

CHAPTER 2

2.0 REVIEW OF LITERARY SEARCH

2.1 BACKGROUND AND SCOPE

Taittiriya Upanishad describes human existence in *pancakōśa viveka*, according to which humans have five layers or sheaths. The first one, namely, *Annamayakośa* corresponds to the gross physical body, followed by *prāṇamayakośa* corresponds to the energy body, *manomayakośa* corresponds to emotional body, *vijñanamayakośa* corresponds to intellectual body and *ānandamayakośa* corresponds to the bliss body (*Taittiriya Upanishad –Briguvalli*) (S. Nikhilananda, Ramakrishna-Vivekananda Center, New York, NY, 1994).

The *prāṇamayakośa* sheath of vital energy is also known as the pranic body. It coexists within the physical body as its source of life, breath and vitality. It interconnects the *annamayakośa* (physical body) with the other more subtle sheaths (S. Gambhirananda Advaita Ashrama, Pithoragarh, 1986). Prāṇā flows throughout the body through energy channels called *nāḍīs*. These *nāḍīs* conglomerate at certain places called chakras (thought to be nerve plexus). There are seven major chakras (*muladhara, śvadhastana, manipura, ānahata, ājña and śahasrara*). Prāṇā moves in the *prāṇamayakośa* as five primary currents or vayus, "vital airs or winds." This *prāṇamayakośa* disintegrates at death along with the physical body (S. N. Saraswati, 1994).

Psychosomatic diseases originate from *manomayakośa* (emotional body), percolate into *prāṇamayakośa* (energy body) through the vital life-force (*prāṇā*), and settle in the physical body, inflicting damage to the weakest organs (Yoga Vasista ch II, verses 709–723), affecting the physiology and functionality of those organs (S. Venkatesananda, 1985).

Diseases are of two kinds, *Adhija* (originated in the mind) and *Anadhija* (non-stress-related) *vyadhis*. *Adhis* are twofold: ordinary and essential. *Samanya*/ordinary diseases could be termed as life style non-communicable diseases since these are produced during the interactions (mental conflicts) with the world (Kavuri, Raghuram, Malamud & Selvan, 2015).

In this thesis, we present three distinct studies related to mind-body problems, The first one is related to meditation and its effect on EPI parameters. The second study is related to mudras and their monitoring through EPI parameters. The third is related to identification of a pattern of EPI parameters in diabetic condition distinctly different from a non-diabetic condition for disease diagnosis using an artificial neural network.

Since the disease originates from the *manomayakośa* it will be relevant to discuss the practices related to the *manomayakośa*, specifically meditation. Effect of meditation on the activation of autonomic nervous system and attentional mechanisms is not new. Some studies have also attempted to understand the mechanism of meditation by monitoring the brain waves and the default mode network activity online.(Mars et al., 2012). There were also focused studies on effect of meditation on pain, stress, anxiety, hypertension and blood sugar (Orme-Johnson, 1995). The

present study is an attempt to understand the effect of meditation on various organs and organs systems using Electro Photonic Imaging (EPI) Technique.

Mudras signify a gesture with hands, eyes and the body. Different configurations of the joining of finger tips is also termed mudra and is used by yoga practitioners for energy manipulation and for therapeutic applications. Electro Photonic Imaging captures the coronal discharge around the fingers as a result of electron capture from the ten fingers. The coronal discharge around each fingertip is studied to understand the effect of mudra on EPI parameters.

Studies on EPI have reported on EPI's use to characterize some key pathologies including cancer, asthma, and autism (Yakovleva, & Korotkov, 2013).

The EPI grams of healthy and diseases subjects, EPI grams before and after yogic practices like Mudra and Meditation show a pattern of variation in the EPI parameters. These patterns are studied for their statistical significance as well as for machine learning to be able to distinctly differentiate them so as to diagnose a disease condition or to study the effect of a yogic practice on EPI parameters.

In this work we use artificial neural network as a machine learning tool and have explored the possibility of coming up with a frame work for disease diagnosis and intervention recognition. Though a Yogic practice is not an intervention we have loosely used the word intervention to mean a yogic practice used in our study.

2.2 AIM & OBJECTIVES

- The aim of the literature review is to understand the human body from an energy perspective as defined in the ancient texts.
- To explore how the energy body is affected through disease and with Yoga Practices like meditation and Mudra.
- To understand the origin and effects of thoughts on human body as described in the ancient texts.
- To understand the mechanism of meditations and Mudras from an energy perspective.

2.3 MATERIALS AND METHODS

The following Vedic and Yoga texts were used for understanding the source of disease.

- *Śrīmadbhagavad gītā* (श्रीमद्भगवद्गीता)
- *Yoga Vasiṣṭha* (योग वसिष्ठ)
- *Patañjali's Yogasūtra* (पतंजलियोगसूत्र)
- *Lalitā sahasranāmāvalī* (ललिता सहस्रनामावलि)
- *Kenopaniṣad* (केनोपनिषद्)
- *Yogasaraupaniṣad* (योगसारा उपनिषद्)
- *Muṇḍakopaniṣad* (मुण्डकोपनिषद्)
- *Praśnopaniṣad* (प्रश्नोपनिषद्)
- *Māṇḍukyopaniṣad* (मान्डुक्य उपनिषद्)

2.3.1 INCLUSION CRITERIA

The search captured only a subset of verses related to disease (*ādhi vyādhi*), *prāna*, *panca kosa* and *dhyāna*. The search also included *manas* and *citta*. Verses describing the source of thoughts, ways to eliminate thoughts were also included.

2.3.2 EXCLUSION CRITERIA

Exclusion criteria was set to eliminate multiple descriptions of the same entity. Verbose literary descriptions which provided rich source of information but not related to the current context were also excluded.

2.3. A. VEDIC SOURCES AND CLASSICAL YOGIC TEXTS INCLUDES

2.3. A.1 ORIGIN OF DISEASE FROM SRIMAD BHAGAVAD GITA

The classical literatures of India have presented mind as a harbinger of disease in the body. A brief introduction to this concept is presented below.

ध्यायतो विषयान्पुंसः सङ्गस्तेषूपजायते ।

सङ्गात्सञ्जायते कामः कामात्क्रोधोऽभिजायते ॥ २-६२ ॥

क्रोधाद्भवति सम्मोहः सम्मोहात्स्मृतिविभ्रमः ।

स्मृतिभ्रंशाद् बुद्धिनाशो बुद्धिनाशात्प्रणश्यति ॥ २-६३ ॥

dhyāyato viṣayānpuṁsaḥ saṅgasteṣūpajāyate |

saṅgātsañjāyate kāmaḥ kāmātkrodho'bhijāyate || 2-62||

krodhādbhavati sammohaḥ sammohātsmṛtivyibhramaḥ |

smṛtibhramāśād buddhināśo buddhināśātpraṇaśyati || 2-63||

(Bhagavad Gita Ch: 2; 62,63)

“While contemplating the objects of the senses, a person develops attachment to them, and from such attachment lust develops, and from lust anger arises. From anger proceeds delusion; from delusion, confused memory; from confused memory the ruin of reason, due to the ruin of reason the person perishes”.

This shows that the thoughts in the mind play a vital role. The thought then changes the breathing patterns as anger takes over and the change in breathing pattern affects the physical body.

2.3. A.2 ORIGIN OF DISEASE FROM YOGA VASISTA

The concept of disease, according to yoga, is found in the treatise called Yoga Vasistha. According to this text, modern diseases such as asthma, diabetes, hypertension, and anxiety are called “ādhijavyādhi” (stress born diseases) originating in *manomayakoça*, the mind layer of our existence. They arise from our actions that are governed by our emotions (strong likes and dislikes) rather than what is right or what is wrong. Often in this phase, we respond to our emotions - the pull of senses knowing fully well that we are going against what is right. This is called *prajnāparadha* in Ayurveda, a mistake at the level of inner consciousness. It is this ‘going against what is right’ - the cosmic law- that causes an imbalance, a disease at the *manomayakoça* called *ādhi*.

