

# Can yoga practices benefit health by improving organism regulation? Evidence from electrodermal measures of acupuncture meridians

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## ABSTRACT

**Objectives:** To document and explain Yoga's effects on acupuncture meridian energies. To understand mechanisms behind Yoga's efficacy by testing links between yoga and traditional Chinese medicine.

**Materials and Methods:** The study compared two groups of yoga practitioners: Novice and experienced. Novices consisted of 33 volunteers from a Swami Vivekananda Yoga Anusandhana Samsthana (S-VYASA) yoga instructor training module and the experienced practitioners were 20 resident SVYASA students. The intervention was 3 weeks of a yoga training program, new for the novices, but the lifestyle of the experienced group, who were therefore assessed only once. Novices were assessed on day 2 and 23 of their program at SVYASA's Yoga Medicine Hospital, making their data a pre-post, self-as-control, prospective study. Main outcome measures were mean acumeridian energy levels assessed by AcuGraph3 measures of electrodermal resistance at acupoints; additionally, gender differences, standard deviations (SDs) of all measures, and comparison of post and experienced group data.

**Results:** Averaged energy levels significantly improved in all 24 meridians (maximum  $P = 0.032$ , 4- $P < 0.01$ , and 19- $P < 0.001$ ). Females improved more than males ( $P < 0.05$ ), both ending at similar levels to experienced practitioners, whose SDs were lower than novices on 19/24 meridians (mean  $F = 3.715$ ,  $P = 0.0022$ ), and 4/5 average variables.

**Conclusions:** AcuGraph3 electrodermal measures contain substantial information,  $P < 0.00001$ . Yoga-lifestyle practice can increase and balance acumeridian energies; long-term practice decreases group SD's. These three suggest reasons why yoga practice impacts health: One, increased prana levels are important; two and three, improved physiological regulation is the key. Further studies relating traditional Indian and Chinese medical systems are needed.

**Key words:** AcuGraph3; energy balance; energy regulation; Jing-Well points; prana; yoga.

## INTRODUCTION

This paper explores mechanisms behind yoga's well-documented health benefits demonstrated in many studies.<sup>[1-20]</sup> How practices such as yoga postures (asanas) and breathing exercises (pranayama) achieve their results is not scientifically understood, though traditional

texts propose a detailed phenomenology. Research on yoga-based techniques first reached top scientific journals in the 1970's,<sup>[1,2]</sup> and for yogasanas and pranayama, with Nagendra and Nagarathna's demonstration of their benefits for asthma.<sup>[3,4]</sup> The first-named spawned two major bodies of health research: First on effects of Transcendental Meditation (TM) on such variables as anxiety,<sup>[5]</sup> substance abuse,<sup>[6]</sup> and hypertension;<sup>[7,8]</sup> and, second, to investigations of the 'relaxation response',<sup>[9]</sup> a founding pillar of mind-body medicine. The asthma studies have since led to many specialized yoga programs for: Autism,<sup>[10,11]</sup> pregnancy,<sup>[12]</sup> back pain,<sup>[13]</sup> climacteric syndrome,<sup>[14,15]</sup> and oncology,<sup>[16]</sup> particularly to quality of life (QoL) in breast cancer patients;<sup>[17,18]</sup> and other conditions including diabetes<sup>[19]</sup> and obesity.<sup>[20]</sup> Levels of potential benefit are high; back pain is primary

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care's highest reporting condition;<sup>[13]</sup> type 2 diabetes mellitus is a modern scourge;<sup>[21]</sup> obesity contributes to many serious disorders through metabolic syndrome.<sup>[22]</sup> Yoga's history of published research demonstrates large effects,<sup>[23]</sup> many comparable to western drug-based treatments,<sup>[24]</sup> and with side-benefits.<sup>[25]</sup> Official funding has supported their study: Major National Institutes of Health (NIH) grants for QoL in breast cancer patients;<sup>[17,18,26]</sup> \$24 million from National Center for Complementary and Alternative Medicine (NCCAM) for TM's effects on hypertension,<sup>[27,28]</sup> particularly in minorities.<sup>[29]</sup> Overall health benefits are substantial: A controlled study of long-term TM practitioners found 50% decrease in health insurance costs;<sup>[30]</sup> another, 7% annual decrease in general practitioner (GP) costs for new practitioners.<sup>[31]</sup>

