

Chapter – 5
METHODS



5 METHODS

5.1 SUBJECTS

Patients with Type 2 Diabetes mellitus (Age range: 30 to 70 years)

One hundred sixty participants (n = 160, 84 males, 76 females, mean age = 53.34±8.97 years, suffering from T2DM for the average of 6.69±4.60 years) who satisfied the selection criteria were recruited after obtaining signed informed consent from every participant.

5.1.1 Sample Size

n = 160

One hundred sixty participants who satisfied the selection criteria were recruited and randomly assigned into two groups: ‘Yoga-based lifestyle’ (n=80) and ‘Physical exercise & health education’ (n=80).

One hundred sixty patients suffering from T2DM who satisfied the selection criteria were recruited for the study. Sample size was calculated based on earlier similar study using G power software considering HbA1c levels as the primary variable (Nagarathna et al., 2012). The study observed an effect size of 0.46 for the yoga arm (critical t =1.99) leading to the calculated sample size of 100 (n= 50 in group arm with power set at 0.90 and alpha at 0.05). The study reported an overall attrition rate of 37.5%, considering which, we added 30 more subjects to each group.

5.1.2 Source of Subjects

One hundred sixty participants suffering from T2DM who satisfied the selection criteria were recruited from Staff Clinics, Metabolic Clinic, OPDs at NIMHANS, Bengaluru, and referral from the collaborating diabetology Centers, Bengaluru.

5.1.3 Inclusion Criteria

- 1) Diagnosis of T2DM by an endocrinologist as per ADA criteria (HbA1c \geq 6.5%)
- 2) Age range between 30 to 70 years, both genders
- 3) With or without oral hypoglycaemic drugs or insulin intake
- 4) With or without co-morbid obesity and/or hypertension
- 5) Mini mental status examination (MMSE) score above 24
- 6) Access to smart phone and internet connection
- 7) Willing to give written informed consent to participate in the study

5.1.4 Exclusion criteria

- 1) Those with known complications of T2DM
- 2) Those with h/o chronic kidney disease or diabetic retinopathy or coronary artery disease or past history of heart disease
- 3) Those with history of stroke or other major neurological disorders
- 4) Subjects with severe mental disorders or any other severe medical co-morbidity including suicidal ideations (except anxiety and depression)
- 5) Subjects with other metabolic disorders such as hypothyroidism, hyperthyroidism, Cushing's syndrome or morbid obesity
- 6) Subjects on long-term treatment with steroids
- 7) Those with the diagnosis of type 1 T2DM, exocrine diseases of the pancreas, endocrinopathies, maturity onset diabetes mellitus or latent autoimmune diabetes in adults
- 8) Subjects who were pregnant or lactating
- 9) Those with history of regular yoga practice in the past 6 months (for at least once a week for one month or more)
- 10) Those unwilling to undergo physical exercise program or yoga based lifestyle program.

5.1.5 Ethical considerations

The Ethical Clearance from S-VYASA Yoga University [RES/IEC-SVYASA/129/2018], Bengaluru was obtained. The Ethical Clearance from National Institute of Mental Health and Neuro Sciences [NIMHANS/EC (BEH.SC.DIV)/11th MEETING 2018], Bengaluru was also obtained. The study was registered in the Clinical Trial Registry of India (CTRI) before starting the data collection process [CTRI/2019/02/017750]. Signed informed consent was obtained from every participant before recruitment.

5.1.6 Source of Funding:

Department of Science and Technology, Science and Engineering Research Board (DST-SERB), Ministry of Science of Technology, Govt. of India [under the PAC-EEC program vide sanction order number EMR/2016/001611/EEC].

5.2 DESIGN OF THE STUDY

5.2.1 Prospective Single-blind Randomized Controlled Parallel Group Design

Subjects were randomized to one of the two instructor-led intervention groups: 1) Yoga-based lifestyle (YBL) group received yoga based lifestyle intervention for a year; 2) Physical exercise and health education (PHE) group received an equivalent (matched duration, therapist interactions and metabolic equivalents) physical exercise and health education program. Participants randomized into PHE group were offered 30 free YBL sessions after completion of the study (to learn the same practices which were taught to the YBL group). The primary outcome measure was HbA1c levels assessed at baseline, 6 months and 1 year. The secondary outcomes were fasting and post-prandial blood sugar levels (FBS and PPBS), thermal imaging parameters, electro-photonic parameters, psychological variables such as depression, anxiety and stress (assessed by DASS-42 scale), anthropometric variables (body mass index and waist-

hip ratio) and T2DM medication score assessed at baseline, 6 months and 1 year, respectively. Subjects in both groups were being monitored by their treating endocrinologists.

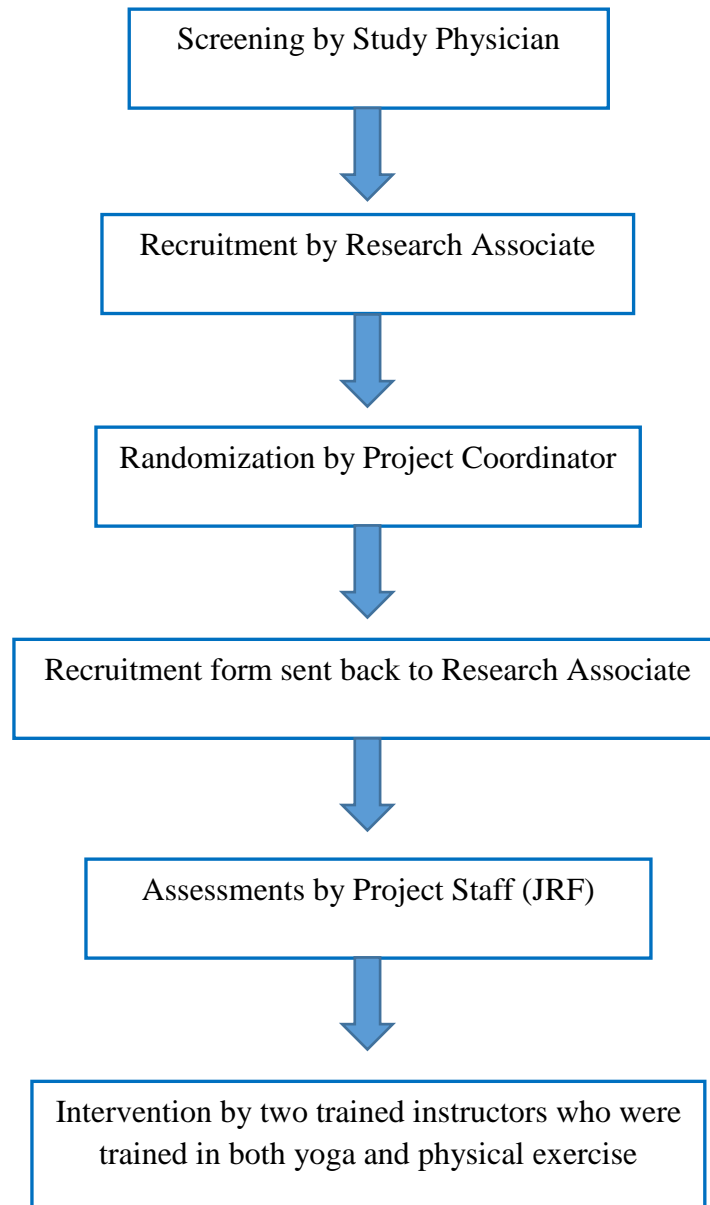
5.2.1.1 Blinding and masking: single blinding

The assessors who carried out the assessments were blind to the group status of the subject. The statistician, who analysed data, was also unaware of the group of the subjects.