यदन्तःमारुतोरूद्धःव्याधिःजन्तोः न जायते ।

देहदुःखंविदुःव्याधिंआध्याख्यंवासनामयम् ॥

*Yadantaùmarutorüddhaùvyädhiùjantotoùnajäyate /
Dehaduùkhaàviduùvyädhimädhyäkhyàäväsanaamaym //*

(Yogavasistha, Ch: XX, V: 29)

If the vital air is bound (or restrained) within, physical ailment is not produced in a living being. The distress of the body is known as (physical) disease. Mental affliction consists of mental impressions (or knowledge derived from memory agitating the human psyche).

दुरन्नाभ्यवहारेण दुर्देशाक्रमणेन च ।
दुष्कालव्यवहारेण दुर्जनासङ्खेगदोषतः ॥
क्षीणत्वात् वाऽतिपूर्णात्वात् नाडीनांरन्ध्रसंततौ ।
प्राणे विधुरतां याते व्याधिः देहे प्रवर्तते ॥

*Durannābhyavahāreḥa durdeṣākramaṇēnaca /
Duñkālavavyavahāreḥa durjanāsaṅgadoṇatau | //
kṣhīḇatvātva' tipūrḇātvaṭnāḇnāārāndhrasāntatāu /
prāḇēvidhuratāāyātevyādhiḥḇeḇepravartate | //*

(Yoga Vasishtha Ch: XX, V: 30)

Disease occurs in the body when prana (Subtle Energy) reaches deprivation in the series of the cavities of the *nāḇis* (energy channels such as nerves, arteries and veins), due to the eating bad food, occupation of bad places, conduct of affairs in unsuitable time, evil of association with bad people and by the diminution or overfilling (of the system with the necessities of life). Thus, the role of mind could result in uneven pranic flow in the *nāḇis*; this is the start of a disease process.

Having said that the source of disease is the mind or the thoughts in the mind, we focus our attention on how thoughts are produced in the mind.

2.3. A.3 ORIGIN OF THOUGHTS FROM YOGASARA UPANISHAD

उद्रिक्तम् मनश्चित्तम् यत्प्रभावृत्तयः ।

Udriktam manaścittam yatprabhāvṛttayaḥ।

(Yoga Sara Upanishad Mantra 7)

When mind is excited and memory is stimulated, then they jointly produce an impulse of energy that is a thought which is a *vritti* that is a tendency. Having understood what *Vriti is* we now focus on how to get rid of these *vritis* using meditation.

2.3. A.4 YOGA AND DHYANA FROM PATANJALI YOGA SUTRAS

योगश्चित्तवृत्तिनिरोधः ।

Yogaścittavṛttinirodhaḥ

(Patañjali Yoga Sūtra I.2)

Yoga is the restraint (cessation) of fluctuation (modification) of the mind.

तत्र प्रत्ययैकतानता ध्यानम् ।

Tatra pratyayaikatānatā dhyānam ।

(Patañjali Yoga Sūtra III.2)

Uninterrupted flow of the mind towards the object of focus is meditation.

2.3. A.5 MANIFEST AND UN-MANIFEST FORMS OF SOUND ENERGY

The Vedas form the sound-manifestation of *Ishvara*. That sound has four divisions. *Para* which finds manifestation only in *prana*, *Pasyanti* which finds manifestation in the mind, *Madhyama* which finds manifestation in the *indriyas*, and *Vaikhari* which finds manifestation in articulate expression.

Articulation is the last and grossest expression of divine sound-energy. The highest manifestation of sound-energy, the primal voice, the divine voice is *Para*. The *Para* voice becomes the root-ideas or germ-thoughts. It is the first manifestation of voice. In *Para* the sound remains in an undifferentiated form. *Para*, *Pasyanti*, *Madhyama* & *Vaikhari* are the various gradations of sound. *Madhyama* is the intermediate unexpressed state of sound. Its seat is the heart.

परा प्रत्यक्कितीरूपा पश्यन्ति परदेवता ।

मध्यमा वैखरी रुपा भक्त मानस हंसिका ॥

parā pratyakcītīrūpā paśyanti paradevatā /
madhyamā vaikhari rūpā bhakta mānasa hamsika / /

(Lalitha Sahasranamavali, verse 82)

The verses above describe the mechanism of how sound is produced. An impulse of energy called *Para Vani* first manifests at the base of the spine (i.e. *Muladhara chakra*). The second form of this energy is *Pasyanti*. It manifests in the navel or the *Manipura Chakra*. *Yoginis* who have subtle inner vision can experience the *Pasyanti* state of a word which has colour and form, which is common for all languages and which has the vibrating homogeneity of sound. Indians, Europeans, Americans, Africans, Japanese, birds, beasts—all experience the same *Bhavana* or feeling of a thing in the *Pasyanti* state of voice or sound. Gesture is a sort of mute subtle language. It then gets transformed as *Madhyama* in the heart and then eventually as *Vaikhari* in the throat and mouth. This is the divine descent of one's voice. *Hamsa* in Sanskrit means a swan and represents the life breath or *prāna*, *Siva* and *Sakti* -- the twin aspects of reality. The incoming breath is called *Sa* and the outgoing one is called the *Ham*, together creating the word *Hamsa*. Air is exhaled with the sound *Sa* and inhaled with the sound *Ham*. Then reciting of the mantra *Hamsa* is continuous (Vijnana Bhairava, 155a). These verses and the others are included here to illustrate the various states and forms of energy just for the purpose of comprehending the complexity of subtle energy measurement and interpretation from a scientific perspective.

Yogis use mudra for channelizing energy from the base of the spine (*mooladhara*) to top of the head (*sahasrara*). The physical based *sadhana*, called hatha yoga is the most widely known type of yoga. Kriya yoga uses visualization, gesture and ritual worship. *Laya* yoga explains how the concentrated mind leads one to forget materialistic world and enter *Samadhi* state. The concept mudra is the physical equivalent/representation of a mantra. In hatha yoga, mudra is used for connecting two points of energy in our body.

2.3. A6 LITERATURE SURVEY ON MUDRAS

A mudra can be perceived as a hand posture with a specific pattern of finger configurations. Using modifiers, complex mudras could be constructed from relatively simple mudras (J.S.Vipin Indian Institute of Science Bangalore, 2008).

The word mudra is derived from Sanskrit word meaning that which dissolves duality and brings the deity and devotee together. Mudras are hand, body or eye positions that facilitate certain energy flows in the body and by forming a specific mudra one can induce certain states of mind and consciousness (Mohini, Hd, Tm, & Yhe, 2015).

It is customary that mudras are typically used during meditation and pranayama as a way to direct energy flow throughout the body. According to yoga philosophy, different areas of the hand stimulate specific areas of the brain. By applying light pressure to these areas of the hand, we will 'activate' corresponding region of the brain, similar to reflexology. Mudras also symbolize various feelings, emotions and representatives of various states of being (Mohini et al., 2015).

Hatha Yoga Pradipika deals with *bandhas* and mudras together and the ancient tantric texts also make no distinction between the two. *Bandhas* are extensively incorporated in mudra as well as in pranayama techniques. Their locking action, however, reveals them as a fundamentally important group of practices in their own right (Muktibodhananda S., 1993).

Prana mudra is formed by placing the tips of the thumb, ring finger, and little finger together. The other fingers remain extended. The Prana mudra claims to increase vitality, reduce fatigue and nervousness, and improve vision. It is used to mitigate eye diseases. On the mental-emotional level, it increases our staying power and assertiveness, healthy self-confidence, gives us the courage to start something new, and the strength to see things through. Clear eyes are also a sign of a mental outlook emphasizing clarity and a clear mind, which means clearly structured thoughts and ideas (Gertrud Hirschi, 2000).