Yoga practices increase well-being,<sup>[24,32]</sup> but the question how this happens remains unanswered. The genetic paradigm regards life and health in biochemical terms, but how could postures, breathing exercises, or meditation bring about biochemical changes? A possible mechanism is yoga's action on the autonomic nervous system<sup>[33]</sup> restoring balance between sympathetic and parasympathetic activation,<sup>[34]</sup> both essential for healthy function. That yoga practices restore 'balance' to physiological systems is central to yoga philosophy. Traditional texts ascribe the power to balance to 'prana',<sup>[35]</sup> a principle activated by all aspects of yoga, especially pranayama-literally the 'ayama' (activation) of 'prana'. Biologically, 'improved balance' is brought about by improved system regulation, which clearly improves health. Here, we report expanded analysis of a yoga study suggesting such a mechanism: Impact on prana levels of 3 weeks' yoga-lifestyle intervention.<sup>[36,37]</sup> Indian systems provide no direct measures of prana, but it is thought equivalent to 'Qi'<sup>[38]</sup> in traditional Chinese medicine (TCM)<sup>[39,40]</sup> [Appendix 1]. Today, electrodermal measurements of meridian bioimpedance are a recognized means to assess Qi imbalances, and constitute a major diagnostic tool.<sup>[41-44]</sup> That meridian imbalance measured electrodermally corresponds to pathology is well understood.<sup>[41,42]</sup> Sancier noted negative correlations between bio-impedance in meridians and health status of corresponding organs.<sup>[45]</sup> His subsequent pre-post study of a two day Qigong workshop found improved Qi balance.<sup>[46]</sup>

Of the electrodermal screening instruments measuring 'Qi' available in the market, AcuGraph3 Digital Meridian Imaging Tool<sup>[47]</sup> is one for which test retest repeatability and coefficient of variation (CV) have been assessed for single operators ( $r = 0.76$ ,  $CV = 25.9\%$ ).<sup>[48]</sup> Another study<sup>[49]</sup> found subject dependence of  $r$  values,  $r = 0.23 \pm 0.27$ , but values were far higher for emotionally stable subjects:  $0.61 < r < 0.9$ . CV for measurements on individual meridians, on the other hand, ranged from 5.6% to as high

as 45%, suggesting that the machine could be made more accurate by assessing average values for groups, which would reduce CVs by a factor equal to the square root of the number in the group.

We used AcuGraph3<sup>[47]</sup> to assess effects of a yoga-lifestyle intervention, the experimental hypothesis being, by analogy with Sancier,<sup>[46]</sup> that the intervention would produce improvements in acumeridian energy levels and stability. Our approach employed electrodermal measurements at Jing-Well acumeridian endpoints, which correlate with levels of Qi,<sup>[50]</sup> to study both novice and experienced yoga practitioners. Preliminary analysis<sup>[36,37]</sup> reported group mean changes in six average variables pre/post novices' yoga-lifestyle course. Correlation analysis revealed shifts towards normal at both ends of balance variable distributions, reducing standard deviations (SDs): Post intervention percentages of subjects with values in the healthy range increased.<sup>[37]</sup> Participation in the yoga program improved regulation of Qi levels as well as increasing them. Here, we present further data analysis confirming these results: Gender and individual meridian differences and comparison with an experienced group.

## MATERIALS AND METHODS

### Subjects

Thirty-three healthy volunteers (15 male, 18 female) attending a yoga instructors course (YIC) (Novice) and 20 male residents (experienced) at Swami Vivekananda Yoga Anusandhana Samsthana's (SVYASA's) campus.

### Inclusion criteria

Novices: Attending YIC; understand English instructions; 18-55 years old; 12<sup>th</sup> standard education complete; willing to volunteer. Experienced group: Minimum 6 months yoga-lifestyle program.

### Exclusion criteria

Diagnosed illness or disability; on medication; abnormality at a Jing-Well point. For ladies: Pregnancy or menstruation on measurement day.

### Study design

Two group design, including novices as the experimental group and experienced yoga students as controls.

Novices: Two assessments, on training program day 2 (pre) and day 23 (post).

Experienced group (added as a control group to evaluate possible long-term effects): One assessment.

## Intervention

The yoga-lifestyle intervention, consisted of 3-week, intensive, residential yoga training, incorporating specific rising (04:30) and retiring times (21:00); vegetarian diet; group meetings with singing (bhajans); and theory lectures. Yoga practices included yoga postures (asanas), breathing exercises (pranayama), yoga purification practices (kriyas), and yogic games; and stress management and relaxation techniques, including meditation practices.

## Assessments

Electrodermal resistance was measured using AcuGraph3 at the Jing-Well endpoints of the 12 main acupuncture meridians on both sides of the body (six on each hand, six on each foot),<sup>[47]</sup> named for 12 major organs: Lung, pericardium, heart, small intestine, triple energizer, large intestine, spleen, liver, kidney, bladder, gall bladder, and stomach (for standard abbreviations see Appendix 2). To keep instrument pressure, location and alignment uniform, and to increase consistency; pre-post measurements were taken by a single, trained operator<sup>[48]</sup> (NN) not involved in study design or intervention. Experienced group data was taken by her trainer (MKB).

## Procedure for AcuGraph3 measurements

Subjects sit comfortably on a chair, with feet on a mat. Damp cotton wool is applied to each acupoint to improve conductivity. With a 'ground bar' held in the opposite hand, the probe is applied to each point in the specified order. Readings are recorded when taken. For each subject, pre and post data was collected at the same time of day between 09:30 and 13:00.

