Optimizing Ayurveda based Human Constituents Diagnosis by Principal Component Analysis

Thesis submitted in partial fulfillment of the requirement for the award of degree of

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in
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Declaration

I hereby declare that the report entitled ***"Optimizing Ayurveda based Human*** **Constituents** ***Diagnosis by Principal Component Analysis"*** *is an authentic record of my own work carried out as a requirement for the award of degree of M.E. (Electronic Instrumentation & Control) at Thapar University, Patiala, under the guidance of Dr. Mandeep Singh (AP, EIED) during July 2010 to July 2011.*

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It is certified that the above statement made by the student is correct to the best of my knowledge and belief.

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Abstract

Ancient Indian culture has many precious gems in its baskets. One of these invaluable gems is Ayurveda, which has been serving the mankind to maintain a healthy and disease free life. Somehow during the British rule this knowledge didn't flourish and thus gradually slipped in to oblivion. As an instrumentation engineer we often emphasize a lot on various aspect of biomedical instrumentation for diagnosis and curing the disease. Somehow we have been so far ignoring the fact that we already have a very rich database of achieving this objective in simple non invasive way, leading to quick healing. It is therefore pertinent that while we update our knowledge of latest advancement in the field of biomedical instrumentation, we also take a peep back in our own heritage and rediscover the hidden treasure. If this ancient science is made to work in conjunction with the precise instrument and vast computational power, a lot can be achieved which cannot be imagined by the so called modern medical scientists. This report introduces the concept of Ayurveda, the three Ayurvedic doshas and a questionnaire that is optimized using Principal Component Analysis (PCA). The need of this questionnaire arises from the fact that no standard questionnaire is available as such. In case we combine all the questions from the entire questionnaire available, the questionnaire so formed becomes too lengthy to be filled in by the subject. The optimized questionnaire so obtained may be used to find the Ayurvedic doshas in a subject and then validate the doshas determined using instrumental methods. This report thus may be considered as spadework for the researchers pursuing the instrumental techniques for determining Ayurvedic dosha. The thesis work results in devising four methods of dosha diagnosis, namely **Gold-Standard, Sub-Group, Minimum-Correlation and Quick-Shot** Methods. It is concluded that either **sub-group** method or **minimum correlation** method questionnaire for general use as both produce equally accurate results. In tricky situations, where the physician wants highly precise results, **comprehensive** or **gold standard** method may be used. However, for common ailments **Quick-Shot** method is recommended for faster and yet reliable diagnosis.

Keywords

Ayurveda

Doshas

Questionnaire

Human constituents

Principal Component Analysis

Chapter1 Introduction

1.1 Ayurveda

It is a holistic system of healing which evolved among the Brahmin sages of ancient India some 3000-5000 years ago.

There are several aspects of this system of medicine which distinguish it from other approaches to health care, namely,

1. It focuses on establishing and maintaining balance of the life energies within us, rather than focusing on individual symptoms.

2. It recognizes the unique constitutional differences of all individuals and therefore recommends different ailments for different types of people. Although two people may appear to have the same outward symptoms, their energetic constitutions may be very different and therefore call for very different remedies.

3. Ayurveda is a complete medical system which recognizes that ultimately all intelligence and wisdom flows from one Absolute source (Paramatman). Health manifests by the grace of the absolute acting through the laws of Nature (Prakriti). Ayurveda assists Nature by promoting harmony between the individual and Nature by living a life of balance according to her laws.

4. Ayurveda describes three fundamental universal energies which regulate all natural processes on both the macrocosmic and microcosmic levels. That is, the same energies which produce effects in the various galaxies and star systems are operating at the level of the human physiology--in your own physiology. These three universal energies are known as the Tridosha.

5. Finally, the ancient Ayurvedic physicians realized the need for preserving the alliance of the mind and body and offers mankind tools for remembering and nurturing the subtler aspects of our humanity. Ayurveda seeks to heal the fragmentation and disorder of the mind-body complex [1].

1.2 The Thirteen Natural Urges

Ayurveda calls attention to thirteen natural urges which should not be suppressed if good health and proper functioning of the body, mind and emotions are to be maintained.

- Crying
- yawning
- hunger
- thirst
- sleep
- breath (shallow)
- urination
- defecation
- ejaculation/orgasm
- flatulence
- sneezing
- belching
- vomiting

1.3 The Five Elements

Everything in the universe is made up of combinations of the Five Elements (Pancha Mahabhutas). This includes the human being which also acquires a soul or spirit. These five elements are known as:

- Space or Akasha
- Air or Vayu
- Fire or Tejas
- Water or Apa
- Earth or Prithvi

These five elements, it should be understood, derive from and are expressions of an unmanifest and undifferentiated Creative Principle, which is One. These five elements are to be understood in a material sense as well as a subtle sense.

-By **earth** we are to understand not only the terrain of our planet or the iron in our red blood cells and spleen, but also the quality of steadfastness of mind, strength of one's moral fiber, one's slow and quiet undeterred advancement towards a goal, and the resistance to the manifestations of others.

-By **wate**r we mean to imply the cohesive aspects of reality which flows into and holds things together, perfectly and simply witnessed in the ubiquitous H_2O molecule. And the other elements too were intended by the ancient vaidyas (physicians) to communicate the essential universal principle inherent in a particular element.

-By **fire** we mean the universal force in nature that produces heat and radiates light; it is our passion to pursue despite obstacles and delays; it is what burns away the cloak of ignorance (avidya) and allows the Truth to shine with brilliance. Fire removes doubt from the mother-substance of human heart and replaces it with joy.

-**Air** is that transparent, rarefied, kinetic force which sets the universe in motion; it moves the blood through the vessels, wastes from the body, thoughts through the mind; it moves the birds to warmer climates in winter, it moves the planets around their suns.

-**Space** is the subtlest of all elements which is everywhere and touches everything; in the mind it is the vessel which receives all impressions, in the heart space accepts love; space is receptivity and non-resistance to what is true.

Thus these Five Subtle Elements (Pancha Mahabhutas) form the basis for all things found in the material creation, from a grain of sand to the complex physiology of every human being. Balancing these elements in just the right way for each unique individual is the key to maintaining health and treating disease should it arise, whether it be physical, mental, or spiritual.

1.4 The Four Forces

Humans are considered miniature versions of the universe, composed of the five elements and four forces:

- atma - soul
- manas - mind
- kala - cycles of time
- indriyas - senses

1.5 The Digestive Fire

Agni is the Vedic term meaning transforming or burning. It is composed of different types of enzymes responsible for good digestion.

There are four types of agni:

- sama - balanced digestion, no after effects
- vishama - irregular, gas, bloating, distention
- tikshna - sharp, hyper, acid reflux, heartburn
- manda - slow digestion, heavy, dull

When agni is not functioning at an optimal level, ama, the by product of undigested food turns to toxic waste clogging the channels. In due time, this will lead to a state of disease. It is of paramount importance to keep your digestive fire strong throughout your entire life.

1.6 How the food we eat affects us

Food choices are an important aspect of Ayurvedic healing and contribute greatly to the formation and function of the doshas and dhatus.

Strategies for healthy eating habits include:

- Maintaining a strong digestive fire
- Proper eating schedule
- Correct quantity of food

- Proper food combinations
- Proper liquid consumption
- Organic food –no genetically modified food
- Preparation of food
- Dosha specific spices/ herbs
- Food in season
- Environment
- Anti Ama Diet – non toxic food sources

1.7 The Seven Dhatus

The word dhatu comes from the root word dha which means basis or foundation. In Ayurvedic medicine, the structural components that nourish the body are called dhatus or tissue levels. There are seven primary sapta dhatus:

- rasa – plasma tissue, lymph
- rakta – blood, red blood cells
- mamsa – muscle
- meda – adipose tissue, fat
- asthi – bone and cartilage
- majja – nerve, marrow, connective tissue
- shukra/artava – male and female reproductive system

Problems that occur in the dhatus are:

- Insufficient nourishment
- Over nourishment

• Structural damage

1.8 Ayurvedic Digestion

During the process of digestion each dhatu is supplied and nourished with refined nutrition to carry our physiological tasks in the body; what is left over becomes the waste product or mala.

- Ahararasa, pure essence is refined, digested food; the waste becomes faeces and urine.
- Rasa dhatu (plasma tissue) is supplied with the nutritive essence of refined, digested food; the mala of rasa is mucus.
- Rakta (blood) is obtained from refined rasa; the mala of the blood is bile.
- Mamsa (muscle tissue) is formed from refined rakta; the mala of mamsa is excrement from the eyes, nose and ears.
- Meda (adipose tissue) is formed from refined mamsa. The mala from the fat tissue is sweat.
- Asthi (bone tissue) is formed from refined meda, the mala is body hair and nails.
- Majja (marrow) is formed from the refinement of the bone; the mala is tears.
- Refinement of marrow produces shukra dhatu or artava dhatu for offspring. The mala is ojas.
- Refined ojas is the energy reserves of the body and generates no mala. It is decreased by: anger, fear, worry, sorrow, overwork, drugs, pollution and unhealthy food.
- Rasa and ojas forms a concentric circle that turns back on itself to nourish the entire body and all the dhatus.

It takes approximately 35 days after food is ingested to go through all the dhatu levels. Ojas is the essence of the seven dhatus and is created when shukra is properly formed from the action of all the dhatu agnis.

If there is any malfunction in the process, ojas, will not receive proper nourishment as the preceding dhatus will obtain the nutrition first.

The most important means of supporting ojas is maintaining a holistic lifestyle with proper diet, rest, exercise and meditation. Ojas is responsible for physical and mental strength, inner and outer beauty, a powerful immune system and strong aura.

1.9 The Malas

A mala is something that is to be excreted. Malas can be excessive, deficient, or polluted. There are three types of malas:

- urine
- faeces
- sweat

1.10 The Srotas

Srota or srotasmi is another word for pathway or channel and is also described as “ducts.” There are 14 srotas that affect the physical structures:

- respiratory system
- digestive system
- water system (intake and distribution)
- lymphatic system
- circulatory system
- muscular system
- adipose system
- skeletal system
- nervous system

• reproductive system

• sebaceous system

• excretory system

• urinary system

• menstrual system

• lactation system

• mind – emotions, sensory impressions, thoughts

According to Charak, keeping the srotas free from obstructions is the key to health.

However, the srotas may ultimately be affected in the following ways:

• deficiency, weakness or too little of a substance

• excessiveness, agitation or drainage

• blockage of flow, obstruction, by passed

• overflow of substances that appear where they should not

1.11 Misuse of the Senses

Further, the body and mind can be affected by how we use our sensory organs and the daily activities we follow. Our mind can be negatively affected by what is seen, felt or heard.

Treatment may involve carefully regulating what is acceptable to the sensory field. There is also an additional possibility for disease or disorders to arise due to these factors:

• overworking

• strenuous physical work

• misuse of the intellect

• over talking, over thinking, over doing

- dwelling on negativity, over reacting
- excess sexual activity
- too much TV, cell phones, computers

1.12 The Disease Process

Ayurvedic literature discusses a series of six steps outlined in the disease process. Samprapti or pathogenesis is the result of the accumulation of the doshas:

- Accumulation – accumulation of the dosha in its primary site; vata-colon, pitta-small intestine, kapha- stomach. This initial stage occurs usually due to dietary factors and is the starting place for the disease process.
- Aggravation – excitation of the accumulated doshas, whereby the doshas leave their normal site.
- Overflow – original site is full and disperses to a new site where it begins to get worse.
- Relocation – disturbances move to wherever a weak site exists.
- Manifestation – disease becomes apparent by which western medicine can identify it by name at this stage.
- Chronic – last stage where complications set in, distinction of the disease manifests at other sites simultaneously leading to a chronic diseased state or the passing away of the person.

1.13 The Tridosha Theory

The Ayurvedic understanding of the universe is based on a three-fold system called the "tridosha theory."

The five elements integrate into physical form as the three doshas. Everyone is a unique combination of the three doshas known as: vata, pitta and kapha.

Vata, pitta and kapha are found in every cell, tissue and organ in different degrees. Your distinct prakruti or individual constitution is established by pulse diagnosis, observation and personal health history. These are important steps to understanding your basic qualities, tendencies and needs. There are seven constitutional types:

- vata
- vata/pitta
- vata/kapha
- pitta
- pitta/kapha
- kapha
- vata-pitta-kapha (tridosha)

1.13.1 The Doshas

- Vata is composed of the ether and air elements. Vata is responsible for movement in the body and mind. Balanced Vata produces flexibility and a balanced mind. Out of balance Vata is fearful, anxious and nervous.

- Pitta is composed of fire and water. Pitta functions are associated with the digestive processes, metabolic activity and body temperature. Balanced Pitta lends itself to intelligence and leadership. Out of balance it expresses itself as anger, hatred and jealousy.

- Kapha is composed of earth and water. Kapha corresponds to the building up of body tissues and stored substances. Kapha lubricates, moistens and maintains immunity. Balanced Kapha is love and forgiveness. Out of balance Kapha is associated with attachment, greed and congestion.

- Tridosha is a combination of all three doshas; Vata, Pitta and Kapha [2].

1.13.2 Imbalances of the Doshas

Tables 1.1-1.3 show effects of the balance, imbalance and aggravating vata, pitta and kapha dosha respectively. Table 1.4 shows the effects of taste and food qualities on Doshas.

Table1.1: Effect of balanced & imbalanced **vata** dosha and factors aggravating **vata** dosha.

Effect of balanced dosha	**Effect of imbalanced dosha**	**Factors aggravating dosha**
Exhilaration	Rough skin	Excessive exercise
Clear and alert mind	Weight loss	Wakefulness
Perfect functioning of bowels and urinary tract	Anxiety, worry	Falling, bone fractures
Proper formation of all bodily tissues	Restlessness	Tuberculosis
Sound sleep	Constipation	Suppression of natural urges
Excellent vitality and immunity	Decreased strength	Cold
	Arthritis	Fear or grief
	Hypertension	Agitation or anger
	Rheumatic disorder	Fasting
	Cardiac arrhythmia	Pungent, astringent, or bitter Foods
	Insomnia	In USA: Late autumn and winter In India: Summer and rainy Season
	Irritable bowel syndrome	

If a person is physically healthy, the three doshas are present in appropriate proportions and in an organized way. If a person is unhealthy, at least one or more of the doshas may be relatively deficient or excessive, so that its quality becomes adulterated.

If a person is physically healthy, the three doshas are present in appropriate proportions and in an organized way. If a person is unhealthy, at least one or more of the doshas may be relatively deficient or excessive, so that its quality becomes adulterated.

Vitiation is a term used to describe aggravation in relationship to doshic imbalance. The term vikruti, is the state of imbalance in the doshas. Awareness is crucial in recognizing vikruti to stave off tendencies leading to illness or disease.

Table1.2: Effect of balanced & imbalanced **pitta** dosha and factors aggravating **pitta** dosha.

Effect of balanced dosha	**Effect of imbalanced dosha**	**Factors aggravating dosha**
Lustrous complexion	Yellowish complexion	Anger
Contentment	Excessive body heat	Strong sunshine
Perfect digestion	Insufficient sleep	Burning sensations
Softness of body	Weak digestion	Fasting
Perfectly balanced heat and thirst Mechanisms	Inflammation	Sesame products, linseed
Balanced intellect	Inflammatory bowel diseases	Yogurt
	Skin diseases	Wine, vinegar
	Heartburn	Pungent, sour, or salty foods
	Peptic ulcer	In USA: Summer and early autumn In India: Rainy season and Autumn
	Anger	

Each of the doshas has an important location that is considered its major site. These sites are where *vitiation* is most likely to occur.

Vata is located in the large intestine.

Pitta is located in the small intestines.

Kapha is located in the stomach.

Table1.3: Effect of balanced & imbalanced **kapha** dosha and factors aggravating **kapha** dosha.

Effect of balanced dosha	**Effect of imbalanced dosha**	**Factors aggravating dosha**
Strength	Pale complexion	Sleeping during daytime
Normal joints	Coldness	Heavy food
Stability of mind	Laziness, dullness	Sweet, sour, or salty foods
Dignity	Excessive sleep	Milk products
Affectionate, forgiving nature	Sinusitis	Sugar
Strong and properly proportioned Body	Respiratory diseases, asthma	In USA: Spring In India: Late winter and spring
Courage	Excessive weight gain	
Vitality	Loose joints	
	Depression	

Table1.4: Tastes and Food Qualities: Effects on the Doshas.

