Work 63 (2019) 243–251
DOI:10.3233/WOR-192925
IOS Press

Effect of yoga on vigilance, self rated sleep and state anxiety in Border Security Force personnel in India

Shirley Telles*, Niranjan Kala, Ram Kumar Gupta, Sadhana Verma, Babita Vishwakarma, Savita Agnihotri, Kumar Gandharva and Acharya Balkrishna
Patanjali Research Foundation, Patanjali Yogpeeth, Haridwar, Uttarakhand, India

Received 20 April 2018
Accepted 3 March 2019

Abstract.
BACKGROUND: Military occupations require heightened vigilance with resultant sleep disturbances, increased anxiety and reduced vigilance.
OBJECTIVE: To compare yoga with physical training to reduce insomnia, anxiety and increase vigilance in security personnel.
METHODS: One hundred and twelve Border Security Force personnel (BSF group, males; mean age ± SD = 30.4 ± 7.4 years) were compared with 112 personnel of a private security firm (SIS group). The BSF group received yoga for nine days and the SIS group received physical training for the same period. Assessments were at baseline and after 9 days, with the digit vigilance test (DVT), Spielberger's STAI-S, and a sleep rating questionnaire.
RESULTS: (1) Between groups: (i) at baseline the BSF group had higher vigilance and more daytime naps compared to the SIS group and (ii) after nine days the SIS group had higher state anxiety compared to the BSF group (ANOVA, Bonferroni adjusted *post-hoc* comparisons; SPSS Version 24.0) (2) In post-pre intervention comparisons (i) the BSF group increased vigilance and decreased state anxiety after yoga, with improved sleep, while (ii) the SIS group showed increased vigilance after physical training.
CONCLUSION: Yoga may improve sleep, reduce anxiety while increasing vigilance in occupations requiring vigilance.

Keywords: Alertness, insomnia, armed forces, unease

1. Introduction

Military occupations can be broadly categorized as combat or support roles. The relevance of this categorization is that a service member would experience difficult levels of stress due to the nature of deployment [1]. Military service members live and work in a unique and challenging environment facing physically and mentally demanding workloads, deployments and exposure to combat [2]. These stressors could contribute to impaired physical and psychological performance. After a simulated combat exercise, U.S. army officers showed impaired vigilance, reaction time, attention, memory, and reasoning [3]. Most military exercises require vigilance, which if prolonged could lead to physiological arousal and stress [4]. Increased vigilance has been associated with increased sympathetic nervous system activity [5].

*Address for correspondence: Shirley Telles, Director, Patanjali Research Foundation, Patanjali Yogpeeth, Haridwar - 249405, Uttarakhand, India. Tel.: +91 9897963254; E-mail: shirleytelles@gmail.com.

The long-term effects of hyper-vigilance can be devastating and may impact cognition, including attention, concentration, memory, as well as various functions essential for health such as sleep [6]. Military personnel have sleep disorders due to multiple factors apart from hyper-vigilance. These include the need to be on night duty, deployment through different time zones, and managing insomnia and drowsiness with sedatives or caffeine, respectively [7–9]. The most common sleep disorder is insomnia.

In India the Border Security Force (BSF) is the chief force guarding the territorial boundaries of the nation [10, 11]. The BSF is a Central Armed Police Force responsible for guarding India's land borders during peace time and preventing transnational crime [12].

Recent studies conducted on BSF personnel to understand their health and wellbeing, showed a high incidence of physical and mental illness including anxiety and insomnia, many of which were listed as lifestyle-related [13]. In many cases BSF, personnel adopted certain unhealthy stress coping strategies [14].

Yoga practice provides an alternative as a stress reducing strategy with additional health benefits [15]. Five hours of yoga practice per day for seven days improved the quality of sleep, total time spent asleep, time taken to fall asleep and number of arousals in healthy adults [16]. Similar benefits were found in a population with chronic insomnia; who showed improvement in sleep efficiency, total sleep time, total wake time, sleep onset latency and wake time after sleep onset following eight weeks of an hour of yoga every day [17]. Apart from insomnia, yoga was useful for the other problems faced by the BSF, i.e., anxiety and increased arousal due to vigilance. Yoga practice reduced both state and trait anxiety in persons with stress related symptoms, who practiced approximately an hour of yoga every day for ten days [18]. This effect of yoga in reducing anxiety may be the reason why after a single two hour session of yoga, military personnel performed better in an attention task while their state anxiety decreased [19].

The present study was designed to determine whether a yoga intervention could (i) reduce state anxiety, (ii) improve self-reported sleep and (iii) improve performance in a vigilance task in BSF personnel. Comparisons were made with age and gender as comparable to private security personnel whose job involved vigilance and who did not receive yoga but who received physical training during the period of intervention.

2. Methods

2.1. Participants

The trial was carried out on 224 males whose job involved security and vigilance. There were two groups: the Border Security Force, India (BSF group) and the Security and Intelligence Services India Ltd (SIS group from a private security service agency). Both groups had 112 participants (BSF group mean age $\pm$ SD = 30.4 $\pm$ 7.4 years; SIS group mean age $\pm$ SD = 29.1 $\pm$ 6.4 years). No incentive was given to either group. To be included in the trial participants had to (i) be male and (ii) spend at least eight hours each day on duty requiring vigilance. The criteria for exclusion were: (i) ill-health at the time of assessment based on a routine case history and clinical examination or (ii) taking any medication or nutraceuticals. None of the participants were excluded for these reasons. The study design was explained to the participants and all participants' signed informed consent was taken. The study was approved by the institution's ethical committee (approval number PRF/16/0014).

2.2. Design

The study was a comparative controlled trial. The two groups were comparable with respect to their age, duty shifts, and lifestyle. The BSF group was given a yoga program consisting of yoga postures (*asanas*), breathing techniques (*pranayamas*) and guided relaxation; for 240 minutes per day for a period of nine days. The SIS group was given a total of 180 minutes of physical training (60 minutes per day for three days) during the nine days. Details of the yoga and physical activity interventions are provided below. The fact that the amount of time allotted to the intervention differed in the two groups is a limitation of the study.