2.4 REVIEW OF WORK IN THIS FIELD

Electro Photonic Image represents a spatially distributed glow areas having varying brightness characteristics. Compute analysis of it reveals general, local and sector based details.(Alexandrova, Fedoseev, & Korotkov, 2004).

The parameters that Electro Photonic Image (EPI) provides are indicative of psycho-emotional and physiological states. It provides information about the stress and normal behavior of organs and organ system (Deshpande, Madappa, & Korotkov, 2013).

The coronal discharge around a human fingertip using an EPI instrument were used to study the effect of textiles on the human body (Ciesielska, 2007).

Psycho-emotional condition is defined by our feelings and thoughts. One of the main questions is what is contained in the EPI data, physical or psychical component. The researchers showed that it is the mental state with the quality of psychic energy of man (Anufrieva, Anufriev, Starchenko, & Timofeev, 2014).

EPI technique has been used to monitor the patients by comparing their normal Electro Photonic emissions before and after surgeries (Kostyuk, Cole, Meghanathan, Isokpehi, & Cohly, 2011).

EPI based analysis on degree of arterial hypertension concluded that EPI could be used to screen patients of hypertension with different levels of severity (Aleksandrova, 2009).

Sympathetic and parasympathetic activities can be extracted from the EPI data. The quantitative difference between the two systems is given out as a parameter called the Activation Coefficient (AC) by the EPI software, it also gives Integral Entropy (IE) which is a measure of deviation from functional physiological state and psycho emotional balance (Cohly, Kostyuk, Isokpehi, & Rajnarayanan, 2009).

The EPI data has a large number of parameters. They are multidimensional and non-linear, which calls for a pattern based approach. Artificial neural networks have been used in the literature for bio-medical applications. The research on early prediction of diabetes using features of EPI Images also concluded that data can be used to train neural networks for classification of diseases for diagnosis (Shanmuga Priya & Rajesh, 2013).

Artificial neural networks were used to predict organ failures in patients with acute pancreatitis (Wd Hong et al., 2013). ANN have also been used to predict the onset of diabetes (Pradhan & Sahu, 2011).

An artificial neural network (ANN) consists of a series of interconnecting parallel nonlinear elements with limited number of inputs and outputs (Wd Hong et al., 2013).

Artificial Neural Network analysis is more successful than the conventional statistical techniques in predicting clinical outcomes when the relationship between variables that determine the prognosis is complex, multidimensional and non-linear (Wan-dong Hong, Ji, Wang, Chen, & Zhu, 2011).

There have been very few studies in capturing subtle effects in an automated environment. This work uses the combination of EPI data and artificial neural network for recognizing the intervention (anapanasati meditation) and works as a frame work for intervention recognition as well as disease diagnosis.

The research work on “understanding type 2 diabetes at the *Prāṇamaya Kośa* level” (Bhavana Shrama, Alex Hankey, 2014) was an attempt to establish normative values of healthy volunteers and Type2 diabetes patients of varying ages of Indian population using the fundamental Electro Photonic Imaging (EPI) parameters.

The research work on “Study the effect of ānāpānasati meditation technique through Electro Photonic imaging parameters” (Guru Deo, Itagi, Srinivasan, & Kushwah, 2015) used EPI

instrument to study the changes in fundamental EPI parameters with short term and long term practice of meditation. This work concluded that the effect of meditation was more profound in female population in comparison to males.

Work on “Efficacy of Integrated Yoga Practices on healthy people using Electro Photonic Imaging Technique” (Kuldeep,2016) established the fact that integrated yoga module (IYM) reduces stress in both males and females after a 4 week practice using EPI parameter Activation Coefficient (AC).

Electro Photonic Imaging (EPI) is subtle energy diagnostic tool which is valid and reliable tool to assess early effects of Mobile Phone-Induced Electromagnetic Field radiations (Hemant Bhargav, T.M.Srinivasan,S.Varambally,B.N.Gangadhar,Prasad KokaHealth, 2015).

The above work established the fact that EPI instrument is capable of detecting changes in the bio-energy in a diseased condition due to a mobile phone induced electromagnetic intervention and after Yoga or a Meditation practice.

In this study we have used a Mudra practice to see if EPI instrument is capable of detecting the subtle changes caused by Prana Mudra. The present study is an attempt to detect a pattern of change and come up with an automated framework using neural network to detect this pattern for each of the practices like anapanasati meditation, Prana mudra and disease condition.

There is a need for an automated study to observe the variations in all parameters with respect to a diseased condition to diagnose the same (Dey & Bajpai, 2008).The combination of EPI and neural network could be used as a framework for diagnosing diabetes. The number of EPI parameters are large and manual inspection of all parameters is not practical. Statistical Analysis is used to establish the gross level changes. Neural network is required to capture and learn the individual changes for diagnosis/detection at an individual sample level.

This is the first study using EPI data and artificial neural network to classify diabetic and non-diabetic population. This study used three different sets of data, namely data corresponding to the organs and organs systems, data for the chakras and data corresponding to the meridians. In this study we have also explored the possibility of detecting the changes in bio-energy due to a practice called *Prāṇa mudra* and also for the anapanasati meditation as two different studies.

2.4.1 CONCLUSION

EPI has been used in diagnosing diseases, detecting the effect of radiation due to mobile phones and studying the effect of meditation and yoga practices. All the studies have made an attempt to identify the EPI parameter that showed statistically significant changes and prove that EPI could be used for their chosen application.

The main focus there was to establish that there is some change in EPI parameters in healthy and disease condition and during meditation and yoga practice.

This work is an attempt to combine the EPI based analysis with ANN by detecting the patterns in various situations and training the neural network for classification of these patterns.

In this work we have used Meditation and Mudra practices for training the neural network and have used diabetes as a disease condition. The emphasis here is to make the EPI instrument a diagnostic tool for disease diagnosis and intervention recognition. Extending this concept, it could be possible to come up with EPI signatures for various disease conditions and yogic practices. Studying these signatures will pave way for mapping the disease condition with the corresponding yogic practice to cure the same.

2.5 SUMMARY

Disease arises because of contemplating and dwelling too much on the thoughts in the mind.

Meditation leads to a thoughtless state and could be used to relax, de-stress or heal the body. It therefore becomes important to understand the mechanisms of the origin of thoughts and techniques of getting rid of the same.

A mudra is a physical equivalent/representation of a mantra. In hatha yoga mudra is used for connecting two points of energy in our body. As an example Jalandar bandh and Udyana bandh applied together allow the flow of prāna from the naval to throat region (i.e. Manipura chakra to Vishudha chakra).

Anapanasati meditation uses the technique of monitoring the breath and has an effect on the subtle energy. The EPI instrument is capable of measuring the subtle energy changes caused by the meditation.

Mantra is energy in sound form. *Lalitha Sahasranama* has some insight into how this form manifests and therefore the corresponding verses were included in our literature review.

In short this review connects the various dots together to understand the source of disease and the mechanisms to prevent the same by using yogic practices like meditation and mudra.

There are 84 EPI parameters corresponding to the meridians of the various organs and organ systems. The changes in these parameters cannot be easily detected for either monitoring the health or for understanding the impact of a yogic practice like asana, pranayama, dhyana or mudra. This therefore calls for an automated pattern recognition technique to identify a set of EPI parameters as a signature to classify a practice or a health condition.

CHAPTER 3

3.0 REVIEW OF SCIENTIFIC LITERATURE

3.1 LITERATURE SURVEY ON EPI AND ITS APPLICATIONS

Electro Photonic Imaging (EPI) instrument is used to capture coronal discharges at the fingertips induced by a pulsed electrical signal (10– 15kV, 1024Hz, 10 microsecond) on a glass plate. The images are captured by a camera under the glass plate. This device produces a type of digital high-voltage electrophotography that is based on the Kirlian effect (Rubik & Brooks, 2005). EPI is a non-invasive technique and is hazard free (Korotkov, Matravers, Orlov & Williams, 2010).