5.2.1.2 Randomization and allocation concealment

The study physician recruited the patients after screening them as per the selection criteria and indicated on a Recruitment Form whether patient is eligible for the study, without revealing the identity of the patient (through a random computer generated number coding system). The physician had no further contact with patients except in case of any adverse events. The allocation schedule of the patient was concealed from the physician. For each eligible patient, the Research Associate (RA) sent Recruitment Form to the project coordinator, who had no contact with participants. Using an online randomization software, the project coordinator randomly assigned each patient to either YBL or PHE group. The project coordinator indicated the patient's intervention assignment in a coded format (in the Recruitment Form) and sent it back to the RA. The RA, who was neither involved in the delivery of interventions nor in assessments, communicated the allocation to each patient. Project staff that performed the assessments was blind to the intervention assignment status of the participants. All Recruitment Forms were stored in locked file cabinets. Except the project coordinator, no study personnel had access to the randomization table, which was stored as a password-protected electronic file. The statistician who analysed the data had no contact with the participants and was not involved in the study in any other way.

Figure 1: Flow chart showing the process of randomization



5.3 VARIABLES STUDIED

Below assessments were performed for both Yoga and control groups at baseline and every 6 months for duration of 1 year

5.3.1 Biochemical Levels

Glycated Haemoglobin (HbA1c), Fasting Blood Sugar (FBS), and Postprandial Blood Sugar (PPBS): Blood samples were collected from an anterior cubital vein for fasting state (FBS and HbA1c) between 7 am and 8 am. Post-prandial blood sample was collected 2 hours after the breakfast (between 10 am and 11am). Yoga and exercise programs were withheld on the day of blood sample collection. The sera were separated within an hour of collection. All tests were carried out at a National Accreditation Board, Quality Council of India certified laboratory by a trained technician. Heparinized blood was used to analyse HbA1c by using NGCP-certified and DCCT aligned affinity assay method on a Nycocard Reader II (StJohn et al., 2006). Glucose oxidase method was used to determine the concentration of glucose (Ambade et al., 1998)

5.3.2 Anthropometric Measurements

The anthropometrical measurements namely height (m), weight (kg), waist and hip (cm) were obtained using standardized techniques. Body Mass Index (BMI) was calculated using the formula “ $BMI = \text{kg}/\text{m}^2$ ”, where kg is a subject’s weight in kilograms and m^2 is his/her height in meters squared. Waist-hip ratio was calculated by dividing waist measurement by hip measurement.

5.3.3 Blood Pressure and Medication Scores

The systolic blood pressure and diastolic blood pressure levels (in mmHg) were recorded, in the sitting position, in the right arm using sphygmomanometer. Medication scores were calculated based on oral hypoglycaemic agents and Insulin intake. Metformin 500 mg or Glimperide 1 mg or insulin 10 unites or another equivalent dose was considered as 1 medication score (Nagarathna et al., 2012).

5.3.4 Thermal Imaging Measurements

Testo 890-2 thermal camera from Testo India Pvt. Ltd. Having 640 x 480 Resolution, super resolution of 1280 x 960 pixels and Thermal sensitivity < 40 m°K (milli Kelvin), was used to capture thermal images. The camera was set with emissivity of 0.98, temperature at 23 °C and relative humidity at 50%. The forehead, bilateral tympanum of ears, inner canthi of eyes, dorsum and palmar surfaces of hands, knee joints, shin, heels, dorsal and plantar surfaces of legs were imaged. The images were captured from a distance of 1 meter with the axis of camera being perpendicular to the ROI surface.

Subjects were asked to remove ornaments from the regions of interest (ROIs) and were seated and acclimatized to the controlled room temperature at 23 °C for 15 minutes. The images of the subjects were taken in empty stomach conditions. They were asked to avoid tea or coffee at least for 2 hours before the assessment. The assessments were done in a dark thermal imaging room, painted matte grey without any reflecting surfaces to avoid any confounding deflections in the measured temperatures. The images were extracted by Testo IRSoft Software. The pointer tools, line and area tools were used to obtain the temperature readings of ROI. Rainbow palette was chosen to view and analyse the images. The pointer tool was used to acquire temperature at the mid-point of ROI and the line/ area tool was used to note the readings across a length of ROI surface. Out of minimum, maximum and average temperature readings, the latter was noted for all ROIs.



Plate 3: Thermal Imaging Camera and its Accessories; Testo 890-2



Plate 4: Thermal Imaging acclimatisation space



Plate 5: Thermal Imaging space

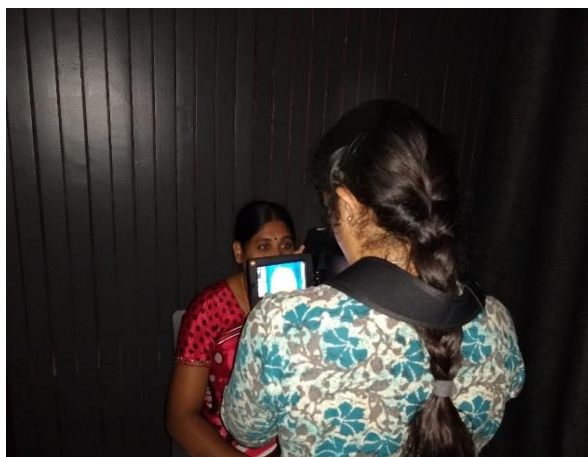
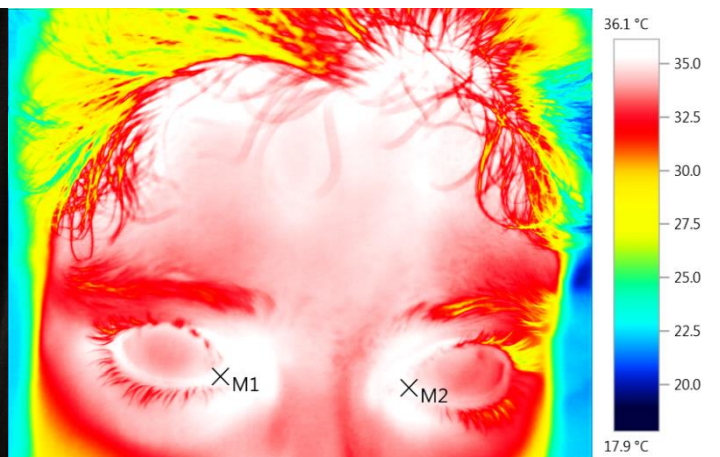


Plate 6: Thermal Imaging data acquisition



5.3.4.1 Thermography regions of interest selected for the study

1) Between the eyebrows (Glabella):

Glabella; M1



Plate 7: Thermal image of glabella

2) Inner canthus of the eye (right & left):

