Cumulative effect of short-term and long-term meditation practice in men and women on psychophysiological...

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Cumulative effect of short-term and long-term meditation practice in men and women on psychophysiological parameters of electrophotonic imaging: a cross-sectional study

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Abstract

Background: Anapanasati is one of the meditation techniques discussed in Buddhism. In this meditation, one focuses one's attention on bodily sensations caused by incoming and outgoing breath. This study aims to track the cumulative effect of long-term meditators (LTM) and short-term meditators (STM) using electrophotonic imaging (EPI).

Methods: To execute the current study, 432 subjects (264 men and 168 women with mean age of 34.36 ± 6.83) were recruited from two meditation centers. LTM had practiced for more than 60 months (mean of months 111 ± 47.20, hoursperday 1.71 ± 1.20). STM had practiced meditation from 6 months to less than 60 months (mean of months 37.17 ± 19.44, hoursperday 2.14 ± 4.99). A cross-sectional research design was applied and data was collected using EPI. Scatter plot and Fisher discriminant model were also used for statistical presentation of values and interdependency of variables with length of practice between groups.

Results: In both LTM and STM, lower values of stress (activation coefficient) were found in woman meditators as compared to men. In both groups, highly significant gender-related differences were observed in integral area parameter, which measures the overall health of an individual. Integral entropy (index of disorderliness of subtle energy in the body) was fluctuating in both groups in both directions for both genders. It was increasing in LTM group and decreasing in STM group with increasing length of practice.

Conclusions: Women of LTM and STM demonstrated lesser stress than men. Both groups showed cumulative health-related improvement. Moreover, in gender-related analysis woman meditators exhibited more positive improvement in EPI parameters than men.

Keywords: anapanasati, cumulative, disorderliness, electrophotonic imaging, gas discharge visualization, meditation, stress

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Introduction

Meditation encompasses specific mental state of consciousness, which induces physiological and neuropsychological changes. Regulation of attention plays a vital role in all techniques of meditation [1]. Even short-term meditation practices have shown beneficial changes on autonomic and physiological functioning of the body [2–4]. It is shown in many studies that long-term meditation practices have provided positive effect on the cognitive and perceptional aspects of brain activity [4–9]. Recent research has shown interesting findings how meditation reduces aging process and enhances gray matter in the brain and brain activity itself [10–18]. Another recent study with large sample size ($n = 100$) presents the potential protective effect of long-term meditation on gray matter atrophy and concludes that meditation is brain protective and reduces deterioration of age-related changes in brain tissues [9].

Traditional anapanasati meditation, which is termed as focused attention meditation, is widely studied in scientific community. In this meditation, practitioners focus on the bodily sensation caused by incoming and outgoing breath and if distracted due to any stimulus, they bring back attention on the object of contemplation [19]. Anapanasati meditation (focused attention meditation) practiced over a long period of time induces an effortless concentrative state of mind. Studies have also been carried out to observe an immediate and comparative effect of short-term versus long-term meditation practices [4, 20–22].

Apart from this angle of observation, there are only a few studies to observe any gender-related changes in meditation practices. A national survey among the population in the United States indicates gender imbalance in the usages of body–mind therapies including meditation (23.8% women and 14.4% men) [23]. In one study, electroencephalogram (EEG) coherence was found different in navigation skill training, wherein women exhibit higher activity in the theta band compared to men [24]. Recently in gender-related studies following Quadrato motor training (QMT), it was seen theta and alpha intra-hemispheric coherence increases in women, indicating enhanced relaxation, heightened attention and reduced activity and thought contents as compared to men. Gender differences are found in several areas of emotional functioning and cognitive correlates of recognition abilities [25]. In behavioral endeavor regarding the role of emotion in visuospatial working memory, differences are found in men and women related to the brain activity pattern [26]. It is reported in Qigong meditation treatment, women showed greater reduction in cravings, anxiety and withdrawal symptoms than men [27]. Women retrieve appearance of others efficiently and have better face recognition throughout than men [17, 28]. It is noted that women have more experiential and cognitive orientation toward spirituality than men [29].

Thus, in the light of findings presented earlier, the current study is devised to explore the gender-based differences in the cumulative effect of meditation in short-term versus long-term meditation practitioners.

Application of electrophotonic imaging

Electrophotonic imaging (EPI) also known as gas discharge visualization (based on Kirlian effect) is used in recording human bioelectromagnetic field. It gives potential information about the physiological and psychophysiological condition of the human body [30]. In measurements using EPI, electrons are drawn out from the body. Under different psychophysiological conditions, the amount of electron emission from the body fluctuates from homeostatic level [31]. In EPI, high voltage and high frequency are applied to the fingertip for less than a millisecond; the resultant response is seen as a luminous glow around the finger which is captured using an optical CCD (charge-coupled device) camera [32]. The captured image is known as EPI-gram. In this way, electrons are extracted from the surface of the cutaneous layer of the skin due to the impressed electromagnetic field [33]. The captured images can be quantified for medical and scientific research. All 10 images taken from the tip of the fingers of both hands give complete information about the possible health status of an individual. Every image is divided into a number of sectors and analyzed based on acupuncture meridian theory [34]. If an image has gaps in its sector, this shows an imbalance in the concerned organ within the body [35]. The image formation changes due to the person's psychoemotional state. On EPI applications, images are taken twice: with filter and without the filter that show physiological and psychophysiological functioning of the human system, respectively [32]. A filter is a specially designed plastic sheet that is placed while taking an EPI-gram. Since the filter absorbs sweat, the values of EPI-gram with filter relate physiological conditions while those without filter provide values for psychophysiological assessments. The variations in EPI measurements in healthy individuals fall within a range of 4.1–6.6 % [32]. This instrument is non-invasive, safe to use, with quick assessments and has high reliability [31, 32, 37]. EPI had been applied to study cardiovascular disease, autism, cancer, diabetes, sport, healing and meditation [31–44].