Effects **Qualities**	Decrease vata	Increase vata	Decrease Pitta	Increase Pitta	Decrease Kapha	Increase Kapha
Tastes	Sweet	Pungent	Sweet	Pungent	Pungent	Sweet
	Sour	Bitter	Bitter	Sour	Bitter	Sour
	Salty	Astringent	Astringent	Salty	Astringent	Salty
Food	Heavy	Light	Cold	Hot	Light	Heavy
	Oily	Dry	Heavy	Light	Dry	Oily
	Hot	Cold	Oily	Dry	Hot	Cold

1.13.3 Common Examples of the Six Tastes and Major Food Qualities:-

Six Tastes and Common Examples:

Sweet: sugar, milk, butter, rice, breads

Sour: yogurt, lemon, cheese

Salty: salt

Pungent: spicy foods, peppers, ginger, cumin

Bitter: spinach, other green leafy vegetables

Astringent: beans, pomegranate

Six Major Food Qualities and Common Examples:

Heavy: cheese, yogurt, wheat products

Light: barley, corn, spinach, apples

Oily: dairy products, fatty foods, oils

Dry: barley, corn, potato, beans

Hot: hot (temperature) foods and drinks

Cold: cold (temperature) foods and drinks [3]

1.13.4 More Insights on the Tridosha:-

Doshas are of two varieties:-

1. saririka (bodily)
2. manasika (psychological, of the mind).

This is often a point of great confusion in Ayurvedic circles. Let's have a closer look at these.

The saririka doshas are Vata, Pitta, and Kapha. They are what we mean when we use the term "tridosha". They are material in form, yet can manifest in aspects of mind as well. Generally, they are intimately connected to physical activities.

The manasika doshas are Rajas, Tamas and Sattva. These are often referred to as the three gunas, or three qualities, of the mind. Manasika doshas have reference only to the mind and mental activities.

- Sattva (pure essence)

- Rajas (movement)
- Tamas (inertia)

-These are the universal qualities within all existence and are contained in prakruti.

-When their equilibrium is disturbed, there is an interaction of the gunas which thus engenders the evolution of the universe.

- Sattva is creative potential (brahma)
- Rajas is kinetic protective force (vishnu)
- Tamas is resistance to change or potential destructive force(Mahesh)

These are 3 manifestation of first cosmic soundless sound "AUM" which are constantly operating in the universe.

Rajas is the active vital life force in the body which moves both the organic and inorganic universal aspects to sattva and tamas, respectively. So sattva and tamas are inactive , potential energies that requires the active , kinetic force of rajas

- First expression of prakruti is MAHAD (intelligence)
- This further forms AHAMKARA (ego , the sense of "I AM")
- AHAMKARA with sattva and rajas forms five senses , five motor organs and mind (organic universe)
- AHAMKARA with tamas and rajas forms five basic elements (space,air,fire,water and earth) to create inorganic universe.

An intimate inter-relationship exists between these two types of doshas. In fact, according to Charaka, derangements in one arena is always accompanied by changes in the other.

However, greater importance is attributed to the tridosha (bodily doshas: Vata, Pitta, and Kapha) as the primary causative agents of disease. For every individual, each dosha has a unique quantity (pramana), quality (guna), and action (karma) in the physiology. Equipoise of these three attributes with respect to an individual engenders health. When this balance is disturbed through indulgence in foods and habits which are similar in nature to a specific dosha, this causes vriddhi--increase--in that dosha; food and habits of a dissimilar nature to

that dosha will likewise cause its kasaya, or decrease. This is the Ayurvedic doctrine of "like increases like".

Example:- Thus if you are cold and you drink iced water or eat ice cream, you will become colder; similarly if you are hot and you consume cayenne peppers or other pungent tastes, you will become hotter. Or if you are dry and you spend a long period of time in a strong wind, you will lose more moisture due to evaporation and become drier. If these examples seem simple and common sense, then you have learned an important feature of Ayurvedic wisdom: its always simple and intuitive

1.14 Source of all existence

Ayurveda is a science of daily living and this system of knowledge evolved from the **rishi's** practical, philosophical and spiritual illumination, which are rooted in their understanding of creation. They perceived how cosmic energy manifests in all living and non-living things .They also realized that the source of all existence is universal consciousness, which manifests as male and female energy - Purusha and Prakruti.

1. Purusha- male energy which is formless, colorless and takes no active part in creation. It witnesses the creation.
2. Prakruti- female energy which yields form, color, and attributes in field of action. It Creates all forms in universe

1.15 Seasonal Effect on Doshas

The rotation of earth and its movement about its axis are responsible both for sunshine and sunset, creating chronological time and for the seasons, creating seasonal time. The season is called rutu. Table 1.5 and figure 1.1 shows the seasonal effect on doshas [4].

There are 6 basic rutus :

1. Vasanta 2. Grishma

3. Varsha 4. Sharada

5. Hemanta 6. Shishira

Table 1.5: Seasonal effect on doshas

SEASON	PITTA	VATA	KAPHA
Spring	May stimulate	Can normalize	Increases
Summer	Increases	Can normalize	Decreases
Rainy weather	Decreases	May stimulate	Can normalize
Autumn	Can normalize	Increases	Can normalize
Winter	Can normalize	May stimulate	May stimulate
Late winter	Can normalize	Decreases	May stimulate

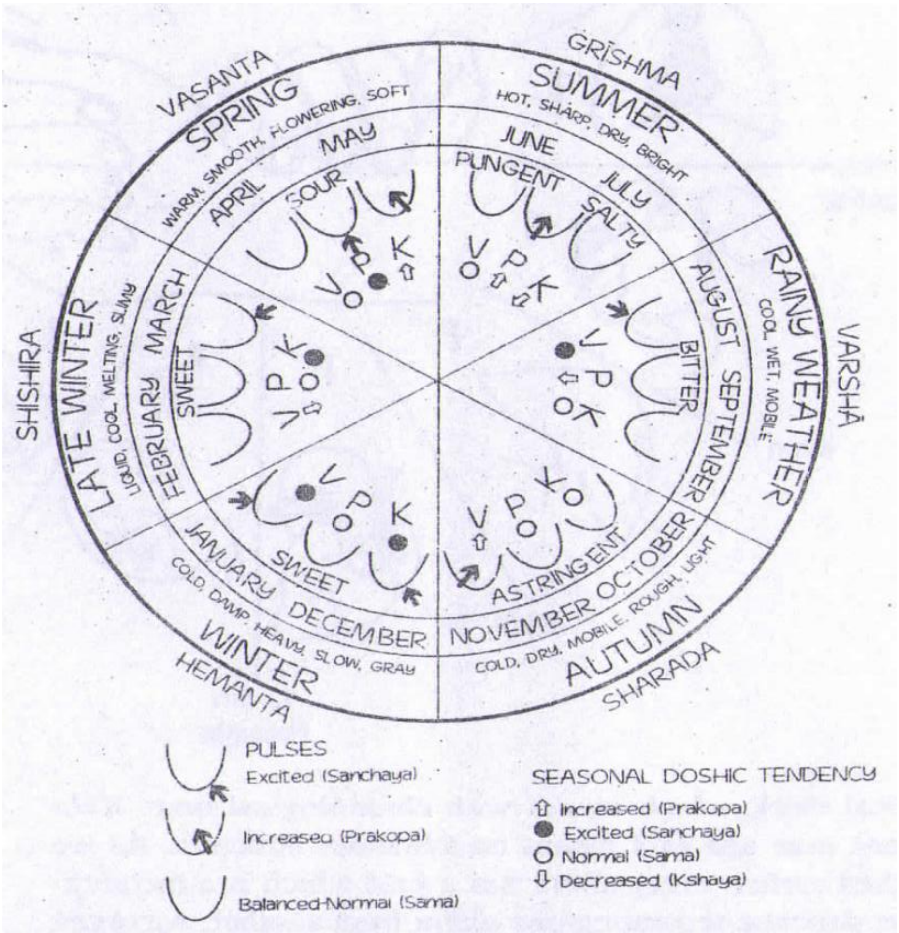

Figure 1.1: Seasonal effect on dosha

1.16 Diagnosis of Ayurvedic Dosha

There are many techniques to find out the doshas. All of them are non-invasive and reveal much information about underlying imbalances and about specific illnesses. Chief among these techniques is:-

- Nadi vigyan (pulse diagnosis).
- Dosha self-test.

1. **Nadi vigyan (pulse diagnosis)**

This allows one to retrieve detailed information about the internal functioning of the body and its organs through signals present in the radial pulse. This information involves not only the cardiovascular system but other bodily systems as well. From the pulse, the diagnostician gains information about the functioning of the bodily tissues, the state of the doshas, and much more. Pulse diagnosis reveals early stages of imbalance that precede full-blown symptoms. In this and other MAV diagnostic modalities, perceiving the body as a pattern of intelligence enables physicians to retrieve enormous amounts of information in a non invasive manner.

2. **Dosha self-test**

A questionnaire was designed, using a comprehensive list of 83 features for identification of one's prakrati. Each question had three choices for response that corresponded to the concerned feature's quality or characteristic for vata, pitta, and kapha, respectively.

1.17 Lifestyle Recommendations

Ayurvedic texts recommend the principle of opposites for reducing the level of a dosha that has become aggravated. Since the characteristics of Vata include dryness, coolness, roughness, lightness and constant motion, qualities that are opposite to these in diet and lifestyle help restore balance to Vata dosha.

1.17.1 Lifestyle Recommendations for Vata Dosha

1. Since Vata dosha is characterized as restless, constantly in motion and irregular, the primary lifestyle recommendation for balancing Vata is to maintain a regular routine.

That means rising and going to bed at roughly the same times each day, eating three meals at about the same times each day, and following a similar pattern of work and rest from day to day.

2. Do not skip meals. Eat a nourishing lunch at mid-day and lighter meals at breakfast and dinner. Sit down to eat each meal, eat in a peaceful atmosphere with your attention on your food, and sit quietly for a few minutes after your meal. If your digestive fire is irregular, practicing these eating habits will help make it more regular.

3. Daily elimination is very important to prevent ama from accumulating in the body. Triphala Rasayana helps promote regularity as well as toning the digestive system. Since Triphala is gentle, not habit forming and not depleting, it can be taken indefinitely to maintain regularity.

4. To pamper dry skin, to promote circulation and to nourish and tone muscles and nerves, indulge in an ayurvedic massage every morning before you bath or shower. Use almond or jojoba oil for your massage. If you like, you can add 3-4 drops of a pure essential oil such as lavender or sweet orange to 2 oz. of massage oil. Mix well before use. Two or three time a week, massage your scalp with warm oil, and let the oil stay for an hour or two before you shampoo. After your shower or bath, apply a generous coating of a pure, gentle moisturizer all over your body to keep your skin feeling smooth all day long.

5. Protect yourself from the cold and wind. Stay warm and toasty in cold weather by wearing several layers of clothing. Wear a cap and scarf when you go out to protect your ears and throat. Wear lip balm to prevent lips from getting dry and chafed.

6. Walking is the ideal exercise for balancing Vata. Walk in the early morning, for about 20 minutes every day.

7. You may have to woo sleep if Vata dosha is aggravated. It is important to get to bed early, so that you can get adequate rest each night. A cup of warm milk, with a pinch of nutmeg, can be helpful before bedtime.

8. Set aside about 30 minutes each day for meditation, to help calm the mind and enhance body-mind-spirit coordination.

Ayurvedic texts recommend the principle of opposites for reducing the level of a dosha that has become aggravated. Since the characteristics of Pitta include sharpness, heat, and acidity, qualities that are opposite to these in diet and lifestyle help restore balance to Pitta dosha.

1.17.2 Lifestyle Recommendations for Pitta Dosha

1. The primary lifestyle recommendation for balancing Pitta is to stay cool--both physically and emotionally. Avoid going out in the heat of the day, especially on an empty stomach or after you have eaten tangy or spicy foods. Avoid exercising when it's hot. Walk away from situations that make you see red.

2. Do not skip meals, do not fast and do not wait to eat until you are ravenously hungry. Start your day with cooked fruit, followed by some cereal. Eat a sustaining meal at lunch, and a lighter meal for dinner. For snacking, choose sweet juicy fruit--fully ripe mangoes, sweet pears and sweet juicy grapes are excellent Pitta-pacifying choices. Delaying meals can cause excess acidity, so eat on time every day. The Amalaki Rasayana helps enhance digestion without aggravating Pitta dosha. It also helps balance stomach acid.

3. Daily elimination is very important to prevent ama from accumulating in the body. Triphala Rasayana helps promote regularity as well as toning the digestive system. Since Triphala is gentle, not habit forming and not depleting, it can be taken indefinitely to maintain regularity.

4. To soothe sensitive skin, to balance the emotions and to nourish and tone muscles and nerves, indulge in an ayurvedic massage every morning before you bath or shower. Use coconut oil for your massage. If you like, you can add 3-4 drops of a pure essential oil such as lavender or rose to 2 oz. of massage oil. Mix well before use. Two or three time a week, massage your scalp with warm oil, and let the oil stay

for an hour or two before you shampoo. After your shower or bath, apply a pure, gentle moisturizer all over your body or spray your skin with pure rose or sandalwood water to keep your skin feeling cool all day long.

5. Protect yourself from the heat. Stay cool in warm weather by wearing loose cotton clothing. Wear a wide-brimmed hat and sunglasses to protect your eyes when you go out. Drink lots of room temperature-water.

6. Water-based activities are ideal exercise for Pitta-dominant people. Try swimming or aqua-aerobics to stay fit but cool. Strolling after sunset, especially along a waterfront, is also a soothing way to fit some leisurely activity into your day.

7. If Pitta dosha is out of balance, you may find that you can fall asleep without much trouble, but you wake up in the very early hours and find it difficult to get back to sleep. It is important to get to bed early, so that you can get adequate rest each night. A cup of warm milk, with some cardamom, can be helpful before bedtime.

8. Balance work and play. Set aside some time for Rest & Recreation every day, and do not get so absorbed in a project that you are unable to detach from it.

9. Set aside about 30 minutes each day for meditation, to help balance the heart and emotions and to enhance body-mind-spirit coordination.

Ayurvedic texts recommend the principle of opposites for reducing the level of a dosha that has become aggravated. Since the characteristics of Kapha include heaviness, softness, sweetness, cold, stability and unctuousness, qualities that are opposite to these in diet and lifestyle help restore balance to Kapha dosha.

1.17.3 Lifestyle Recommendations for Kapha Dosha

1. The primary lifestyle recommendation for balancing Kapha is to get moving. Physically, get some exercise every single day. Mentally, challenge yourself with new activities—learn a new skill, solve some puzzles or take a class. Emotionally,

welcome new relationships in your life by making it a point to meet people—volunteering comes naturally to the caring Kapha nature and can provide a forum for building nurturing new bonds.

2. Do not skip meals, and do not fast. The Kapha digestive agni tends to be low, as does appetite, and not eating on time slows down the metabolism even more. Start your day with a light breakfast. Eat a sustaining meal at lunch, and a lighter meal for dinner.

3. Daily elimination is very important to prevent ama from accumulating in the body. Triphala Rasayana helps promote regularity as well as toning the digestive system. Since Triphala is gentle, not habit forming and not depleting, it can be taken indefinitely to maintain regularity.

4. Deep-cleanse oily skin twice a day with a natural cleanser to rid the skin of surface impurities and grime. Once a week, exfoliate your skin with a cleansing scrub. Shampoo your hair every other day at least with a gentle natural shampoo. The ayurvedic oil massage, performed each morning before your shower or bath can help dislodge embedded toxins and increase natural energy levels.

5. Protect yourself from the damp and cold. Drink lots of warm water, infused with warming spices such as turmeric, dried ginger and black pepper.

6. Vigorous activities are ideal exercise for Kapha-dominant people. Exercise everyday for best results, but without overstraining. Racquetball, singles tennis, jogging and aerobics are good activity choices for balancing Kapha. Exercise in the morning if you can to get a good charge for the day ahead.

7. If Kapha dosha is out of balance, you'll tend to feel tired even after a solid ten hours of uninterrupted sleep. Go to bed early and wake up really early in the morning, definitely before sunrise, to improve the quality of your rest.

8. Add zest to your life by consciously incorporating variety and new experiences into your life. Travel, meeting new.

9. Set aside about 30 minutes each day for meditation, to help balance the heart, mind and emotions and to enhance body-mind-spirit coordination [5-7].

1.18 Dietary Recommendations

One of the most unique facets of Ayurvedic dietetics is that different foods from each food groups are recommended for different Ayurvedic Constitutional Types. Table 1.6 shows the Dietary Recommendations for vata, pitta and kapha.

"Often" in this context means consuming these foods **every day** would be fine.

"In Moderation" means that you should consume approximately **one-third to one-half** the amount of these foods as you do the "Often" foods. These foods are an important part of your diet in the proper amounts.

"Seldom" means about **once a month** [8].