Inner canthus of each eye; M1 and M2

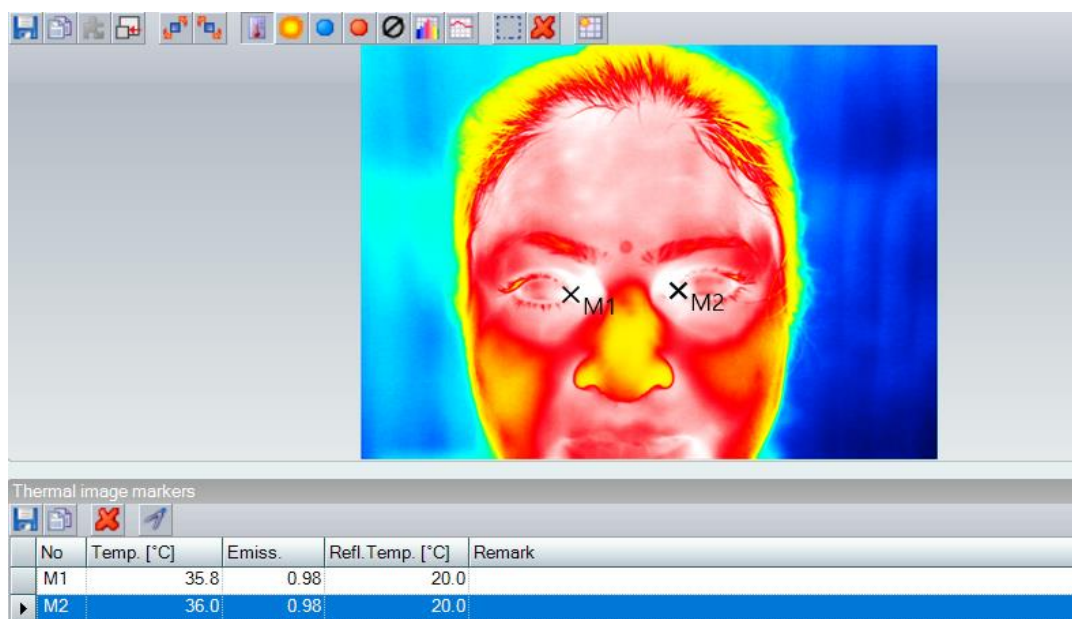


Plate 8: Thermal image of the inner canthi of eyes

3) **Tympanum of the ear (right & left):**

Tympanum of each ear; M1 & M2

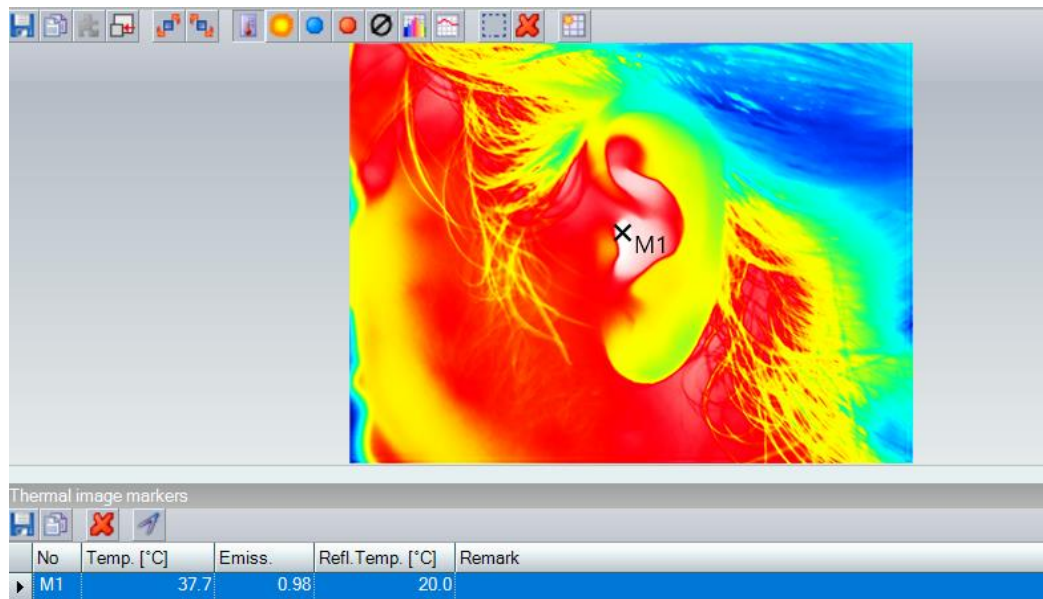


Plate 9: Thermal image of tympanums of ears

4) **Dorsum of the hands:**

- i. M1, M3: The point at the base of the middle finger on the dorsal side of the hand.
- ii. M2, M4: The point at the centre of the wrist.
- iii. A straight line connecting M1 and M2; M3 and M4. This gives the average values of temperatures across the points being connected by the line on dorsum of hand: AV1, AV2.

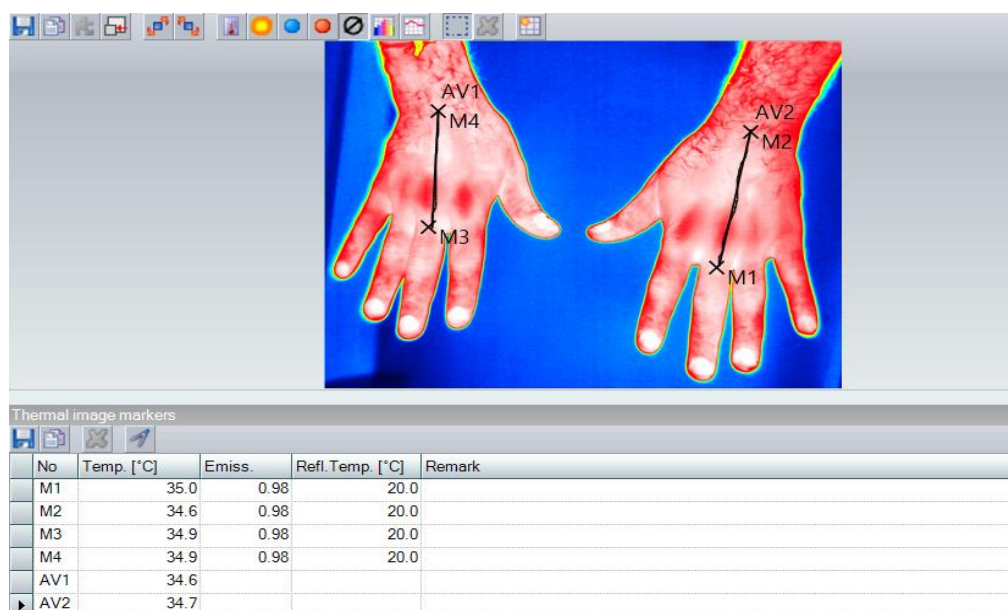


Plate 10: Thermal image of dorsum of the hands

5) **Back of the fingers:**

Points just proximal to eponychium of fingers (M1, M2, M3, M4, M5, M6, M7, M8, M9, M10)

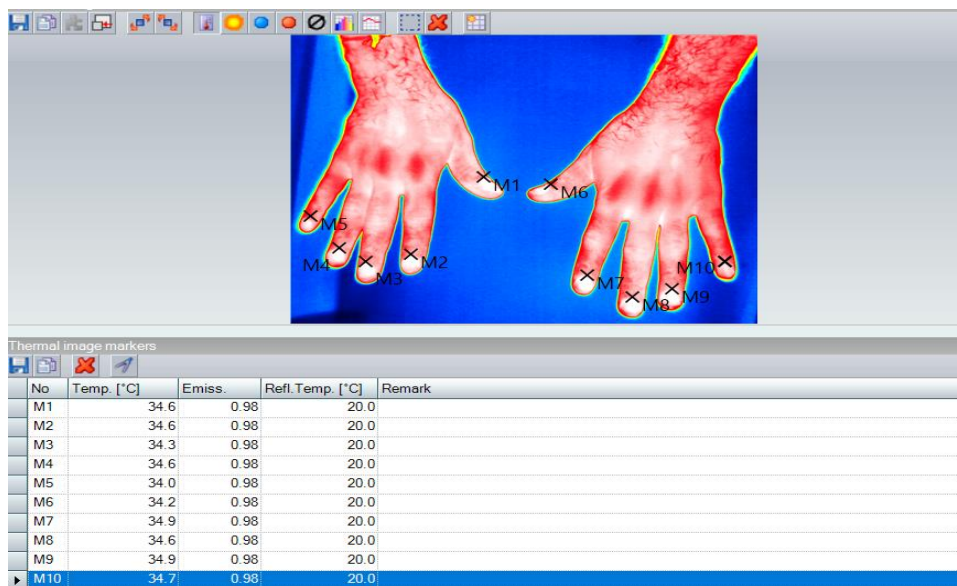


Plate 11: Thermal image of back of the fingers

6) **Palmar surface of the hands:**

- i. M1, M4: The centre of base of the middle finger on the palmar side of the hand.
- ii. M2, M3: A point at the centre of the wrist on the palmar side.
- iii. A straight line connecting M1 and M2; M3 and M4. This gives the averages of temperatures across the points being connected by the line on the palmar surface of the hand: AV1, AV2.