Electro Photonic Image represents a spatially distributed glow area having varying brightness characteristics; it reveals general, local and sector based details (Alexandrova et al., 2004). One of the main questions is what EPI data contains, namely physical or psychological component. Depending on its use (either with filter or without filter) EPI shows physiological or psychological conditions.

The study on correlation of EPI parameters with Fasting Blood Sugar (FBS) concluded that FBS correlates differently in the normal, pre-diabetic, and diabetic groups (Bhat & Deo, Guru, Ramesh Mavathur, 2016)

A study on the characteristics of Indian diabetic population concluded that differences between diabetic and healthy groups increase with increasing duration of the disease (Bhavana Shrama, Alex Hankey, 2014).

The work on altered brain physiology and stem cell functioning due to mobile phone/cell tower radiations, its association with increased cancer risk explored the use of EPI in detecting Electro Magnetic Field induced changes on human bio-electromagnetic (BEM) field (Hemant Bhargav, T.M.Srinivasan,S.Varambally,B.N.Gangadhar,Prasad KokaHealth, 2015).

Study on long term and short term anapanasati meditation practice concluded that in both Long term as well as Short term meditation practices lower values of stress (activation coefficient) were found in woman meditators as compared to men (Guru Deo, Itagi R. Kumar, 2015).

The effect of Indian music on the autonomous imbalance on diabetic subjects concluded that music does have a positive impact on autonomic balance (Rao & Nagendra, 2014).

A study on autistic children concluded that EPI instrument is promising from a bio-metric perspective (Kostyuk N, Rajnarayanan R V, Isokpehi RD, 2010).

Research on early prediction of diabetes using features of Electro Photonic Imaging also concluded that data can be used to train neural networks for classification of diseases for diagnosis (Shanmuga Priya & Rajesh, 2013).

There are several papers on use of neural networks in disease diagnosis one of them is in predicting the onset of diabetes using neural networks with a set of attributes as inputs to the neural network (Pradhan & Sahu, 2011). There is exclusive survey on bio-medical applications of neural networks that has a comprehensive description of various papers.

3.2 LITERATURE SURVEY ON DIABETES AND ITS DIAGNOSIS

The study on Type 2 Diabetes Mellitus (T2DM) by Sharma et al. in 2014 demonstrated that the two groups, T2DM and healthy subjects, have significant differences in EPI parameters for cardiovascular, endocrine, immune and urogenital systems. Differences between diabetic and healthy groups showed increasing trend of EPI parameters with increase in duration of the disease. Dividing the diabetes group according to their pathological duration revealed systematic increases in values in all organs and organ systems (Sharma, Hankey, & Nagendra, 2014).

Diabetes is defined as hyperglycemia for a long term. Abnormal glucose metabolism leading to hyperglycemia defines diabetes (“How Do We Define Cure of Diabetes ?” 2009). Diabetes Mellitus is a family of diseases with increased levels of blood sugar due to defects in insulin action or secretion associated with long term damage or failure of various organs like eyes kidneys, blood vessels and nerves (American Diabetes Association, 2011).

Presence of sugar in the blood for a long time leads to various disorders like thickening of the arterial walls causing blood pressure to increase and organs and organ systems becoming weaker and non-functional due to non-availability of the required quantity of glucose (Mezuk, Eaton, Albrecht, & side Golden, 2008). Obesity, high fat diet and sedentary lifestyle contribute to the prevalence of type2 diabetes (Pradhan & Sahu, 2011). Diabetes is a lifestyle non-communicable (*Ädhi ja -samanya*) disorder.

Brain's role in glucose homeostasis was proposed by scientists in the nineteenth century; however the current research diagnosis and treatment is based on the functioning of pancreatic islets. Recent works indicates that brain controlled glucose regulation can improve glucose homeostasis (Woods et al., 2013).

It is important to diagnose diabetes early to prevent further deterioration of the organs and organ systems. Electro Photonic Imaging (EPI) studies on Qigong suggests that EPI could be used for early diagnosis, earlier than the conventional mechanisms of diagnosis (Rubik & Brooks, 2005). Diagnosing diabetes is not a onetime event, treatment of diabetes leads to processes like Self-monitoring of blood glucose. The process of frequent blood sampling is costly, painful and leads to finger insensitivity (Vadis, 2011).

Analysis on degree of arterial hypertension concluded that EPI could be used to screen patients of hypertension with different levels of severity (Aleksandrova, 2009).

Diagnosis of diabetes and its treatment need to be more holistic. The EPI instrument generates chakra based data which is more holistic. It also generates coronary discharges corresponding to the meridians as well as the organs and organ systems. The chakras can be thought of as energy centers, these energy centers are located on the spinal column starting from the base of the spine to the top of the head (Deshpande et al., 2013).

There is a need for an automated study to observe the variations in all parameters with respect to a diseased condition to diagnose the same (Dey & Bajpai, 2008). The combination of EPI and neural network could be used as a framework for diagnosing diabetes.

In this work we use artificial neural network as a machine learning tool and have explored the possibility of coming up with a frame work for disease diagnosis and to detect the effect of a yogic practice using EPI.

3.3 LITERATURE SURVEY ON ANAPANASATI MEDITATION

Among the various meditation practices, there are three styles that are commonly studied. One style, focused attention (FA) meditation, entails voluntary focusing of attention on a chosen object. The other style, open monitoring (OM) meditation, involves non- reactive monitoring of the content of experience from moment to moment. The potential regulatory functions of these practices on attention and emotion processes could have a long-term impact on the brain and behavior (Lutz, Slagter, Dunne, & Davidson, 2008).

A third type is Transcendental Meditation (TM) which is a specific form of mantra meditation developed by Maharishi Mahesh Yogi. The meditation practice involves the use of a mantra and is practiced for 15–20 minutes twice per day while sitting with one's eyes closed. Beginning in 1965, the Transcendental Meditation technique has been incorporated into certain schools, universities, corporations, and prison programs in the USA, Latin America, Europe and India.

Sanskrit meaning of *ānāpānasati*, is "mindfulness of breathing" ana means inhalation pana means exhalation sati is becoming aware of or mindful of, anapanasati means to feel the sensations caused by the movements of the breath in the body as is practiced in the context of

mindfulness. According to tradition, Anapanasati was originally taught by Gautama Buddha in several suttas including the *Ānāpānasati Sutta*. It is a form of Buddhist meditation now common to Tibetan, Zen, Tiantai and Theravada Buddhism as well as western mindfulness programs.

Anapanasati is a meditation in which one obtains mastery over one's unruly mind through objective observation of one's own natural and normal breath. This practice of anapanasati meditation helps to sharpen the mind and to induce peace of mind to participants for the next step of *Vipassana* meditation. *Vipassana* means to observe things as they really are in their natural and true characteristics of impermanence (Guru Deo et al., 2015).

There are numerous neurophysiological studies on meditation; some of the studies were online monitoring mechanisms using EEG and HRV for monitoring individual traits (Murata et al., 2004).

There have been fMRI studies for understanding the areas of the brain that are typically more active during rest than during active task performance (Mars et al., 2012).

In this study, our aim was to detect the changes in EPI parameters due to anapanasati meditation using artificial neural network.

3.4 LITERATURE SURVEY ON BIO MEDICAL APPLICATION OF NEURAL NETWORKS

Artificial Neural Networks are extensively used in medical research. At the moment, the research is mostly on modelling parts of the human body and recognizing diseases from various scans (e.g. cardiograms, CAT scans, ultrasonic scans, etc.) (Christos & Dimitrios 1996).

Neural networks are ideal in recognizing diseases using scans since there is no need to provide a specific algorithm on how to identify the disease. Neural networks learn by example so the details of how to recognize the disease are not needed. What is needed is a set of examples that are representative of all the variations of the disease. The quantity of examples is not as important as the 'quality'. The examples need to be selected very carefully if the system is to perform reliably and efficiently (Christos & Dimitrios 1996).