Table1.6: Dietary Recommendations for vata, pitta and kapha

The Vata Diet

Fruits

Often		**In Moderation**	**Seldom**
Apricot	Mango	Apples	Dried Fruits
Avocado	Melons (sweet)	Sour sop	Cranberries
Bananas	Oranges	Strawberries	Pears
Berries(all)	Papaya		Persimmon
Cherries	Peaches		Pomegranate
Coconut	Pineapples		Prunes
Dates	Plums		Quince
Figs(fresh)	Raisins(soaked)		
Grapefruit	Rhubarb		
Grapes	Watermelon		
Kiwi	Limes		
Lemons			

Vegetables

Often		**In Moderation**	**Seldom**
(cooked vegetables)	Radish	Broccoli	(cooked vegetables)
Acorn Squash	Rutabaga	Cauliflower	Radish
Artichokes	ScallopiniSquash	Fresh Corn	Broccoli
Asparagus	Summer Squash	Peas	(frozen,dried,raw
Beets	Watercress	Potatoes(white)	vegetables)
Butternut Squash	Winter Squash	Spinach	Beet Greens
Carrots	Yellow Squash	Tomatoes	Brussels Sprouts
Cucumber	Zucchini		Burdock Root
Daikon Radish	Turnips		Cabbage
Fenugreek Greens	Turnips Greens		Celery
Green Beans(well cooked)			Eggplant
Olives(black & green)			Jerusalem Artichoke
Onion(cooked)			Jicama
Parsnip			Kohlrabi
Potato(sweet)			Leafy Greens
Pumpkin			Lettuce
Spaghetti Squash			Mushrooms
Sprouts			Onions (raw)
			Parsley
			Peppers

Sweeteners

Often	**In Moderation**		**Seldom**
None	Barley Malt Syrup	Jaggery	White Sugar
	Brown Rice Syrup	Maple Syrup	
	Fructose	Sucanat	
	Most Fruit Juice	Sugar Cane Juice	
	Concentrates	Stevia	
	Honey		

Condiments

Often		In Moderation	Seldom
Black Pepper	Onion(cooked)	Cardamom	None
Coconut	Orange Peel	Cayenne	
Coriander Leaves	Oregano	Cloves	
Cottage Cheese	Paprika	Parsley	
Grated Cheese	Peppermint	Poppy Seeds	
Daikon Radish	Pippali	Thyme	
Dulse	Rosemary	Neem Leaves	
Garlic	Rosewater		
Ghee	Saffron		
Ginger(fresh)	Sage		
Gomasio	Savory		
Hijiki	Spearmint		
Horseradish	StarAnise		
Kelp	Tamarind		
Kombu	Tarragon		
Lemon	Turmeric		
Lime	Vanilla		
Lime Pickle	Wintergreen		
Mango Chutney	Mint Leaves		
Mango Pickle			

Dairy

All dairy is acceptable in moderation.

Often		In Moderation	Seldom
Buttermilk	Soft Cheese	Goat's Milk (liquid)	Goat's Milk (powdered)
Cow's Milk	Goat Cheese	Ice Cream	
Hard Cheese	Yogurt	Sour Cream	Cow's Milk

Grains

Often	In Moderation	Seldom	
Amaranth	Barley	(cold, dry, puffed	Oat Bran
Oats (cooked)	Corn	cereals)	Quinoa
Rice	Wheat Bran	Buckwheat	Rice Cakes
Wheat		Millet	Rye
		Oats(dry)	Granola

Animal Food

Often		In Moderation	Seldom
Beef	Red Snapper	Freshwater Fish	Lamb
Blue Green Algae	Swordfish	Shellfish	Pork
Chicken	Turkey (white meat	Shrimp	Rabbit
Mahi	Tuna		Venison

Legumes

Often	In Moderation	Seldom	
Adzuki Beans	Black Beans	Black Eyed Beans	Soy Powder
Black Lentils	Common Lentils	Chana Dal	Split Peas
Mung Beans	Lima Beans	Garbanzos	Tempeh
Red Lentils	Soy Bean	Kala Chana	White BeansS
Soy Milk (liquid)		Kidney Beans	
Tepery Beans		Navy Beans	
Tofu		Pinto Beans	
Tur Dal		Soy Flour	

Nuts

Often		**In Moderation**	**Seldom**
Almonds Black Walnuts Brazil Nuts Cashews Coconut	English Walnuts Filberts (Hazelnuts) Macadamia Nuts Pecans	Peanuts Pine Nuts Pistaschios	None

Seeds

Often		**In Moderation**	**Seldom**
Chia Flax Sesame	Pumpkin Sunflower	Psyllium	None

Oils

All oils are fine, especially sesame, olive and flaxseed

Beverages

Often		
Almond Apricot Juice Banana Shake or Smoothie Carrot Juice Carrot-Veg Combinations Carrot-Ginger Juice	Cherry Juice Coconut Milk Dairy Drinks (hot) Date Shake Grain Teas (Cafix,Roma,Pero) Grape Juice	Grapefreuit Juice Lemonade Mango Juice Milk (hot,spiced) Miso Broth Mixed Vegetable Juice

Often	**In Moderation**	**Seldom**	
Orange Juice Papaya Juice Peach Nectar Pineapple Juice Salted Drinks Sour Juices & Teas Soy Milk well spiced & hot Herb Teas (Ajwan,Bansha w/ milk & sweetener,Basil,Catnip,Cinna-mon,Elder Flowers,Eucalyptus, Fennel,Fenugreek,Ginger(fresh) Ginseng,Hawthorne,Hyssop, Juniper Berries,Lavender,Lemon Balm,Lemon Grass,Licorice,Lotus Marshmaflow,Oat Straw,Orange Peel,Osha,Peppermint,Red Zinger Roseflowers,Rosehip,Saffron, Sarsaparilia,Sassafras,Spearmint Wild Ginger)	Alcohol Aloe Vera Juice Berry Juice Chocolate Herb Teas (Chamomile,Cloves,Comfrey,Jasmine,Raspberry, Sage,Yarrow)	Apple Juice Pear Juice Caffeine Pomegranate Juice Carob Prune Juice Carbonated Drinks V-8 Juice	Coffee Cranberry Juice Dairy Drinks (cold) Ice Cold Drinks Herb Teas (Alfalfa,Barley, Blackberry,Borage,Burdock, Cranberry Juice Chrysanthemum,Corn Silk,Dandelion, Hibiscus,Hops, Mormon Dairy Drinks (cold) Tea,Nettle,Passion Flower,Red Clover,Strawberry,Violet,Wintergreen Ice Cold Drinks Yerba Mate)

The Pitta Diet

Fruits

Often		**In Moderation**	**Seldom**
Apple (sweet)	Pears	Apples (sour)	Apricots (sour)
Apricots(sweet)	Pineapples	Bananas	Berries (sour)
Avocado	Plums(sweet)	Cherries	Grapefruit
Berries (sweet)	Pomegranates Prunes	(sweet)	Lemons
Coconut	Quince(sweet)	Cranberries	Oranges (sour)
Dates	Raisins	Grapes (green)	Pineapples (sour)
Figs	Raisins	Kiwi	Persimmon
Grapes (sweet)	Watermelon	Limes	Plums (sour)
Mango		Papaya	Rhubarb
Melons		Peaches	Soursop
Oranges (sweet)			Strawberries

Grains

Often		**In Moderation**	**Seldom**
Barley	Wheat Bran	Amaranth	Buckwheat
Oats (cooked)	Wheat Granota	Corn	Millet
Rice (basrnati)		Oats(dry)	Oat Granola
Rice Cakes		Oat Bran	Quinoa
Rice (white)		Rice(brown)	Rye Wheat

Vegetables

Often		**In Moderation**	**Seldom**
Acorn Squash	Mushrooms	Beets	Beet Greens
Artichoke	Okra	Carrots	Fenugeek Greens
Asparagus	Olives(black)	Daikon Radish	Garlic
Bell Pepper	Parsley	Eggplant	Horseradish
Brocolli	Parsnip	Leeks (cooked)	Green Olives
Brussel Sprouts	Peas	Spinach	Kohlrabi (cooked)
Burdock Root	Peppers(green)		Mustard Greens
Butternut Squash	Potatoes (sweet or white)		Onions (cooked & raw)
Cabbage	Rutabaga		Peppers (hot)
Fresh Corn	Scallopini Squash		Pumpkin (cooked)
Cauliflower	Spaghetti Squash		Radish
Cucumber	Sprouts		Tomatoes
Celery	Summer Squash		Turnips
Green Beans	Watercress		Turnip
Jerusalem Artichoke	Winter Squash		Greens
Jicama	Yellow Crookneck Squash		
Leafy Greens (esp.Collards & Dandelion)	Zucchini		

Animal Foods

Often	**In Moderation**	**Seldom**	
Chicken or Turkey (white meat)	Egg Yolk	Beef	Pork
Egg White	Rabbit	Duck	Shellfish
Freshwater Fish	Shrimp	Lamb	Venison

Legumes (all are recommended "**Often**")

Often			
Aduki Beans	Chana Dal	Black Lentils	Tofu
Kidney Beans	Lima Beans	Navy Beans	Kala Chana
Soy Beans	Soy Powder	Tempeh	Red Lentils
Black Beans	Black Eyed Beans	Garbanzos	Urad Dal
Lentils	Mung Beans	P nto Beans	White Beans
Soy Products	Split Peas		

Nuts

Often	**In Moderation**	**Seldom**
Coconut	Almonds	Black Walnuts
	Macadamia Nuts	Brazil Nuts
	Pecan	Cashews
	Pine Nuts	English Walnuts
		Filberts (Hazelnuts) Peanuts
		Pistachios

Seeds

Often	**In Moderation**	**Seldom**
Psyllium	Flax	None
Pumpkin		
Sunflower		
Sesame		

Sweeteners

Often	In Moderation	Seldom
Barley Malt Brown Rice Syrup Maple Syrup Syrup Fructose Sucanat	Fruit Juice Concentrate Honey Sugar Cane Juice	Jaggery Molasses White Sugar

Condiments

Often		In Moderation	Seldom
Black Pepper Coconut Coriander Leaves Cottage Cheese Dulse (well-rinsed) Ghee	Hijiki(well-rinsed) Kombu Lettuce Mango Chutney Mint Leaves Sprouts	Daikon(Radish) Grated Cheese Lime Yogurt (undiluted)	Black Sesame Seeds Chili Peppers

Oils

Often	In Moderation	Seldom
Coconut Olive Soy Sunflower Walnut	Almond Apricot Avocado Safflower	Corn Sesame

Spices

Often		**In Moderation**	**Seldom**	
Fresh Basil Leaves	Neem Leaves	Allspice	Ajwan	Marjoram
Black Pepper	Orange Peet	Almond Extract	Amchoor	Mustard Seeds
Cardarnom	Parsley	Anise	Asafoetida	Nutmeg
Tamarind	Peppernunt	Bay Leaf	Basil	Onion (esp. raw)
Cinnamon	Rose Water	Fenugreek	Caraway	Oregano
Tarragon	Saffron	Rosemary	Cayenne	Paprika
Coriander	Spearmint	Star Anise	Cloves	Pippali
Cumin	Turmeric	Thyme	Garlic (esp. raw)	Poppy Seeds
Dill	Vanilla		Ginger	Sage
Fennel	Wintergreen		Horseradish	Savory Mint

Dairy

Often	**In Moderation**	**Seldom**
Unsalted Butter	Ice Cream	Salted Butter
Cottage Cheese	Hard Cheeses	Buttermilk (commercial)
Mild Soft Cheeses	Yogurt	Feta Cheese
Dilute Yogurt (1-3pints water)		Sour Cream
Ghee		
Cow's Milk		
Goat's Milk		

Beverages

Often	**In Moderation**	**Seldom**
Almond Milk	Banana Shake or Smoothie	Alcohol
Peach Nectar	Caffeine	Berry Juice(sour)
Aloe Vera Juice	Carrot Juice	Carbonated Drinks
Pear Nectar	Carrot-Vegetable Combination	Carrot-Ginger Juice
Apple Juice	Coffee	Cranberry Juice
Pomegranate Juice	Chocolate	Grapefruit
Apricot Juice	Ginger(fresh)	Highly Salted Drinks
Prune Juice	Hawthorne	Ice Cold Drinks
Berry Juice (sweet)	Herb Teas (BurdockComfrey)	Lemonade
Soy Milk	Orange Juice	Miso Broth (in excess)
Mixed Veg (fresh)	Rosehips	Papaya Juice
Vegetable Bouillon	Wild Ginger	Pungent Teas
Carob		Sour Juices and Teas
Herb Teas		Tomato Juice
Coconut Milk		V-8 Juice
Cherry Juice (sweet)		HerbTeas
Coconut Smoothies		
Cool Dairy Drinks		
Date Shake		
Fig Shake		
Goat Milk		
Grain Teas		
Grape Juice		
Mango Juice		

The Kapha Diet

Fruits

Often	**In Moderation**		**Seldom**
Apples	Oranges	Figs (raw)	Bananas
Pears	Strawberries	Cherries	Dates
Pomegranate	Grapefruits	Passion fruit	Mango
Cranberries	Raspberries	Plums	Coconut
Persimmons	Pineapple	Peaches	Avocado
	Papaya	Loquats	Raisins
	Grapes	Lychees	Prunes
	Lemon	Nectarine	Honeydew
	Cantaloupe	Guava	
	Lime	Blueberries	
		Apricots	

Grains

Often	**In Moderation**	**Seldom**
Barley	Basmati rice	Wheat
Millet	Brown rice	Semolina
Rye	Oats	Wild rice
Buckwheat		White rice
Amaranth		Corn
Arrowroot		Sorghum
Quinoa		

Vegetables

Often		**In Moderation**	**Seldom**
Green Peppers	Lettuce (all)	Beets	Tomatoes
Red Peppers	Watercress	Potatoes	Squash (all)
Asparagus	Celery	Pumpkin	Corn
Cauliflower	Collards	Mushrooms	Okra
Artichoke (Globe)	Onions		Sweet potatoes
Dandelion	Mung Beans		Yams
Garlic	Parsley		Cucumbers
Fennel	Bean Sprouts (all)		Pickles
Artichoke (Jerusalem)	Parsnips		
Horseradish	Cabbage		
Bamboo Shoots	Chili peppers		
Kale	Brussel Sprouts		
Green Beans	Radishes		
Leeks	Carrots		
Peas	Shallots		
Mustard Greens	Spinach		
Lima Beans	Swiss Chard		
Turnips			

Legumes

All legumes and beans without exception are good for Kapha types. Consider them all to be "**Often**" foods.

Often		
Adzuki beans	Lima beans	Soybeans
Common Beans	Broad beans	Mung beans
Tofu	Kidney beans	Peas
Miso	Chickpeas	Split peas
Tempeh	Jackbeans	Lentils

Nuts and Seeds

Although nuts and seeds are an excellent protein source and need not be strictly avoided, they are dense, heavy, and oily and are best used in moderation.

Often	**In Moderation**		**Seldom**	
None	Alfalfa seeds Pumpkin seeds Sesame seeds Almonds Chestnuts	Flaxseeds Pinenuts	Brazil nuts Cashew nuts Coconut Filberts(Hazelnuts) Macademia Peanuts	Pecans Pistachio nuts Sunflower seeds Walnuts

Fats and Oils

All fats and oils are best used in strict moderation and in small amounts.

Often	**In Moderation**	**Seldom**	
None	Unrefined Flaxseed oil Unrefined Olive oil (extra virgin only) Unrefined Sesame oil Ghee	Canola oil Corn oil Butter Soy oil Tahini Sunflower oil Olives	Safflowerоil Mayonnaise Almond oil Cottonsed oil Peanut oil Palm kernel oil Coconut oil

Animal Foods

Often	**In Moderation**	**Seldom**
Chicken (dark) Turkey (dark) Eggs (not fried or scrambled w/ fat) Rabbit	Duck Pork Freshwater fish	Beef Saltwater fish Shellfish Venison Lamb

Spices

Often		**In Moderation**	**Seldom**
Fresh Basil Leaves	Ajwan	Neem Leaves	Nutmeg
Cumin	Turmeric	Wintergreen	Vanilla
Marjoram	Bay Leaf	Orange Peel	Rose Water
Black Pepper	Rosemary	Almond Extract	Poppy Seeds
Amchoor	Dill		
Mustard Seeds	Star Anise		
Cardarnon	Fenugreek		
Parsley	Asafoetida		
Thyme	Pippali		
Anise	Allspice		
Tamarind	Peppermint		
Basil	Horseradish		
Onion (esp. raw)	Cinnamon		
Oregano	Caraway		
Tarragon	Saffron Sage		
Cayenne	Garlic (esp.		
Fennel	raw)		
Paprika	Savory Mint		
Coriander	Spearmint		
Cloves	Ginger		

Sweeteners

All sweeteners should be used in very, very small amounts.