EPI parameters

Activation coefficient

Activation coefficient (AC) measures the level of stress in an individual. The normal range is 2–4 in healthy people. These values are derived through taking the difference of measurements obtained with and without filter [32].

Integral area

Integral area (IA) is a measure of general health index with a range of −0.6 to +1 for healthy people. It indicates the presence of structural and functional state in normal mind–body activities [32, 45]. This is a ratio between EPI background area and area of an ideal image of EPI. The mathematics related to this is available elsewhere [32].

Integral entropy

Integral entropy (IE) is an evaluation of disorderliness in human energy field with normal range of 1–2 in healthy people. This is mathematically derived from the uniformity of the EPI-gram and the presence of deficiencies in the organs measured [35].

Materials and methods

A total number of 482 subjects were recruited from Pyramid Valley International, Bangalore, and The Pyramid Spiritual Trust, Kailashpuri, Hyderabad, India, including 264 men and 168 women (mean age of 34.36 ± 6.83 years). All the 432 subjects were considered for analysis after excluding 50 subjects (23 men and 27 women) due to four reasons, viz. defective images, only without filter measurement, ill health issues and having extreme values in the images. Subjects were divided into two groups: long-term meditators (LTM) practicing more than 60 months (mean months of practice 111 ± 47.20, hoursperday 1.71 ± 1.20) and short-term meditators (STM) practicing from 6 months to less than 60 months (mean months of practice 37.17 ± 19.44, hoursperday 2.14 ± 4.99). There were 184 subjects in LTM group (mean age 35.28 ± 6.49inyears) consisting of 116 men and 68 women, 248 in STM (mean age 33.69 ± 7.00) consisting of 148 men and 100 women. All the subjects gave written informed consent for voluntary participation in this research and the study received approval from the Institutional Ethical Committee. The cross-sectional research design was applied, and data were collected using EPI.

The inclusion criteria were healthy volunteers, age range between 24 and 45 years, both genders and willing to participate in the study. To be included in either LTM or STM group, subjects required to have at least 6 months of prior anapanasati meditation experience. Subjects with missing fingers or having cut in fingers, smoked or taken alcohol on test day, having any disease or on prescription drugs were excluded from the study.

Demographic sheets were served to seek self-reported health status, age and prior meditation experience to assign in either of the groups.

Data acquisition and analysis

EPI instrument also known as gas discharge visualization produced by "Kirlionics Technologies International," Saint Petersburg, Russia (GDV camera Pro with analog video camera, model number: FTDI.13.6001.110310), was used to collect data. Raw data from EPI program was exported to excel for analysis of the required three parameters, namely, AC, IA and IE. R statistical packages (R version 3.0.1, 2013) by R Foundation for Statistical Computing Platform were used to process data for statistical analysis [46]. Parametric independent *t*-test was performed within each group where a level of $p < 0.05$, $p < 0.01$ and $p < 0.001$ were considered as statistically significant, higher significance and highly significant, respectively. To account for possible variability in atmospheric temperature and humidity, a hygrometer (Equinox, EQ 310 CTH) was used during data collection. During data recording at different time intervals, mean temperature was 26.63 ± 3.47 and humidity 52.18% measured in °C and percent, respectively, to observe atmospheric effect and possible variability of electrophotonic emission in human subjects [32]. To determine the interdependency among variables, we carried out Fisher discriminant function analysis and scatter plots are presented for visual representation.

Results

Gender-dependent differences within LTM group

Table 1 shows results in LTM group, AC values were less in women in comparison to men but this difference was not significant. At physiological level (with filter), values of IA with filter left side (IAWL) were highly significantly lower ($p < 0.001$) in women. Higher mean values of IA with right side (IAWR) in women were found highly significant ($p < 0.001$) in comparison to men.

At the psychophysiological level (without filter), significant lower values of IANL (IA no filter left) ($p = 0.03$) and IANR (IAN right side) ($p = 0.04$) were found in women as compared to men. Higher value of IENL (IE no filter left) was observed in women as compared to men but the result was not significant. The mean values of IENR (IE no right side) were higher in women than men. This difference was statistically significant ($p = 0.04$) in women in comparison to men.

Table 1: Gender based values of EPI parameters within LTM group.