The table 3.4 shows a list of papers along with the domain published just in the year 2015. There were 59 publications related to bio-medical applications of neural networks. Our study is the first of its kind using EPI parameters and Neural networks for disease diagnosis (K Shiva Kumar, TM Srinivasan, HR Nagendra & P Marimuthu, 2016).

Table 3.4 List of papers on Bio-Medical Application of Classifiers (Neural Network =1, Support Vector Machine =2, Fuzzy Logic =3, others =4)

S. No	Paper Title, Abstract and Journal Name	Domain	Data	Classifiers.
1	El-Nagar AM, El-Bardini M. Interval type-2 fuzzy neural network controller for a multivariable anesthesia system based on a hardware-in-the-loop simulation. <i>Artif Intell Med [Internet]. Elsevier</i> ; 2015 May 1; 61(1):1–10. Available from: http://www.aiimjournal.com/article/S0933-3657(14)00021-9/abstract	Anesthesia	Specific set of Parameters	1
2	Bárdossy A, Blinowska A, Kuzmicz W, Ollitrault J, Lewandowski M, Przybylski A, et al. Fuzzy logic-based diagnostic algorithm for implantable cardioverter defibrillators. <i>Artif Intell Med [Internet]. Elsevier</i> ; 2015 May 1;60(2):113–21. Available from:	Heart	Specific set of Parameters	3

	http://www.aiimjournal.com/article/S0933-3657(13)00164-4/abstract			
3	Cruz-Ramírez M, Hervás-Martínez C, Fernández JC, Briceño J, de la Mata M. Predicting patient survival after liver transplantation using evolutionary multi-objective artificial neural networks. <i>Artif Intell Med</i> [Internet]. Elsevier; 2015 May 1;58(1):37–49. Available from: http://www.aiimjournal.com/article/S0933-3657(13)00012-2/abstract	Liver	Specific set of Parameters	1
4	De Carvalho Filho AO, de Sampaio WB, Silva AC, de Paiva AC, Nunes RA, Gattass M. Automatic detection of solitary lung nodules using quality threshold clustering, genetic algorithm and diversity index. <i>Artif Intell Med</i> [Internet]. Elsevier; 2015 May 1;60(3):165–77. Available from: http://www.aiimjournal.com/article/S0933-3657(13)00154-1/abstract	Lung	Specific set of Parameters	2
5	Dhondalay GK, Lawrence K, Ward S, Ball G, Hoare M. Relationship between preparation of cells for therapy and cell quality using artificial neural network analysis. <i>Artif Intell Med</i> [Internet]. Elsevier; 2015 May 1;62(2):119–27. Available from: http://www.aiimjournal.com/article/S0933-3657(14)00083-9/abstract	Cell Membrane	Specific set of Parameters	1
6	Di Nuovo AG, Nuovo S Di, Buono S. Intelligent quotient estimation of mental retarded people from different psychometric instruments using artificial neural networks. <i>Artif Intell Med</i> [Internet]. Elsevier; 2015 May 1;54(2):135–45. Available from: http://www.aiimjournal.com/article/S0933-3657(11)00145-X/abstract	Psychometric Tests	Specific set of Parameters	1

7	Hung W-L, Chen D-H, Yang M-S. Suppressed fuzzy-soft learning vector quantization for MRI segmentation. <i>Artif Intell Med</i> [Internet]. Elsevier; 2015 May 1;52(1):33–43. Available from: http://www.aiimjournal.com/article/S0933-3657(11)00005-4/abstract	MRI	Specific set of Parameters	1
8	Jerez JM, Molina I, García-Laencina PJ, Alba E, Ribelles N, Martín M, et al. Missing data imputation using statistical and machine learning methods in a real breast cancer problem. <i>Artif Intell Med</i> [Internet]. Elsevier; 2015 May 1;50(2):105–15. Available from: http://www.aiimjournal.com/article/S0933-3657(10)00067-9/abstract	Breast Cancer	Specific set of Parameters	1
9	Ling SH, Nguyen HT. Natural occurrence of nocturnal hypoglycemia detection using hybrid particle swarm optimized fuzzy reasoning model. <i>Artif Intell Med</i> [Internet]. Elsevier; 2015 May 1;55(3):177–84. Available from: http://www.aiimjournal.com/article/S0933-3657(12)00049-8/abstract	Diabetes	ECG	3
10	Monte-Moreno E. Non-invasive estimate of blood glucose and blood pressure from a photoplethysmograph by means of machine learning techniques. <i>Artif Intell Med</i> [Internet]. Elsevier; 2015 May 1;53(2):127–38. Available from: http://www.aiimjournal.com/article/S0933-3657(11)00056-X/abstract	Diabetes	Photoplethysmograph	1
11	Pereira C, Veiga D, Mahdjoub J, Guessoum Z, Gonçalves L, Ferreira M, et al. Using a multi-agent system approach for microaneurysm detection in fundus images. <i>Artif Intell Med</i> [Internet]. Elsevier; 2015 May 1;60(3):179–88. Available from: http://www.aiimjournal.com/article/S0933-3657(13)00165-6/abstract	Diabetes	Fundus Image	4

12	Pombo N, Araújo P, Viana J. Knowledge discovery in clinical decision support systems for pain management: A systematic review. <i>Artif Intell Med</i> [Internet]. Elsevier; 2015 May 1;60(1):1–11. Available from: http://www.aiimjournal.com/article/S0933-3657(13)00157-7/abstract	Clinical Decision Support System	Survey Paper	4
13	Velikova M, Lucas PJF, Samulski M, Karssemeijer N. On the interplay of machine learning and background knowledge in image interpretation by Bayesian networks. <i>Artif Intell Med</i> [Internet]. Elsevier; 2015 May 1; 57(1):73–86. Available from: http://www.aiimjournal.com/article/S0933-3657(12)00152-2/abstract	Breast Cancer	Mammogram	4
14	Zambanini S, Sablatnig R, Maier H, Langs G. Automatic image-based assessment of lesion development during hemangioma follow-up examinations. <i>Artif Intell Med</i> [Internet]. Elsevier; 2015 May 1;50(2):83–94. Available from: http://www.aiimjournal.com/article/S0933-3657(10)00094-1/abstract	Hemangioma	Digital Image	4
15	Adankon MM, Dansereau J, Labelle H, Cheriet F. Noninvasive classification system of scoliosis curve types using least-squares support vector machines. <i>Artif Intell Med</i> [Internet]. Elsevier; 2015 May 1; 56(2):99–107. Available from: http://www.aiimjournal.com/article/S0933-3657(12)00108-X/abstract	Scoliosis	Digital Image	2
16	Ahmed MU, Begum S, Funk P, Xiong N, von Scheele B. A multi-module case-based biofeedback system for stress treatment. <i>Artif Intell Med</i> [Internet]. Elsevier; 2015 May 1;51(2):107–15. Available from: http://www.aiimjournal.com/article/S0933-3657(10)00117-X/abstract	Clinical Decision Support System	Sensor Signal	4

17	Armañanzas R, Bielza C, Chaudhuri KR, Martinez-Martin P, Larrañaga P. Unveiling relevant non-motor Parkinson's disease severity symptoms using a machine learning approach. <i>Artif Intell Med</i> [Internet]. Elsevier; 2015 May 1; 58(3):195–202. Available from: http://www.aiimjournal.com/article/S0933-3657(13)00054-7/abstract	Parkinson	Hoehn & Yahr index	4
18	Jalali A, Ghaffari A, Ghorbanian P, Nataraj C. Identification of sympathetic and parasympathetic nerves function in cardiovascular regulation using ANFIS approximation. <i>Artif Intell Med</i> [Internet]. Elsevier; 2015 May 1; 52(1):27–32. Available from: http://www.aiimjournal.com/article/S0933-3657(11)00003-0/abstract	Heart	Physiological Parameters	4
19	Krakovská A, Mezeiová K. Automatic sleep scoring: A search for an optimal combination of measures. <i>Artif Intell Med</i> [Internet]. Elsevier; 2015 May 1;53(1):25–33. Available from: http://www.aiimjournal.com/article/S0933-3657(11)00074-1/abstract	Polysomnography	EEG, ECG, EMG, EOG	4
20	Lee J, Steele CM, Chau T. Classification of healthy and abnormal swallows based on accelerometry and nasal airflow signals. <i>Artif Intell Med</i> [Internet]. Elsevier; 2015 May 1;52(1):17–25. Available from: http://www.aiimjournal.com/article/S0933-3657(11)00032-7/abstract	Dysphagia	Sensor Signal	4
21	Li B, Meng MQ-H, Lau JYW. Computer-aided small bowel tumor detection for capsule endoscopy. <i>Artif Intell Med</i> [Internet]. Elsevier; 2015 May 1;52(1):11–6. Available from: http://www.aiimjournal.com/article/S0933-3657(11)00004-2/abstract	Small Bowel	Endoscopy	1