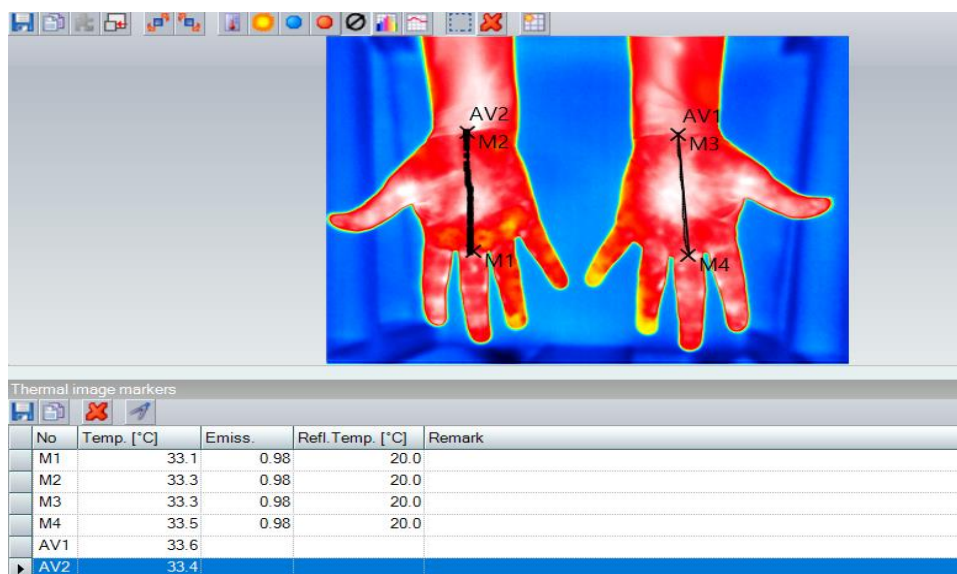


Plate 12: Thermal image of palmar surface of hands

7) **Palmar side of the fingers:**

The tips of all the fingers on the palmar side of the hand (M1, M2, M3, M4, M5, M6, M7, M8, M9, M10)

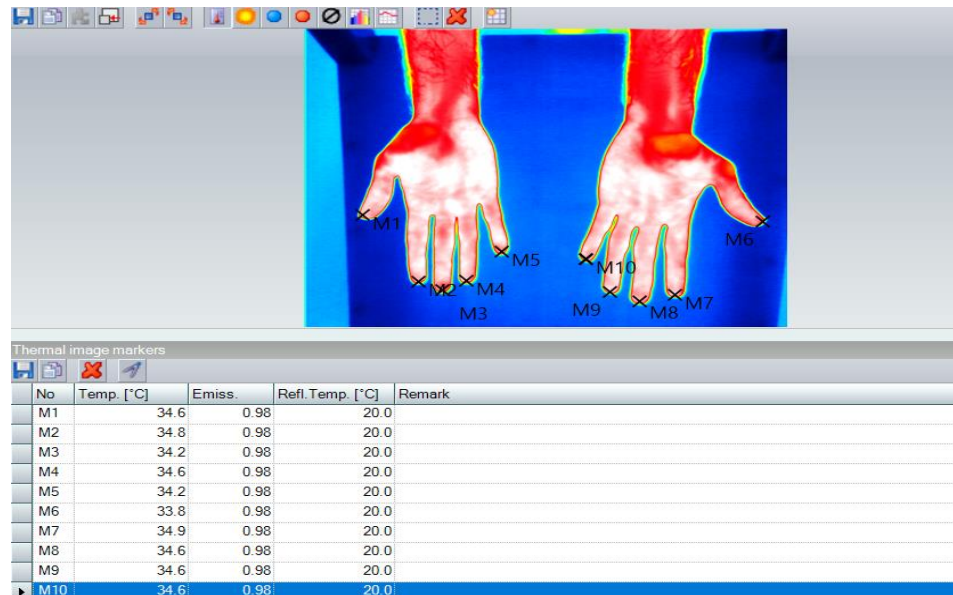


Plate 13: Thermal Image of the Tips of Fingers (palmar side)

8) **Knee and ankle joints of both the legs:**

- i. M1, M2: The centre of the knee joints on both the sides
- ii. M3, M4: The centre of the dorsal ankle crease (or) line joining the medial and lateral malleoli on the dorsal side

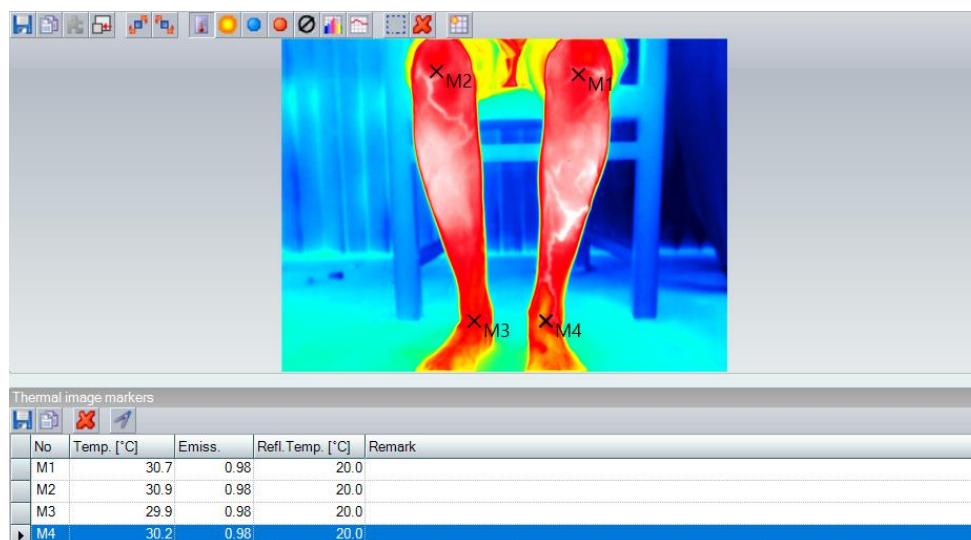


Plate 14: Thermal image of knee and ankle joints of legs

9) **Shins of both legs:**

- i. M1, M2: Centre of the knee joint (as marked in the above step)
- ii. M3, M4: Centre of the ankle joint (as marked in the above step)
- iii. A straight line connecting M1 and M4; M2 and M3. This will give the average values of temperatures across the points being connected by the line on the shin: AV1, AV2.