Type of measurement	Variable	Male, mean ± SD	Female, mean ± SD	p-Value
Physiological (with filter)	AC	2.79 ± 0.88	2.78 ± 1.05	0.93
	IAWL	0.49 ± 0.12	0.41 ± 0.13	**<0.001**[b]
	IAWR	0.42 ± 0.12	0.50 ± 0.12	**<0.001**[b]
	IEWL	1.93 ± 0.14	1.91 ± 0.15	0.58
	IEWR	1.94 ± 0.16	1.94 ± 0.15	0.89
Psychophysiological (without filter)	IANL	0.16 ± 0.21	0.09 ± 0.23	**0.03**[a]
	IANR	0.17 ± 0.18	0.10 ± 0.24	**0.04**[a]
	IENL	1.85 ± 0.20	1.87 ± 0.18	0.41
	IENR	1.85 ± 0.16	1.91 ± 0.18	**0.04**[a]

[a]$p < 0.05$, [b]$p < 0.001$. AC, activation coefficient; IAWL, integral area with filter left; IAWR, integral area with filter right; IEWL, integral entropy with filter left; IEWR, integral entropy with filter right; IANL, integral area no filter left; IANR, integral area no filter right; IENL, integral entropy no filter left; IENR, integral entropy no filter right.

Gender-related differences within STM group

Table 2 shows results in STM group, AC values were lower in women as compared to men though the result was not significant. At the physiological level (with filter), there were highly significant ($p < 0.001$) lower values of IAWL found in women as compared to men. Highly

Table 2: Gender-related differences of EPI parameters within STM group.

Type of measurement	Variable	Male, mean ± sd	Female, mean ± sd	p-Value
Physiological (with filter)	AC	2.92 ± 0.97	2.82 ± 0.75	0.39
	IAWL	0.50 ± 0.13	0.44 ± 0.13	**<0.001**[b]
	IAWR	0.52 ± 0.13	0.56 ± 0.12	**<0.001**[b]
	IEWL	1.90 ± 0.22	1.93 ± 0.15	0.13
	IEWR	1.91 ± 0.20	1.91 ± 0.16	0.86
Psychophysiological (without filter)	IANL	0.17 ± 0.23	0.12 ± 0.18	**0.04**[a]
	IANR	0.17 ± 0.23	0.13 ± 0.19	0.14
	IENL	1.85 ± 0.19	1.85 ± 0.16	0.99
	IENR	1.85 ± 0.18	1.89 ± 0.16	0.06

[a]$p < 0.05$, [b]$p < 0.001$. AC, activation coefficient; IAWL, integral area with filter left; IAWR, integral area with filter right; IEWL, integral entropy with filter left; IEWR, integral entropy with filter right; IANL, integral area no filter left; IANR, integral area no filter right; IENL, integral entropy no filter left; IENR, integral entropy no filter right.

significant ($p < 0.001$) higher values of IAWR were observed in women in comparison to men.

At the psychophysiological level (without filter), values of IANL were found significantly lower in women ($p = 0.04$) in comparison to men.

Gender-related comparison of EPI parameters between LTM and STM groups

In this section, comparison between LTM and STM groups were made to observe in mean values of variables. Table 3 shows the values of AC in men were lower in LTM as compared to men in STM. At the physiological level, mean values of IAWL and IAWR in LTM were found lower than STM in men. However, mean values of IEWL and IEWR were higher in LTM men in comparison to STM men.

At the psychophysiological level, mean values of IANL were lower and IANR mean values higher in LTM men as compared to STM men. No differences in mean values of IENL were found in both groups. Higher mean values of IENR were observed in LTM men than STM men. The comparative results of LTM and STM men discussed above were not statistically significant.

Women have less values of AC in LTM group as compared to women of STM. The result of IAWL ($p = 0.05$) and IAWR ($p = 0.04$) was statistically significant. The mean value of IEWR was more in LTM women than STM.

At psychophysiological level, mean values of IANL and IANR were lower in LTM women in comparison to STM but not significant. Higher values of IENL and IENR were found in LTM women as compared to STM women but not significant.

LTM scatter plot shows (Figure 1) unexpected increasing trend in entropy with increase in total hours of meditation. This is possibly due to constant fluctuation of energy in the body system and washout of cumulative effect of meditation at the psychophysiological level in LTM group. This may also be due to participants' attitude of habituation that sets in due to their long-term practice, both of which needs to be studied further.

STM scatter plot demonstrates (Figure 2) with increase of total hours of practice, entropy decreases, which is a

Table 3: Gender-related values of EPI parameters and comparisons between groups: LTM and STM.