2.3. Assessments

The assessments were done on the day before beginning the intervention and on the day after completing the intervention. The following variables were assessed using tests which have been standardized for use in an Indian population:

2.3.1. Vigilance and sustained attention

The digit vigilance test (DVT) was used to measure vigilance and sustained attention which has proven test-retest reliability ($r = 0.91$) and alternate form reliability ($r = 0.90$) [20]. The DVT is not culture sensitive and has been used in an Indian population earlier [4]. The DVT consisted of an A4 size sheet with 1500 digits from 1 to 9 randomly arranged on it in 50 rows with 30 digits in each row. The participants were instructed to cancel the target digits (i.e., 6 and 9) as accurately as possible. Missing any target digits and cancellation of other digits were counted as errors. The score obtained was the total number of digits cancelled minus the errors. The total time given to complete the test was eight minutes.

2.3.2. State anxiety

State anxiety was measured using Spielberger's state-trait anxiety inventory (STAI-S) which has been standardized for use in an Asian population (of which 6.5% was an Indian population) with test-retest reliability ($r = 0.60$–0.94) and Cronbach's alpha score of 0.86 [21]. It is a 4-point Likert scale and comprises 20 items to describe the feelings of anxiety at the moment of testing [22]. The STAI-S The participants had to choose one out of the four options provided for each item i.e., not at all, somewhat, moderately so, and very much so. The scores ranged from 20 to 80.

2.3.3. Self-rated sleep quality

The sleep rating questionnaire (SRQ) was used to self-rate the participants' quality of sleep [23]. The SRQ has been standardized for use in an Indian population with test-retest reliability ($r = 0.20$–0.85) and internal consistency ($r = 0.58$–0.69) [23]. The SRQ consisted of one open-ended and six close-ended items which were: (1) Approximately how long in minutes does it take you to fall asleep? (2) How many hours do you sleep each night? (3) How many times (if any) do you wake up during the night? (4) What are the usual reasons for waking up if you do so? (5) Do you feel rested in the morning (yes/no)? (6) Do you sleep in the day time (yes/no)? (7) If your answer to question 6 was 'yes', for how long do your daytime naps last?

2.4. Intervention

2.4.1. Yoga

The yoga intervention was for 240 minutes in each day. The yoga sessions included a universal prayer, yoga postures (*asanas*), voluntarily regulated breathing techniques (*pranayamas*), loosening exercises and guided relaxation. Yoga practices were derived from teachings in traditional texts (Hatha Pradipika Circa 1500 C.E., Gheranda Samhita Circa 1700 C.E.) [24]. The timings for yoga sessions were between 05:00–07:00 hours and 16:00–18:00 hours daily for nine days. The details of the yoga session are given in Table 1.

2.4.2. Physical training

Physical training (PT) was between 13.00 hours to 14.00 hours each day. The participants attended three PT sessions during nine days. The PT sessions included drill and marching. The details are provided in Table 2.

2.5. Data analysis

Data were analyzed using SPSS (Version 24.0). A repeated measures ANOVA with Bonferroni adjusted multiple *post-hoc* comparisons was performed. The ANOVA had one Within subjects factor i.e., States, with two levels (pre and post) and one Between subjects factor i.e., Groups which were (i) BSF and (ii) SIS. Two items of the SRQ (i.e., number 5 and number 6) were measured on a nominal scale (i.e., yes = 0, no = 1) and analyzed with Pearson's chi-square test.

3. Results

The group mean values ± SD for different values are given in Tables 3 and 4 and ANOVA values are given in Table 5.

3.1. Repeated measures ANOVA

There was a significant difference between groups for vigilance ($p < 0.001$), state anxiety ($p < 0.001$), time taken to fall asleep ($p = 0.02$), number of arousals during the night ($p < 0.001$), and duration of daytime naps ($p < 0.001$). A significant difference within groups was noted in vigilance ($p < 0.001$), state anxiety ($p < 0.001$), arousals during the night ($p < 0.01$), and duration of daytime naps ($p < 0.001$). A significant interaction between groups and states was seen in state anxiety ($p < 0.001$), time taken to fall asleep ($p < 0.01$), numbers of arousals during the night ($p < 0.001$) and duration of daytime naps ($p < 0.001$); suggesting that these variables were interdependent with respect to the groups (i.e., BSF and SIS) and states (i.e., pre and post).

Table 1
Details of a yoga practice session

S. No		Yoga Practice	Duration
1	Starting	*Mantra* chanting	3 minutes
2	Warming up	Sun salutation *(Surya namaskara)*	10 minutes
3	Standing postures	Swaying palm tree pose *(Tirryaktadasana)*	3 minutes
		Tree pose *(Vrikshasana)*	3 minutes
		Feet and hands posture *(Padahastasana)*	2 minutes
	Sitting postures	Frog posture *(Mandukasana)*	3 minutes
		Rabbit posture *(Sasakasana)*	3 minutes
		Sitting lateral twisting posture *(Vakrasana)*	5 minutes
		Cow face posture *(Gomukhasana)*	5 minutes
5	Prone postures	Crocodile posture *(Makarasana)*	5 minutes
		Cobra posture *(Bhujangasana)*	3 minutes
		Half-locust posture *(Salabhasana)*	3 minutes
6	Supine postures	Half-plough posture *(Ardhhalasana)*	3 minutes
		Rotating leg pose *(Padavritasana)*	6 minutes
		Leg circling pose *(Dwichakrasana)*	6 minutes
7	Relaxation	Supine relaxed posture *(Shavasana)* with breath awareness	5 minutes
8	Yoga breathing series *(pranayamas)*	Yoga bellows type breathing *(Bhastrika)*	3 minutes
		High frequency yoga breathing *(Kapalabhati)*	10 minutes
		External breath holding (*Bahyavriti pranayama*)	3 minutes
		Victorious breath (*Ujjayi)*	3 minutes
		Alternative nostril yoga breathing *(Anlom- vilom)*	10 minutes
		Bee breathing practice *(Bhramari)*	3 minutes
		Om chanting *(Udgeeth)*	3 minutes
9	Relaxation	Supine relaxed posture *(Shavasana)* with breath awareness	5 minutes
10	Loosening exercises	Neck rotation	3 minutes
		Knee & ankle rotation	3 minutes
		Shoulder rotation	3 minutes
		Butterfly pose	1 minute
11		Conclusion prayer	2 minutes

Total duration of the session was 120 minutes and the same practices have been repeated during the evening session too.