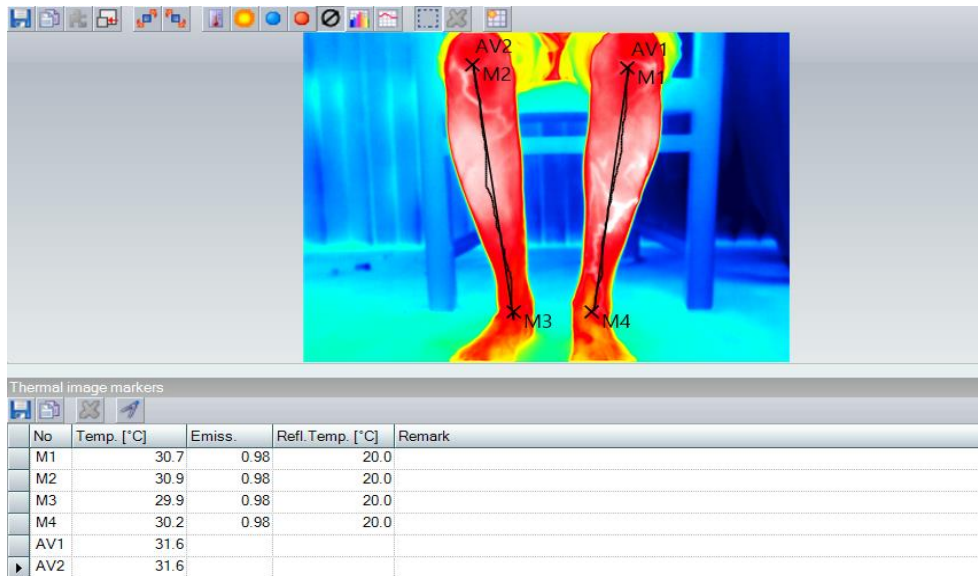


Plate 15: Thermal image of shins of legs

10) **Plantar surface of the toes:**

The tips of all the toes (M1, M2, M3, M4, M5, M6, M7, M8, M9, M10)

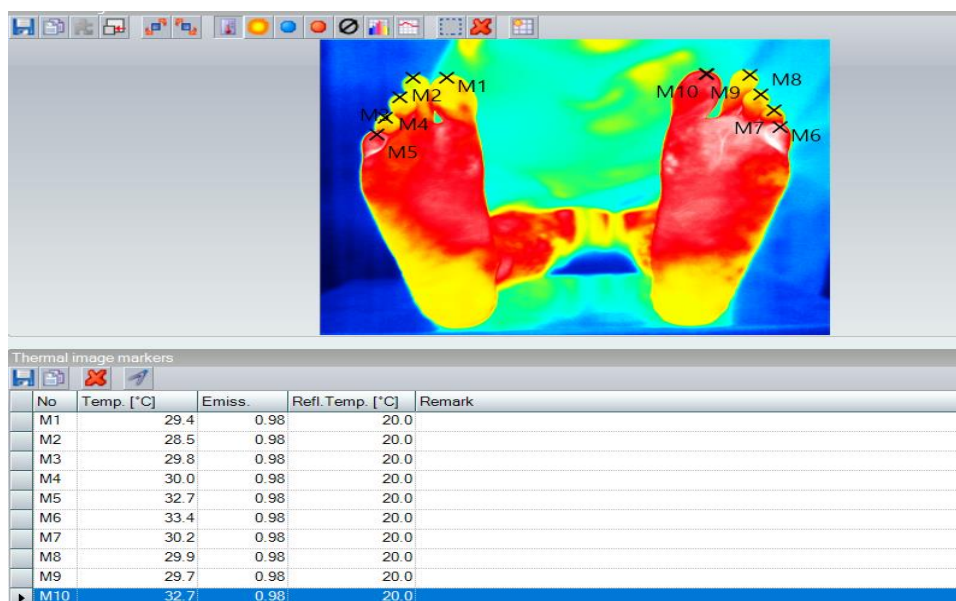


Plate 16: Thermal image of the plantar surfaces of toes

11) **Heels:**

M1, M2: The centres of the heels of both the legs.

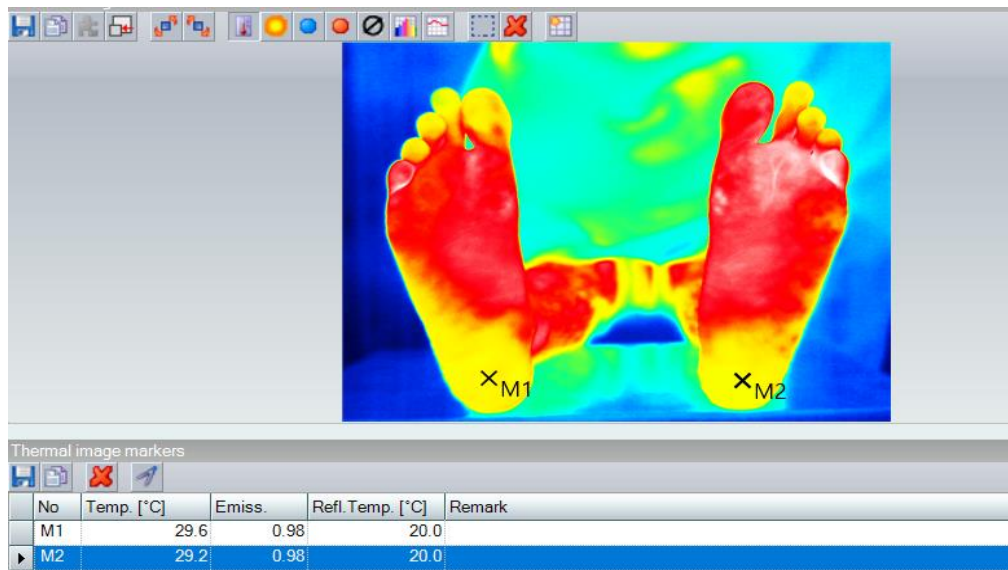


Plate 17: thermal image of heels

12) **Dorsum of the toes:**

The point just proximal to eponychium of each toe

(M1, M2, M3, M4, M5, M6, M7, M8, M9 and M10)

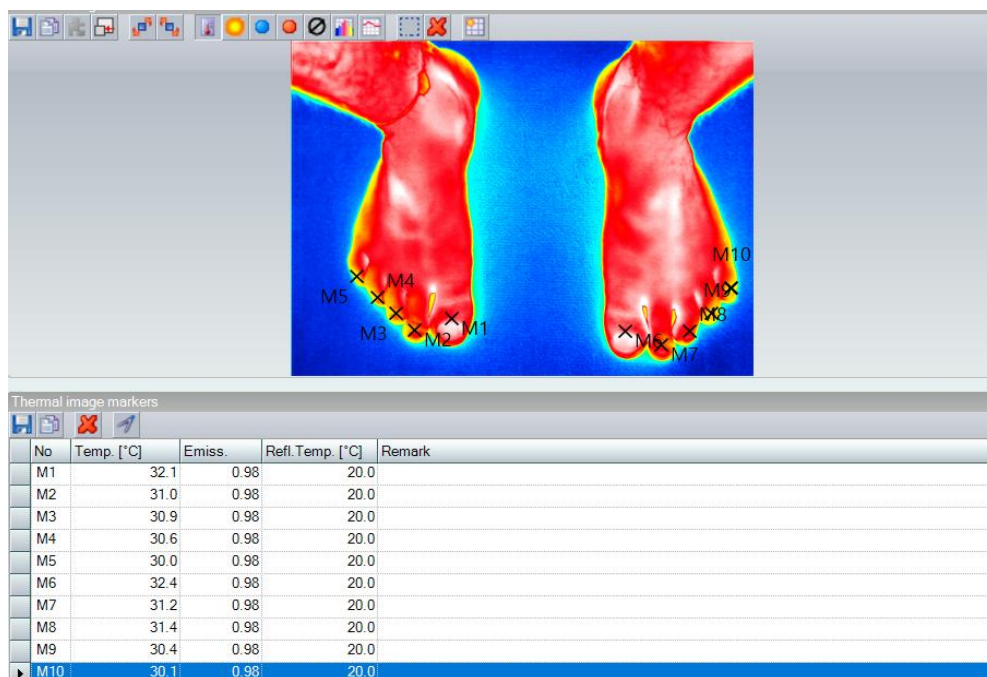


Plate 18: Thermal image of dorsum of the toes

13) **Plantar surface of feet:**

- i. M1, M2: Centre of the base of the 2nd toe as shown in the fig. below.
- ii. M3, M4: Centre of the heel of both feet as shown in the fig. below.
- iii. A straight line connecting M1 and M3; M2 and M4. This will give the average values of temperatures across the points being connected by the line on the plantar surface of the feet: AV1, AV2.