Often	**In Moderation**	**Seldom**	
Raw honey	Barley malt	White sugar	Sugar cane juice
Fruit juice concentrates	Brown rice syrup	Fructose	
(e,g, apple,pear)	Maple syrup	Molasses	
Stevia	Jaggery (small amts.)	Sucanat	

Beverages

Dilute all fruit juices with water,1:1,and always drink in moderation

Often		**In Moderation**	**Seldom**
Aloe vera juice	Burdock	Lemonade	Almond drinks
Apple juice Berry	Peppermint	Orange juice	Fruits-
juices Carob drinks	Catnip	Tomato juice	based"smoothies"
Cranberry juice	Raspberry	V-8 juice	Hot chocolate
Spiced warm goat milk	Chamomile	(high salt content)	Chocolate milk
Spiced warm soy milk	Red clover	Miso broth	TEAS:
Mixed vegetable juices	Chicory	Red zinger	Licorice root
Pear juice	Rose petal	Rosehip	Marshmollow
Pomegrante juice	Chrysanthemum		Comfrey
TEAS:	Saffron		Oat straw
Ajwan	Cinnamon		Blue green algae
Lemon grass	Sage		Spirulina
Alfalfa	Clove		
Mormon tea	Sarsparilla		
Barley	Corn silk		
Nettles	Sassafras		
Basil	Dandelion		
Orange peel	Spearmint		
Bansha	Elder flowers		
Osha root	Strawberry leaf		
Blackberry	Eucalyptis		
Passionflower	Violet		
Borage	Fennel		
Pennyroyal	Wintergreen		
Hawthorne	Fenugreek		
Hibiscus	Yarrow		
Hops	Ginger		
Hyssop	Yerba mate		
Ginseng			

Diary

Often	**In Moderation**	**Seldom**
None	Unsalted Butter	Salted Butter
	Cottage Cheese	Buttermilk (commercial)
	Hard Cheeses	Feta Cheese
	Ghee	Sour Cream
	Cow's Milk	Yogurt
	Goat's Milk	Soft Cheeses
	Dilute Yogurt (1:1 water)	Ice Cream

Chapter2 Literature Survey

2.1 Parallel Analysis: a method for determining significant principal components

In 1995, Franklin et al. discussed the numerous ecological studies use Principal Components Analysis (PCA) for exploratory analysis and data reduction. Determination of the number of components to retain is the most crucial problem confronting the researcher when using PCA. An incorrect choice may lead to the under extraction of components, but commonly results in over extraction. Of several methods proposed to determine the significance of principal components, Parallel Analysis (PA) has proven consistently accurate in determining the threshold for significant components, variable loadings, and analytical statistics when decomposing a correlation matrix. In this procedure, eigenvalues from a data set prior to rotation are compared with those from a matrix of random values of the same dimensionality (*p* variables and *n* samples). PCA eigenvalues from the data greater than PA eigenvalues from the corresponding random data can be retained. All components with eigenvalues below this threshold value should be considered spurious. Parallel Analysis is an efficient and robust means for determining the number of principal components to retain for further analysis and interpretation when decomposing a correlation matrix. The example analysis of environmental data from Land between the Lakes shows the capability of PCA to extract meaningful information from a data matrix when the data have a linear relationship and are normally distributed. The example PA demonstrates that significant eigenvalues and variable loadings may be objectively determined. This simple technique leads to parsimonious results, the purpose for analyzing data with PCA [9].

2.2 Intelligent Diagnosis of Human Disorders based on Ayurveda

In 1996, S.Kher. Presented Intelligent Diagnosis of Human Disorders based on Ayurveda. The Ayurvedic approach of treatment of human disorders is tested for over hundred years. The work proposed in this paper is an attempt towards diagnosis of human disorders and is based on Ayurveda. The system is configured using the fuzzy logic concept. The paper discusses the Ayurvedic approach of treatment, the design and its implementation. System has been simulated and tested for a number of patients. It is found that performance of the system is satisfactory. It is evaluated in number of cases and the results are consistent with

the expert physician. The system can further be augmented with set of rules for diagnosis, if needed. It may prove to be a valuable resource for "Ayurveda" [10].

2.3 Ayurvedic Physiology and Etiology: Ayurvedo Amritanaam

In 2004, Alex Hankey discussed The Doshas and Their Functioning in Terms of Contemporary Biology and Physical Chemistry. The three doshas of Ayurveda and their five respective subdoshas are related to the modern scientific framework of systems theory, phase transitions, and irreversible thermodynamics. These empirically well-established concepts of Ayurveda then appear to be far more general biologic concepts than the neuroendocrinology of their functioning might imply. They express universal concepts applicable across living organisms—control structures governing living systems. The hypothesis that the 15 subdoshas can themselves be considered as 5 triplets implies that on the level of the whole organism, these secondary structures of control appeared at specific stages in the evolution of life, yielding new insights into their development and evolution. The description of varying states of health and disease given in Ayurvedic etiology is related to the format of phase transitions in irreversible thermodynamics [11].

2.4 A Biostatistical Approach to Ayurveda: Quantifying the Tridosha

In 2004, Rajani R. Joshi discussed A Biostatistical Approach to Ayurveda: Quantifying the Tridosha. The objective is to compute quantitative estimates of the tridosha—the qualitative characterization that constitutes the core of diagnosis and treatment in Ayurveda—to provide a basis for biostatistical analysis of this ancient Indian science, which is a promising field of alternative medicine. The data sources were 280 persons from among the residents and visitors/training students at the Brahmvarchas Research Centre and Shantikuj, Hardwar, India. A quantitative measure of the tridosha level (for vata, pitta, and kapha) is obtained by applying an algorithmic heuristic approach to the exhaustive list of qualitative features/factors that are commonly used by Ayurvedic doctors. A knowledge-based concept of worth coefficients and fuzzy multi attribute decision functions are used here for regression modelling. Statistical validation on a large sample shows the accuracy of this study's estimates with statistical confidence level above 90%. The estimates are also suited for diagnostic and prognostic applications and systematic drug-response analysis of Ayurvedic (herbal and rasayanam) medicines [12].

2.5 A Test of the Systems Analysis Underlying the Scientific Theory of Ayurveda's Tridosha

In 2005, Alex Hankey proposes independent scientific evidence for the proposed identification of the doshas and for the systems analysis on which it is based. In particular, it points to coenzyme A, a key component of fatty acid metabolism. Its universal presence in all cells implies that it is an evolutionary invariant ant that the biochemical pathway on which it lies must be exceptionally significant. The systems analysis shows that the pathway connects the cellular functions of energy turnover and energy storage, fundamental to the overall strategy of cell regulation. This, combined with the requirement for the pathway's close regulation, makes it effectively impossible to replace coenzyme A by a combination of simultaneous mutations or sequence of mutations and it should indeed remain invariant during evolution [13].

2.6 The Scientific Value of Ayurveda

In 2005, Alex Hankey explains the the Scientific Value of Ayurveda. The concept of tridosha, the Ayurvedic theory of physiologic regulation involving the integrated function of the three doshas—vata, pitta, and kapha—is a cornerstone of Ayurveda. Its connection to modern science, showing that the doshas constitute systems of regulatory function, each with a particular area of responsibility and its present preliminary validation, are first steps to bringing the discipline wider acceptance within modern medicine. The paucity of independent empirical validation of concepts within complementary and alternative medicine (CAM), or lack of theory for them, presents a challenge to doctors and scientists alike. A proposed theory of tridosha, being based on systems theory, fulfils this requirement.

The combination of experimental work and developing theory is in accordance with the suggestion made by Cooper that every aspect of CAM should have its biology. If we extend this idea to CAM systems other than Ayurveda, we might hope that a similar approach might help every scientifically valid part of complementary medicine, including traditional medicine, make sense in the context of biology and physical science, even if these have to be extended in the process. This idea can guide theoretical and experimental research in all fields of CAM, and indeed in biology and biophysics [14].

2.7 A Computer Model for diagnosis of Human Constituents

In 2006, D.S.Kalana Mendis et al. Introduced a Computer Model for diagnosis of Human Constituents. This paper presents a novel computer model for diagnosis of Prakurthi in Ayurvedic medicine. The present mechanisms used for diagnosis of Prakurthi, which is considered, as classification of human constitutions is inconsistent about its findings. Therefore a research has been conducted to reduce such inconsistencies using a computer model. In this issue multi technique integrated computer model has been implemented for addressing the problem. Statistical technique and artificial intelligent techniques have been described as multi techniques involved in the computer model. The implemented model has been tested and gained accuracy of 77% of its findings [15].

2.8 Ayurvedic Genomics: Establishing a Genetic Basis for Mind–Body Typologies

In 2008, B. Patwardhan and G. Bodeker established a Genetic Basis for Mind–Body Typologies. Ayurveda, India's natural health care tradition has a unique way of classifying human population based on individual constitution or prakriti. Ayurveda's tridosha theory identifies principles of motion (vata), metabolism (pitta), and structure (kapha) as discrete phenotypic groupings. Patwardhan hypothesized in a paper published in this journal that there is a genetic connotation to prakriti and as proof of this concept showed a correlation between HLA alleles and prakriti type, establishing a rationale and preliminary experimental support for the concept of an association between HLA alleles and the Ayurvedic tridosha theory of individual prakriti types. This work is both part of and a catalyst for a wider revolution in the scientific investigation of Ayurveda in India, referred to as "Ayurvedic biology" and "AyuGenomics." Subsequently, Chen reported a similar study in this journal using a classification based on Traditional Chinese Medicine (TCM) theory. The findings of a genetic basis for both Ayurvedic and TCM classifications indicate a commonality between Asia's great medical traditions in their diagnostic typologies and a genetic basis for Asian traditional medicine's theory of discrete and discernable groupings of psycho-physiologic differences. Accordingly, new horizons have opened for collaborative East–East research and for an individualized approach to disease management and activation of the full range of human potential, as articulated in Ayurveda and TCM [16].

2.9 An approach to develop Multi Techniques Integrated Expert System for Diagnosis of Human Constitutions

In 2008 D.S.Kalana Mendis et al. introduced an approach to develop Multi Techniques Integrated Expert System for Diagnosis of Human Constitutions. Tacit knowledge has always been influential to change the directions and emphasis of explicit models of knowledge. All explicit knowledge is rooted in tacit knowledge. Due to these reasons modelling of tacit knowledge is of great interest. Tacit knowledge in Ayurvedic sub-domain of individual classification has been acquired through a questionnaire and analysed to identify the dependencies, which lead to make tacit knowledge in the particular domain. In the first place analysis was done using statistical techniques of principal components and the results were not compatible with the experiences of Ayurvedic experts. As such, fuzzy logic has been used to further model the Ayurvedic sub-domain. The result of the modelling of Ayurvedic domain using fuzzy logic has been compatible with the experiences of the Ayurvedic experts. A framework for diagnosis of human constitutions has been integrated with an expert system shell thereby enabling the development of expert systems for domains with tacit knowledge. Currently, it has been integrated with FLEX expert system shell. The development has been done using Visual basic and the system runs on Windows platform. The framework has been successfully applied for several tacit domains. Performances were very close to handling tacit knowledge by the human expert in tacit domain [17].

2.10 Measuring the Tridosha Symptoms of Unmāda (Psychosis): A Preliminary Study

In 2010 Sureshrao P. Suchitra et al. introduces the preliminary study of Measuring the Tridosha Symptoms of Unmāda (Psychosis). This is a preliminary report on the development of a scale to measure the symptoms of unmāda (psychosis) attributable to tridosa (metabolic principles) by using the concepts of Ayurvedic medicine. The 67-item unmāda specific symptom scale was developed on the basis of translation of Sanskrit verses describing vātaja (V), pittaja (P), and kaphaja (K) unmāda (specific symptoms of psychosis due to the imbalances of metabolic components) and by taking the opinions of experts. The unmāda specific symptom scale was associated with excellent internal consistency. The Cronbach's α for V, P, and K scales were 0.98, 0.98, and 0.97, respectively. The split-half reliability for V, P, and K scales were 0.97, 0.97, and 0.88 respectively. Scores on vātaja, pittaja, and kaphaja scales were inversely correlated, suggesting that they are mutually exclusive. The three

subgroups of psychoses—paranoid schizophrenia, schizophrenia (unspecified), and unspecified nonorganic psychosis—had significantly different loadings on the three scores, having high scores on vātaja, pittaja, and kaphaja, respectively. The tridoshas in psychotic disorders can be measured reliably by this instrument. The scores on each of these doṣas help in differentiating three types of psychosis (according to Āyurveda) that have good correspondence with prevailing classification. However, this scale must also be applied to the other 28 separate subcategories of the psychoses that are identified in the International Statistical Classifications of Diseases (version 10) and to the 10 variants of psychosis as defined by the American Psychiatric Association Diagnostic and Statistical Manual-IV-R to help better understand the true utility for use here with the various subcategories of schizophrenia [18].

Chapter3 Preliminary Study

3.1 The Existing Technique

In this study we have collected five different questionnaires from various sites and journal which are helpful in finding the three doshas present in human body. Each set of these questionnaire are given to 100 different subjects. All these subjects are the normal healthy students of Thapar University, Patiala and age of all the subjects are between 18-24 years. Table 3.1 shows the percentage of Vata, Pitta and Kapha for different prevalent questionnaires of 12 subjects. After collection of this data, Root Mean Square Difference (RMSD) between each questionnaire in **Microsoft Office Excel Worksheet** for 12 subjects is calculated as shown in table 3.2 and figure 3.1. At the end RMSD between all of these is more than 5%.

3.2 Root mean square difference

The root-mean-square difference (RMSD) is a frequently used measure of the differences between values predicted by a model or an estimator and the values actually observed from the thing being modelled or estimated. RMSD is a good measure of precision. These individual differences are also called residuals, and the RMSD serves to aggregate them into a single measure of predictive power. The formula is given below:

$$\mathrm{RMSD}(\theta_1, \theta_2) = \sqrt{\mathrm{MSD}(\theta_1, \theta_2)} = \sqrt{\mathrm{D}((\theta_1 - \theta_2)^2)} = \sqrt{\frac{\sum_{i=1}^{n}(x_{1,i} - x_{2,i})^2}{n}}$$

$$\theta_1 = \begin{bmatrix} x_{1,1} \\ x_{1,2} \\ \vdots \\ x_{1,n} \end{bmatrix} \text{ and } \theta_2 = \begin{bmatrix} x_{2,1} \\ x_{2,2} \\ \vdots \\ x_{2,n} \end{bmatrix}$$

x = Observed value;

n = Range of observed value;

MSD = Mean Square Difference;

D = Difference [19];

Table3.1: Percentage of Vata, Pitta& Kapha dosha of 12 subjects using five different prevalent questionnaires

Subjects	Questionnaire 1 results (%)			Questionnaire 2 results (%)		
	Vata	Pitta	Kapha	Vata	Pitta	Kapha
1	41.67	41.67	16.67	44.44	33.33	22.22
2	33.33	37.5	29.17	27.78	50	22.22
3	45.83	33.33	20.83	61.11	27.78	11.11
4	33.33	58.33	8.33	33.33	55.56	11.11
5	25	54.17	20.83	38.89	44.44	16.67
6	25	33.33	41.67	22.22	44.44	33.33
7	16.67	66.67	16.67	11.11	72.22	16.67
8	20.83	41.67	37.5	11.11	50	38.89
9	4.17	54.17	41.67	0	38.89	61.11
10	29.17	33.33	37.5	33.33	33.33	33.33
11	12.5	75	12.5	5.56	83.33	11.11
12	41.67	33.33	25	44.44	27.78	27.78

Subjects	Questionnaire 3 results (%)			Questionnaire 4 results (%)		
1	51.72	34.48	13.79	48.15	33.33	18.52
2	31.03	48.28	20.69	22.22	48.15	29.63
3	55.17	20.69	24.14	51.85	25.93	22.22
4	34.48	55.17	10.34	22.22	62.96	14.81
5	24.14	48.28	27.59	29.63	37.04	33.33
6	24.14	44.83	31.03	25.93	33.33	40.74
7	20.69	58.62	20.69	22.22	62.96	14.81
8	13.79	48.28	37.93	14.81	44.44	40.74
9	13.79	51.72	34.48	11.11	55.56	33.33
10	41.38	31.03	27.59	37.04	29.63	33.33
11	10.34	82.76	6.9	11.11	77.78	11.11
12	31.03	55.17	13.79	40.74	37.04	22.22

Subjects	Questionnaire 5 results (%)		
	Vata	Pitta	Kapha
1	56.92	26.15	16.92
2	33.85	40	26.15
3	56.92	27.69	15.38
4	36.92	49.23	13.85
5	23.08	46.15	30.77
6	21.54	29.23	49.23
7	29.23	53.85	16.92
8	20	30.77	49.23
9	15.38	52.31	32.31
10	27.69	36.92	35.38
11	12.31	69.23	18.46
12	32.31	41.54	26.15

Table 3.2: RMSD (%) values of Vata, Pitta and Kapha of 12 subjects between the results of all questionnaire.