Monograph: Figures 1a and b.

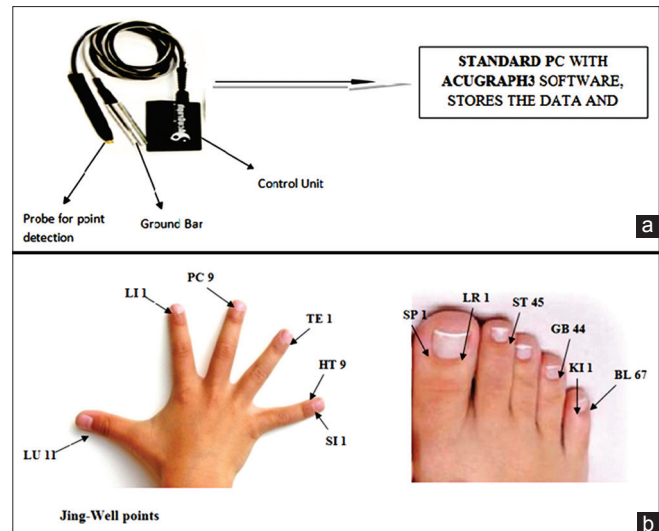
## Data analysis

Statistical Packages for Social Sciences (SPSS) version 16, Shapiro-Wilk tests were used to assess normality of distributions: Almost all variables were normally distributed, so pre-post changes were evaluated with paired sample *t*-tests, and male-female differences and novice-experienced group comparisons with independent sample *t*-tests; between group differences in SD were evaluated with F-tests.

## RESULTS

### Novice group pre-post results

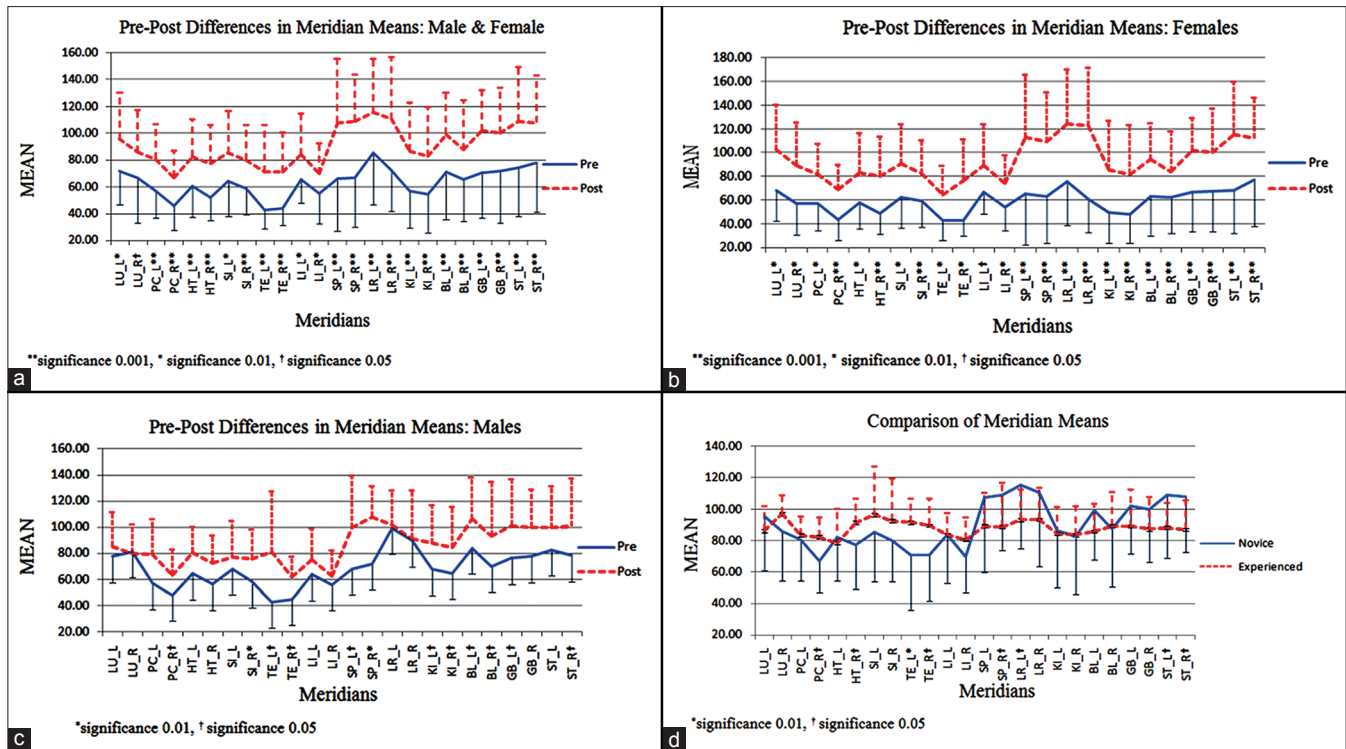
Of the 33 novice subjects, five (one female, four male) gave very high or very low meridian readings, either due to hyperhidrosis or previously undetected pathology, and were therefore excluded from further analysis. Data from the remaining 28 subjects (17 female,  $25.41 \pm 5.69$  years;