Type of measurement	Variable	Male		p-Value	Female		p-Value
		LTM, mean ± sd	STM, mean ± sd		LTM, mean ± sd	STM, mean ± sd	
Physiological (with filter)	AC	2.80 ± 0.88	2.92 ± 0.97	0.30	2.79 ± 1.05	2.89 ± 0.75	0.83
	IAWL	0.49 ± 0.12	0.50 ± 0.13	0.43	0.41 ± 0.13	0.45 ± 0.13	**0.05**[a]
	IAWR	0.50 ± 0.12	0.52 ± 0.13	0.29	0.42 ± 0.12	0.46 ± 0.12	**0.04**[a]
	IEWL	1.93 ± 0.14	1.90 ± 0.22	0.26	1.91 ± 0.15	1.93 ± 0.15	0.41
	IEWR	1.94 ± 0.16	1.91 ± 0.20	0.22	1.94 ± 0.15	1.91 ± 0.16	0.22
Psychophysiological (without filter)	IANL	0.16 ± 0.21	0.17 ± 0.23	0.68	0.09 ± 0.23	0.12 ± 0.18	0.24
	IANR	0.17 ± 0.18	0.16 ± 0.23	0.63	0.10 ± 0.24	0.13 ± 0.19	0.38
	IENL	1.85 ± 0.20	1.85 ± 0.19	0.85	1.87 ± 0.18	1.86 ± 0.16	0.58
	IENR	1.85 ± 0.16	1.84 ± 0.18	0.66	1.91 ± 0.18	1.90 ± 0.16	0.78

[a]$p < 0.05$. LTM, long-term meditators; STM, short-term meditators; AC, activation coefficient; IAWL, integral area with filter left; IAWR, integral area with filter right; IEWL, integral entropy with filter left; IEWR, integral entropy with filter right; IANL, integral area no filter left; IANR, integral area no filter right; IENL, integral entropy no filter left; IENR, integral entropy no filter right.

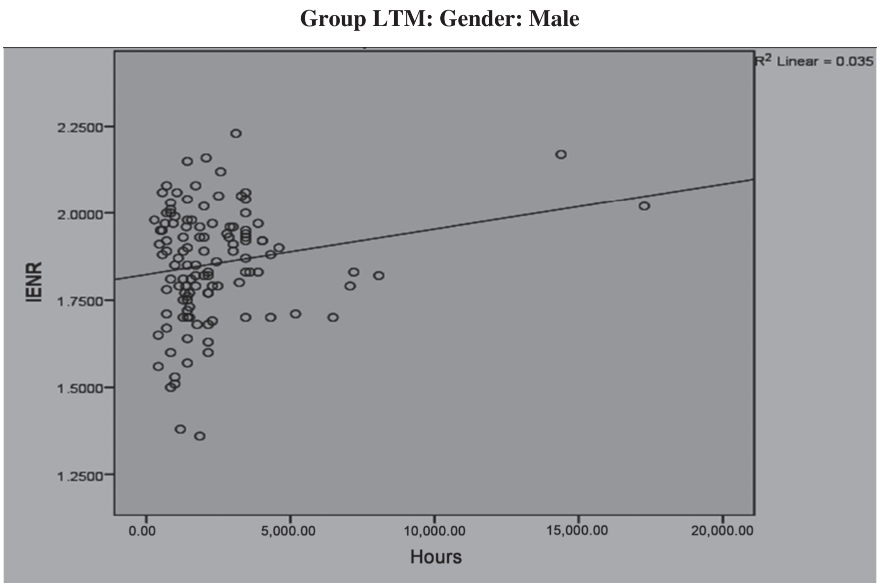

Figure 1: Scatter plot showing relationship between IENR and hours of practice in LTM group.

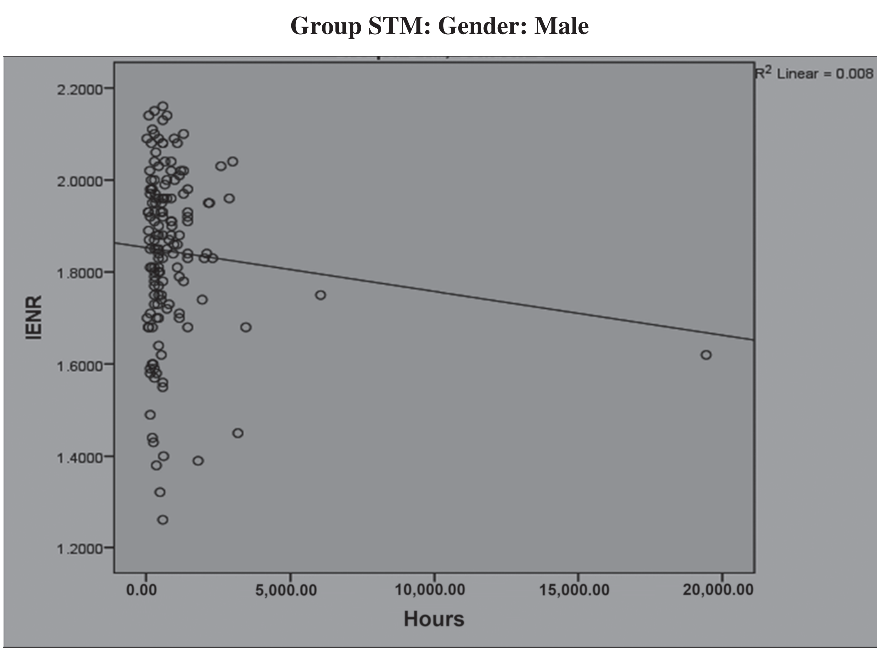

Figure 2: Scatter plot showing relationship between IENR and hours of practice in STM group.

positive change in meditators. This may be due to cumulative effect of meditation at the psychophysiological level in STM group. This may also be due to the initial enthusiasm and commitments of the practitioners.