22	Li D-C, Liu C-W, Hu SC. A fuzzy-based data transformation for feature extraction to increase classification performance with small medical data sets. <i>Artif Intell Med</i> [Internet]. Elsevier; 2015 May 1;52(1):45–52. Available from: http://www.aiimjournal.com/article/S0933-3657(11)00018-2/abstract	General	Medical Data Set	3
23	Marrocco C, Molinara M, D’Elia C, Tortorella F. A computer-aided detection system for clustered microcalcifications. <i>Artif Intell Med</i> [Internet]. Elsevier; 2015 May 1;50(1):23–32. Available from: http://www.aiimjournal.com/article/S0933-3657(10)00039-4/abstract	Breast Cancer	Mammogram	4
24	Mukhopadhyay S, Palakal M, Maddu K. Multi-way association extraction and visualization from biological text documents using hyper-graphs: Applications to genetic association studies for diseases. <i>Artif Intell Med</i> [Internet]. Elsevier; 2015 May 1;49(3):145–54. Available from: http://www.aiimjournal.com/article/S0933-3657(10)00029-1/abstract	Genetics	Physiological Parameters	4
25	Oliva J, Serrano JI, del Castillo MD, Iglesias Á. A methodology for the characterization and diagnosis of cognitive impairments—Application to specific language impairment. <i>Artif Intell Med</i> [Internet]. Elsevier; 2015 May 1;61(2):89–96. Available from: http://www.aiimjournal.com/article/S0933-3657(14)00038-4/abstract	Cognition	Cognitive Parameters	4
26	Rakotomamonjy A, Petitjean C, Salaün M, Thiberville L. Scattering features for lung cancer detection in fibered confocal fluorescence microscopy images. <i>Artif Intell Med</i> [Internet]. Elsevier; 2015 May 1;61(2):105–18. Available from: http://www.aiimjournal.com/article/S0933-3657(14)00053-0/abstract	Lung Cancer	fibered confocal fluorescence microscopy	4

27	Santos PE, Thomaz CE, dos Santos D, Freire R, Sato JR, Louzã M, et al. Exploring the knowledge contained in neuroimages: Statistical discriminant analysis and automatic segmentation of the most significant changes. <i>Artif Intell Med</i> [Internet]. Elsevier; 2015 May 1;49(2):105–15. Available from: http://www.aiimjournal.com/article/S0933-3657(10)00030-8/abstract	General	Medical Data Set	4
28	Schipper JD, Dankel II DD, Arroyo AA, Schauben JL. A knowledge-based clinical toxicology consultant for diagnosing single exposures. <i>Artif Intell Med</i> [Internet]. Elsevier; 2015 May 1; 55(2):87–95. Available from: http://www.aiimjournal.com/article/S0933-3657(12)00046-2/abstract	Clinical Decision Support System	Medical Data Set	4
29	Soda P, Mazzoleni S, Cavallo G, Guglielmelli E, Iannello G. Human movement onset detection from isometric force and torque measurements: A supervised pattern recognition approach. <i>Artif Intell Med</i> [Internet]. Elsevier; 2015 May 1;50(1):55–61. Available from: http://www.aiimjournal.com/article/S0933-3657(10)00040-0/abstract	Rehabilitation	Sensor Signal	4
30	Soda P, Onofri L, Iannello G. A decision support system for <i>Crithidia Luciliae</i> image classification. <i>Artif Intell Med</i> [Internet]. Elsevier; 2015 May 1;51(1):67–74. Available from: http://www.aiimjournal.com/article/S0933-3657(10)00070-9/abstract	Systemic Lupus Erythematosus	Digital Image	4
31	Tsipouras MG, Tzallas AT, Rigas G, Tsouli S, Fotiadis DI, Konitsiotis S. An automated methodology for levodopa-induced dyskinesia: Assessment based on gyroscope and accelerometer signals. <i>Artif Intell Med</i> [Internet]. Elsevier;	Parkinson	Sensor Signal	4

	2015 May 1; 55(2):127–35. Available from: http://www.aiimjournal.com/article/S0933-3657(12)00032-2/abstract			
32	Wang Y-Y, Sun Y-N, Lin C-CK, Ju M-S. Segmentation of nerve fibers using multi-level gradient watershed and fuzzy systems. <i>Artif Intell Med</i> [Internet]. Elsevier; 2015 May 1;54(3):189–200. Available from: http://www.aiimjournal.com/article/S0933-3657(11)00151-5/abstract	Nervous System	Digital Image	4
33	Yang X, Cao A, Song Q, Schaefer G, Su Y. Vicinal support vector classifier using supervised kernel-based clustering. <i>Artif Intell Med</i> [Internet]. Elsevier; 2015 May 1;60(3):189–96. Available from: http://www.aiimjournal.com/article/S0933-3657(14)00005-0/abstract	Breast Cancer	Mammogram	3
34	Yin L, Xu G, Torii M, Niu Z, Maisog JM, Wu C, et al. Document classification for mining host pathogen protein–protein interactions. <i>Artif Intell Med</i> [Internet]. Elsevier; 2015 May 1;49(3):155–60. Available from: http://www.aiimjournal.com/article/S0933-3657(10)00035-7/abstract	General	Survey	3
35	Bichindaritz I, Montani S. Advances in case-based reasoning in the health sciences. <i>Artif Intell Med</i> [Internet]. Elsevier; 2015 May 1;51(2):75–9. Available from: http://www.aiimjournal.com/article/S0933-3657(11)00002-9/abstract	Clinical Decision Support System	Medical Data Set	4
36	Cattinelli I, Bolzoni E, Chermisi M, Bellocchio F, Barbieri C, Mari F, et al. Computational intelligence for the Balanced Scorecard: Studying performance trends of hemodialysis clinics. <i>Artif Intell Med</i> [Internet]. Elsevier; 2015 May 1;58(3):165–73. Available from:	General	General	4

	http://www.aiimjournal.com/article/S0933-3657(13)00068-7/abstract			
37	Depeursinge A, Racoceanu D, Iavindrasana J, Cohen G, Platon A, Poletti P-A, et al. Fusing visual and clinical information for lung tissue classification in high-resolution computed tomography. <i>Artif Intell Med</i> [Internet]. Elsevier; 2015 May 1;50(1):13–21. Available from: http://www.aiimjournal.com/article/S0933-3657(10)00038-2/abstract	Lung	Computer Tomography	3
38	Hayashi Y, Setiono R, Yoshida K. A comparison between two neural network rule extraction techniques for the diagnosis of hepatobiliary disorders. <i>Artif Intell Med</i> [Internet]. Elsevier; 2015 May 1;20(3):205–16. Available from: http://www.aiimjournal.com/article/S0933-3657(00)00064-6/abstract	Liver	Medical Data Set	1
39	Kim S. Data mining for the study of disease genes and proteins. <i>Artif Intell Med</i> [Internet]. Elsevier; 2015 May 1;49(3):133–4. Available from: http://www.aiimjournal.com/article/S0933-3657(10)00034-5/abstract	Genetics	Medical Data Set	4
40	Laippala V, Viljanen T, Airola A, Kanerva J, Salanterä S, Salakoski T, et al. Statistical parsing of varieties of clinical Finnish. <i>Artif Intell Med</i> [Internet]. Elsevier; 2015 May 1;61(3):131–6. Available from: http://www.aiimjournal.com/article/S0933-3657(14)00019-0/abstract	Clinical Decision Support System	Medical Data Set	4
41	Li S-T, Chen C-C, Huang F. Conceptual-driven classification for coding advise in health insurance reimbursement. <i>Artif Intell Med</i> [Internet]. Elsevier; 2015 May 1;51(1):27–41. Available from:	Clinical Decision Support System	Medical Data Set	3