Questionnaires	Root Mean Square Difference(RMSD)		
	Vata (%)	Pitta (%)	Kapha (%)
1&2	7.6	8.7	7.5
1&3	7.2	9.8	6.9
1&4	6.6	7.1	5.1
1&5	8	8.4	6.4
2&3	8.6	9.9	10.6
2&4	7.5	8	10.6
2&5	10.6	12	11.2
3&4	5.8	7.9	5.9
3&5	5.5	10	9
4&5	8	8.4	5.9

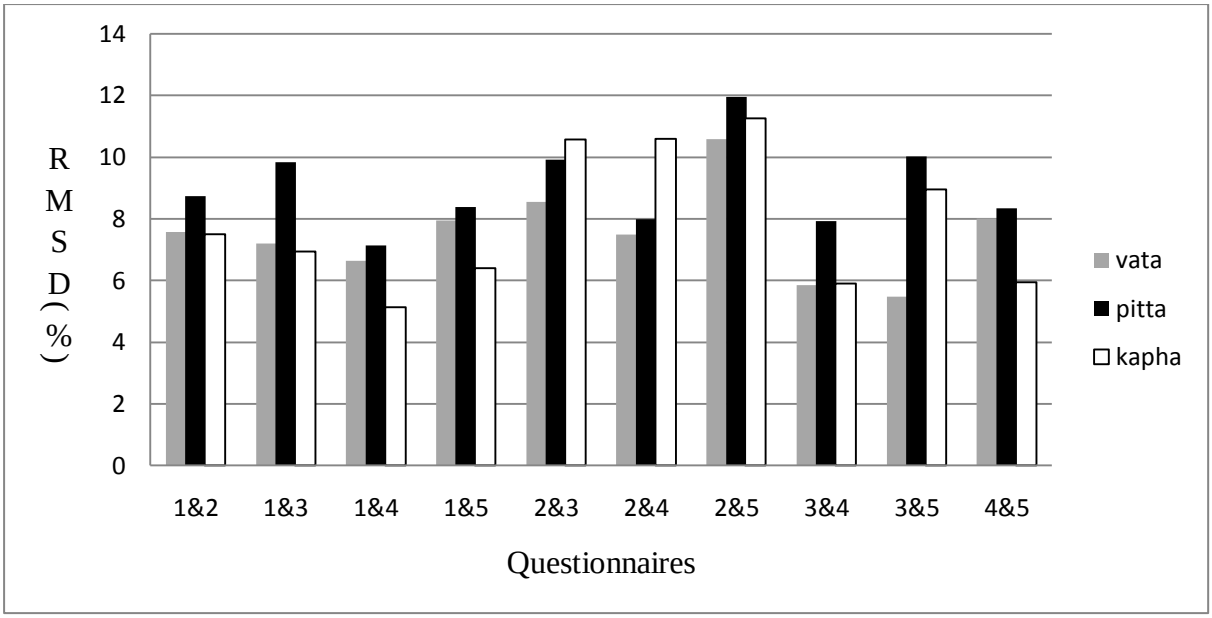

Figure 3.1: RMSD (%) values of Vata, Pitta and Kapha of 12 subjects between the results of all questionnaires.

Chapter4 Problem Definition

The basic of Ayurvedic system is TriDosha i.e. the three Doshas namely Vata, Pitta and Kapha. There are several ways of determining these doshas in a subject. One of the prevalent methods used by many practitioners is by questioning the subject. For this the subject is required to fill in a questionnaire with each question having three options. The three options point to three different doshas present in subject.

There are several sites which propose online questionnaires for knowing these doshas. The questions in these questionnaires seldom match and during preliminary studies it is found that the results obtain to determine the three doshas for same subject at same time under same conditions are different. On account of different questionnaire being used this is shown in chapter three. Since the results on account of different questionnaire being used vary significantly the reliability of these questionnaires is under question mark.

There is no consensus amongst the practitioners regard to the questionnaire to be used. We propose in this work to combine all the questions from all practically possible sources and then reduce the questions using appropriate mathematical technique. The optimised questionnaire so designed shall be validated by cross checking it with the comprehensive questionnaire formed by taking the largest set of questions.

Chapter5 Methodology

5.1 Overview

This thesis work is primarily divided into five different methods .This method is listed as under:

METHOD A: In this method all the questionnaires which are used in preliminary studies have been combined. This considers all 83 questions with each questions having the weight age of one. This technique may be called as **Comprehensive Method**.

METHOD B: This method is named as **Gold-Standard Method**. This consider 83 questions after applying Principal Component Analysis(PCA), its divided into 31 sub groups and each sub group is given a total weightage of one. Weightage to each question in each group is given on the basis of the number of questions present in that group. Group containing one question is weighted with 1 score and further if group contains more than one question then the weightage given is 1 divided by number of questions present in that group.

METHOD C: This method is named as **Sub-Group Method**. This contains 31 questions by selecting one question from each sub group. That question is selected from a sub group which has maximum correlation sum within the sub group.

METHOD D: This method is named as **Minimum-Correlation Method**. This method considers the correlation matrix of 83 questions those are filled by 100 subjects. Each column represents one question and the correlation of one question with other 82 questions. Then the sum of absolute value of correlations of all the columns in the correlation matrix is found. First, the column which has maximum sum value is removed along with its corresponding row from the matrix. After that the correlation matrix with 82 questions are left and now we apply the same to the column which has maximum sum value and so on. From the above process the correlation matrix are left with 31 columns of minimum correlation sum value and each of these columns represent one question. This results in one new questionnaire of 31 questions.

METHOD E: This method is named as **Quick-Shot Method**. The common questions of Method C and D are considered for quick estimation of doshas. These questions come out to be 13.

5.2 Root mean square difference

The root-mean-square difference (RMSD) is a frequently used measure of the differences between values predicted by a model or an estimator and the values actually observed from the thing being modelled or estimated. RMSD is a good measure of precision. These individual differences are also called residuals, and the RMSD serves to aggregate them into a single measure of predictive power. The formula is given below:

$$\mathrm{RMSD}(\theta_1, \theta_2) = \sqrt{\mathrm{MSD}(\theta_1, \theta_2)} = \sqrt{\mathrm{D}((\theta_1 - \theta_2)^2)} = \sqrt{\frac{\sum_{i=1}^{n}(x_{1,i} - x_{2,i})^2}{n}}$$

$$\theta_1 = \begin{bmatrix} x_{1,1} \\ x_{1,2} \\ \vdots \\ x_{1,n} \end{bmatrix} \text{ and } \theta_2 = \begin{bmatrix} x_{2,1} \\ x_{2,2} \\ \vdots \\ x_{2,n} \end{bmatrix}$$

x = Observed value;

n = Range of observed value;

MSD = Mean Square Difference;

D = Difference;

5.3 Principal Component Analysis (PCA)

Principal component analysis is appropriate when you have obtained measures on a number of observed variables and wish to develop a smaller number of artificial variables (called principal components) that will account for most of the variance in the observed variables. The principal components may then be used as predictor variables in subsequent analyses.

5.3.1 Variable Reduction Procedure

Principal component analysis is a variable reduction procedure. It is useful when we have obtained data on a number of variables (possibly a large number of variables), and believe that there is some redundancy in these variables. In this case, redundancy means that some of the variables are correlated with one another, possibly because they are measuring the same construct. Because of this redundancy, we believe that it is possible to reduce the observed variables into a smaller number of principal components (artificial variables) that will account for most of the variance in the observed variables.

Because it is a variable reduction procedure, principal component analysis is similar in many respects to exploratory factor analysis. In fact, the steps followed when conducting a principal component analysis are virtually identical to those followed when conducting an exploratory factor analysis. However, there are significant conceptual differences between the two procedures, and it is important that you do not mistakenly claim that you are performing factor analysis when you are actually performing principal component analysis [20].

5.3.2 How many Factors to Extract

Remember that, so far, we are considering principal components analysis as a data reduction method, that is, as a method for reducing the number of variables. The question then is, how many factors do we want to extract? Note that as we extract consecutive factors, they account for less and less variability. The decision of when to stop extracting factors basically depends on when there is only very little "random" variability left. The nature of this decision is arbitrary; however, various guidelines have been developed, and they are reviewed in reviewing the Results of a Principal Components Analysis under Eigen values and the Number-of- Factors Problem.

5.3.3 Reviewing the Results of a Principal Components Analysis

Without further ado, let us now look at some of the standard results from a principal components analysis. To reiterate, we are extracting factors that account for less and less variance. To simplify matters, you usually start with the correlation matrix, where the variances of all variables are equal to 1.0. Therefore, the total variance in that matrix is equal to the number of variables. For example, if we have 10 variables each with a variance of 1 then the total variability that can potentially be extracted is equal to 10 times 1. Suppose that in the satisfaction study introduced earlier we included 10 items to measure different aspects of satisfaction at home and at work. Table 5.1 shows the variance accounted for by successive factors.

5.3.4 Eigen values

In the second column (Eigen value) above, we find the variance on the new factors that were successively extracted. In the third column, these values are expressed as a percent of the total variance (in this example, 10). As we can see, factor 1 accounts for 61 percent of the variance, factor 2 for 18 percent, and so on. As expected, the sum of the Eigen values is equal

to the number of variables. The third column contains the cumulative variance extracted. The variances extracted by the factors are called the **Eigen values**. This name is derived from the computational issues involved.

Table 5.1: The variance accounted for by successive factors:

STATISTICA FACTOR ANALYSIS	**Eigenvalues (factor.sta)** **Extraction: Principal components**			
Value	**Eigenval**	**% total Variance**	**Cumul. Eigenval**	**Cumul. %**
1	6.118369	61.18369	6.11837	61.1837
2	1.800682	18.00682	7.91905	79.1905
3	.472888	4.72888	8.39194	83.9194
4	.407996	4.07996	8.79993	87.9993
5	.317222	3.17222	9.11716	91.1716
6	.293300	2.93300	9.41046	94.1046
7	.195808	1.95808	9.60626	96.0626
8	.170431	1.70431	9.77670	97.7670
9	.137970	1.37970	9.91467	99.1467
10	.085334	.85334	10.00000	100.0000

5.3.5 Eigen values and the Number-of-Factors Problem

Now that we have a measure of how much variance each successive factor extracts, we can return to the question of how many factors to retain. As mentioned earlier, by its nature this is an arbitrary decision. However, there are some guidelines that are commonly used, and that, in practice, seem to yield the best results.

a. The Kaiser criterion

First, we can retain only factors with Eigen values greater than 1. In essence this is like saying that, unless a factor extracts at least as much as the equivalent of one original variable, we drop it. This criterion was proposed by Kaiser (1960), and is probably the one most

widely used. In our example above, using this criterion, we would retain 2 factors (principal components).

b. The Scree test

A graphical method is the scree test, first proposed by Cattell (1966). We can plot the eigenvalues shown above in a simple line plot.Cattell suggests to find the place where the smooth decrease of eigenvalues appears to level off to the right of the plot. To the right of this point, presumably, you find only "factorial scree" - "scree" is the geological term referring to the debris which collects on the lower part of a rocky slope. According to this criterion, we would probably retain 2 or 3 factors in our example. Figure 5.1 shows Plot of Eigen value.

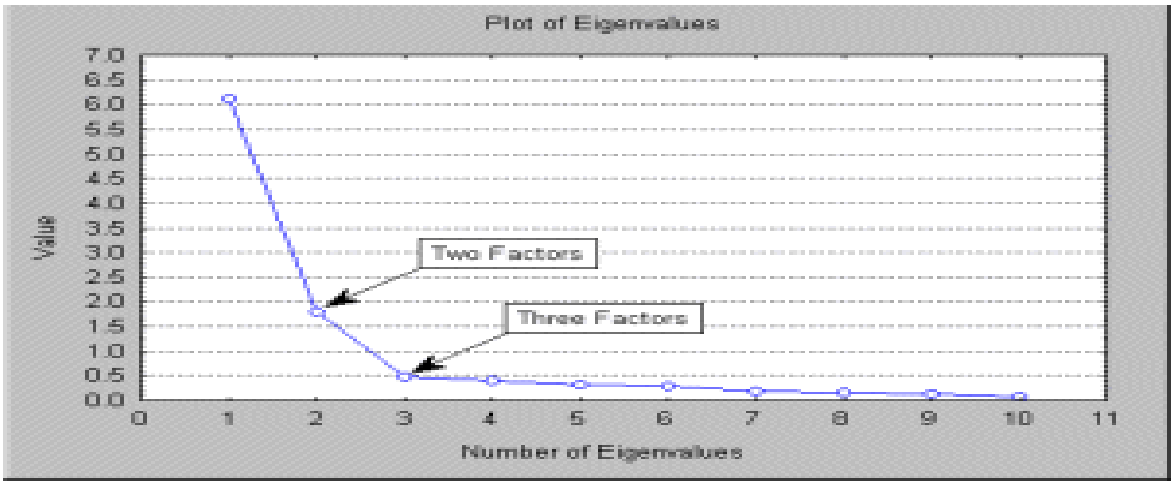

Figure 5.1: Plot of eigen value.

5.3.6 Which criterion to use

Both criteria have been studied in detail (Browne, 1968; Cattell & Jaspers, 1967; Hakstian, Rogers, & Cattell, 1982; Linn, 1968; Tucker, Koopman & Linn, 1969). Theoretically, you can evaluate those criteria by generating random data based on a particular number of factors. You can then see whether the number of factors is accurately detected by those criteria. Using this general technique, the first method (Kaiser criterion) sometimes retains too many factors, while the second technique (scree test) sometimes retains too few; however, both do quite well under normal conditions, that is, when there are relatively few factors and many cases. In practice, an additional important aspect is the extent to which a

solution is interpretable. Therefore, you usually examines several solutions with more or fewer factors, and chooses the one that makes the best "sense" [21].

5.4 Principal Component Analysis is Not Factor Analysis

Principal component analysis is sometimes confused with factor analysis, and this is understandable, because there are many important similarities between the two procedures: both are variable reduction methods that can be used to identify groups of observed variables that tend to hang together empirically.

5.4.1 Difference between Principal Component Analysis and Factor Analysis

Table5.2: Differences between Principal Component Analysis (PCA) and Factor Analysis:

Principal Component Analysis	**Exploratory Factor Analysis**
Principal Components retained account for a maximal amount of variance of observed variables	Factors account for common variance in the data.
Analysis decomposes correlation matrix	Analysis decomposes adjusted correlation matrix
Ones on the diagonals of the correlation matrix	Diagonals of correlation matrix adjusted with unique factors
Minimizes sum of squared perpendicular distance to the component axis	Estimates factors which influence responses on observed variables
Component scores are a linear combination of the observed variables weighted by eigenvectors	Observed variables are linear combinations of the underlying and unique factors

5.4.2 Similarities between Principal component Analysis and Factor Analysis

- Measurement scale is interval or ratio level

- Random sample - at least 5 observations per observed variable and at least 100 observations. Larger sample sizes recommended for more stable estimates, 10-20 observations per observed variable
- Over sample to compensate for missing values
- Linear relationship between observed variables
- Normal distribution for each observed variable
- Each pair of observed variables has a bivariate normal distribution
- PCA and EFA are both variable reduction techniques. If communalities are large, close to 1.00, results could be similar.

5.4.3 Common definitions for Principal Component analysis and Factor analysis

- An **observed variable** can be measured directly, is sometimes called a **measured variable,** an **indicator** or a **manifest variable**.
- A **principal component** is a linear combination of weighted observed variables. Principal components are uncorrelated and orthogonal.
- A **latent construct** can be measured indirectly by determining its influence to responses on measured variables. A latent construct could be also referred to as a **factor**, **underlying construct**, or **unobserved variable**.
- **Unique factors** refer to unreliability due to measurement error and variation in the data.
- **Principal component analysis** minimizes the sum of the squared perpendicular distances to the axis of the principal component while least squares regression minimizes the sum of the squared distances perpendicular to the x axis (not perpendicular to the fitted line) (Truxillo, 2003).
- **Principal component scores** are actual scores.
- **Factor scores** are estimates of underlying latent constructs.
- **Eigen vectors** are the weights in a linear transformation when computing principal component scores.
- **Eigen values** indicate the amount of variance explained by each principal component or each factor.
- **Orthogonal** means at a 90 degree angle, perpendicular.

- **Oblique** means other than a 90 degree angle.
- An observed variable "**loads**" on factors if it is highly correlated with the factor has an Eigen vector of greater magnitude on that factor.
- **Communality** is the variance in observed variables accounted for by common factors. Communality is more relevant to EFA than PCA (Hatcher, 1994).

In summary, both factor analysis and principal component analysis have important roles to play in social science research, but their conceptual foundations are quite distinct [22].