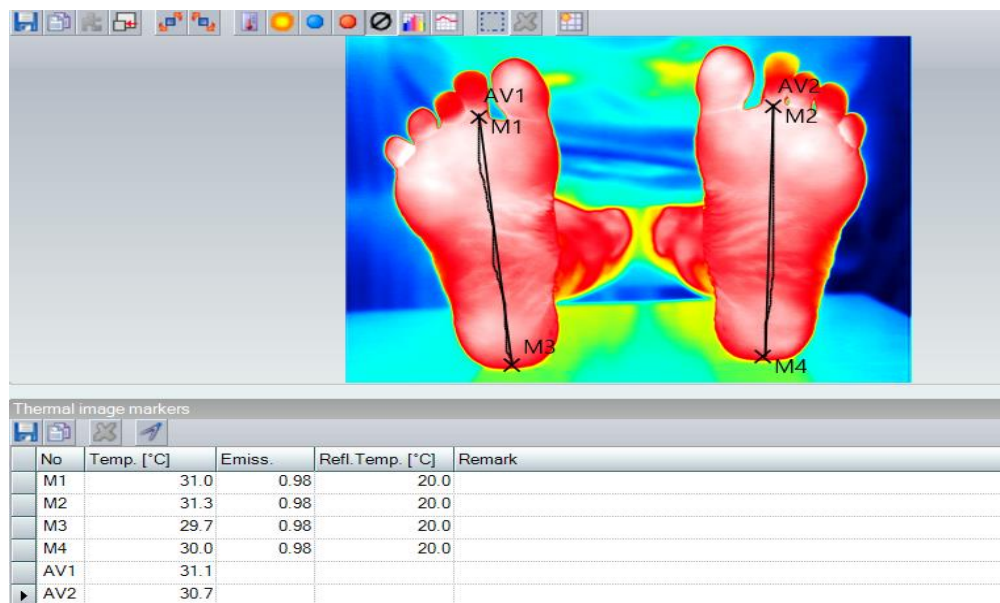


Plate 19: Thermal image of plantar surface of feet

5.3.5 Assessment Procedure for Electro-photonic Imaging Variables

Electro-photonic Imaging procedures were done at baseline, after six months and after completion of one year.

In EPI measurement, low electrical current in microamperes (undetectable) with high voltage [10 KV] and high frequency [1024 Hz] is applied to the fingertips of ten fingers for less than 1 millisecond as a stimulant to draw electrons and photons from the body (Wróbel et al., 2010; Ciesielska, 2009). In this process, electrons and photons are drawn from the cutaneous layer of skin due to the impact of electromagnetic field, (Kostyuk et al., 2011). In response to the given

stimulation, there is a formation of glow around the fingertip, which is captured by the optical CCD (Charge Coupled Devices) camera placed under a dielectric plate in the GDV/EPI system (Hacker et al., 2005). The image taken by GDV camera is known as GDV-gram.

The ten images taken from tips of 10 fingers of both hands reflect the subject's health status. If the image is not symmetrical, it shows an bio-energy imbalance in a related area of the human body (Korotkov, 2002). Further, the acquired 10 GDV images are divided into various sectors, which are correlated with different organs and systems in the human body (Korotkov et al., 2012). The sector diagnosis in GDV is based on a diagnostic table, correlating the characteristics of the glow of different sectors of the tips of 10 fingers with the functional state of the different zones of body. The diagnostic table is based on the concepts of traditional Chinese medicine, micro-acupuncture systems and empirical findings (Korotkov, 2002; Korotkov et al., 2012; Korotkov, 2004).

Bellow protocol was followed to insure uniformity in data collection, analysis, interpretation, and reproducibility for GDV technique in clinical experiences and empirical study. Subjects should be examined in the morning before breakfast or in the first part of the day; at least 3 hours after meals Other diagnostic procedures being run in the time of GDV measurement (medicines, natural substances and supplements), smoking, alcohol use, other drugs use, and menstruation in women should be avoided. For repeated measurements, GVD measurements should be done at the same time of the day, by the same assessor, in the same assessment room with constancy of temperature, air composition, humidity and maintenance through ongoing ventilation and heating system controls. Psychological and physical comforts for the subjects are necessary with quiet and calming environment. Routine GDV device calibrations should be maintained (Alexandrova et al., 2002).

The Activation Coefficient (AC), Integral Area (IA: Right and Left), Integral Entropy (IE: Right and Left) are the primary GDV variables. However, unlike the traditional GDV camera, recent version of the GDV camera (Bio-well device with Bio-well software) calculates the energy level and energy balance score for every organs of the body which facilitates the proper interpretation of results. The AC variable mentioned above is an indicator of stress level which is the difference between sympathetic and parasympathetic responses. The AC ranges from 0 to 10. AC between 2 and 4 is an indication of normal state of mind. AC below 2 is a state of relaxed and calm mind. AC below 2 may be because of one of the two reasons; 1) deep meditation and 2) chronic depression. AC above 4 shows excited state of mind with higher levels of stress. IA (left and right) variable is magnitude of general health index of the subject being investigated. IA ranging from -0.6 to $+1$ indicates good health condition. IE (left and right) variable is indicator of disorderliness in the human bio-energy system. IE ranging from 1 to 2 indicates a healthy pattern of bio-energy in an organism. (Kostyuk et al., 2011; Korotkov, 2002; Cioca, Giacomoni, & Rein, 2004).



Plate 20: Bio-well GDV Camera 2 and its Accessories

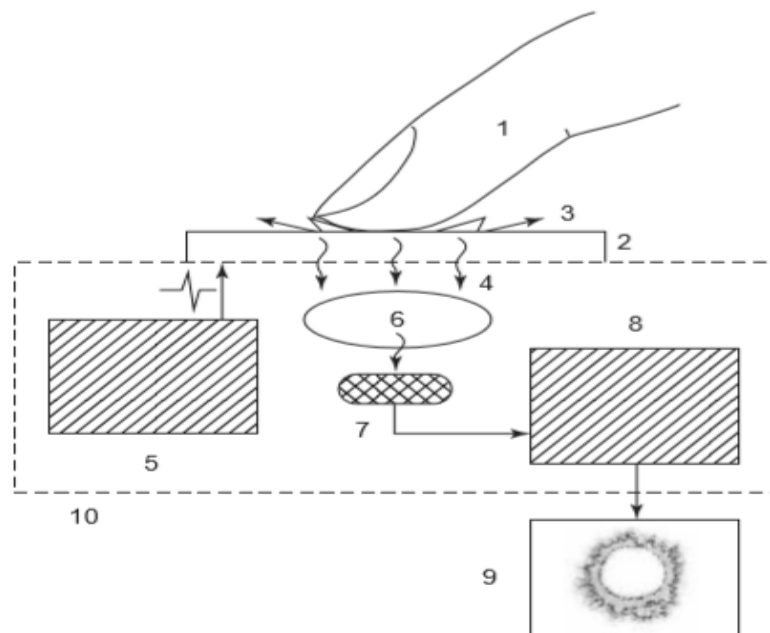


Plate 21: The experimental scheme of the Electro-photonic Imaging technique: 1) Subject under study, 2) Optical glass with coating underneath 3) Gaseous discharge 4) Optical radiation 5) Impulse generator 6) Optical system 7) Charge coupled device camera 8) Video digitizer 9) Personal computer 10) Device box (Courtesy for Image: Dr Korotkov, 2004)