**Figure 1:** (a) The AcuGraph3 Digital Meridian Imaging System consists of computer software directing an electronic unit in control of a probe and a ground bar used to measure electrodermal resistance at acupuncture points. The ground bar is held in one of the subject's hands, while the probe is used by the operator to measure acupoints on the opposite hand and foot. (b) The 24 Jing-Well acupoints are located at the end of left and right branches of each of the 12 main acupuncture meridians, six on each hand and foot as depicted here for the left hand and right foot. In AcuGraph3 operation, the 5 mm head of the probe is placed in contact with each Jing-well acupoint in the order specified by its computer control program. The breadth of the head makes it simple to train operators to locate points correctly. Each reading is recorded by the computer as appropriate pressure is applied by the operator

11 male,  $27.00 \pm 8.87$  years) was analyzed. The preliminary analysis<sup>[37]</sup> was restricted to the novice group's pre- and post-means for AcuGraph3's six average variables. Here, we extend this to individual meridians, and male-female differences. Post readings for the whole group showed significant increases in group average values for all meridians [Figure 2a], 19 meridians  $P < 0.001$  (minimum  $P = 1.05 \times 10^{-7}$ ), four meridians  $0.001 < P < 0.01$ , one meridian  $0.01 < P = 0.015 < 0.05$ ). Mean energy level (EL) increased significantly, but no significant change occurred in overall Yin-Yang balance, upper-lower balance or left-right balance [Table 1], as previously stated.<sup>[37]</sup> However, the preliminary analysis noted a distinct narrowing of the mean  $\pm 2SD$ 's in upper-lower and left-right balance variables, which was shown to originate in highly significant, negative correlations between pre-values and pre-post differences ( $P < 0.001$ ) in both variables<sup>[37]</sup> [Tables 2a and b].

Separate analysis of male and female data revealed important between gender differences: Female average meridian energy level preintervention ( $55.76 \pm 16.49$ ) was significantly lower than male ( $68.09 \pm 20.27$ ),  $P < 0.001$ , in agreement with previous AcuGraph3 analysis of between gender differences.<sup>[51]</sup> Postintervention they were slightly higher, almost reaching significance,  $P = 0.0514$ . As a result of this reverse, female data for individual meridians showed significantly greater increases than did the corresponding male data: Significantly increased mean values in all 24 meridians [Figure 2b]; male data, on the other hand, showed



**Figure 2:** (a) This depicts the mean AcuGraph3 readings for 28 subjects of both genders for each of the 24 Jing-Well acupoints before and after a 3 week yoga-lifestyle course for novice yoga students. Note that the upper, dashed line representing the post-course readings is well separated from the lower, continuous line representing the pre-course readings. From this, a sign test rejects the null hypothesis by a value of  $P = 10-24 \ll 0.000001$ . For individual meridians, the standard deviations of the readings for each meridian are as shown, together with corresponding  $P$  values along the axis of the graph. (b) This depicts the mean AcuGraph3 readings for the 18 ladies attending the 3-week yoga-lifestyle course. The same comments and statistics apply as in Figure 1a. Despite the small numbers, levels of statistical significance suggest that the results can be considered qualitatively robust. (c) This depicts the mean AcuGraph3 readings for the 11 men attending the yoga-lifestyle course. In this case pre and post data are very close at three points, but the statistics are still decisively against the null hypothesis ( $P = 0.00012$ ). Overall Figure 2 a-c leave little room for doubt that well-conducted yoga-lifestyle programs will improve electrodermal measures of acumeridian energies. (d) This depicts the mean AcuGraph3 readings for each of the 24 Jing-Well acupoints for the 28 novice yoga course participants after 3 weeks yoga-lifestyle training (continuous line), compared to 20 experienced practitioners with more than 6 months participation in yoga-lifestyle programs (dashed line). Note that the overall means are very close (87.82/87.65 Table 2a), and that while the dashed line is relatively level, there are far greater departures from the mean by the dashed line (SD's 23.04 vs 10.46) [Table 2b]. The  $F$ -statistic of 4.852,  $P = 0.0004$  [Table 2b], indicates that experienced yoga practitioners have more balanced acumeridian systems suggesting better regulation of corresponding organs and organ systems