Table 2
Details of a physical training session

S No		Practices	Repetitions	Duration
1	Marches	Marching with instructions		10 minutes
2	Stretching exercises	Exercise 1(lateral stretch)	8–10	2 minutes
		Part 1. Bending to the left with right hand extended upwards.		
		Part 2. Bending to the right with left hand extended upwards.	8–10	2 minutes
		Exercise 2.(backward stretch)		
		Bending backward with both hands extended upwards.	10–15	3 minutes
		Exercise 3.(forward stretch)		
		Bending forward with both hands stretched downwards.	10–15	3 minutes
3	Whole body exercises	Exercise 1.		3 minutes
		Arms extended laterally and feet moved apart with a jump, then bringing the feet together and arms to the thighs.		
		Exercise 2.	20	3 minutes
		Arms extended laterally, feet apart. Jumping and bringing the feet together and hands together above the head with a clap.		
		Exercise 3. Jumping and bringing right leg forward and left leg backward with arms akimbo. Then jumping again with bringing left leg forward and right leg backward.	20	
		Exercise 4. Arms extended to the front with feet slightly apart, then twisting to the right, coming back and twisting to the left.	20	3 minutes
		Exercise 5. (simple squat)		
		Hands stretched in front, sitting with knees bent.	10	3 minutes
4	Running	Running in a 750 meters track with medium pace	2	15 minutes
5	Ending	Sitting with eyes closed	–	10 minutes

Total duration of the session was 60 minutes.

Table 3
Scores of DVT and STAI-S, values are group mean ± SD

Variables	BSF ($n = 112$)			SIS ($n = 112$)		
	Pre	Post	Cohen's d	Pre	Post	Cohen's d
Vigilance	283.5 ± 41.6	309.9 ± 14.2$^{\phi}$	0.85	257.8 ± 60.5$^{\blacklozenge}$	287.5 ± 42.6$^{\phi,\bullet}$	0.56
State anxiety	40.3 ± 10.9	31.3 ± 9.0$^{\phi}$	0.89	41.5 ± 9.8	42.4 ± 7.9$^{\bullet}$	0.10

$^{\phi}p < 0.001$ *post-hoc* within groups analyses with Bonferroni adjustment, post compared with pre.
$^{\blacklozenge}p < 0.001$ *post-hoc* between groups analyses with Bonferroni adjustment, pre compared with pre.
$^{\bullet}p < 0.001$ *post-hoc* between groups analyses with Bonferroni adjustment, post compared with post. BSF = Border Security Force group, who received 9 days of yoga; SIS = Security and Intelligence Services group, who received 9 days of physical training; DVT = digit vigilance test; STAI-S = Spielberger's state-trait anxiety inventory.

Table 4
Scores of sleep rating questionnaire, values are group mean ± SD

	BSF ($n = 112$)				SIS ($n = 112$)			
	Pre	Post	χ^2	Cohen's d/Cramer's V	Pre	Post	χ^2	Cohen's d/Cramer's V
Time taken to fall asleep (minutes)	30.7 ± 19.3	21.0 ± 13.9*	–	0.57[d]	30.0 ± 19.9	35.2 ± 48.9	–	0.14[d]
Duration of sleep (minutes)	275.2 ± 53.8	304.2 ± 48.0$^{\phi}$	–	0.57[d]	359.7 ± 48.2	347.6 ± 59.0	–	0.23[d]
Number of arousals during night	1.4 ± 0.9	0.8 ± 0.9$^{\phi}$	–	0.62[d]	1.5 ± 1.0	1.6 ± 0.9	–	0.09[d]
Duration of daytime naps (minutes)	66.7 ± 37.5	40.3 ± 36.6$^{\phi}$	–	0.71[d]	7.2 ± 29.4$^{\blacklozenge}$	7.5 ± 25.3$^{\bullet}$	–	0.01[d]
Feeling of rest in the morning (number of participants reported 'Yes')[a]	79	102[#]	15.23	0.26[v]	98	101	0.41	0.04[V]
Sleep in daytime (number of participants reported 'Yes')[a]	93	67[#]	14.79	0.25[v]	77	96	1.43	0.08[V]

$^{*}p < 0.01$, $^{\phi}p < 0.001$ *post-hoc* analyses with Bonferroni adjustment, post compared with pre.
$^{\blacklozenge}p < 0.001$ *post-hoc* between groups analyses with Bonferroni adjustment, pre compared with pre.
$^{\bullet}p < 0.001$ *post-hoc* between groups analyses with Bonferroni adjustment, post compared with post.
$^{\#}p < 0.001$ Pearson's chi-square test.
[a]Rest of the participants reported 'No'. [d]Cohen's d. [v]Cramer's V.
BSF = Border Security Force group, who received 9 days of yoga; SIS = Security and Intelligence Services group, who received 9 days of physical training.

Table 5
Details of the Repeated Measures ANOVA

Sl. no.	Factors	Variables	F	df	Huynh-Feldt ε	*p*-value
I	Within Subjects	Vigilance	90.06	1, 222	1	<0.001
		State anxiety	35.98	1, 222	1	<0.001
		Time taken to fall asleep	0.75	1, 222	1	0.388
		Number of arousals during night	9.27	1, 222	1	0.01
		Duration of daytime naps	28.29	1, 222	1	<0.001
II	Between Subjects	Vigilance	23.75	1, 222	1	<0.001
		State anxiety	32.57	1, 222	1	<0.001
		Time taken to fall asleep	5.35	1, 222	1	0.05
		Number of arousals during night	18.91	1, 222	1	<0.001
		Duration of daytime naps	164.36	1, 222	1	<0.001
III	States × Groups	Vigilance	0.291	1, 222 (States) × 222 (Groups)	1	0.590
		State anxiety	54.13	1, 222 (States) × 222 (Groups)	1	<0.001
		Time taken to fall asleep	8.68	1, 222 (States) × 222 (Groups)	1	0.01
		Number of arousals during night	10.62	1, 222 (States) × 222 (Groups)	1	<0.001
		Duration of daytime naps	29.67	1, 222 (States) × 222 (Groups)	1	<0.001

3.2. Post-hoc analyses

There were two *post-hoc* comparisons i.e., between groups and within groups.