5.5 Principal Component Analysis using MATLAB

One of the difficulties inherent in multivariate statistics is the problem of visualizing data that has many variables. In MATLAB, the plot command displays a graph of the relationship between two variables. The **plot3** and **surf** commands display different three-dimensional views. But when there are more than three variables, it is more difficult to visualize their relationships.

Fortunately, in data sets with many variables, groups of variables often move together. One reason for this is that more than one variable might be measuring the same driving principle governing the behaviour of the system. In many systems there are only a few such driving forces. But an abundance of instrumentation enables you to measure dozens of system variables. When this happens, you can take advantage of this redundancy of information. You can simplify the problem by replacing a group of variables with a single new variable.

Principal components analysis is a quantitatively rigorous method for achieving this simplification. The method generates a new set of variables, called principal components. Each principal component is a linear combination of the original variables. All the principal components are orthogonal to each other, so there is no redundant information. The principal components as a whole form an orthogonal basis for the space of the data.

There are an infinite number of ways to construct an orthogonal basis for several columns of data. What is so special about the principal component basis?

The first principal component is a single axis in space. When you project each observation on that axis, the resulting values form a new variable. And the variance of this variable is the maximum among all possible choices of the first axis.

The second principal component is another axis in space, perpendicular to the first. Projecting the observations on this axis generates another new variable. The variance of this variable is the maximum among all possible choices of this second axis.

The full set of principal components is as large as the original set of variables. But it is common place for the sum of the variances of the first few principal components to exceed 80% of the total variance of the original data. By examining plots of these few new variables, researchers often develop a deeper understanding of the driving forces that generated the original data.

You can use the function **princomp** to find the principal components. To use **princomp**, you need to have the actual measured data you want to analyze. However, if you lack the actual data, but have the sample covariance or correlation matrix for the data, you can still use the function **pcacov** to perform a principal components analysis.

Mat lab code for finding PCA is given below:-

1. uiimport('C:\Users\anil anand\Desktop\final.xls')

- **uiimport:-** Open Import Wizard to import data

2. save('final.mat','data');
   p=whos;
   r=corrcoef(data);
   b=eig(r);
   [coefs,scores,variances,t2] = princomp(r);
   percent_explained = 100*variances/sum(variances);

- **save:-** save stores all variables from the current MATLAB workspace in a MATLAB-formatted file (MAT-file) named matlab.mat that resides in the current working directory.

- **p = whos:-** returns structure **p** containing the following fields for the variables specified in the given list that meet the conditions specified in file. Table 5.3 shows variable specified by whos command.

- **corrcoef(Correlation coefficients)**

  Syntax:-

  r = corrcoef(X)

Description:- corrcoef(X) returns a matrix r of correlation coefficients calculated from an input matrix X whose rows are observations and whose columns are variables. Table 5.4 shows the correlation Matrix for representative five characteristics as filled by 100 subjects.

Table 5.3: Variable specified by whos command

Field Name	Description
`name`	Name of the variable
`size`	Dimensions of the variable array
`bytes`	Number of bytes allocated for the variable array
`class`	Class of the variable. Set to the string `'(unassigned)'` if the variable has no value.
`global`	True if the variable is global; otherwise false
`sparse`	True if the variable is sparse; otherwise false
`complex`	True if the variable is complex; otherwise false
`nesting`	Structure having the following fields: • `function` — Name of the nested or outer function that defines the variable • `level` — Nesting level of that function
`persistent`	True if the variable is persistent; otherwise false

Table5.4: The Correlation Matrix for representative five characteristics as filled by 100 subjects.

Sr.no.	**1**	**2**	**3**	**4**	**5**
1	1	0.34	0.49	0.37	0.26
2	0.34	1	0.47	0.46	0.22
3	0.49	0.47	1	0.30	0.23
4	0.37	0.46	0.30	1	0.23
5	0.26	0.22	0.23	0.23	1

- **eig(Eigen value)**

  Syntax:-

  d = eig(A)

  Description:-

  d = eig(A) returns a vector of the eigenvalues of matrix A. Table 5.5 shows the Eigen Value of correlation matrix and figure 5.2 shows graph of Eigen value.

Table5.5: Eigen values of Correlation matrix.

Sr.no.	Eigen value	Sr.no.	Eigen value	Sr.no.	Eigen value	Sr.no.	Eigen value
1	5.37	22	1.43	43	0.61	64	0.01
2	4.53	23	1.45	44	0.60	65	0.02
3	3.71	24	1.33	45	0.52	66	0.02
4	3.57	25	1.23	46	0.55	67	0.02
5	3.31	26	1.21	47	0.54	68	0.19
6	2.98	27	1.15	48	0.47	69	0.03
7	2.65	28	1.10	49	0.46	70	0.14
8	2.59	29	1.06	50	0.42	71	0.04
9	2.39	30	1.01	51	0.39	72	0.17
10	2.23	31	0.99	52	0.39	73	0.10
11	2.16	32	0.87	53	0.36	74	0.06
12	2.00	33	0.94	54	0.34	75	0.15
13	1.96	34	0.90	55	0.31	76	0.09
14	1.92	35	0.83	56	0.28	77	0.07
15	1.85	36	0.80	57	0.29	78	0.04
16	1.83	37	0.78	58	0.27	79	0.16
17	1.71	38	0.79	59	0.25	80	0.08
18	1.64	39	0.72	60	0.01	81	0.12
19	1.58	40	0.68	61	0.23	82	0.06
20	1.52	41	0.66	62	0.22	83	0.08
21	1.49	42	0.62	63	0.20		

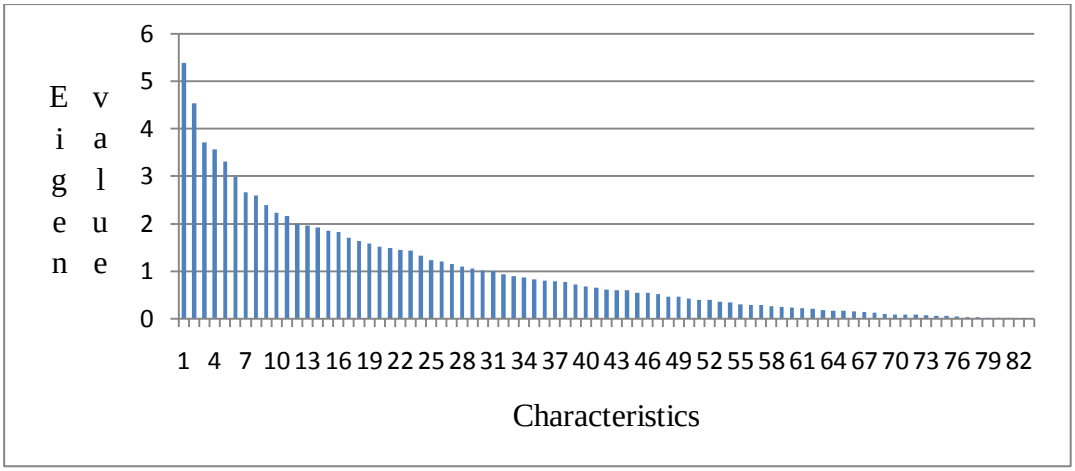

Fig 5.2: Graph of Eigen values.

- **[coefs,scores,variances] = princomp(r)**
  - The first output of the princomp function, **coefs**, contains the coefficients for nine principal components. These are the linear combinations of the original variables that generate the new variables.
  - The second output, **scores**, is the original data mapped into the new coordinate system defined by the principal components. This output is the same size as the input data matrix.
  - The third output, **variances**, is a vector containing the variance explained by the corresponding principal component. Each column of scores has a sample variance equal to the corresponding element of variances. Table 5.6 shows the variance of correlation matrix and figure 5.3 graph of variance.

- **percent_explained = 100*variances/sum(variances)**

  Here it is used to calculate the percent of the total variability explained by each principal component. Table 5.7 shows the percentage variance of correlation matrix

5.6 Data Collection

The data table of human constituents having 83 characteristics, where the value assigns to Vata, Pitta and Kapha are 0.1, 0.5 and 0.9 respectively. The data has been collected form 100 subjects. All these subjects are the students of Thapar University, Patiala and age of all the subjects are lies between 18-24 years. Table 5.8 shows the sample data table for seven characteristics collected from 4 subjects.

Table5.6: Variance of Correlation matrix.

Sr.no.	Variance	Sr.no.	Variance	Sr.no.	Variance	Sr.no.	Variance
1	0.268	22	0.025	43	0.004	64	0.0003
2	0.177	23	0.025	44	0.004	65	0.0003
3	0.167	24	0.022	45	0.004	66	0.0002
4	0.152	25	0.018	46	0.003	67	0.0002
5	0.115	26	0.018	47	0.003	68	0.0001
6	0.100	27	0.016	48	0.003	69	0.0001
7	0.083	28	0.015	49	0.002	70	0.0001
8	0.079	29	0.014	50	0.002	71	8.62E-05
9	0.066	30	0.012	51	0.002	72	8.13E-05
10	0.058	31	0.012	52	0.002	73	5.23E-05
11	0.054	32	0.011	53	0.002	74	4.07E-05
12	0.049	33	0.010	54	0.001	75	3.14E-05
13	0.047	34	0.009	55	0.001	76	1.78E-05
14	0.045	35	0.008	56	0.001	77	1.37E-05
15	0.041	36	0.008	57	0.001	78	9.13E-06
16	0.039	37	0.007	58	0.001	79	6.18E-06
17	0.035	38	0.007	59	0.001	80	4.08E-06
18	0.033	39	0.006	60	0.001	81	1.87E-06
19	0.029	40	0.006	61	0.001	82	1.53E-06
20	0.028	41	0.005	62	0.000	83	0
21	0.027	42	0.005	63	0.000		

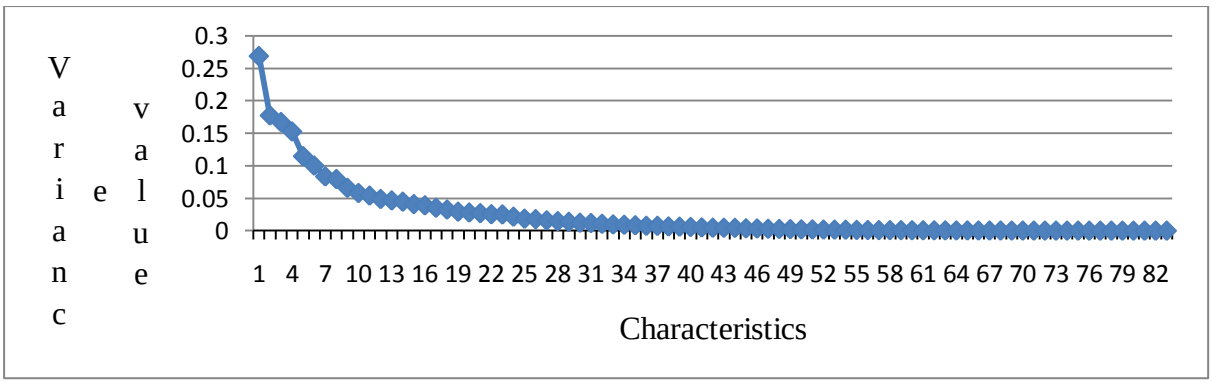

Fig 5.3: Graph of Variance of correlation matrix.

Table5.7: Percentage Variance of Correlation matrix.

Sr.no.	%Variance	Sr.no.	%Variance	Sr.no.	%Variance	Sr.no.	%Variance
1	13.49	22	1.27	43	0.22	64	0.02
2	8.90	23	1.26	44	0.22	65	0.02
3	8.40	24	1.08	45	0.18	66	0.01
4	7.66	25	0.93	46	0.17	67	0.01
5	5.76	26	0.89	47	0.15	68	0.01
6	5.03	27	0.80	48	0.13	69	0.01
7	4.19	28	0.74	49	0.12	70	0.01
8	3.99	29	0.68	50	0.10	71	0.00
9	3.31	30	0.61	51	0.10	72	0.00
10	2.91	31	0.59	52	0.08	73	0.00
11	2.71	32	0.53	53	0.08	74	0.00
12	2.45	33	0.48	54	0.07	75	0.00
13	2.34	34	0.45	55	0.06	76	0.00
14	2.24	35	0.42	56	0.05	77	0.00
15	2.06	36	0.38	57	0.04	78	0.00
16	1.96	37	0.38	58	0.04	79	0.00
17	1.77	38	0.33	59	0.04	80	0.00
18	1.63	39	0.31	60	0.03	81	0.00
19	1.47	40	0.29	61	0.03	82	0.00
20	1.40	41	0.25	62	0.02	83	0.00
21	1.36	42	0.23	63	0.02		

Table5.8: Sample data collection of human constituents.

Characteristic / Subjects	body frame	structure	body weight	chest	shape of face	size of eyes	colour of eyes
1	0.5	0.5	0.5	0.1	0.9	0.5	0.1
2	0.5	0.1	0.1	0.5	0.5	0.5	0.1
3	0.1	0.1	0.1	0.1	0.5	0.1	0.1
4	0.5	0.5	0.5	0.5	0.9	0.1	0.1

Chapter6 Results and Discussion

6.1 Comprehensive Method

In this method we have combined all the questionnaire which are used in chapter 3 and made one single questionnaire of 83 questions and each question is weighs 1. The 83 questions questionnaire which are collected from five different sites and journal and are helpful in finding the three doshas present in human body is given in appendix A [2, 12, 23-25]. In appendix option-1,2,3 indicates vata, pitta and kapha respectively.

6.2 Gold-Standard Method

In this method we apply Principal Component Analysis (PCA) using MATLAB on Comprehensive method and extracted 83 principal components. First we calculated the correlation matrix of collected data from 100 subjects (as shown in table 5.4). Then Eigen value, Variance, Percentage Variance is calculated of the correlation matrix obtained above resulting in 83 components (as shown in table 5.5, 5.6 and 5.7). These 83 components are reduced to 31 components containing relevant data in it by applying Kaiser Criterion on Eigen values and Scree Test on variance. With the help of correlation matrix we distributed 83 questions into 31 groups made of 83 questions. Each group contains one or more questions. Weightage to each question in each group is given on the basis of the number of questions present in that group. Group containing one question is weighs as 1 score and further if group contains more than one question then the weightage given is 1 divided by number of questions present in that group. At the end Root Mean Square Difference (RMSD) is calculated for the 12 subjects so analyzed by above stated two methods and it is found that difference is less than 4 %(as shown in figure 6.1). Table 6.1 shows the value of percentage and RMSD (%) of Vata, Pitta and Kapha dosha of the 12 subjects for **gold-standard** and **comprehensive** method.

Before discussing the numerical results obtained by given method (below), it is relevant that we understand the concept of proportionate error.

Gold-standard and **comprehensive** method have 83 questions while **sub-group** method has 31 questions. If the difference between **gold-standard** and **comprehensive** method is say 4% then the difference between **gold-standard** and **sub-group** method taking the proportionate quantization error should be 4*(83/31).

This is based on the fact that if the subject answers wrongly, its effect in **comprehensive** method will be 1/83 while its effect in **sub-group** will be 1/31. If the difference comes out to be significantly less than 4*(83/31), then **sub-group** is better than **comprehensive** method. We are assuming **gold-standard** to be the standard method. All comparison there after shall be made with **gold-standard**. The method with least proportionate difference thus may be considered for all practical purposes to be better one.

Table6.1:- Percentage and RMSD of Vata, Pitta and Kapha dosha of 12 subjects for **gold-standard** and **comprehensive** method.

Gold-Standard method results (%)				**Comprehensive method results (%)**		
Vata	**Pitta**	**Kapha**		**Vata**	**Pitta**	**Kapha**
16	43.43	40.71		15.66	36.14	48.19
25.34	39.91	34.88		25.3	42.17	32.53
27.95	48.05	24.14		26.51	46.99	26.51
27.92	49.51	22.7		24.1	50.6	25.3
38.37	49.76	12		37.35	48.19	14.46
20.26	45.77	34.11		21.69	43.37	34.94
28.4	43.82	27.91		22.89	44.58	32.53
25.39	40.33	34.42		20.48	44.58	34.94
26.19	43.55	30.39		27.71	49.4	22.89
26.98	43.35	29.81		26.51	44.58	28.92
33.76	35.77	30.6		27.71	38.55	33.73
34.84	38.41	26.89		39.76	37.35	22.89
RMSD (%)						
Vata	**Pitta**	**Kapha**				
3.38	3.31	3.92				

6.3 Sub-Group Method

Above we have distributed 83 questions in to 31 groups. Now the groups with more than one question are found and we calculate the sum of correlation of each question with other questions within the same group. The questions which came out with the maximum sum value are selected with weightage of one score. In this way we have found 31 questions. At

the end for 12 subjects we found RMSD between **gold-standard** and **sub-group** method (as shown in figure6.2). The proportionate difference was less than the difference which came out in **gold-standard** and **comprehensive** method. The Percentage and RMSD (%) between **gold-standard** and **sub-group** method is shown in table 6.2.