Table 4 shows Fisher discriminant function. The Fisher discriminant function analysis is performed to determine how well a function explains the interdependency among EPI variables for LTM and STM groups.

Overall conclusion of this analysis is that while a difference between LTM and STM groups may be suspected,

Table 4: Fisher's linear discriminant function model for LTM and STM groups to estimate coefficient and interdependency of variables.

The discriminant function: F
LTM = −220.779 + 19.171(AC)-42.667 (IAWL)-25.426 (IAWR) + 45.180 (IEWL) + 52.495 (IEWR) + 42.372 (IANL) + 45.905 (IANR) + 55.623 (IENL) + 60.771 (IENR).
STM = −219.555 + 19.568 (AC)-42.797 (IAWL)-24.557 (IAWR) + 45.056 (IEWL) + 51.244 (IEWR) + 44.156 (IANL) + 45.656 (IANR) + 55.732 (IENL) + 60.5139 (IENR).

Fisher's linear discriminant function indicates that there is no statistical difference between the groups.

Eigenvalue (Table 5)

For a good model, the eigenvalue must be >1. The bigger the eigenvalue, the stronger is the discriminating power of the function. Our analysis found that the eigenvalue is 0.03 (<1) which shows we could not find any discriminant variable to predict the cumulative effect in the study.

Table 5: Summary of canonical discriminant functions.

Eigenvalues

Function	Eigenvalue	% of variance	Cumulative %	Canonical correlation
1	0.030[a]	100.0	100.0	0.171

Wilks lambda

Test of function(s)	Wilks lambda	Chi-square	df	Sig.
1	0.971	12.635	9	0.180

[a]First, one canonical discriminant function was used in the analysis. df = degree of freedom.

Wilks lambda (Table 5)

In a discriminant analysis, Wilks lambda is used to test the significance of discriminant function. In our model, we found Wilks lambda = 0.971 and p-value = 0.180. It shows that there is no statistical difference ($p>0.05$) among the EPI variables with respect to LTM and STM groups.

Discussion

The aim of the current study was to explore the gender-related cumulative effect of meditation in short-term and long-term practitioners. Mindfulness and other techniques of meditation are used for health-oriented purposes at the physical and psychophysical levels [47–49]. Studies have been reported to observe the changes in long-term, short-term, immediate and premeditative state of the human brain due to meditation. Application of EEG, ECG (electrocardiogram) and fMRI (functional magnetic resonance imaging) to detect the effect at neurophysiological and psychophysiological levels has drawn the attention of the medical community as well [6–9, 18, 20–22, 49, 50].

Here attempts are carried out to observe cumulative changes in men and women at the physiological and psychophysiological levels by using EPI. In both STM ($p=0.39$) and LTM ($p=0.93$) groups, lower values of AC were found in women as compared to men. But these trends were not significant in both groups. This indicates more positive improvement due to practice at the physiological and psychophysiological levels took place in women as compared to men. Previous finding also reports women benefited more than men during complementary and alternative intervention due to more spiritual orientation in women [29]. Though the result is not significant in AC, yet the direction of trend is the observed in STM and LTM groups. The lower mean value of stress parameter AC found herein using EPI measurement is in line with earlier findings in women [<U>27, 32</U>]. Higher coherence in women reported previously exhibits better coordination between hemispheres [24]. In QMT, a kind of walking meditation, increased theta and alpha demonstrate heightened attention and enhanced relaxation found in women compared to men [51]. In Qigong meditation, findings demonstrate women reduced anxiety and withdrawal symptoms significantly more than men [27].

At the physiological level, the mean values of IAWL (parameter of the healthy subject, normal range is 0.6 to +1) [35] were highly significantly lower in women than men. In both STM ($p<0.001$) and LTM ($p<0.001$) groups, lesser values of left side IA parameters in women indicate overall reserves of high functional energy and good stress tolerance in the body [32]. Energy required for the normal functioning of the body in day-to-day activities is constantly replenished due to normal metabolic processes [32]. The difference in mean values between female and male meditators is found to be 0.08 for IAWL. This shows that female meditators are having more stress tolerance than male meditators. A previous study concludes that longer the duration of meditation more the significant changes in physiological parameters observed such as heart rate, respiratory rate and blood pressure positively [52]. Highly significant larger values of IAWR (STM $p<0.001$ and LTM $p<0.001$) in women as compared to men show compensatory process occurring to bring swift changes in the system back to the homeostatic state. This, in other words, is called the influence of synchronizing transmission due to interconnections within the system [35]. Interestingly, this pattern of change took place in both LTM and STM groups. It demonstrates larger physiological cumulative effect in women than in men.