3.2.1. Between groups post-hoc comparisons

The scores obtained in the digit vigilance test were significantly higher for the BSF group at pre assessment ($p < 0.001$) and post assessment ($p < 0.001$) compared to the SIS group. The post scores of Spielberger's state-trait anxiety inventory were significantly higher for the SIS group ($p < 0.001$). The BSF group reported significantly more frequent daytime naps compared to the SIS group at both pre ($p < 0.001$) and post assessments ($p < 0.001$).

3.2.2. Within group post-hoc comparisons (post-pre)

The BSF group showed a significant increase in DVT scores ($p < 0.001$) and a significant decrease in STAI-S scores ($p < 0.001$) at post assessment. Also a significant increase in total duration of sleep ($p < 0.001$) and a significant decrease in time taken to fall asleep ($p < 0.01$), number of arousals during the night ($p < 0.001$) and duration of daytime naps ($p < 0.001$) was noted. The SIS group showed a significant increase in DVT scores ($p < 0.001$) at post assessment.

3.3. Pearson's chi-square test

In the BSF group, 'feeling of rest in the morning' ($\chi^2 = 15.23$, $p < 0.001$, Cramer's $V = 0.261$) and 'daytime naps' ($\chi^2 = 14.79$, $p < 0.001$, Cramer's $V = 0.257$) differed significantly after yoga compared to before.

4. Discussion

Border Security Force (BSF) personnel showed improved performance in a vigilance test, self-rated sleep and reduced state anxiety after practicing yoga for nine days. A control group of private security personnel (SIS) who received physical training improved their performance in the vigilance task, with no change in their sleep or anxiety.

The two groups did not differ at baseline with respect to their levels of state anxiety or self-rated sleep with one exception, i.e., more frequent daytime naps in the BSF group. Also, the BSF group had better vigilance at baseline. This was possibly due to the heightened vigilance required at night by the BSF. Despite the other changes in self-rated sleep after 9 days of yoga, the BSF group continued to have more frequent daytime naps than the SIS group. Also their DVT scores remained higher compared to the SIS group after nine days.

The Border Security Force guard the country's borders, a job which involves considerable responsibility as well as remaining in a state of hyper vigilance most of the time. In psychology and cognitive science, vigilance is used to describe the ability to sustain attention to a task [25]. When a person attends to a task for a prolonged period it requires alertness and sustained attention which could influence several underlying brain processes including the sleep-wakefulness cycle [6]. Alertness and sustained attention influence parts of the brain which promote wakefulness as well as those which are required for actively inducing sleep [4]. To sustain alertness for long periods the neural systems which are essential include thalamic projections from the upper brainstem, sub-cortical cholinergic nuclei and specific hypothalamic nuclei [26]. Hence sleep-wake pathways are distinct and during tonic alertness, the activity of pathways involved in actively generating sleep may be inhibited [27].

In the Border Security Force personnel who practiced yoga there was an improvement in various aspects of sleep. These improvements included falling asleep in a shorter time (average decrease in time taken to fall asleep = 9.7 minutes), fewer episodes of day time sleep, less awakenings in the night and the feeling of being more rested in the morning.

The reasons for the improvement in sleep are probably many and complex. Dam et al. reported an association between low levels of oxygen saturation (less than 90%) while awake and poor quality of sleep [28]. Yoga practice is believed to improve the respiratory functions with resultant better tissue perfusion and improved oxygen saturation [29]. A particular yoga program (60 minutes/day for 60 days) helped Indian military personnel acclimatize sooner to altitudes of more than 3000 meters [30]. The better acclimatization could be due to an improved ability to adapt to lower levels of atmospheric oxygen at that height, possibly related to better tissue perfusion and oxygen saturation.

The yoga program in the present study included postures (*asanas*), regulated breathing (*pranayama*) and guided relaxation. Considering that BSF personnel are most often based at high altitudes, an improvement in their adaptation to rarefied oxygen may have contributed to their better sleep after yoga. In addition the yoga breathing practices used in the present study have been associated with reduced sympathetic activity and lower frequencies in the EEG [31]. Yoga postures are associated with an increase in central nervous system gamma-aminobutyric acid (GABA) levels measured through Nuclear Magnetic Resonance Spectroscopy (NMRs) [32, 33] which would promote cortical inhibition and hence facilitate sleep. Guided relaxation is associated with better relaxation than lying supine without instructions and this could also facilitate sleep [34].

Yoga and meditation based interventions which influence the lifestyle reduce the severity of major depressive disorder and increase systemic biomarkers associated with positive changes in the brain [35]. The physical activity component of yoga could also be beneficial. This was observed in military personnel in Iran, in a comparison between physically active versus inactive persons showing higher cardiovascular risk factors in those who were inactive [36]. While a systematic review did not report sufficient evidence to consider yoga as a definite treatment for diagnosed anxiety disorders the result of the eight studies reviewed was considered encouraging [37]. As mentioned above, the practice of yoga postures (*asanas*) increases the level of GABA in the cortex, while yoga breathing and guided relaxation have been separately shown to reduce sympathetic nervous system activity [34, 38]. Hence yoga practice can be said to reduce physiological arousal both centrally and in the autonomic nervous system. This reduced arousal would facilitate a decrease in anxiety.

Despite reducing arousal certain yoga breathing practices especially alternate nostril yoga breathing have been found to improve performance in the vigilance task used in the present study [19], without the expected rise in sympathetic nervous system activity which is associated with increased vigilance [4]. The present results also show that the BSF personnel performed better in the vigilance task with a decrease in state anxiety. The SIS group in contrast improved performance in the vigilance task but showed no significant change in state anxiety. The results in the BSF group suggest a possible benefit of introducing yoga for persons whose job requires prolonged periods of hyper-vigilance and periodic night shifts or disruption of sleep due to day time heightened vigilance.

The main difference between the BSF and the SIS groups was the duration of yoga practice (i.e., 2160 minutes and 180 minutes over the period of nine days respectively). Hence comparisons with earlier studies which assessed sleep, state anxiety and vigilance using the same questionnaires but where the duration of yoga was considerably less are cited here.