**Table 1: Pre-post changes in overall energy level and balance variables**

	Overall energy level and balance			Female energy level and balance			Male energy level and balance		
	Pre	Post	% Difference	Pre	Post	% Difference	Pre	Post	% Difference
EL	60.61±18.73	87.82±23.04	44.89**	55.76±16.49	89.24±25.84	60.04**	68.09±20.27	85.64±18.88	25.77*(†)
ES	67.64±13.10	61.29±13.33	-9.39	70.35±14.50	58.65±14.34	-16.63*	63.45±9.75	65.36±10.77	3.01(†)
PIE	59.11±16.12	50.07±18.11	-15.29**	62.18±17.52	48.53±21.49	-21.13**	54.36±13.05	52.45±11.67	-3.51(*)
Yin/Yang bal	1.29±10.54	-3.25±15.71	-351.94	5.41±8.33	-4.59±16.83	-184.84†	-5.09±10.72	-1.18±14.32	-76.82(†)
U_L_bal	-9.93±29.24	-18.68±18.95	88.12	-6.12±29.38	-17.12±22.05	179.74	-15.82±29.38	-21.09±13.47	33.31
L_R_bal	-6.18±9.76	-5.18±7.72	-16.18	-5.76±10.08	-4.47±6.59	-22.40	-6.82±9.69	-6.27±9.45	-8.06

Table 1 presents pre-post changes in variables denoting overall acumeridian energy (EL=energy level) and various kinds of energy balance. Energy Stability (ES) is derived from the difference between the highest meridian value and lowest meridian value in a reading, while personal integrated energy (PIE) corresponds to the fraction of balanced meridians with no identified high, low, or split problem. The three variables, Yin/Yang balance, upper-lower balance, and left-right balance are given by the difference in total values for their respective classes of meridian, Yang meridians minus Yin meridians (Yin/Yang), values for meridians on the hands (upper) minus values for those on the feet (U\_L), and for each of the 12 meridians, the value of the left branch minus the value of the right branch (L\_R). As in all tables and figures, significance of differences of means are indicated by: \*\* $P < 0.001$ , \* $0.001 < P < 0.01$ , † $0.01 < P < 0.05$ . Symbols in parenthesis in the final column represent significance of differences between male and female readings as given by independent samples  $t$ -tests

increased values in 23 of 24 meridians, of which 13 were significant  $P < 0.05$ , and another group of three were between 0.05 and 0.066. Three meridians were essentially unchanged on both left and right sides, liver, lung, and large intestine [Figure 2c]; and another two also had  $P \geq 0.168$ . The reasons for this split require further investigation, as

it was not present in the female data. Finally, female data showed a significant shift from Yang to Yin [Table 1].

### Comparison of yoga and novice group

To assess the progress of effects of yoga-lifestyle for the

**Table 2a: Comparison of means between novice and experience groups**

	EL	ES	PIE	Yin/Yang bal	U_L_Bal	L_R_Bal
Novice-post	87.82±23.04	61.29±13.33	50.07±18.11	-3.25±15.71	-18.68±18.95	-5.18±7.72
Experienced	87.65±10.46	82.00±9.89***	76.40±9.86**	0.60±8.18	1.00±12.74**	1.45±3.58**

Table 2a presents means and standard deviations of the six average variables from Table 1 for the novices post data, following 3 weeks participation in the yoga-lifestyle course, and for the experienced group with more than 6 months participation in yoga-lifestyle programs. It is noteworthy that the PIE, U\_L, and L\_R balance variables were better for the experienced group with significance levels  $P < 0.001$ , represented by \*\*, and for the energy stability (ES) variable with significance  $P < 0.000001$ , represented by \*\*\*. These figures suggest that long-term experience of yoga-lifestyle programs improve balance in meridian energies, something that traditional Chinese medicine (TCM) acupuncture treatments are at pains to achieve. Improved balance variables also indicates that yoga-lifestyle programs strengthen overall regulation of acumeridian energy system, and are therefore improving regulation of individual organs and their organ systems. Finally the consistently lower standard deviations for the experienced group should be noted (Table 2b)

**Table 2b: Comparison of standard deviations for balance variables between novice and experience groups-f test**

	EL	ES	PIE	Yin/Yang bal	U_L_Bal	L_R_Bal
Standard deviation (novice-post)	23.04	13.33	18.11	15.71	18.95	7.72
Standard deviation (experienced)	10.46	9.89	9.86	8.18	12.74	3.58
F statistic	4.852	1.816	3.374	3.688	2.212	4.650
P value	0.0004	0.0908	0.0033	0.0023	0.0380	0.0005

Table 2b specifically shows the reduction of standard deviations for the six meridian average and balance variables, their F statistics, and statistical significance of the reductions. Lower SD is a sign of order and information, so higher F values indicate increased order, as well as higher statistical significance-given in the bottom line. This data therefore represents important indications of increased orderliness of the acumeridian energies of different subjects in the experienced group, which can only be attributed to improved system regulation. Since poor system regulation brings poor health, improved overall regulation implies stronger overall health parameters

novice group, their data was compared with results of measurements on a more experienced group of SVYASA students who had been participating in similar yoga-lifestyle programs for a minimum of 6 months (mean  $18.6 \pm 16.85$  months) [Table 2a]. It is of significance that mean energy levels were effectively identical ( $P = 0.88$ ), but mean energy stability of the experienced group was much higher ( $P < 0.0001$ ), while the various kinds of balance (personal integrated energy (PIE), Yin/Yang, upper-lower, and left-right) were all significantly improved for the experienced group [Table 2a for P values].