The mean values of IEWL (measure of disorderliness in the system) were lesser in LTM women as compared to STM women. Entropy is a measure of disorder at the molecular level in the system. A system having high disorder has more entropy values. The system can generate entropy but cannot destroy it. It can be increased or decreased depending upon the energy exchange from or to the system. Mediation reduces sympathetic arousal in the system with enhanced parasympathetic activation [53]. Meditation is supposed to reduce overall entropy in the system. Meditation, if practiced over a long period of time, is supposed to give more equilibrium in the system at both physiological and neurophysiological levels [20]. So in the present study, in women, lower values of entropy in LTM but not in STM are likely due to the cumulative impact of the practice. Though they practiced meditation for long period of time, fluctuations in IE parameter were observed. This could be due to stress experienced by the participants due to unknown measurement technique. Further, people who are sensitive (at the energy level) to high voltage might have instability in entropy values. These aspects need further carefully monitored studies.

At the psychophysiological level, in both LTM and STM groups, mean values of IANL were significantly lower in women as compared to men. Lower values in this parameter demonstrate that women of both groups are more receptive in benefits from the practice as compared to men. Earlier finding has shown that STM is associated with physiological relaxation responses with significant decreased galvanic skin response, whereas LTM result was a significant improvement in emotional quotients and cognitive performances [6]. There were positive highly significant lower trends of IAWL values in LTM and STM groups for women as compared to men. The unexpected higher mean values of IAWR in LTM and STM women may be due to higher activity of left hemisphere of the brain with logical thinking predominating in them while practicing meditation. The lower mean values of IA at both physiological and psychophysiological levels in LTM women as compared to men are possibly due to reduced sympathetic activation and enhanced parasympathetic arousal as seen in LTM study [52]. Previous studies also reported measuring some aspects of perception and correlating with mechanism of consciousness using EPI [43]. The larger value of changes observed in women may be due to improved perception and enhanced consciousness in female meditators.

The mean values of IENR were higher in both groups showing more existence of disorderliness in women as compared to men. In LTM, mean value of IENR was significantly more in comparison to STM. This demonstrates larger chaos in psychological level in women than men though they show better responses at the physiological level. However, in STM women, the mean value of IEWL was more than in men which may be due to disorderliness of energy at physiological level.

Between-group analysis

In Table 3, comparison was carried out between groups to record changes based on gender. In AC (stress parameter, normal range 2–4 in healthy individual), IAWL and IAWR, lower mean values were found at the physiological level in LTM men as compared to STM men. The results support the earlier findings: the longer the duration of meditation practice, the more the positive changes [20, 52]. Mean values of IEWL and IEWR were higher in LTM men as compared to men in STM. This indicates that although LTM practitioners have positive effect, yet, at a subtle level disorderliness is indicated.

Lower values of IANL were observed at the psychophysiological level in LTM men in comparison to STM men. This is possibly due to dose–effect response of practice in long-term practitioners. The mean values of IANR and IENR were higher in LTM men in comparison to STM. This may be possibly due to the engagement of the left hemisphere of the brain [35].

At the physiological level in LTM women, the trends of mean values were lower in AC, IAWL, IAWR and IEWL parameters as compared to STM women. LTM women were displaying less stress in comparison to STM women. Positive significant lower mean values of IAWL and IAWR were observed in LTM women in comparison to STM women. The lower values in LTM women may be likely due to the practice of anapanasati meditation over a long period of time. The overall results between groups showed that long time practices induce beneficial effect over body and mind which is apparent in LTM women.

At the psychophysiological level, the mean values of IANL and IANR were less in LTM women as compared to STM women. The lower mean values in LTM are possibly due to cumulative effect of longer meditation practice. Absence of such trends in values of these variables in STM supports the conviction of cumulative effect. These results were not statistically significant.

Unexpected higher values of IEWR at the physiological level, and higher values of IENL and IENR at the psychophysiological level were found in LTM women as compared to STM. The correlational trend of entropy with hours of practice in LTM and STM groups is demonstrated through scatter plots shown in Figures 1 and 2, respectively. However, these results were not significant. A possible reason for these results could be washout effects of meditation practice in these variables. As mentioned earlier, this may also be due to participants' attitude of habituation and routine attitude to the practice, both of which needs to be studied further.

The Fisher discriminant linear analysis is carried out to identify the discriminant variables and interdependency in LTM and STM groups. The study concludes that there is no significant difference between the groups and interrelationship of variables.

This is the first study reporting gender-dependent changes in LTM and STM using EPI. The study presents reliability and reproducibility with bigger sample size using EPI. Unlike other earlier studies where EPI is used with small sample size, bigger sample size was used here to find out minute changes in meditators in all three parameters, viz. AC, IA and IE.

The limitations of this study can be summed up as follows: (a) self-reporting in demographic sheets on the duration of practice by participants; (b) data collection at two sites and (c) LTM and STM effects were not measured through any other way in this study which is also a shortcoming of the study.

Future study may consider the following points to be incorporated while using EPI: (a) include control group to compare the results with nonmeditators; (b) include one more group to see an immediate effect in meditators and lasting effect over long time; (c) equal number of men and women and (e) environmental entropy should be controlled by taking care of all environmental factors.