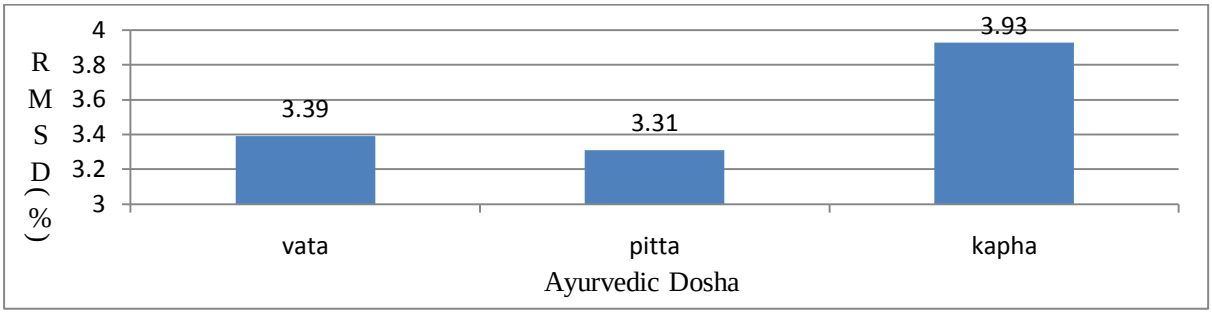

Figure6.1: RMS Difference (%) of Vata, Pitta and Kapha doshas for **Gold-standard and Comprehensive method.**

Table6.2: Percentage and RMSD (%) of Vata, Pitta and Kapha dosha of 12 subjects for **gold-standard** and **sub-group** method.

Gold-standard method results (%)				**Sub-group method results (%)**		
Vata	**Pitta**	**Kapha**		**Vata**	**Pitta**	**Kapha**
16	43.43	40.71		16.13	41.94	41.94
25.34	39.91	34.88		19.35	48.39	32.26
27.95	48.05	24.14		29.03	41.94	29.03
27.92	49.51	22.7		35.48	48.39	16.13
38.37	49.76	12		32.26	54.84	12.9
20.26	45.77	34.11		16.13	51.61	32.26
28.4	43.82	27.91		22.58	48.39	29.03
25.39	40.33	34.42		19.35	45.16	35.48
26.19	43.55	30.39		22.58	45.16	32.26
26.98	43.35	29.81		32.26	41.94	25.81
33.76	35.77	30.6		25.81	38.71	35.48
34.84	38.41	26.89		32.26	45.16	22.58
RMSD (%)						
Vata	**Pitta**	**Kapha**				
5.24	4.79	3.46				

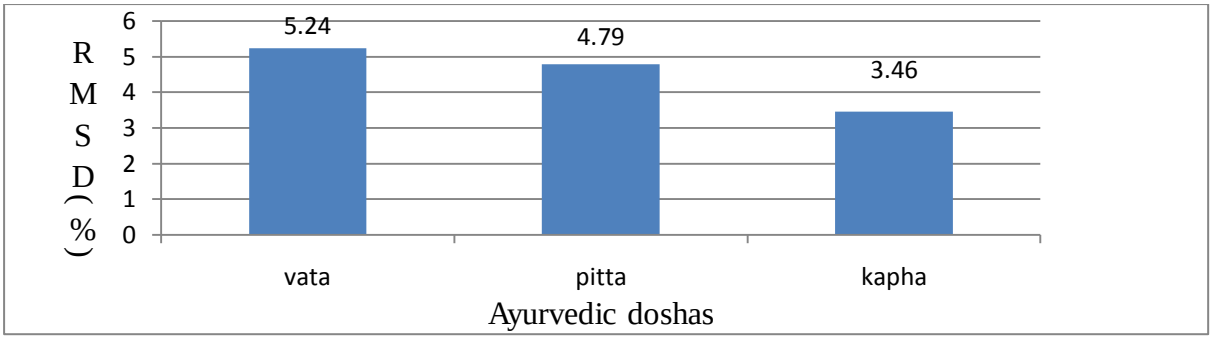

Figure6.2: RMS Difference (%) of Vata, Pitta and Kapha doshas for **gold-standard** and **sub-group** method.

6.4 Minimum-Correlation Method

Then we have taken the correlation matrix of 83 questions those are filled by 100 subjects. Each column represents one question and the correlation of one question with other 82 questions. We have found the sum of absolute value of correlations of all the columns in the correlation matrix. First, the column which has maximum sum value is removed, along with its corresponding row from the matrix. After that we are left with the correlation matrix of 82 questions and now we apply the same to the column which has maximum sum value and so on. From the above process we are left with 31 columns of minimum correlation sum value and each of these columns represents one question. This results in one new questionnaire of 31 questions. At the end for 12 subjects we found RMSD between **gold-standard** and **minimum-correlation** method (as shown in figure 6.3). The proportionate difference was less than the difference which came out in **gold-standard** and **comprehensive** method. The Percentage and RMSD (%) between **gold-standard** method and **minimum-correlation** method is shown in table 6.3.

6.5 Quick-Shot Method

As in above methods we have selected two sets of 31 questions (**sub-group** method and **minimum-correlation** method). In this we have extract one more questionnaire having 13 questions those are common in both the sets. At the end for 12 subjects we found RMSD between Gold-standard and quick-shot method (as shown in figure6.4). The proportionate difference is approximately equal to the difference which came out in gold-standard and comprehensive method. The Percentage and RMSD (%) graph between Gold-standard and

quick-shot method as shown in table 6.4. So, this questionnaire is considered for quick estimation of doshas.

Table6.3: Percentage and RMSD (%) of Vata, Pitta and Kapha dosha of 12 subjects for **gold-standard** and **minimum-correlation** method.

Gold-standard method results (%)				**Minimum-correlation method results (%)**		
Vata	**Pitta**	**Kapha**		**Vata**	**Pitta**	**Kapha**
16	43.43	40.71		9.68	38.71	51.61
25.34	39.91	34.88		25.81	45.16	29.03
27.95	48.05	24.14		29.03	45.16	25.81
27.92	49.51	22.7		29.03	41.94	29.03
38.37	49.76	12		29.03	58.06	12.9
20.26	45.77	34.11		19.35	48.39	32.26
28.4	43.82	27.91		25.81	45.16	29.03
25.39	40.33	34.42		22.58	51.61	25.81
26.19	43.55	30.39		19.35	48.39	32.26
26.98	43.35	29.81		19.35	51.61	29.03
33.76	35.77	30.6		35.48	41.94	22.58
34.84	38.41	26.89		35.48	38.71	25.81
RMSD (%)						
Vata	**Pitta**	**Kapha**				
4.59	6.12	5.36				

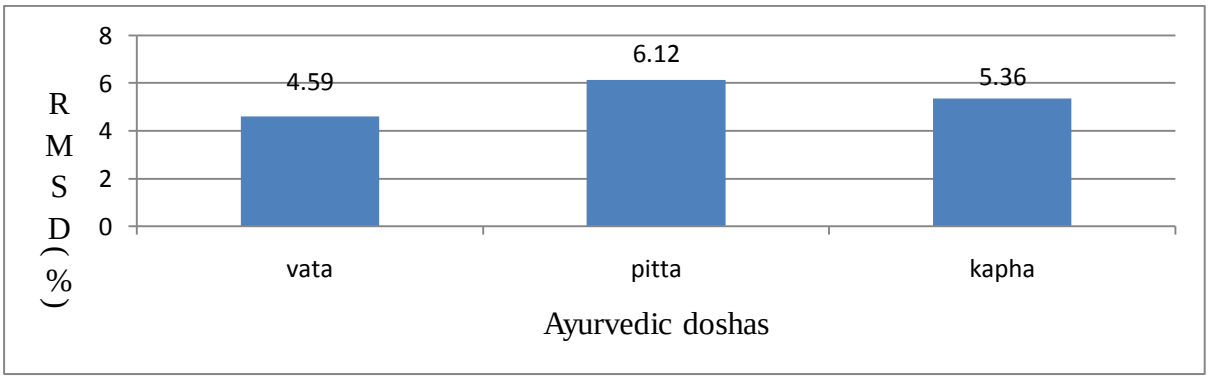

Figure6.3: RMS Difference (%) of Vata, Pitta and Kapha doshas for **gold-standard** and **minimum-correlation** method.

Table6.4: Percentage and RMSD (%) of Vata, Pitta and Kapha dosha of 12 subjects for **gold-standard** and **quick-shot** method

Gold-standard method results (%)				**Quick-shot method results (%)**		
Vata	**Pitta**	**Kapha**		**Vata**	**Pitta**	**Kapha**
16	43.43	40.71		15.38	53.85	30.77
25.34	39.91	34.88		30.77	38.46	30.77
27.95	48.05	24.14		38.46	38.46	23.08
27.92	49.51	22.7		38.46	38.46	23.08
38.37	49.76	12		30.77	69.23	0.00
20.26	45.77	34.11		15.38	53.85	30.77
28.4	43.82	27.91		23.08	61.54	15.38
25.39	40.33	34.42		30.77	46.15	23.08
26.19	43.55	30.39		15.38	46.15	38.46
26.98	43.35	29.81		15.38	53.85	30.77
33.76	35.77	30.6		53.85	30.77	15.38
34.84	38.41	26.89		30.77	46.15	23.08
RMSD (%)						
Vata	**Pitta**	**Kapha**				
9.40	10.48	8.51				

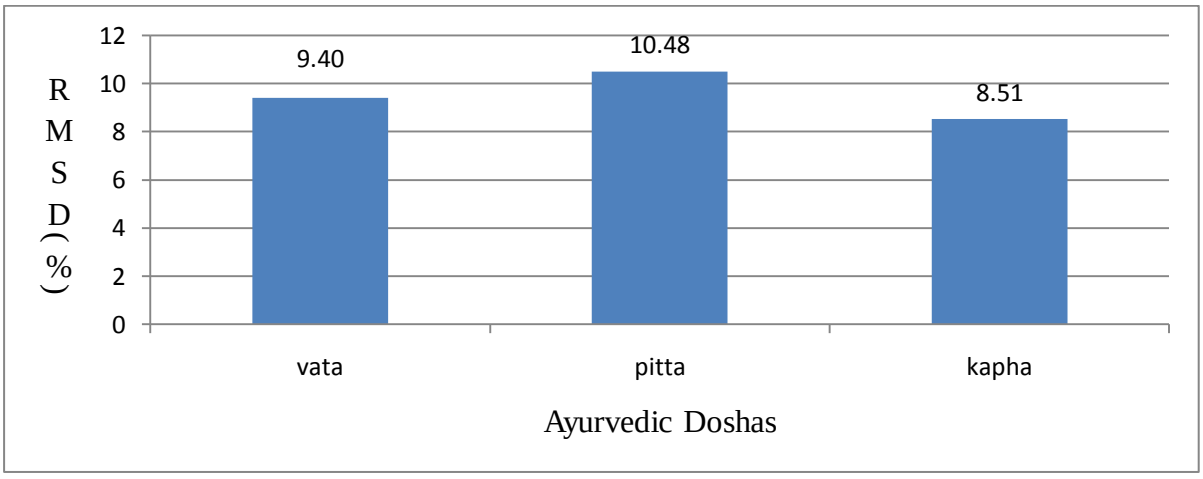

Figure6.4: Showing RMS difference (%) of vata, pitta & kapha doshas for **gold-standard** and **quick-shot** method.

6.6 Performance check of Sub-group and Minimum-Correlation method

To check the efficiency of sub-group method and minimum correlation method following steps are used:

Step1: 12 subjects are chosen randomly.

Step2: Their Vata, Pitta and Kapha is determined by 83-questions questionnaire each questions carrying a weightage of 1.

Step3: Vata, Pitta and Kapha of these 12 subjects are determined using the **gold standard** method containing 83 questions of different weightage as described above.

Step4: Vata, Pitta and Kapha of these 12 subjects are determined using **sub-group** method containing 31 questions.

Step5: Vata, Pitta and Kapha of these 12 subjects are determined using **minimum correlation** method containing 31 questions.

Step6: RMSD for Vata, Pitta and Kapha in 12 subjects is calculated between the results obtained in step 2 and step 3.

Step7: Expected proportionate error for 31 questions **sub-group** method as well as 31 questions **minimum correlation** method is calculated, simply by multiplying the RMSD calculated in step 6 by factor (83/31).

Step8: RMSD of Vata, Pitta and Kapha is calculated for the results obtained in step 4 and step 3.

Step9: RMSD of Vata, Pitta and Kapha is calculated for the results obtained in step 5 and step 3.

Step10: Tabulate and Plot the results in Table 6.5 and Fig6.5 for interpretation.

Table6.5: Actual and expected proportionate percentage RMSD of 12 subjects for different techniques.

Dosha	RMSD(%) for 83-question and gold standard method	Expected proportionate RMSD(%) for 31 question method	Actual RMSD(%) for 31 questions sub-group and gold standard method	Actual RMSD(%) for 31 questions minimum correlation and gold standard method
Vata	3.38	9.04	5.24	4.59
Pitta	3.31	8.84	4.79	6.12
Kapha	3.92	10.48	3.46	5.36

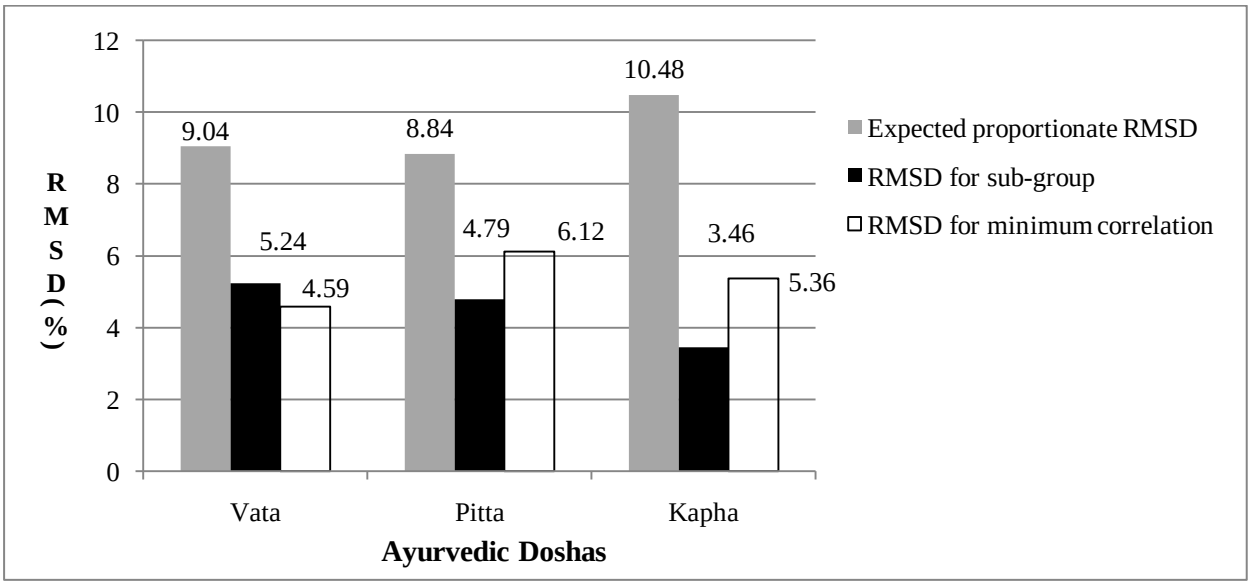

Figure6.5: Actual and expected proportionate percentage RMSD of 12 subjects for different techniques.

6.7 Performance check of Quick-Shot method

To check the efficiency of **Quick-shot** method and compare it vis-à-vis **sub-group** method and **minimum correlation** method the following steps are used:

Step1: 36 subjects are chosen randomly.

Step2: Their Vata, Pitta and Kapha are determined by 83-questions questionnaire each questions carries a weightage of 1.

Step3: Vata, Pitta and Kapha of these 36 subjects are determined using the **gold standard** method containing 83 questions of different weightage as described above.

Step4: Vata, Pitta and Kapha of these 36 subjects are determined using **sub-group** method containing 31 questions.

Step5: Vata, Pitta and Kapha of these 36 subjects are determined using **minimum correlation** method containing 31 questions.

Step6: RMSD for Vata, Pitta and Kapha in 36 subjects is calculated between the results obtained in step 2 and step 3.

Step7: Expected proportionate error for 31 questions **sub-group** method as well as 31 questions **minimum correlation** method is calculated, simply by multiplying the RMSD calculated in step 6 by factor (83/31).

Step8: RMSD of Vata, Pitta and Kapha is calculated for the results obtained in step 4 and step 3.