Of particular interest are the SD's on the six variables in Table 2a, which were smaller for the long-term yoga group than for novice post measurements (and pre-measurements, see Table 1), indicating that long term yoga-lifestyle has a substantial normalizing effect on acumeridian energies, balancing energies in different meridians to a great extent. The significance of six to zero change on the null hypothesis is  $2^{-6} = 0.015625$ ; for individual F-values for significance of change in SD, see Table 2b.

Furthermore, reductions in SDs between novice post, and the experienced group, data were observed for 23 out of 24 sets of individual meridians. The mean F-value was  $3.714 \pm 1.707$ , with a corresponding average  $P \sim 0.0005$  for each of the 24 meridians [Table 2c]. The SD of mean

**Table 2c: Comparison of standard deviations and means between novice and experience groups; F tests**

Variables	Novice-post	Experienced	F value	P value (from F)
LU_L	95.57±34.51	86.20±15.27	5.108	0.0002
LU_R	85.64±31.1	97.00±11.84	6.899	0.0001
PC_L	80.50±25.9	83.40±11.70	4.900	0.0003
PC_R	66.86±19.98	82.30±12.53	2.543	0.0171
HT_L	82.21±27.88	78.50±21.30	1.713	0.1079
HT_R	77.35±28.59	91.40±15.38	3.456	0.0028
SI_L	85.11±31.30	96.40±30.44	1.057	0.4563
SI_R	79.79±25.89	92.40±26.84	0.930	(0.5776)
TE_L	70.86±35.06	91.60±14.88	5.552	0.0001
TE_R	70.71±29.43	89.60±16.80	3.069	0.0059
LI_L	83.71±31.07	83.60±13.54	5.266	0.0002
LI_R	69.57±22.51	80.50±13.93	2.611	0.0148
SP_L	107.57±47.95	89.30±20.78	5.325	0.0001
SP_R	108.71±34.79	88.70±27.84	1.562	0.1527
LR_L	115.21±40.33	93.20±19.34	4.349	0.0006
LR_R	110.29±46.56	93.30±20.23	5.297	0.0001
KI_L	86.50±36.29	84.30±16.76	4.688	0.0004
KI_R	82.37±36.84	83.60±18.32	4.044	0.0010
BL_L	99.00±30.94	85.80±17.42	3.155	0.005
BL_R	87.64±36.76	89.30±21.41	2.948	0.0075
GB_L	101.79±30.12	89.00±23.24	1.680	0.1165
GB_R	100.00±33.79	87.20±20.48	2.722	0.0118
ST_L	109.00±40.25	88.20±15.61	6.649	0.0001
ST_R	107.71±35.02	86.90±18.37	3.634	0.0020
Mean	90.15±33.04	87.99±18.51	3.715	0.0022
Standard deviation	14.73	4.76	9.576	0.0000

Table 2c shows consistently lower standard deviations for meridian averages of the experienced group in Table 2b and 2c presents corresponding data for each meridian. The SD failed to decrease in only one case, and 18 out of 24 reached significance with 16 below  $P=0.01$ , mean  $F=3.715$  with a corresponding P value 0.0022. Those experienced in yoga-lifestyle have better organized acumeridians. The SD's for the means of all meridian energies were 14.73 vs 4.76; see the visual scatter of points in Figure 2d where the dashed line has smaller deviations from the mean than the continuous line. The F statistic of 9.576 and corresponding low P value for this overall analysis of data suggests that the conclusion of increasing orderliness in meridian energies for longer term yoga-lifestyle practice is genuinely robust.

meridian energies for the experienced group was also greatly reduced,  $F = 9.58$  [Table 2c], something evident from inspection of Figure 2d.

## DISCUSSION

### Principal findings

The 3 week integrated yoga-lifestyle module produced several significant results: (1) Decrease in meridian

bioimpedance corresponding to increased meridian energy levels, the changes being about twice as large for female subjects as for males, and in all meridians in females; whereas three meridians in males, the liver, lung, and large intestine were unaffected. (2) Energy levels in the post readings of the novice group were comparable to those of the long-term yoga-lifestyle program participants, but their variability was far higher. SDs for the experienced group were significantly lower, both for individual acumeridians (all but one) and importantly, for the six average variables, including the balance variables.