	http://www.aiimjournal.com/article/S0933-3657(10)00122-3/abstract			
42	Lima CAM, Coelho AL V. Kernel machines for epilepsy diagnosis via EEG signal classification: A comparative study. <i>Artif Intell Med</i> [Internet]. Elsevier; 2015 May 1;53(2):83–95. Available from: http://www.aiimjournal.com/article/S0933-3657(11)00104-7/abstract	Epilepsy	EEG	3
43	Linkens DA, Vefghi L. Recognition of patient anaesthetic levels: neural network systems, principal components analysis, and canonical discriminant variates. <i>Artif Intell Med</i> [Internet]. Elsevier; 2015 May 1;11(2):155–73. Available from: http://www.aiimjournal.com/article/S0933-3657(97)00028-6/abstract	Anesthesia	Physiological Parameters	1
44	Marble RP, Healy JC. A neural network approach to the diagnosis of morbidity outcomes in trauma care. <i>Artif Intell Med</i> [Internet]. Elsevier; 2015 May 1;15(3):299–307. Available from: http://www.aiimjournal.com/article/S0933-3657(98)00059-1/abstract	Trauma	Medical Data Set	1
45	Milenković J, Hertl K, Košir A, Žibert J, Tasič JF. Characterization of spatiotemporal changes for the classification of dynamic contrast-enhanced magnetic-resonance breast lesions. <i>Artif Intell Med</i> [Internet]. Elsevier; 2015 May 1;58(2):101–14. Available from: http://www.aiimjournal.com/article/S0933-3657(13)00036-5/abstract	Breast Cancer	MRI	3
46	Mobley BA, Schechter E, Moore WE, McKee PA, Eichner JE. Predictions of coronary artery stenosis by artificial neural network. <i>Artif Intell Med</i> [Internet]. Elsevier; 2015 May 1;18(3):187–203. Available from:	Heart	Angiogram	1

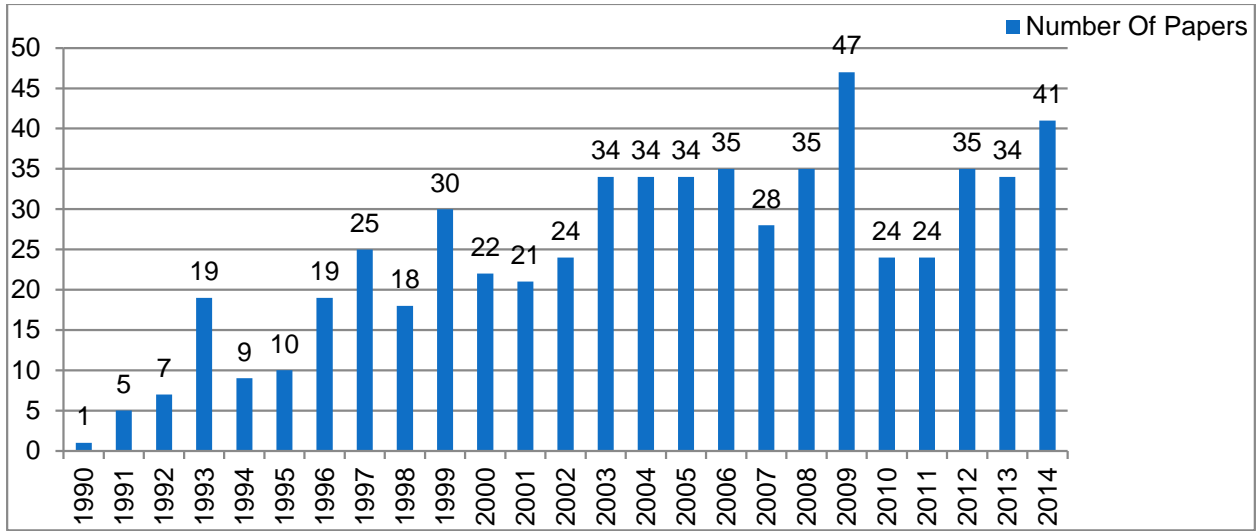
	http://www.aiimjournal.com/article/S0933-3657(99)00040-8/abstract			
47	Nanni L, Lumini A, Brahnam S. Local binary patterns variants as texture descriptors for medical image analysis. <i>Artif Intell Med</i> [Internet]. Elsevier; 2015 May 1;49(2):117–25. Available from: http://www.aiimjournal.com/article/S0933-3657(10)00027-8/abstract	General	General	3
48	Omlin CW, Snyders S. Inductive bias strength in knowledge-based neural networks: application to magnetic resonance spectroscopy of breast tissues. <i>Artif Intell Med</i> [Internet]. Elsevier; 2015 May 1;28(2):121–40. Available from: http://www.aiimjournal.com/article/S0933-3657(03)00062-9/abstract	Breast Cancer	MRI	1
49	Pesonen E, Eskelinen M, Juhola M. Treatment of missing data values in a neural network based decision support system for acute abdominal pain. <i>Artif Intell Med</i> [Internet]. Elsevier; 2015 May 1;13(3):139–46. Available from: http://www.aiimjournal.com/article/S0933-3657(98)00027-X/abstract	Appendicitis	Medical Data Set	1
50	Ulbricht C, Dorffner G, Lee A. Neural networks for recognizing patterns in cardiocograms. <i>Artif Intell Med</i> [Internet]. Elsevier; 2015 May 1;12(3):271–84. Available from: http://www.aiimjournal.com/article/S0933-3657(97)00052-3/abstract	obstetrics	Cardiotocogram	1

51	Wiegerinck W. Clinical Applications of Artificial Neural Networks. Artif Intell Med [Internet]. Elsevier; 2015 May 1;27(2):223–6. Available from: http://www.aiimjournal.com/article/S0933-3657(02)00081-7/abstract	Book	Book	1
52	Wiegerinck WAJ. Functional Networks with Applications. A Neural-Based Paradigm, by E. Castillo, A. Cobo, J.M. Gutiérrez and R.E. Pruneda, Kluwer Academic Publishers, Dordrecht, 1998. NLG 300, US\$132, GB£90, HB, 328 pp, ISBN: 0-7923-8332-X. Artif Intell Med [Internet]. Elsevier; 2015 May 1;18(3):267–70. Available from: http://www.aiimjournal.com/article/S0933-3657(99)00044-5/abstract	Book	Book	1
53	Zhou Z-H. Artificial Neural Networks in Biomedicine. Artif Intell Med [Internet]. Elsevier; 2015 May 1;25(2):211–4. Available from: http://www.aiimjournal.com/article/S0933-3657(02)00016-7/abstract	Book	Book	1
54	Zhou Z-H, Jiang Y, Yang Y-B, Chen S-F. Lung cancer cell identification based on artificial neural network ensembles. Artif Intell Med [Internet]. Elsevier; 2015 May 1;24(1):25–36. Available from: http://www.aiimjournal.com/article/S0933-3657(01)00094-X/abstract	Lung Cancer	Digital Image	1
55	Abbass HA. An evolutionary artificial neural networks approach for breast cancer diagnosis. Artif Intell Med [Internet]. Elsevier; 2015 May 1;25(3):265–81. Available from: http://www.aiimjournal.com/article/S0933-3657(02)00028-3/abstract	Breast Cancer	Digital Image	1
56	Allen R, Smith D. Neuro-fuzzy closed-loop control of depth of anaesthesia. Artif Intell Med [Internet]. Elsevier; 2015 May 1;21(1):185–91. Available from:	Anesthesia	EEG	1