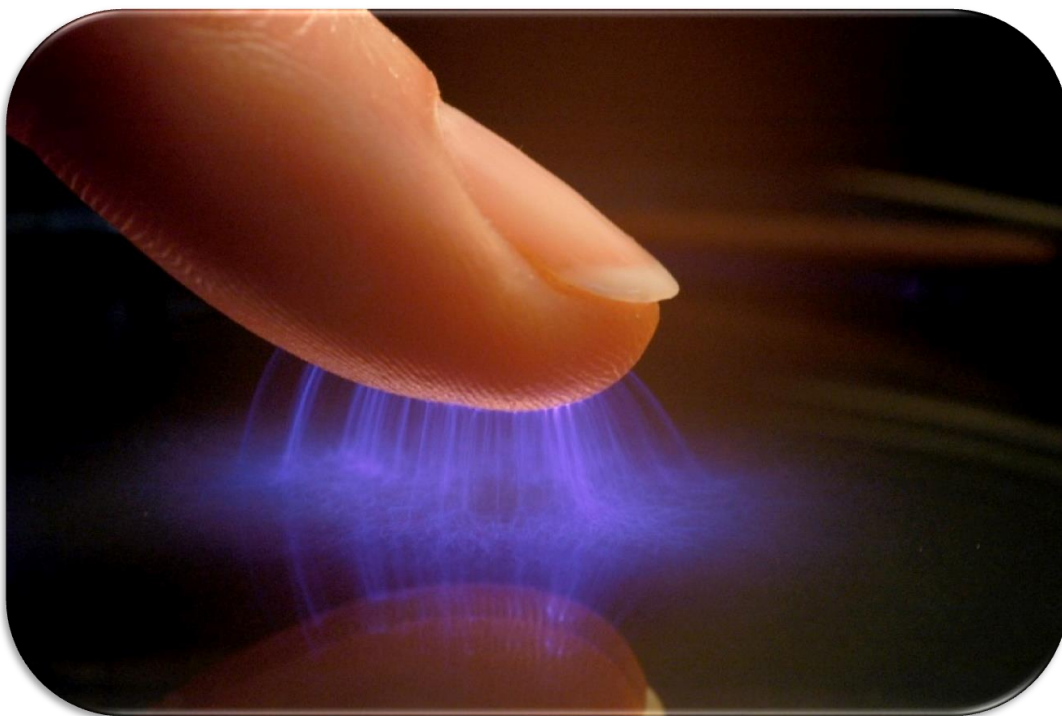


Plate 22: Presentation of electrical discharge from the finger during EPI process

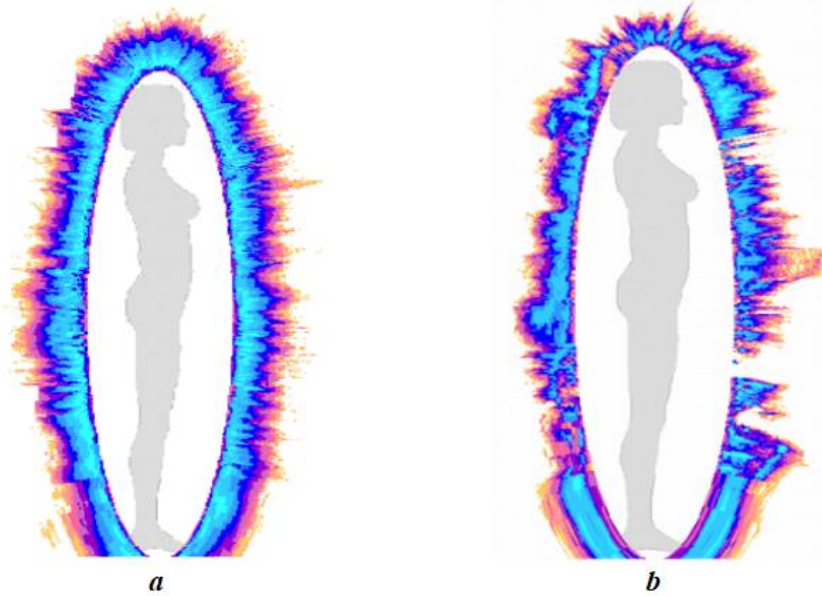


Plate 23: Bioenergy pattern of a healthy individual (a) and an individual suffering from several physical disorders (b) (Courtesy for Image: Dr Korotkov, 2014)

5.3.5.1 Bio-well GDV Camera 2.0

The Bio-well GDV Camera, manufactured by Kirlionics International, St. Petersburg, was used for the current study. This Bio-well camera consists of an electrode covered with dielectric, a generator of electrical field of the suitable voltage and frequency and a CCD video camera. The device operates in both static and dynamic mode, and allows recording in real-time. It measures the energy flows in both animates and inanimate subjects.

5.3.5.2 Features of the GDV Camera

EPI bio-electrography parameters from 10 fingers of both the hands were measured with the computerized complex “EPI-camera” instrument. The technical parameters of the camera are impulse duration [10.0 mks], repetition frequency [11.0 – 3.0 kHz], voltage amplitude [1000.0 – 4000.0 V], maximum impulse power consumption [80 Watt], schematic impulse current limitation [on the level of 1mA] and CCD matrix resolution [800 x 600] (Konstantin Korotkov, 2004).

5.3.5.3 Reliability and validity of the GDV Camera

The validity and reliability of EPI method was well established in the St. Petersburg Federal Medical University, establishing baseline with practically healthy individuals and patients with bronchial asthma (BA). The experiments revealed that among the healthy people the average amplitude of variation in the GDV-gram parameters in daily average is at 4.1% and the 10 minutes average amount is 6.6%. For the BA patients these values amounted to 8.6% and 7.7%. For the titanium calibration cylinder, the variation is less than 1% at night time and >3% in the daytime, providing calm environment conditions. While assessing individuals with a stable psycho-physiological state, the GDV-gram parameters were reproduced with a 5% to 10% precision (Korotkov, 2002).

5.3.5.4 EPI Parameters Selected for the Study

- 1) **Stress:** Stress variable is also known as Activation Coefficient (AC) which ranges from 0 to 10. AC between 2 and 4 is an indication of normal quiescent state of mind. AC below 2 signifies the state of mind in either deep meditation or chronic depression. AC above 4 indicates excited state of mind, pointing towards higher levels of stress (Korotkov, 2002; Kostyuk et al., 2011).
- 2) **Energy:** Energy variable demonstrate the overall level of energy for the particular person both in Joules and in % related to the database of apparently healthy people, measured from 0 to 100%. 0 to 20% indicates low energy (may be related to energy deficiency, as well as to meditative state); 20% to 40% indicates decreased energy; 40% to 70% indicates typical energy; 70% to 90% indicates heightened energy (characteristic of people with high level of energy); 90% to 100% indicates high energy (typical for athletes, top managers, at the same time may be an indication of inflammation) (Alexandrova et al., 2002; Yakovleva & Korotkov, 2012).

- 3) **Balance:** Balance variable shows the uniformity of the distribution of overall energy in the body. The balance is measured in %. 0 to 50% shows very low balance (indication of serious disorder); 50% to 90% indicates low balance (indication of functional disorder); 90% to 100% shows typical balance (Yakovleva & Korotkov, 2012).
- 4) **Organs balance - left & right:** Organs balance show the uniformity of the distribution of energy in overall organs and systems of the body represented by both right and left hand (Yakovleva & Korotkov, 2012).
- 5) **Emission coefficient (EC):** Emission coefficient characterizes the power of small fragments deleted from the GDV-gram and is measured in pixels (Korotkov, 2002; Kostyuk et al., 2011).
- 6) **Form coefficient (FC):** Form coefficient shows the degree of irregularity of the GDV-gram external contour (Korotkov, 2002; Kostyuk et al., 2011).
- 7) **Area - left, front & right:** Area represents the amount of light quanta generated by the subject in computer units in pixels. Area of glow is in proportion to quantity of electrons. More electrons shows the higher level of metabolic rate. Left, front and right represent the left side, right side and front side of human energy body (Yakovleva & Korotkov, 2012).
- 8) **Energy - left, front & right:** It is the same energy mentioned earlier divided into the left side, right side and front side of human energy body
- 9) **Energy - Body organs** (energy received by individual organs and systems):
 Head energy, Eyes energy, Cerebral zone cortex energy, Cardiovascular system energy, Heart energy, Cerebral zone vessels energy, Coronary vessels energy, Respiratory system energy, Thorax energy, Endocrine system energy, Hypothalamus energy, Epiphysis energy, Pituitary gland energy, Thyroid gland energy, Adrenals energy, Musculoskeletal system energy, Cervical spine energy, Thorax spine energy, Lumber spine energy, Sacrum energy, Digestive system energy, Colon descending energy, Colon sigmoid energy, Rectum energy,