The BSF group showed an improvement of 31.6 percent in the time taken to fall asleep and 10.5 percent improvement in the duration of sleep after 9 days. Similarly an improvement of 8.7 percent in the time taken to fall asleep and 20.1 percent improvement in the duration of sleep occurred after 60 minutes of yoga practice over three months in a geriatric population [23]. After 240 minutes of yoga practice there was a reduction of 22.3 percent in state anxiety in the BSF personnel while in an earlier study on army personnel there was a 10.1 percent reduction in state anxiety after a single session of 45 minutes of yoga practice [19]. Vigilance was improved by 8.5 percent in the BSF personnel who practiced yoga for 240 minutes, while a single session 18 minutes of yoga improved performance in the same vigilance task by 9.4 percent [4].

5. Limitations

The main limitation of the study is in the design. It would have been ideal to randomize the BSF personnel to yoga and control (or an alternate intervention) groups. However the BSF personnel were especially deputed for intensive training in yoga for their stress-related health problems. Hence all of them had to receive the yoga intervention. As an alternative, age matched male security personnel (i.e., the SIS group) whose jobs also required vigilance were selected for comparison. This was not ideal as the levels of vigilance required for the BSF and SIS groups were not comparable. Also the BSF group received 240 minutes of yoga training a day compared to physical training for 60 minutes a day thrice in 9 days for the SIS group. It is impractical to suggest 240 minutes of yoga practice in a day. In order to make the present findings applicable to everyday situations examples are cited from the literature, where single and repeat sessions of 45 to 60 minutes duration also improved sleep, vigilance and reduced anxiety even though the magnitude of change was less than for 240 minutes of yoga.

These limitations suggest guidelines for future studies keeping in mind the regulated tight schedule and job requirements of Border Security Force personnel.

Acknowledgments

Authors acknowledge the Border Security Force personnel for their co-operation.

Conflict of interest

Authors declare no competing interests with respect to the research, authorship, and/or publication of this article.

References

[1] Lovering ME, Proctor SP, Heaton KJ. A retrospective study of anxiety disorder diagnoses in the military from 2000 to 2009. J Anxiety Disord. 2013;27(1):25-32.

[2] Redmond SA, Wilcox SL, Campbell S, Kim A, Finney K, Barr K, Hassan AM. A brief introduction to the military workplace culture. Work. 2015;50(1):9-20.

[3] Lieberman HR, Bathalon GP, Falco CM, Kramer FM, Morgan CA, Niro P. Severe decrements in cognition function and mood induced by sleep loss, heat, dehydration, and undernutrition during simulated combat. Biol Psychiatry. 2005;57(4):422-29.

[4] Telles S, Verma S, Sharma SK, Gupta RK, Balkrishna A. Alternate-nostril yoga breathing reduced blood pressure while increasing performance in a vigilance test. Med Sci Monit Basic Res. 2017;23:392-98.

[5] Subramanya P, Telles S. Performance in the Stroop task and simultaneously recorded heart rate variability before and after meditation, supine rest and no-intervention. Int J Brain Cogn Sci. 2015;4(1):8-14.

[6] Beck AT, Emery G. Anxiety disorders and phobias: A cognitive perspective. Cambridge MA: Basic Books; 2005.

[7] Chou HW, Tzeng WC, Chou YC, Yeh HW, Chang HA, Kao YC, Huang SY, Yeh CB, Chiang WS, Tzeng NS. Stress, sleep and depressive symptoms in active duty military personnel. Am J Med Sci. 2016;352(2):146-53.

[8] Mysliwiec V, McGraw L, Pierce R, Smith P, Trapp B, Roth BJ. Sleep disorders and associated medical comorbidities in active duty military personnel. Sleep. 2013;36(2):167-74.

[9] Harrison E, Glickman GL, Beckerley S, Taylor MK. Self-reported sleep during U.S. navy operations and the impact of deployment-related factors. Mil Med. 2017;182(S1):189-94.

[10] Ministry of Law (Legislative Department), Government of India. The Border Security Force Act, 1968. 1968 [cited 2018 Mar 17]. Available from: http://bsf.nic.in/doc/bsfActRules.pdf.

[11] Border Security Force [Internet]. Role of the BSF [cited 2018 Mar 17]. Available from: http://bsf.nic.in/en/introduction1.html.

[12] Wikipedia [Internet]. Border Security Force [cited 2018 Mar 17]. Available from: https://en.wikipedia.org/wiki/Border_Security_Force.

[13] More BSF men dying of mental illness, lifestyle diseases rather than operations [Newspaper article]. Hindustan Times [cited March 21 2017]. Available from: https://www.hindustantimes.com/india-news/more-bsf-men-dying-of-mental-illness-lifestyle-diseases-rather-than-operations/story.

[14] Sharma S. Occupational stress in the armed forces: An Indian army perspective. IIMB Manag Rev. 2015;27(3):185-95.

[15] Telles S., Gupta RK, Bhardwaj AK, Singh N, Mishra P, Pal DK, Balkrishna A. Increased mental well-being and reduced state anxiety in teachers after participation in a residential yoga program. Med Sci Monit Basic Res. 2018;24: 105-12.

[16] Telles S, Singh N, Yadav A, Balkrishna A. Effect of yoga on different aspects of mental health. Indian J Physiol Pharmacol. 2012;56(3):245-54.

[17] Khalsa SB. Treatment of chronic insomnia with yoga: A preliminary study with sleep–wake diaries. Appl Psychophysiol Biofeedback. 2004;29(4):269-78.

[18] Gupta N, Khera S, Vempati RP, Sharma R, Bijlani RL. Effect of yoga based lifestyle intervention on state and trait anxiety. Indian J Physiol Pharmacol. 2006;50(1):41.

[19] Telles S, Bhardwaj AK, Kumar S, Kumar N, Balkrishna A. Performance in a substitution task and state anxiety following yoga in army recruits. Psychol Rep. 2012;110(3):963-76.

[20] Kelland DZ, Lewis RF. The digit vigilance test: Reliability, validity, and sensitivity to diazepam. Arch Clin Neuropsychol. 1996;11(4):339-44.

[21] Seok, CB, Hamid HA, Mutang J., Ismail R. Psychometric properties of the state-trait anxiety inventory (form Y) among Malaysian university students. Sustainability. 2018;10(9):3311.

[22] Dias R, Baliarsing L, BArnwal BK, Mogal S, Gujjar P. Role of pre-operative multimedia video information in allaying anxiety related to spinal anaesthesia: A randomised controlled trial. Indian J Anaesth. 2016;60(11):843.