Reasons for observed accumulating increases in energy levels may be partly due to yoga-lifestyle and partly due to the environment, which is rural and relaxing, allowing participants' sense of well-being to improve. Yoga practices aim to increase prana levels in the body; this, we hypothesize to be the reason for almost universal increases in AcuGraph3 readings on individual meridians, since Qi energy and prana are usually taken as synonymous.

### Strengths and weaknesses

The strength of the study lies in data consistency and high statistical significance of findings. Significant increases in energy levels were observed in all meridians; similarly the decrease in SDs yielded an impressive range of F-values and corresponding statistical significances. Although the study was small, the results seem robust. Clearly the size of the groups and subgroups should ideally be larger, but the robustness and significance of the results make them worthy of wide dissemination, especially as both yoga and acupuncture are increasingly widely practiced.

Another weakness was the control group of experienced subjects, who were not matched to the novice subjects. At SVYASA, we are less concerned about which aspects of yoga life-style programs produce which changes. The chief concern is the overall impact of programs received by patients, that is, all aspects of a yoga-lifestyle program. The pre-post design suffices to assess overall impact. The proximity of the experienced group's mean meridian energy to that of the novice group's post data [Table 2a], appears to make up for that defect. In contrast, three average variables in the experienced group provided interesting extensions of observed pre-to-post changes in the novice group's data.

### Relation to other studies

As far as we know, this study, showing that yoga practice improves readings on average acumeridian energies, is the first of its particular kind. Sancier's 1994 pilot study of the effect of Qigong on acupuncture meridians<sup>[45]</sup> found increased mean meridian energies following practice of a qigong exercise of the subject's choice. His 2003 study

of the effect of a Qigong workshop<sup>[46]</sup> found significantly reduced SD's between mornings and afternoons, which he interpreted as indicating increased balance of body energy due to participation in the workshop. However, his observations of increased meridian energies in the afternoon following Qigong practice could not be distinguished from biorhythms. Our measurements were specifically made at precisely the same times of day, meaning that changes in individual readings cannot be attributed to diurnal biorhythms. Our decreased SD's are greater than Sancier's and indicate that balance is stabilized by long-term practice. As regards male-female differences, the initial values in our study agree with previous findings,<sup>[51]</sup> that average female meridian energies tend to be lower than males, but their final values, with females roughly equal to males on average, suggest that female meridian energies should be the same as males. Reasons for the widely observed discrepancies clearly need further investigation.

### Meaning of the study

One can interpret our results on two levels: First that of the acumeridians themselves, and modern phenomenological interpretations of their energies for individual health; second, in terms of yoga concepts and phenomenology. In the first case, they suggest that yoga-lifestyle programs result in two kinds of effect, those that increase energies, and those that establish better balance between meridians. Increased energies could be achieved two ways, either by increasing energy at source, or by removing blockages and opening meridians up to permit freer flow of Qi. or Prana.<sup>[52]</sup> Yoga offers an energy-based therapeutic approach<sup>[53]</sup>, which improves the sense of well-being.<sup>[54]</sup> Its practices calm the mind<sup>[55,56]</sup>; by balancing Prana in the nadis, they restore equilibrium.<sup>[35,52]</sup> In the language of the ancient Yoga texts, this translates as opening up nadi channels to allow freer flow of Prana<sup>[35,52]</sup>. The texts explain how Prana is brought into equilibrium<sup>[57-59]</sup>, and how various kinds of stress can disturb or block its flow.<sup>[60-62]</sup> If not redressed, such imbalances in the body lead to vyadhi (disease).<sup>[63]</sup> Yoga medicine<sup>[64]</sup> therefore acts as an energy medicine.

In the language of yoga, this translates as, opening up nadi channels to allow freer flow of prana, as stated in ancient texts.<sup>[35,52]</sup> Our observations of increased average energy levels suggest that prana flow improves in the whole body, creating better health.<sup>[45]</sup> Our observations of consistently decreased SD's of meridian energies and balance variables for the experienced group suggest that regulation of meridian energies is improved, and thus that regulation of associated physiological processes has become more sensitive. This suggests that incorporating yoga activities into a person's lifestyle should improve meridian energy levels and balance, and thus, individual health.<sup>[45,53,54]</sup> This would agree with yoga texts, which state

that persistent yoga practice creates a peaceful mind and improves health.<sup>[55,56]</sup> Modern medical science is coming to view regulation as central to health: The converse of the recognition that regulatory failure compromises health, is that improving regulation improves health.<sup>[39,40]</sup> The idea that improved prana assists balance in system regulation would help explain findings of research on yoga's health benefits.<sup>[3-8,10-20]</sup> Consistency of these results is attributable to use of specific styles of yoga in integrative health programs run by physicians with western medical degrees.