Blind gut energy, Colon ascending energy, Colon transverse energy, Duodenum energy, Ileum energy, Jejunum energy, Liver energy, Gallbladder energy, Appendix energy, Abdominal zone energy, Urogenital system energy, Kidneys energy, Nervous system energy, and Immune system energy

10) **Balance - Body organs** (uniformity of the distribution of energy inside every individual organs and systems):

Head balance, Eyes balance, Cerebral zone cortex balance, Cardiovascular system balance, Heart balance, Cerebral zone vessels balance, Coronary vessels balance, Respiratory system balance, Thorax balance, Endocrine system balance, Hypothalamus balance, Epiphysis balance, Pituitary gland balance, Thyroid gland balance, Adrenals balance, Musculoskeletal system balance, Cervical spine balance, Thorax spine balance, Lumber spine balance, Sacrum balance, Digestive system balance, Colon descending balance, Colon sigmoid balance, Rectum balance, Blind gut balance, Colon ascending balance, Colon transverse balance, Duodenum balance, Ileum balance, Jejunum balance, Liver balance, Gallbladder balance, Appendix balance, Abdominal zone balance, Urogenital system balance, Kidneys balance, Nervous system balance, and Immune system.

5.3.6. Psychological Variables

5.3.6 Depression Anxiety Stress Scale - 42

Depression Anxiety Stress Scale – 42 (DASS-42) consists of 42 items divided into three subscales of 14 items; depression, anxiety, and stress. The DASS-42 is an reliable and valid measure of depression, anxiety, and stress (Brown et al., 1997; Lovibond & Lovibond, 1995). The Depression Anxiety Stress Scale – 42 questionnaire and scoring details are provided in *Appendix 4*.

5.4 INTERVENTION

Both the interventions (yoga and physical exercise) were delivered at the Department of Integrative Medicine, National Institute of Mental Health and Neuro Sciences (NIMHANS), Bengaluru by two trained instructors (with a master's degree).

5.4.1 Yoga-based Lifestyle (YBL) / Yoga Group

Participants allocated to the YBL group practiced a validated yoga based lifestyle program for T2DM. This program has been used previously in a Nationwide Multi-centric Trial (Nagarathna et al., 2019). The module includes loosening practices, asana (yogic postures), pranayama (breathing techniques), meditation, mantra chanting and relaxation techniques specifically designed to reduce psychological stress and enhance glycaemic control. Yoga-based counselling on regulating lifestyle and calming the mind according to yogic philosophical principles was delivered in groups to all the participants for 10 minutes per week. The details of the YBL program are provided in *Appendix 1, Table 30*.

Subjects were trained in below three program in three modes:

1) Direct supervised sessions for first 4 weeks

Participants attended the one-hour yoga program for 5 days per week between 7:00 am to 8:00 am in the morning, i.e. initial 20 yoga sessions were supervised. Yoga performance assessments showed that more than 80% of participants were able to learn the module completely at the end of 20 supervised sessions (Hariprasad et al., 2013).

2) Supervised tele-yoga sessions for 11 months

After completing direct supervised sessions, participants were shifted to supervised tele-yoga practice. Same program consisting of yoga practice (one hour per day between 8:00 am to 9:00 am in the morning, five days per week) and once a week group counselling (10 minutes) was continued for next 11 months through tele-yoga mode.

3) Supervised booster sessions

One booster yoga session of 1 hour per month was delivered under the direct supervision from 2nd to 6th month, Participants were corrected for their yoga practices during these booster sessions.

5.4.2 Physical Exercise and Health Education Programme (PHE) / Physical Exercise Group

Participants allocated to the PHE group / Physical Exercise Group followed a similar regimen like the YBL group with the intervention, divided into above mentioned three phases with same timelines respectively. The physical exercises included were those with matched metabolic equivalents to the yoga practices. One metabolic equivalent (MET) is defined as the amount of oxygen consumed while sitting at rest and is equal to 3.5 ml O₂ per kg body weight x min. As per WHO grading, this physical exercise given in this study falls into moderate physical activity level. The health education program also involved in discussions on usefulness of healthy lifestyle, importance of physical activity and diet for T2DM (10 minutes, once per week). *Appendix 1* and *Table 31* provide the details of the PHE programme.

Both YBL and PHE groups had access to reading material on conventional diabetes education. A diary was kept by the instructor to monitor daily attendance. Participants were asked to keep the camera on during tele-yoga/tele-exercise sessions. The performance and attendance of participants in tele-sessions were monitored by a trained instructors. Participants who practiced less than 50% of the recommended YBL/PHE programme (at 6 months and 12 months follow-ups) were excluded from the final analysis.

5.5 DATA EXTRACTION

Heparinized blood was used to extract HbA_{1c} value by using NGCP-certified and DCCT aligned affinity assay method on a Nycocard Reader II. All biochemical tests were carried out

at a National Accreditation Board, Quality Council of India certified laboratory by a trained technician, and the provided extracted biochemical values were entered in Microsoft Excel. The thermal imaging data were extracted by Testo IRSoft Software. The pointer tools, line and area tools were used to obtain the temperature readings of ROI. Rainbow palette was chosen to view and analyse the images. The pointer tool was used to acquire temperature at the mid-point of ROI and the line/ area tool was used to note the readings across a length of ROI surface. Out of minimum, maximum and average temperature readings, the latter was noted for all ROIs. The thermal imaging data were transfer to Microsoft Excel from Testo IRSoft Software for final analysis. Electro-photonic imaging data were extracted using Bio-well software. The EPI images were converted into continuous data using the Bio-well software then were exported to Microsoft Excel before analysis. The extracted values (through standard methods) for other study variables were also entered in Microsoft Excel before analysis.

5.6 DATA ANALYSIS

Approach to Intention to treat (ITT) Analysis

Intention to treat analysis with a mixed model approach was applied to deal with subjects that had data missing at random (MAR) at any given time point (Chakraborty & Gu, 2019; Nich & Carroll, 2002). Linear mixed effects (LME) models were fit with Restricted Maximum Likelihood (REML) estimation to investigate the effects of add-on yoga intervention on primary and secondary outcome measures. Group was modelled as a between-subject fixed-effects factor with 2 levels (YBL and PEH) and Time as within-subject fixed-effects factor with 3 levels (Baseline, 6 month and 1 year). A p-value of < 0.05 (two-sided) was considered statistically significant. Statistical analyses were performed with R software version 4.0.3 using package "lme4".

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Approach to Per-protocol (PP) Analysis

In studies with high dropout rates, there are chances that imputation of large amount of data during ITT analysis may artificially increase the sample size and hence, the degree of freedom. Therefore, we decided to analyse the data using per protocol approach too in study completers. Study completers were defined as those who provided both baseline, 6 months and 1 year data ($n = 51$). The analysis was performed by applying repeated measures analysis of variance (RMANOVA) with between-subject fixed-effects factor with two levels (YBL and PEH) and Time as within-subject fixed-effects factor with three levels (Baseline, 6 months and 1 year) (Telles et al., 2011).

Independent t test and chi square test were used to compare the demographic details for continuous and nominal data respectively between YBL and PHE groups at the baseline as well as for demographic comparisons between study completers and drop-outs. Pearson correlation coefficient test was used to examine the correlations of Thermal Imaging Parameters and Electro-photonic Imaging parameters with HbA1c level.