[23] Manjunath NK, Telles S. Influence of Yoga & Ayurveda on self-rated sleep in a geriatric population. Indian J Med Res. 2005;121(5):683.

[24] Ramacharaka Y, Atkinson WW. Hatha Yoga: or, the yogi philosophy of physical well-being, with numerous exercises. Martino Fine Books; 2017.

[25] Tucha L, Tucha O, Walitza S, Sontag TA, Laufkötter R, Linder M, Lange KW. Vigilance and sustained attention in children and adults with ADHD. J Atten Disord. 2009;12(5):410-21.

[26] McGinty D, Szymusiak R. Brain structures and mechanisms involved in the generation of nrem sleep: Focus on the preoptic hypothalamus. Sleep Med Rev. 2001;5(4):323-42.

[27] Bonnet M, Arand D. Sleepiness as measured by MSLT varies as a function of preceding activity. Sleep. 1998;21(5):477-83.

[28] Dam TT, Ewing S, Ancoli-Israel S, Ensrud K, Redline S, Stone K. Association between sleep and physical function in older men: The osteoporotic fractures in men sleep study. J Am Geriatr Soc. 2008;56(9):1665-73.

[29] Soni R, Munish K, Singh K, Singh S. Study of the effect of yoga training on diffusion capacity in chronic obstructive pulmonary disease patients: A controlled trial. Int J Yoga. 2012;5(2):123-7.

[30] Himashree G, Mohan L, Singh Y. Yoga practice improves physiological and biochemical status at high altitudes: A prospective case-control study. Altern Therapies. 2016;22(5):56-61.

[31] Telles S, Gupta RK, Yadav A, Pathak S, Balkrishna A. Hemisphere specific EEG related to alternate nostril yoga breathing. BMC Res Notes. 2017;10(1):306.

[32] Streeter CC, Jensen JE, Perlmutter RM, Cabral HJ, Tian H, Terhune DB, Ciraulo DA, Renshaw PF. Yoga Asana

sessions increase brain GABA levels: A pilot study. J Altern Complement Med. 2007;13(4):419-26.

[33] Streeter CC, Whitfield TH, Owen L, Rein T, Karri SK, Yakhkind A, Perlmutter R, Prescot A, Renshaw PF, Ciraulo DA, Jensen JE. Effects of yoga versus walking on mood, anxiety, and brain GABA levels: A randomized controlled MRS study. J Altern Complement Med. 2010;16(11):1145-52.

[34] Neuendorf R, Wahbeh H, Chamine I, Yu J, Hutchison K, Oken BS. The effects of mind-body interventions on sleep quality: A systematic review. Evid Based Complement Alternat Med. 2015;2015:902708.

[35] Tolahunase MR, Sagar R, Faiq M, Dada R. Yoga- and meditation-based lifestyle intervention increases neuroplasticity and reduces severity of major depressive disorder: A randomized controlled trial. Restor Neurol Neurosci. 2018;36(3):423-42.

[36] Naghii MR, Almadadi M, Zarchi AA. Regular physical activity as a basic component of lifestyle modification reduces major cardiovascular risk factors among male armored force personnel of Shabestar army installation in Iran. Work. 2011;40(2):217-27.

[37] G Kirkwood, H Rampes, V Tuffrey, J Richardson, K Pilkington. Yoga for anxiety: A systematic review of the research evidence. Br J Sports Med. 2005;39(12):884-91.

[38] Joshi A, Kiran R, Singla HK, Sah AN. Stress management through regulation of blood pressure among college students. Work. 2016;54(3):745-52.

Work 63 (2019) 243–251
DOI:10.3233/WOR-192925
IOS Press

Effect of yoga on vigilance, self rated sleep and state anxiety in Border Security Force personnel in India

Shirley Telles*, Niranjan Kala, Ram Kumar Gupta, Sadhana Verma, Babita Vishwakarma, Savita Agnihotri, Kumar Gandharva and Acharya Balkrishna
Patanjali Research Foundation, Patanjali Yogpeeth, Haridwar, Uttarakhand, India

Received 20 April 2018
Accepted 3 March 2019

Abstract.
BACKGROUND: Military occupations require heightened vigilance with resultant sleep disturbances, increased anxiety and reduced vigilance.
OBJECTIVE: To compare yoga with physical training to reduce insomnia, anxiety and increase vigilance in security personnel.
METHODS: One hundred and twelve Border Security Force personnel (BSF group, males; mean age ± SD = 30.4 ± 7.4 years) were compared with 112 personnel of a private security firm (SIS group). The BSF group received yoga for nine days and the SIS group received physical training for the same period. Assessments were at baseline and after 9 days, with the digit vigilance test (DVT), Spielberger's STAI-S, and a sleep rating questionnaire.
RESULTS: (1) Between groups: (i) at baseline the BSF group had higher vigilance and more daytime naps compared to the SIS group and (ii) after nine days the SIS group had higher state anxiety compared to the BSF group (ANOVA, Bonferroni adjusted *post-hoc* comparisons; SPSS Version 24.0) (2) In post-pre intervention comparisons (i) the BSF group increased vigilance and decreased state anxiety after yoga, with improved sleep, while (ii) the SIS group showed increased vigilance after physical training.
CONCLUSION: Yoga may improve sleep, reduce anxiety while increasing vigilance in occupations requiring vigilance.

Keywords: Alertness, insomnia, armed forces, unease

1. Introduction

Military occupations can be broadly categorized as combat or support roles. The relevance of this categorization is that a service member would experience difficult levels of stress due to the nature of deployment [1]. Military service members live and work in a unique and challenging environment facing physically and mentally demanding workloads, deployments and exposure to combat [2]. These stressors could contribute to impaired physical and psychological performance. After a simulated combat exercise, U.S. army officers showed impaired vigilance, reaction time, attention, memory, and reasoning [3]. Most military exercises require vigilance, which if prolonged could lead to physiological arousal and stress [4]. Increased vigilance has been associated with increased sympathetic nervous system activity [5].

*Address for correspondence: Shirley Telles, Director, Patanjali Research Foundation, Patanjali Yogpeeth, Haridwar - 249405, Uttarakhand, India. Tel.: +91 9897963254; E-mail: shirleytelles@gmail.com.

