones and impotence are the diseases caused due to suppression in expulsion of *Retas* [9,10,12].

3.8. Vomiting

Vomiting or emesis is the actual oral expulsion of gastrointestinal contents and is the result of contractions of the gut and the thoraco-abdominal wall musculature. Retching is the term used to describe the muscular events of vomiting without expulsion of vomitus (dry heaves). Vomiting is triggered when motor pathways get activated in the vomiting centre i.e. medulla oblongata [55].

Angina caused due to coronary artery disease is associated with nausea and vomiting [56].

Contents released out through mouth and eyes are called *Chhardi* (emesis) and A*shru* (tear) respectively. Suppression of emesis leads to morbidity in the heart through *Shwas* (breathlessness) and *kaas* (cough) [9,11]. Suppression of tears has a direct impact on heart causing CVDs [9,10]. *Chhardi and Ashru* are facilitated by *Udaana Vayu* with the help of *Vyaana Vayu*. Suppression of tears [9,10] that are influenced by emotions due to anxiety, sorrow are causative factors for vitiation of *Rasadhatu* (nourishing metabolites) and thereby disrupting *Vyaana Vayu* in heart [57].

3.9. Thirst

Trushna (thirst) is caused by aggravated *Pitta* along with *Vayu* in the soft *Taalu* (palate). *Vata, Pitta* and the *Rasavaha Dhamanis* (arteries) in the tongue causes drying up of tongue, neck and buccal cavity leading to pathologic thirst.

Chronic thirst can cause hypovolemic condition which consequently leads to arterial stiffness, endothelial dysfunctions, impaired vascular functions, cardiovascular regulation and BP regulations [58].

4. Findings in brief

Diseases of the heart i.e. *Hridrog*, abnormalities in rates and rhythm i.e. *Hridvibandha,* and *Hridayoparodha,* pain in the cardiac region i.e. *Hridpida, Hridshool and Hridvyatha*, symptoms that consequently leads to CVD like *Shwas* (dyspnea) and obstruction in inhalation i.e. *Utshwasavarodh* were the terms mainly used by the authors from *Bruhat Trayi*, to describe morbidities caused due to suppression of NU [16].

Repeated forceful initiation or inhibition of heavy breathing during exercise, belching, thirst and expulsion of semen were mentioned by all the authors from *Bruhat Trayi* that cause morbidity in the *Hrdaya* (heart). Manipulation of urges like coughing, sneezing, and vomiting consequently lead to CVDs through *Shwas* (dyspnea). Some actions like yawning, hunger, sleep, expulsion of urine are not studied here since they are referred to have a direct impact on other diseases when manipulated.

It is seen that not only different techniques were used to objectively quantify natural physiologic urges, but their terms also differ (Table 2). Sneezing, breathing and ejaculation of semen were measured in terms of velocity but their techniques used were different. Even though two different techniques were used to evaluate the intensities of belching, they were studied in terms of pressure, using esophageal electrical impedance monitoring which measured their pressure through resistance. Similarly, expulsion of flatus was also studied in two different techniques, where intestinal was-out technique quantified the intensity in terms of volumetric flow rate and anorectal manometry quantified it in terms of pressure. Some findings were obtained in terms of frequency, as in belching and expulsion of faeces.

5. Dynamics of *Vata* influencing cardiac region

Vayu when normal (unvitiated), holds up the system and organs [59]. Generally, all locomotive activities inside the body are influenced by *Vayu* [60]. It has five forms – *Praana, Udaana, Samana, Vyaana and Apaana*. Even though their subtypes are identified and characterized according to their location, all of them have the potential to influence, initiate and sustain functions related to flow and conductance [19].

5.1. Potential to influence [61]

Vayu possesses great speed and moves in all directions. It attends to functions like contraction and relaxation of voluntary or involuntary muscles and is associated with the circulation of essential nutrients or *Rasasamvahana* from the heart [62] influencing the flow of macro and micronutrients through vessels to different organs also called as *Srotas* [63]. This is facilitated by *Vyaana Vayu*. Generally, all dynamic activities are governed by *Vyaana Vayu.* It originates from the heart and performs its unique function of *Prasarana* (expansion) and *Akunchana* (contraction). *Vayu* controls and regulates the flow of metabolites; however, when vitiated, causes altered kinesis in the heart muscles, termed as *Hrd Stambhana, Hrdvibandha, Hrdvyatha and Hrdayoparodha.*

Urges such as heavy breathing [64], expulsion of *Retas* (Spermatic fluid), *Ashru* (flow of tears), *Trushna* (thirst) and *Chhardi* (emises) if voluntarily withheld, alter the function of *Vyaana* with the help of *Vayus* such as *Praana*, *Udana* and *Apaana* (Table 3), causing severe morbid conditions of the heart like stable and unstable angina [54], stress-induced CVDs [13], arterial stiffness, vascular dysfunctions [58] and de-compensated heart failure [14].