	http://www.aiimjournal.com/article/S0933-3657(00)00084-1/abstract			
57	Azuaje F, Dubitzky W, Lopes P, Black N, Adamson K, Wu X, et al. Predicting coronary disease risk based on short-term RR interval measurements: a neural network approach. <i>Artif Intell Med</i> [Internet]. Elsevier; 2015 May 1;15(3):275–97. Available from: http://www.aiimjournal.com/article/S0933-3657(98)00058-X/abstract	Heart	ECG	1
58	Bologna G. A model for single and multiple knowledge based networks. <i>Artif Intell Med</i> [Internet]. Elsevier; 2015 May 1;28(2):141–63. Available from: http://www.aiimjournal.com/article/S0933-3657(03)00055-1/abstract	Blood Cancer	Electrophoresis	1
59	Camps-Valls G, Martínez-Sober M, Soria-Olivas E, Magdalena-Benedito R, Calpe-Maravilla J, Guerrero-Martínez J. Foetal ECG recovery using dynamic neural networks. <i>Artif Intell Med</i> [Internet]. Elsevier; 2015 May 1;31(3):197–209. Available from: http://www.aiimjournal.com/article/S0933-3657(04)00050-8/abstract	obstetrics	ECG	1

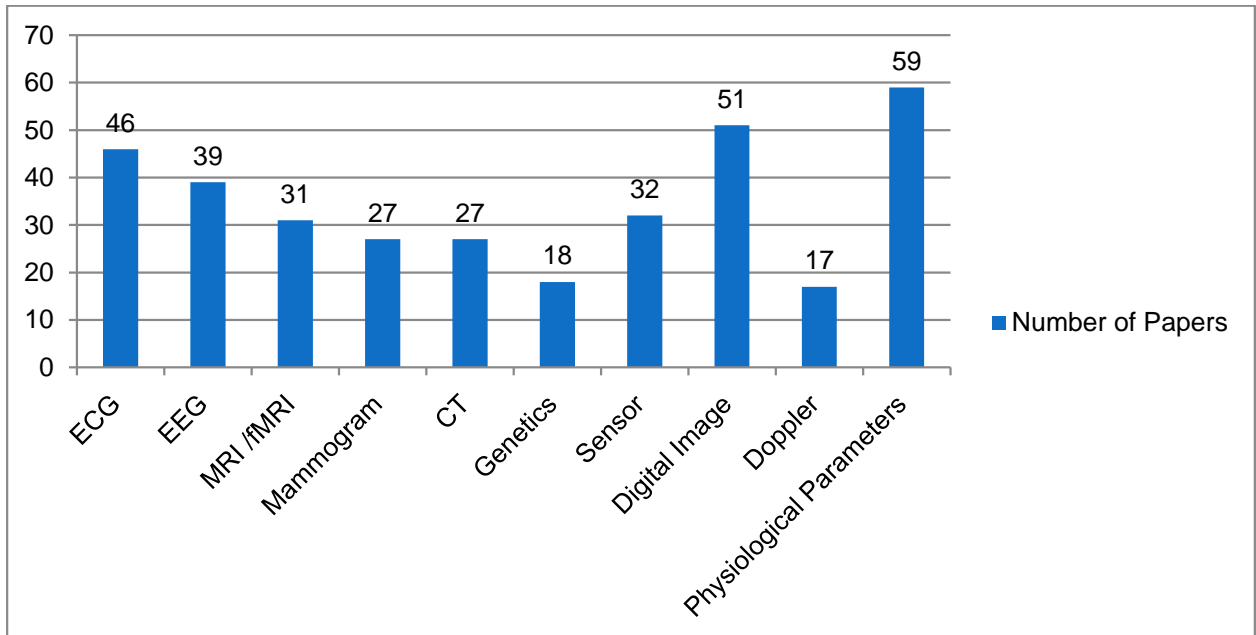
The graphs in Fig 3.1 and 3.2 show the number of research papers published using artificial neural network for bio-medical applications.

Fig 3.1 Number of Papers Published year-wise



The graph below shows the application areas of neural network in each domain. As an example there were 46 paper using ECG data to classify cardiac problems. On similar lines neural networks were used to take inputs from the various Scans like EEF, MRI, CT Doppler etc. and classify the subjects based on the scan results.

Fig 3.2 Number of Papers Published in different domains



3.5 SUMMARY OF RECENT STUDIES WITH EPI

Table - 3.5 Studies On EPI, Meditation, Mudra & Diabetes				
Author and year of publication	Sample size (n)	Design	Variables studied	Findings
Guru Deo et al., 2016	482	Pre-Post Study	Four fundamental EPI variables	Used the EPI instrument to study the gender related cumulative effects of Anapanasati meditation. This work concluded that the effect of meditation was more on female population in comparison to male.
Romesh Kumar Bhat, Guru Deo, Ramesh Mavathur, T.M. Srinivasan, 2016	102	Correlation study of EPI variables with Fasting Blood Sugar	EPI Variables Pancreas, liver, Immuse system, Kidneys, Coronary vessels, cerebral vessels, Area, Intensity, Entropy, Fractality and Form Coefficient	Studied the correlation of EPI variables with Fasting Blood sugar values for pre-diabetics, diabetic and healthy subjects. Established a significant relationship of FBS with pancreas and right kidney for pre-diabetic. In the case of normal participants, a significant relationship of FBS was found with area and form coefficient of the EPI gram.

Kuntal Ghosh, Alex Hankey, TM Srinivasan, 2016	52	Pre-Post with control and repeated measures	Jing-well Acupuncture meridian points	Sitting in Lotus Posture for 30 min showed increases in subtle energy levels in all acupuncture meridians; those sitting in chair produced Universal decreases. Results for 10 and 20 min of sitting in lotus posture showed how these changes in energy values took time to build up with increasing time.
T. Indira Rao & H.R Nagendra 2014	29	Single group pre- post with repeated measures	EPI variables, Area, Intensity, Entropy, and Activation Coefficient	The effect of Indian music on the autonomous imbalance of the patients with DM2 was studied and concluded that music does have an effect.
B. Shanmuga Priya & R. Rajesh (2013)	41 training records and 19 for testing	Neural network based classifier for classifying diabetic and non- diabetic subjects	8 EPI variables of the ring finger	Explored the possibility of pre-detection of diabetes using EPI. Sample size of diabetic subjects was not statistically significant.
Sharma, Hankey & Nagendra (2014)	138 T2DM people 84 healthy people	Two groups comparativ e design	EPI Screening, All variables related to Organs and Organ systems as given by the EPI Software.	Significant differences were observed between the two groups in the cardiovascular, endocrine, immune and urogenital systems. Differences between diabetic and healthy groups increase with increasing duration of the disease. Population norms require further investigation.
Rao, Kushwah & Srinivasan (2014)	12 students 5 singers and accompanist s	Mixed Method Design	Area, intensity and entropy	EPI parameters- area and intensity increased and the entropy decreased the decrease was not significant in the students. The same

				trend is found in the singers and accompanists.
Korotkov et al. (2012)	33 healthy subjects	Single group pre-test and post-test	EPI gram image area, average intensity, and activation coefficient	There was increase in fingertip florescence area and average intensity, reduction in stress levels, and improved blood pressure measurements.
Kostyuk, Rajnarayanan, Isokpehi & Cohly (2010)	6 autistic participants and their parents and siblings. 7 control and their parents	Experimental design with Control	48 acupuncture point's assessments at both psycho-emotional physiological levels.	The activity of the sympathetic autonomic nervous system is significantly altered in children with autism as measure through the EPI grams.