The long-term effects of hyper-vigilance can be devastating and may impact cognition, including attention, concentration, memory, as well as various functions essential for health such as sleep [6]. Military personnel have sleep disorders due to multiple factors apart from hyper-vigilance. These include the need to be on night duty, deployment through different time zones, and managing insomnia and drowsiness with sedatives or caffeine, respectively [7–9]. The most common sleep disorder is insomnia.

In India the Border Security Force (BSF) is the chief force guarding the territorial boundaries of the nation [10, 11]. The BSF is a Central Armed Police Force responsible for guarding India's land borders during peace time and preventing transnational crime [12].

Recent studies conducted on BSF personnel to understand their health and wellbeing, showed a high incidence of physical and mental illness including anxiety and insomnia, many of which were listed as lifestyle-related [13]. In many cases BSF, personnel adopted certain unhealthy stress coping strategies [14].

Yoga practice provides an alternative as a stress reducing strategy with additional health benefits [15]. Five hours of yoga practice per day for seven days improved the quality of sleep, total time spent asleep, time taken to fall asleep and number of arousals in healthy adults [16]. Similar benefits were found in a population with chronic insomnia; who showed improvement in sleep efficiency, total sleep time, total wake time, sleep onset latency and wake time after sleep onset following eight weeks of an hour of yoga every day [17]. Apart from insomnia, yoga was useful for the other problems faced by the BSF, i.e., anxiety and increased arousal due to vigilance. Yoga practice reduced both state and trait anxiety in persons with stress related symptoms, who practiced approximately an hour of yoga every day for ten days [18]. This effect of yoga in reducing anxiety may be the reason why after a single two hour session of yoga, military personnel performed better in an attention task while their state anxiety decreased [19].

The present study was designed to determine whether a yoga intervention could (i) reduce state anxiety, (ii) improve self-reported sleep and (iii) improve performance in a vigilance task in BSF personnel. Comparisons were made with age and gender as comparable to private security personnel whose job involved vigilance and who did not receive yoga but who received physical training during the period of intervention.

2. Methods

2.1. Participants

The trial was carried out on 224 males whose job involved security and vigilance. There were two groups: the Border Security Force, India (BSF group) and the Security and Intelligence Services India Ltd (SIS group from a private security service agency). Both groups had 112 participants (BSF group mean age $\pm$ SD = 30.4 $\pm$ 7.4 years; SIS group mean age $\pm$ SD = 29.1 $\pm$ 6.4 years). No incentive was given to either group. To be included in the trial participants had to (i) be male and (ii) spend at least eight hours each day on duty requiring vigilance. The criteria for exclusion were: (i) ill-health at the time of assessment based on a routine case history and clinical examination or (ii) taking any medication or nutraceuticals. None of the participants were excluded for these reasons. The study design was explained to the participants and all participants' signed informed consent was taken. The study was approved by the institution's ethical committee (approval number PRF/16/0014).

2.2. Design

The study was a comparative controlled trial. The two groups were comparable with respect to their age, duty shifts, and lifestyle. The BSF group was given a yoga program consisting of yoga postures (*asanas*), breathing techniques (*pranayamas*) and guided relaxation; for 240 minutes per day for a period of nine days. The SIS group was given a total of 180 minutes of physical training (60 minutes per day for three days) during the nine days. Details of the yoga and physical activity interventions are provided below. The fact that the amount of time allotted to the intervention differed in the two groups is a limitation of the study.

2.3. Assessments

The assessments were done on the day before beginning the intervention and on the day after completing the intervention. The following variables were assessed using tests which have been standardized for use in an Indian population:

2.3.1. Vigilance and sustained attention

The digit vigilance test (DVT) was used to measure vigilance and sustained attention which has proven test-retest reliability ($r = 0.91$) and alternate form reliability ($r = 0.90$) [20]. The DVT is not culture sensitive and has been used in an Indian population earlier [4]. The DVT consisted of an A4 size sheet with 1500 digits from 1 to 9 randomly arranged on it in 50 rows with 30 digits in each row. The participants were instructed to cancel the target digits (i.e., 6 and 9) as accurately as possible. Missing any target digits and cancellation of other digits were counted as errors. The score obtained was the total number of digits cancelled minus the errors. The total time given to complete the test was eight minutes.

2.3.2. State anxiety

State anxiety was measured using Spielberger's state-trait anxiety inventory (STAI-S) which has been standardized for use in an Asian population (of which 6.5% was an Indian population) with test-retest reliability ($r = 0.60$–0.94) and Cronbach's alpha score of 0.86 [21]. It is a 4-point Likert scale and comprises 20 items to describe the feelings of anxiety at the moment of testing [22]. The STAI-S The participants had to choose one out of the four options provided for each item i.e., not at all, somewhat, moderately so, and very much so. The scores ranged from 20 to 80.

2.3.3. Self-rated sleep quality

The sleep rating questionnaire (SRQ) was used to self-rate the participants' quality of sleep [23]. The SRQ has been standardized for use in an Indian population with test-retest reliability ($r = 0.20$–0.85) and internal consistency ($r = 0.58$–0.69) [23]. The SRQ consisted of one open-ended and six close-ended items which were: (1) Approximately how long in minutes does it take you to fall asleep? (2) How many hours do you sleep each night? (3) How many times (if any) do you wake up during the night? (4) What are the usual reasons for waking up if you do so? (5) Do you feel rested in the morning (yes/no)? (6) Do you sleep in the day time (yes/no)? (7) If your answer to question 6 was 'yes', for how long do your daytime naps last?

2.4. Intervention

2.4.1. Yoga

The yoga intervention was for 240 minutes in each day. The yoga sessions included a universal prayer, yoga postures (*asanas*), voluntarily regulated breathing techniques (*pranayamas*), loosening exercises and guided relaxation. Yoga practices were derived from teachings in traditional texts (Hatha Pradipika Circa 1500 C.E., Gheranda Samhita Circa 1700 C.E.) [24]. The timings for yoga sessions were between 05:00–07:00 hours and 16:00–18:00 hours daily for nine days. The details of the yoga session are given in Table 1.

2.4.2. Physical training

Physical training (PT) was between 13.00 hours to 14.00 hours each day. The participants attended three PT sessions during nine days. The PT sessions included drill and marching. The details are provided in Table 2.