### Questions for future research

Our results suggest that yoga's success in therapy<sup>[10-20]</sup> springs from its ability to influence system regulation, and correct faults in that area through the agency of the pranic energy system. If so, improving balance in energy levels; both 'energy stability' in AcuGraph3 terms and reduction in group SD's is important. Determining which yogic practices most effectively remove blockages, and regularize flow of prana through the nadis would be valuable. Both TCM and Indian systems of medicine state that, to bring patients to states of good health, all physiological systems, that is, all organs and organ systems should be brought into balance and their functioning optimized. Future work should aim to establish the validity of this concept of balance, even samatvam, the state of optimal or perfect health. Regarding male and female differences, the most remarkable contrast was that, in the female group, the liver meridians increased most in energy by far, whereas in males they increased the least. Reasons for this difference need further investigation. Investigating trends in high initial energy groups with more pranic energy than normal will be a topic of further study, as will the hypothesis that females may be more sensitive than the males to these kinds of change. Future investigations will require large sample sizes and taking into account variables like time in the menstrual cycle. Most important is the need for fully controlled trials to confirm the results of this study and Sancier's.<sup>[45,46]</sup> Finally, the relationship between TCM and yoga requires further careful exploration.

### CONCLUSIONS

Our results suggest reasons why carefully selected yoga practices have significant therapeutic effects: 3 weeks yoga-lifestyle intervention reliably increases conductivity at all Jing-Well acupoints, improves energy stability, and reduces SDs on all variables; indicating that regulation of Qi energies in the acumeridians improves. Could this explain yoga's efficacy in so many clinical applications?

Equating Qi as a form of vital energy flowing in the acumeridians with corresponding yoga concepts of prana as a form of energy flowing in the nadis, means that our observations support traditional explanations for yoga practices' efficacy: They increase and balance the flow of

prana in the nadis. This study thus presents a first step to demonstrate how improving measurable attributes of prana through yoga-lifestyle benefits health.

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## APPENDICES

### Appendix 1: Prana and Qi

The ancient texts state that yoga practice balances the bodily system by bringing prana into equilibrium. The texts explain how this occurs, and state that the flow of prana is disturbed or blocked by various kinds of stress. If not redressed, such imbalances in the body lead to vyadhi (disease). Yoga practices calm the mind, and by maintaining balance to prana in the nadis, restore health. These statements form a general phenomenology of yoga, and suggest that yoga medicine is a form of energy medicine, the benefits of which may be attributed to yoga's action on 'energy systems' in the body.

Energy medicine is largely identified with acupuncture, and related treatments of acupuncture meridians in TCM, all of which concern balancing the flow of Qi in the meridians. Prana on one hand and Qi on the other thus possess a series of properties in their respective traditions that are parallel to each other:

1. For both; good, balanced levels are considered essential for health
2. Both are said to flow in specific channels
3. For both; blockages in flow are said to result in pathology
4. Both their traditions emphasize the value of practices that enliven and balance them for health promotion; Qigong and yoga.

These parallels constitute a first justification for considering Qi and prana to be equivalent. Clearly, full justification is a complex issue, and will be treated in detail in a later publication.

For medical practice, points (3) and (4) are most significant, since specific blockages are associated with specific kinds of pathology. In TCM, identifying Qi imbalances in specific meridians is therefore the key diagnostic step.

### Appendix 2: AcuGraph3 Terminologies

All major acupuncture meridians; 6 on each hand 6 on each foot, corresponding to the left and right meridians for the 12 major organs in the body:

On the hands

LU\_L: Lung left

LU\_R: Lung right

PC\_L: Pericardium left

PC\_R: Pericardium right

HT\_L: Heart left

HT\_R: Heart right

SI\_L: Small Intestine left

SI\_R: Small Intestine right

TE\_L: Triple Warmer left

TE\_R: Triple Warmer right

LI\_L: Large Intestine left

LI\_R: Large Intestine right

On the feet

SP\_L: Spleen left

SP\_R: Spleen right

LR\_L: Liver left

LR\_R: Liver right

KI\_L: Kidney left

KI\_R: Kidney right

BL\_L: Bladder left

BL\_R: Bladder right

GB\_L: Gall Bladder left

GB\_R: Gall Bladder right

ST\_L: Stomach left

ST\_R: Stomach right

Other terms

EL: Energy level (mean electrical conductance of all meridians).

ES: Energy Stability, determined by values of the highest and lowest readings compared to the mean value of all meridians.

PIE: Personal Integrated Energy: related to the fraction of meridians in reasonable balance, neither 'high', nor 'low', nor 'split'.

Yin/Yang bal: Yin Yang Balance (tendency); positive and negative values indicate Yang and Yin dominance respectively.

U\_L\_bal: Upper Lower balance (i.e., between Jing-Well points on the hands and those on the feet); positive and negative values indicate upper and lower dominance respectively.

L\_R\_bal: Left Right balance (i.e., between Jing-Well meridian points on left and right sides of the body); positive and negative values indicate Right and Left dominance respectively.