Step9: RMSD of Vata, Pitta and Kapha is calculated for the results obtained in step 5 and step 3.

Step10: Common 13 questions obtained from the **sub-group** method and **minimum correlation** method. These questions are used in a new method called **Quick-Shot** method to determine the Vata, Pitta and Kapha of 36 subjects.

Step11: Expected proportionate error for 13 questions method is calculated simply by multiplying RMSD calculation in step8 by (31/13).

Step12: RMSD of Vata, Pitta and Kapha is calculated for results obtained in step10 and step3.

Step13: Tabulate and Plot the results in Table 6.6 and Fig6.6 for interpretation.

Table6.6: Actual and expected proportionate percentage RMSD of 36 subjects for different techniques.

Dosha	RMSD for 83 question and gold standard method	Expected proportionate RMSD for 31 question method	Actual RMSD for 31 questions sub-group and gold standard method	Actual RMSD for 31 questions minimum correlation and gold standard method	Expected proportionate RMSD for 13 question method	Actual RMSD for 13questions quick shot and gold standard method
Vata	3.76	10.06	4.9	5.12	11.68	10.52
Pitta	3.54	9.48	4.22	4.06	10.06	10.04
Kapha	3.65	9.77	3.96	4.14	9.44	9.52

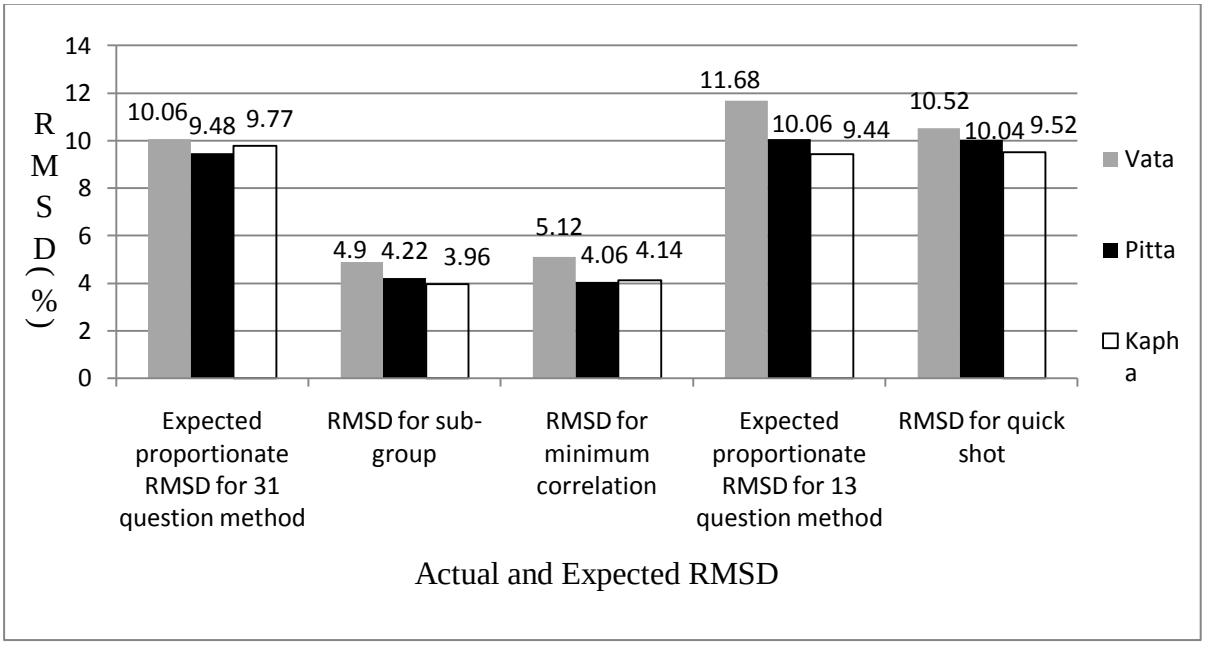

Figure 6.6: Actual and expected proportionate percentage RMSD of 36 subjects for different techniques.

Chapter7 Conclusion and Future Scope

Determining Vata, Pitta and Kapha dosha by questionnaire method is prevalent but not standardized. Every researchers uses a different set of questionnaire does resulting in different results. This work combined all the questions of various possible practical sources which are helpful in finding the three doshas present in human body and subsequently applied Principal Component Analysis (PCA). On applying PCA we find that there are only 31 characteristics that need to be considered. To crosscheck this, 31 sub-groups are found and the weightage to the questions is adjusted accordingly. The 83-question questionnaire and 31-sub-group questionnaire (**gold-standard method**) are to be used for determining Vata, Pitta and Kapha in 36 subjects. We get an RMSD of less than 4 % between both. Now each sub-group contains the questions having maximum correlation amongst themselves within the sub-group. In this investigation it is proposed that 1 question each from 31 sub-groups be selected. The base of this selection is taken as the total sum of correlation with other questions within that sub-group. A parallel alternate study is made independent of formulation of subgroups by choosing 31 questions as suggested by PCA, that are mutually orthogonal to all other components, on the basis of minimum absolute correlation taken with the all questions in the group. While the former method is thereafter referred to as **sub-group method**, the latter is referred as **minimum correlation method.** The **sub-group method and minimum correlation method** containing 31 questions is to be used for determining Vata, Pitta and Kapha in 36 subjects and the results are to be compared with the gold standard using RMSD. The RMSD is appreciably lower than its expected proportionate difference. So, these both methods are reliably used for diagnosis of Vata, Pitta and Kapha doshas constituents of human being. At last Common 13 questions obtained from the **sub-group** method and **minimum correlation** method. These questions are used in a new method called **quick-shot** method to determine the Vata, Pitta and Kapha of 36 subjects. Then the RMSD is calculated between **quick-shot** method and **gold-standard** method and the expected proportionate difference is comparable to 31 questions method. So for quick diagnosis we can use quick-shot method. Therefore we may finally say that it is optimal to use either 31-question sub-group method or 31-question **minimum correlation** method questionnaire for general use as both produce equally accurate results. In tricky situations, where the physician wants highly precise results, 83-question questionnaire with each question having weightage of 1 may be used. However, for common ailments **Quick-Shot** method containing 13 question is recommended for faster and yet reliable diagnosis.

In future, this work can be extended in using:-

1. Fuzzy logic and Artificial Neural Networks for better classification.
2. Number of subjects can be increased for better accuracy.

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Appendix A Human Doshas Questionnaire

Table A1: The 83 questions questionnaire in which subject has to choose one option in each characteristic (question).

Sr. No	Characteristics	Option 1	Option 2	Option 3
1.	Body Frame	Thin, irregular, very short or very tall	Medium, well proportioned	large, broad, evenly Proportioned, ample in build
2.	Structure	Light bones, prominent joints	Medium bones	Heavy bone structure
3.	Body Weight	Low ,Hard time gaining Weight	Moderate, Gain or lose easily, if you put your mind to	Heavy, Gain easily, hard time Losing
4.	Chest	flat, sunken	Moderate	large, broad
5.	Shape of face	thin, boney	medium, angular	full, round
6.	Size of Eyes	Small	Medium,	Big, wide
7.	Colour of Eyes	active, dark, dry, Brown, Black, unsteady	Sharp, Penetrating light, green, grey or amber, reddish, piercing.	Blue, attractive eyes, thick eyelashes
8.	Whites of eyes	Blue/brown	Yellow or red	Glossy white
9.	Skin type	Dry skin, Rough, chaps Easily	Soft, Warm, Oily skin(normal to oily)	Oily, Thick, well lubricated , wavy.
10.	Skin colour	Brown	Red, fair	Pale
11.	Skin temperature	Cold hand/feet	Warm	Cool
12.	Complexion	Dark, tan easily	Fair, sunburn easily, pink-red, reddish, coppery	Tan slowly but evenly, skin stays cooler than most, pale-white, whitish,

				clear
13.	Nails	Brittle ,thin, cracking	Flexible, but pretty Strong, medium, soft, pink	thick, strong, white
14.	Teeth	Small ,Protruded spaces between teeth; crooked: gums emaciated	yellow ,Moderate in size, soft or bleeding gums	large, Strong, White; gums, well formed
15.	Stamina	Short	Moderate	Strong
16.	Speech	Fast, sometimes missing words, omits words, uninterrupted, not very clear, but fill of new ideas	Fast, Sharp and cutting , clear-cut, precise ,incisive, (make good leaders)	Slow ,monotonous(with long gaps) but melodious voice, often good orators, clear, sweet
17.	Appetite(desire for food)	Variable, Low mostly, can get very hungry	Good, Sharp, excessive, needs food when hungry, Irritable if you miss a meal or can't eat when hungry	Slow but steady & strong (can withstand fasting),like to eat, fine appetite, but can skip meals if you have to
18.	Taste preference	Sweet, sour, salty	Sweet, bitter, astringent	Pungent, bitter, astringent
19.	Food	Like to snack, nibble, creamy, rich	Like high protein foods, like chicken, fish, eggs ,beans	Love fatty foods, bread, starch
20.	Thirst	Variable	Excessive, Usually thirsty	Low, Rarely thirsty
21.	Preference of food and Drink	Prefers warm	Prefers cold	Prefers dry and warm

22.	Illness/Disease vulnerability(pre-disposition)	Nervous disorders or sharp pain more likely , Neurological and stress disorders; gas in abdomen, pain etc.	Fevers, skin rashes, Inflammation more likely, Acid indigestion, infection	Excess fluid retention or mucous secretion more likely, respiratory congestion, obesity related disorders.
23.	Perspiration	Cold hands and feet, little perspiration	Good circulation, perspire frequently	Moderate perspiration
24.	Climate	Prefer warm climate, sunshine, moisture	Prefer cool well ventilated places	Any climate as long as it is not too humid
25.	Bowel movements	Irregular, hard, dry, stools; constipated	Easy and regular, if anything soft, oily, loose stools twice a day, soft, oily, loose/copious stools	Regular daily steady, thick, heavy stools, oily, slow motion.
26.	Routine	Dislike routine, very restless, irregular	Enjoy planning and routine especially if you create it, instructing others(but may not take kindly to unwanted instruction),punctual, sharp	Work well with routine
27.	Physical activity	High(mostly on the move), Like to stay active	Moderate, Enjoy activity Especially	Lethargic(dislike physical activity), love leisurely activities

				most
28.	How do you achieve Goals	Easily distracted	Focused and driven	Slow and steady
29.	Emotional temperament	Tend towards fear, insecurity and anxiety, under stress, fearful, indecisive, nervous , perceptive.	Confident; tend towards anger, frustration or Irritability , intelligent, Arrogant, successful, Impatient; expects compliance from others	Tend to avoid stress and difficult Situations but once confronted, faces stoically, without faltering, greedy, Calm, stable, stubborn, easy going.
30.	Emotional trauma causes	Anxiety	Denial	Depression
31.	Dreams	Often dream, but rarely remember them, fearful, flying, jumping, running dreams	Remember dreams easily, often dream in colour , fiery, angry, violence, war, passionate, colourful, adventurous, struggle	Only remember dreams if they are especially significant or intense, watery, ocean, romantic dreams, few, include water, clouds, relationships, romance.
32.	Moods	Changeable moods and ideas, change quickly	Forceful about expressing your ideas and feelings, change slowly	Steady, reliable, slow to change, unchanging
33.	Sleep	Light sleeper, Insomnia, interrupted	Moderate, short, but sound , Usually sleep well	Deep & prolonged , Sound, long, heavy sleeper

34.	Attachment / Loyalty	Variable / Shifting	Intense & extreme;(averse to easily forget & forgive)	Deep & consistent (can be possessive)
35.	Finance(spending habits)	Doesn't save, Spends quickly, Money is to be Spent.	Spends moderately , Spend on special items or on purchases that will advance you	Spends slowly; Easy to save
36.	Relationships	Many casual	Intense	Long and deep
37.	Preference for Music	Variable; instrumental preferred; Also likes group music; rhythmic tunes; sometimes soft music	Exciting / noisy / loud; racy music; Group singing and group dances; folk music	Soft and romantic music; likes Classical and devotional music (Bhajans) , with good lyrics.
38.	Memory	Learn easy/forgets, Recent memory Sharp; remote memory poor, short-term best	Sharp & distinct recent memory; Selective / long term Memory, good general memory	Slow and distinct (rarely forgets, once memorized), long term best.
39.	Intellect	Very quick, impulsive, (can be faulty)	Sharp & accurate (quick in grasping)	Slow, but exact and sound
40.	Prefers to work	While supervised	Alone	In groups
41.	How do you react to Stress	Excites quickly	Medium	Slow to get excited
42.	Thoughts	Constantly changing	Fairly steady	Steady, stable, fixed

43.	Concentration	Short-term focus best	Better than average mental concentration	Good ability for long term focus
44.	Prayers	Occasionally	Daily	Never
45.	Voice	High pitched	Medium pitched	Low pitched
46.	Adjusting nature	Variable	Almost null	Very good
47.	Veins and tendons	Very prominent	Fairly prominent	Well covered
48.	In social situations	I feel shy or lacking Confidence	I like to be centre of attraction, and feel confident	I feel calm, relaxed, and often humorous
49.	In difficult situations	I tend to feel Overwhelmed	I try to take control	I remain calm and Unruffled
50.	Endurance	Fair	Good	Excellent
51.	Walking speed	Fast	Average	Slow and steady
52.	Muscle tone	Lean, low body fat	Medium, with good definition	Brawny/bulky with higher fat percentage
53.	More sensitive to	Own feelings	Not sensitive	Others' feelings
54.	Expresses affection	With words	With gifts	With touch
55.	When feeling hurt	Cries	Argues	Withdraws
56.	Cleanliness	High	Moderate	Low
57.	Desire	Little	Some	Lot
58.	Pride	Moderate	Some ego	Vain
59.	Exercise	Feel more mentally relaxed when exercising	Exercise helps keep emotions from going out of control	Exercise keeps weight down in a way a diet alone won't.
60.	Exercise tolerance	Low	medium	High
61.	Digestion	Sometimes good, sometimes bad(irregular)	Usually good, strong	Fine but sometimes slow

62.	Quality of mind	Quick, creative	penetrating	Stable, lethargic
63.	Spirituality	Spiritually disciplined	Tendency to material	Fundamentally material
64.	How do you eat	Quick	medium	Slow
65.	how is your hunger level	Irregular	Sharp, needs food when hungry	Can easily miss meals
66.	Friendship	Tends toward short-term friendships ,makes friends quickly	Tends to be a longer, friends related to occupation	Tends to form long-lasting friendships.
67.	Ability to understand	Quick grasp of learning	Medium to moderate grasp	Slow to learn new things
68.	Weather preference	Aversion to cold	Aversion to heat	Aversion to damp, cool
69.	I am often described as	Restless, hyperactive, Overworking	Perfectionist, competitive, Little aggressive	Overly complacent about life
70.	Among my older blood relatives	Low bone density, joint pain, arthritis are common	Hyperacidity, high blood pressure, heart disease are common	Obesity, diabetes, slow metabolism are common
71.	Strength	Fair	Better than average	excellent
72.	Competition	Do not like competitive pressure	Driven competitor	Deals easily with competitive pressure
73.	Runs like	Deer	Tiger	Bear
74.	Responses towards environment	Variable	Prompt, sharp	Slow reactions
75.	Reaction time	Quick	average	Slow
76.	Reacts to stress	Fear	anger	indifference

	with			
77.	Amount of hair	Average	thinning	Thick
78.	Hair type	Dry	normal	Oily
79.	Hair colour	Light brown, blonde	Red, auburn	Dark brown, black
80.	When threatened tends to	Run	fight	Make piece
81.	Confidence level	Timid	Outwardly self confident	Inner confidence
82.	Anger	Sometimes	frequently	Rarely
83.	Patience	Variable	less	Very good

Accepted Papers

1. “Consistency Analysis for determination of Ayurvedic doshas using prevalent questionnaires" authors Dr. Mandeep Singh and Anil Anand, International Journal of Computer Science and Communication (ISSN 0973-7391), Volume-II, Number-II of September 2011.
2. “Principal Component Analysis of combined questionnaire for determining Human Constituents" authors Dr. Mandeep Singh and Anil Anand, International Journal of Computer Science and Communication (ISSN 0973-7391), Volume-II, Number-II of September 2011.
3. “Optimization of questionnaire for determining Ayurvedic Imbalances" authors Dr. Mandeep Singh and Anil Anand, International Journal of Computer Science and Communication (ISSN 0973-7391), Volume-II, Number-II of September 2011.
4. “Analyzing Quick-Shot method for Ayurvedic Diagnosis" authors Dr. Mandeep Singh and Anil Anand, International Journal of Computer Science and Communication (ISSN 0973-7391), Volume-II, Number-II of September 2011.