Another *Vayu* that plays a vital role in influencing and is chiefly responsible for the existence of life is *Praana Vayu*. The absence of

Table 3
Involvement of vitiated *Vayus*, responsible for causing pathologically significant actions.

Sr.No.	Altered Actions	Vitiated *Vayus* Involved
1.	Belching [12,73]	*Praana, Udaana, Apaana*
2.	Sneeze [28]	*Udaana and Praana*
3.	Cough [74]	*Udaana and Praana*
4.	Heavy breathing [64]	*Praana, Udaana and Vyaana.*
5.	Expulsion of Flatus [12]	*Apaana, Praana*
6.	Expulsion of Feacus [12]	*Apaana, Praana, Udaan*
7.	Expulsion of Sperm [56]	*Apaana, Vyaana*
8.	Tear [12,75]	*Udaana, Vyaana*
9.	Thirst [76]	*Vyaana*
10.	Emesis [57]	*Udaana,Vyaana*

Table 2
Intensities of involuntary actions during normalcy along with the techniques used.

Sr. No.	IA	Technique	Intensity (Normal values)
1	Belching	Esophageal electrical impedance monitoring	≥1000 Ω
		High resolution manometer	9–27 mmHg
2	Sneeze	Shadowgraph imaging technique	4.5 m/s
3	Cough	Tussometry	300 L/min
4	Normal Breathing Nasal/Mouth	Shadowgraph imaging technique	1.4 m/s (nasal)
			1.3 m/s (mouth)
6	Expulsion of Flatus	Intestinal washout technique	476–1491 ml/24 h
7	Expulsion of Flatus	Anorectal manometry	≥40 mmHg
8	Ejaculation of Semen	Turbidimetric technique	96.5 mu/sec

Praana in a living being or *Karmapurusha* denotes its death. The *Hrdaya* and *Mahasrotas* (lungs) are the seats of *Praana Vayu*. When normal, it attends to inspiration, swallowing and belching, but certainly gets altered if frequently suppressed. Initially the system tries to restore the mechanism, but, in case of failure, gets aggravated and vitiated. Suppressing urges like belching, heavy breathing, expulsion of flatus and faeces aggravates the *Praana Vayu* and combines with *Vayus* such as *Apaan* and *Udaan*. These aggravated *Vayus* gets vitiated leading to various morbidities of the heart such as *Hrdpida* (pain in the chest), *Shramashwas* (dyspnea on exertion) [65], ischemic heart disease [23], arrhythmia [66] and heart failure [14] [Table 3].

5.2. Potential to initiate

Any effort taken to initiate the smallest act or *Prayatna* is done by *Udaana Vayu* [67]. Movement of this *Vayu* is usually upwards, within the region of nasal passage and umbilicus. When normal, it is released out through nose and mouth. It attends to expectoration, sneezing and expiration, but gets altered consequently if manipulated. Urges such as sneezing and coughing aggravates *Udaana Vayu* leading to obstruction in the throat region vitiating *Udaana and Praana Vayus* [68]. Their flows are redirected, exerting pressure on diaphragm downwards bringing negative impact on the heart and disrupting the normal flow of *Vyaana* and *Praana Vayus* leading to disorders of the heart through pulmonary hypertension [39], aortic dissection [20] and many more [Table 3].

5.3. Potential to sustain [61]

Vayu that flows downwards is *Apaana Vayu.* It pushes the *Adhovata* (abdominal gas), *Mutra* (urine), *Shakrut* (feaces) [69] and *Retas* (semen) downwards for expulsion. *Vayu* when normal performs the above functions without any impedance and sustains health [67]; however, it gets altered and aggravated when suppressed leading to vitiation of *Apaana Vayu*, redirecting the flow in the opposite direction, exerting upward pressure on the diaphragm. This increases intra-thoracic pressure bringing a negative impact on the heart by disrupting the normal flow of *Vyaana and Praana Vayus,* and consequently leading to *Hrdvyatha* (stable, unstable angina), *Hrdayoparodh* (arrhythmia), de-compensated heart failure, and many more conditions related to CVDs [11] [Table 3].