Conclusions

To verify the changes in LTM and STM at the electron emission level, a novel technique called EPI is used in this study. Gender-related analysis showed that female practitioners are more benefited due to meditation practice than men. Women of both LTM and STM groups demonstrated lesser stress in comparison to men of both groups.

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References

1. Davidson RJ, Goleman DJ. The role of attention in meditation and hypnosis: a psychobiological perspective on transformations of consciousness. Int J Clin Exp Hypn 1977;25: 291–308.
2. Ditto B, Marie E, Goldman N. Short term autonomic and cardiovascular effects of mindfulness body. Ann Behav Med 2006;32:227–34.
3. Ankad RB, Patil S, Shashikala GV, Herur A, Chinagudi S. Effect of short term pranayama and meditation on cardiovascular functions in healthy individuals. Heart Views 2011;12:1–58.
4. Sukhsohale ND, Phatak MS. Effect of short-term and long-term Brahmkumaris Raja Yoga meditation on physiological variables. Ind J Physiol Pharmacol 2012;56:388–92.
5. Pasquini HA, Tanaka GK, Basile LF, Velasques B, Lozano MD, Ribeiro P. Electrophysiological correlates of long-term Soto Zen meditation. Biomed Res Int2015;2015:1–7.
6. Singh Y, Sharma R, Talwar A. Immediate and long-term effects of meditation on acute stress reactivity, cognitive functions, and intelligence. Altern Ther Health Med 2012;18:46–53.
7. Pavlov SV, Reva NV, Loktev KV, Korenyok VV, Aftanas LI. Impact of long-term meditation practice on cardiovascular reactivity during perception and reappraisal of affective images. Int J Psychophysiol 2015;95:1–9.
8. Pavlov SV, Korenyok VV, Reva NV, Tumyalis AV, Loktev KV, Aftanas LI. Effects of long term meditation practice on attentional biases towards emotional faces: an eye tracking study. Cogn Emot 2015;29:1–9.
9. Luders E, Cherbuin N, KurthF. Forever Young(er): potential age-defying effects of long-term meditation on gray matter atrophy. Front Psychol 2015;5(January):1–7.
10. Fotenos AF, Snyder AZ, Girton LE, Morris JC, Buckner RL. Normative estimates of cross-sectional and longitudinal brain volume decline in aging and AD. Neurology 2005;64:1032–9.
11. Gard T, Holzel BK, Lazar SW. The potential effects of meditation on age-related cognitive decline: a systematic review. Ann N Y Acad Sci 2014;1307:89–103.
12. Kumar U, Guleria A, Kishan SS, Khetrapal CL. Effect of Soham meditation on human brain: a voxel-based morphometry study. J Neuroimaging 2014;24:187–90.