If there is chronic impedance in flow of *Praana* and *Vyaana Vayus*, actions motivated by these *Vayus* becomes pathologic and have a direct impact on the heart leading CVDs. *Udaana Vayu* and *Apaana Vayu* first gets redirected to the opposite path, disrupting the *Praana* and *Vyaana Vayu* functions finally leading to disorders of *Hrdaya* (CVDs).

Heavy breathing after exercise is seen to be the most affected action leading to CVDs since it involves both the main *Vayus* that originate from the heart (*Praana and Vyaana Vayu*) [64]. Every human being is uniquely designed with varied endurance capacity. This in turn depends upon the energy store and its release. The energy required for exercise is derived from Adenosine Tri-Phosphate (ATP) which is generated in the cells by 3 processes - aerobic oxidation of glycogen and fatty acids, anaerobic hydrolysis of phosphocreatine and anaerobic metabolism of glycogen. Aerobic glycogen and fatty acid metabolism provide the major source of ATP and constitute the only source during moderate intensity exercise. During heavy or sustained exercise, aerobic metabolism is unable to meet the demand; consequently, anaerobic generation of ATP occurs. During exercise, heart rate, respiratory rate, VT and VE increase. VO_2 and VCO_2 rise steadily till the anaerobic threshold is reached [70]. Guidelines from Ayurveda on exercise or *Vyaayaam,* clearly correlate with this concept and indicate that one should exercise until half of his energy is consumed [71]. This altered metabolism during exercise is automatically restored after rest. Thus, the scope of voluntary altered breathing is very less after stress or exercise. But when outperformed beyond one's capacity repeatedly by forcefully switching to an anaerobic mode of respiration may induce shortness of breath even during rest leading to serious consequences of cardio-pulmonary disorders like COPD, heart failure, etc.

Initially some *Vega lakshanas* (pathologic urges) such as *Udgar Bahulya* (excessive belching), *Apaana Vayu* (release of abdominal gas) etc. occurs as a primary homeostatic mechanism in the body, restoring the disrupted *Vata* physiology; it re-expresses itself as a normal *Vega*, but may become pathologic if fail to restore. Thus, the intensity or frequency of such physiological or pathological *Vegas* if quantified, may serve as candidate markers to screen primary disruption in specific type of *Vata* physiology at an earlier phase. This may give us an approximate idea to approach strategically where a forthcoming morbidity in the heart due to disrupted *Vata* may be prevented.

There are few subtle urges like *Lobha* (greed), *Moha* (delusion), *Irshya* (jealousy), *Dwesha* (hatred), *Krodha* (anger), *Mada* (ego) etc. which are strictly advised to be held. Even though it is impossible to quantify these subtle urges as they are seated in mind, they certainly bring an impact in the *Hrdaya* through altered vascular resistance, reflected as hypertension due to stress [72].

6. Conclusion

The dynamic nature of *Vata* when encouraged to perform without any impedance, becomes a resource to inspire, influence and sustain life. Every natural urge is uniquely expressed in different intensities due to a unique locomotive property of *Vata.* The same property is also expressed during pathologic state but in altered intensities. The advancement in technology has enabled these intensities to be quantified. Studies with intensities found during normalcy can be taken as baseline to detect their altered functions. These altered functions need to be timely detected as they are influenced by many factors. As a result, they either appear as one of the symptoms or independently. Transgression of their intensity or frequency can lead to serious morbidities in the heart causing CVDs.

Attending to them on priority basis or maintaining their values within an acceptable range without manipulation and preventing them from influencing factors, would certainly enable *Vata* to sustain its function, thereby preventing the heart from possible disorders.

7. Gaps in the knowledge

a. There is a need to explore an appropriate range of intensity or frequency to classify the urges as normal physiologic or pathologic through Ayurvedic concept.
b. It is necessary to conduct a cohort study to confirm the influence of manipulation of NU on heart such as chronic history of constipation, untreated heavy breathing, chronic persistent cough or belching etc.
c. Ayurveda gives more importance on the impact of food and lifestyle modifications in metabolic disorders. Metabolomic studies on normal individuals against cardiac patients along with their details of above mentioned 14 natural urges would benefit the health care professionals to manage the issue more swiftly.
d. There is a need to provide severity scores for all the above-mentioned actions as explained in DOE in terms of New York Heart Association (NYHA) functional class. Probably

asymptomatic cardiac patients may have a history of other altered actions other than DOE.

e. There is a need for studying the variations in electrocardiogram on established CVDs with special reference to the chronic history of manipulation of natural urges.

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Conflict of interest

None.

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