13. Newberg AB, Serruya M, Wintering N, Moss AS, Reibel D, Monti DA. Meditation and neurodegenerative diseases. Ann N Y Acad Sci 2014;1307:112–23.
14. Oh H, Madison C, Villeneuve S, Markley C, Jagust WJ. Association of gray matter atrophy with age, β-amyloid, and cognition in aging. Cereb Cortex 2014;24:1609–18.
15. Luders E, Clark K, Narr KL, Toga AW. Enhanced brain connectivity in long-term meditation practitioners. NeuroImage 2011;57:1308–16.
16. Luders E. Exploring age-related brain degeneration in meditation practitioners. Ann N Y Acad Sci 2014;1307:82–8.
17. Marciniak R, Sheardova K, Cermáková P, Hudeček D, Sumec R, Hort J. Effect of meditation on cognitive functions in context of aging and neurodegenerative diseases. Front Behav Neurosci 2014;8:17.
18. Vestergaard-Poulsen P, Martijn VB, Skewes J, Bjarkam CR, Stubberup M, Bertelsen J, et al. Long-term meditation is associated with increased gray matter density in the brain stem. NeuroReport 2009;20:170–4.
19. Lee TM, Leung MK, Hou WK, Tang JC, Yin J, So KF, et al. Distinct neural activity associated with focused-attention meditation and loving-kindness meditation. PLoS One 2014;7: e40054.
20. Singh Y, Sharma R, Talwar A. Immediate and long-term effects of meditation on acute stress reactivity, cognitive functions, and intelligence. Altern Ther Heal Med 2012; 18:46–53.
21. Brand S, Holsboer-Trachsler E, Naranjo JR, Schmidt S. Influence of mindfulness practice on cortisol and sleep in long-term and short-term meditators. Neuropsychobiology 2012;65:109–18.
22. Pradhan B, Nagendra H. Immediate effect of two yoga-based relaxation techniques on attention in children. Int J Yoga 2010;3:67–9.
23. Barnes PM, Bloom B, Nahin RL. Complementary and alternative medicine use among adults and children: United States, 2007. Natl Health Stat Report 2008;12:1–23.
24. Ramos-Loyo J, Sanchez-Loyo LM. Gender differences in EEG coherent activity before and after training navigation skills in virtual environments. Hum Physiol 2011;37:700–7.
25. Brody LR. Gender differences in emotional development: a review of theories and research. J Pers Soc Psychol 1985;53:102–49.
26. González-Garrido AA, Gómez-Velázquez FR, Sequeira H, Ramos-Loyo J, López-Franco AL. Gender differences in visuospatial working memory – does emotion matter?. Int J Psychol Stud 2013;5:11–21.
27. Chen KW, Comerford A, Shinnick P, Ziedonis DM. Introducing Qigong meditation into residential addiction treatment: a pilot study where gender makes a difference. J Altern Complement Med 2010;16:875–82.
28. Hall JA, Schmid MM. Are women always more interpersonally sensitive than men? Impact of goals and content domain. Pers Soc Psychol Bull 2008;34:144–55.
29. Miller AS, Stark R. Gender and religiousness: can socialization explanations be saved?. Am J Sociol 2002;107:1399–423.
30. Korotkov KG. Measuring energy fields: current research. Fair Lawn, NJ: Backbone Publishing Co., 2004:193–208.
31. Korotkov KG, Williams B, Wisneski LA. Assessing biophysical energy transfer mechanisms in living systems: the basis of life processes. J Altern Complement Med 2004;10:49–57.
32. Korotkov KG. Energy fields electrophotonic analysis in human and nature. St. Petersburg: Amazon.com Publishing, 2011:30–55.
33. Cohly HH, Kostyuk N, Cole P, Meghanathan N, Isokpehi RD. Gas discharge visualization: an imaging and modeling tool for medical biometrics. Int J Biomed Imaging 2011; 2011:3.
34. Korotkov KG. The principles of GDV analysis. Embourg, Belgium: Amazon.com Publishing, Marco Piet., 2009.
35. Korotkov KG. Human energy field: study with GDV bioelectrography. Fair Lawn, NJ: Backbone Publishing Co; 2002. 24–43 p.
36. Korotkov KG, Matravers P, Orlov DV, Williams BO. Application of electrophoton capture (EPC) analysis based on gas discharge visualization (GDV) technique in medicine: a systematic review. J Altern Complement Med 2010;16:13–25.
37. Kushwah KK, Srinivasan TM, Nagendra HR. Effect of yoga based technique on stress and health indices using electro photonic imaging technique in managers. J Ayurveda Integr Med 2015; in press.
38. Sharma B, Hankey A, Nagendra HR. Gas discharge visualization gas discharge visualization characteristics of an Indian diabetes population. Voice Res 2014;2:28–33.
39. Luiza I, Wróbel C, Szadkowska I, Masajtis J, Goch JH. Images of corona discharges in patients with cardiovascular diseases as a preliminary analysis for research of the influence of textiles on images of corona discharges in textiles' users. AUTEX Res J 2010;10:26–30.
40. Kostyuk N, Rajnarayanan RV, Isokpehi RD, Cohly HH. Autism from a biometric perspective. Int J Environ Res Public Health 2010;7:1984–95.
41. Korotkov KG, Shelkov O, Shevtsov A, Mohov D, Paoletti S, Mirosnichenko D, et al. Stress reduction with osteopathy assessed with GDV electrophotonic imaging. J Altern Complement Med 2012;18:251–7.
42. Korotkov KG, Bundzen PV, Bronnikov VM, Lognikova LU. Non-local consciousness influence to physical sensors: experimental data. Philos Study 2011;1:295–304.
43. Deo G, Itagi RK, Srinivasan TM, Kuldeep KK. Effect of anapanasati meditation technique through electrophotonic imaging (EPI) parameters: a pilot study. Int J Yoga 2015;8: 117–21.
44. Bundzen P, Korotkov KG. Health quality evaluation on the basis of GDV parameters. In: Korotkov KG, editor. Human energy field: study with bioelectrography. Fair Lawn, NJ: Backbone Publishing Co., 2002:103–7.
45. R Development Core Team. A language and environment for statistical computing. Available at: http://www.r-project.org/. Accessed 5 June 2015.
46. Chiesa A, Serretti A. Mindfulness based cognitive therapy for psychiatric disorders: a systematic review and meta-analysis. Psychiatr Res 2011;187:441–53.
47. Chiesa A, Serretti A. A systematic review of neurobiological and clinical features of mindfulness meditations. Psychol Med 2010;40:1239–52.

48. Grossman P, Niemann L, Schmidt S, Walach H. Mindfulness-based stress reduction and health benefits: a meta-analysis. J Psychosom Res 2004;57:35–43.
49. Lutz A, Greischar LL, Rawlings NB, Ricard M, Davidson RJ. Long-term meditators self-induce high-amplitude gamma synchrony during mental practice. Proc Natl Acad Sci U S A 2004;101:16369–73.
50. Ben-Soussan TD, Berkovich-Ohana A, Glicksohn J, Goldstein A. A suspended act: Increased reflectivity and gender-dependent electrophysiological change following Quadrato Motor Training. Front Psychol 2014;5:1–12.
51. Dincer I, Cengel YA. Energy, entropy and exergy concepts and their roles in thermal engineering. Entropy 2001;3:116–49.
52. Korotkov KG, Bundzen PV, Bronnikov VM, Lognikova LU. Bioelectrographic correlates of the direct vision phenomenon. J Altern Complement Med 2005;11:885–93.