2.5. Data analysis

Data were analyzed using SPSS (Version 24.0). A repeated measures ANOVA with Bonferroni adjusted multiple *post-hoc* comparisons was performed. The ANOVA had one Within subjects factor i.e., States, with two levels (pre and post) and one Between subjects factor i.e., Groups which were (i) BSF and (ii) SIS. Two items of the SRQ (i.e., number 5 and number 6) were measured on a nominal scale (i.e., yes = 0, no = 1) and analyzed with Pearson's chi-square test.

3. Results

The group mean values ± SD for different values are given in Tables 3 and 4 and ANOVA values are given in Table 5.

3.1. Repeated measures ANOVA

There was a significant difference between groups for vigilance ($p < 0.001$), state anxiety ($p < 0.001$), time taken to fall asleep ($p = 0.02$), number of arousals during the night ($p < 0.001$), and duration of daytime naps ($p < 0.001$). A significant difference within groups was noted in vigilance ($p < 0.001$), state anxiety ($p < 0.001$), arousals during the night ($p < 0.01$), and duration of daytime naps ($p < 0.001$). A significant interaction between groups and states was seen in state anxiety ($p < 0.001$), time taken to fall asleep ($p < 0.01$), numbers of arousals during the night ($p < 0.001$) and duration of daytime naps ($p < 0.001$); suggesting that these variables were interdependent with respect to the groups (i.e., BSF and SIS) and states (i.e., pre and post).

Table 1
Details of a yoga practice session

S. No		Yoga Practice	Duration
1	Starting	*Mantra* chanting	3 minutes
2	Warming up	Sun salutation *(Surya namaskara)*	10 minutes
3	Standing postures	Swaying palm tree pose *(Tirryaktadasana)*	3 minutes
		Tree pose *(Vrikshasana)*	3 minutes
		Feet and hands posture *(Padahastasana)*	2 minutes
	Sitting postures	Frog posture *(Mandukasana)*	3 minutes
		Rabbit posture *(Sasakasana)*	3 minutes
		Sitting lateral twisting posture *(Vakrasana)*	5 minutes
		Cow face posture *(Gomukhasana)*	5 minutes
5	Prone postures	Crocodile posture *(Makarasana)*	5 minutes
		Cobra posture *(Bhujangasana)*	3 minutes
		Half-locust posture *(Salabhasana)*	3 minutes
6	Supine postures	Half-plough posture *(Ardhhalasana)*	3 minutes
		Rotating leg pose *(Padavritasana)*	6 minutes
		Leg circling pose *(Dwichakrasana)*	6 minutes
7	Relaxation	Supine relaxed posture *(Shavasana)* with breath awareness	5 minutes
8	Yoga breathing series *(pranayamas)*	Yoga bellows type breathing *(Bhastrika)*	3 minutes
		High frequency yoga breathing *(Kapalabhati)*	10 minutes
		External breath holding (*Bahyavriti pranayama*)	3 minutes
		Victorious breath (*Ujjayi)*	3 minutes
		Alternative nostril yoga breathing *(Anlom- vilom)*	10 minutes
		Bee breathing practice *(Bhramari)*	3 minutes
		Om chanting *(Udgeeth)*	3 minutes
9	Relaxation	Supine relaxed posture *(Shavasana)* with breath awareness	5 minutes
10	Loosening exercises	Neck rotation	3 minutes
		Knee & ankle rotation	3 minutes
		Shoulder rotation	3 minutes
		Butterfly pose	1 minute
11		Conclusion prayer	2 minutes

Total duration of the session was 120 minutes and the same practices have been repeated during the evening session too.

Table 2
Details of a physical training session

S No		Practices	Repetitions	Duration
1	Marches	Marching with instructions		10 minutes
2	Stretching exercises	Exercise 1(lateral stretch)	8–10	2 minutes
		Part 1. Bending to the left with right hand extended upwards.		
		Part 2. Bending to the right with left hand extended upwards.	8–10	2 minutes
		Exercise 2.(backward stretch)		
		Bending backward with both hands extended upwards.	10–15	3 minutes
		Exercise 3.(forward stretch)		
		Bending forward with both hands stretched downwards.	10–15	3 minutes
3	Whole body exercises	Exercise 1.		3 minutes
		Arms extended laterally and feet moved apart with a jump, then bringing the feet together and arms to the thighs.		
		Exercise 2.	20	3 minutes
		Arms extended laterally, feet apart. Jumping and bringing the feet together and hands together above the head with a clap.		
		Exercise 3. Jumping and bringing right leg forward and left leg backward with arms akimbo. Then jumping again with bringing left leg forward and right leg backward.	20	
		Exercise 4. Arms extended to the front with feet slightly apart, then twisting to the right, coming back and twisting to the left.	20	3 minutes
		Exercise 5. (simple squat)		
		Hands stretched in front, sitting with knees bent.	10	3 minutes
4	Running	Running in a 750 meters track with medium pace	2	15 minutes
5	Ending	Sitting with eyes closed	–	10 minutes

Total duration of the session was 60 minutes.

Table 3
Scores of DVT and STAI-S, values are group mean ± SD

Variables	BSF ($n = 112$)			SIS ($n = 112$)		
	Pre	Post	Cohen's d	Pre	Post	Cohen's d
Vigilance	283.5 ± 41.6	309.9 ± 14.2$^{\phi}$	0.85	257.8 ± 60.5$^{\blacklozenge}$	287.5 ± 42.6$^{\phi,\bullet}$	0.56
State anxiety	40.3 ± 10.9	31.3 ± 9.0$^{\phi}$	0.89	41.5 ± 9.8	42.4 ± 7.9$^{\bullet}$	0.10

$^{\phi}p < 0.001$ *post-hoc* within groups analyses with Bonferroni adjustment, post compared with pre.
$^{\blacklozenge}p < 0.001$ *post-hoc* between groups analyses with Bonferroni adjustment, pre compared with pre.
$^{\bullet}p < 0.001$ *post-hoc* between groups analyses with Bonferroni adjustment, post compared with post. BSF = Border Security Force group, who received 9 days of yoga; SIS = Security and Intelligence Services group, who received 9 days of physical training; DVT = digit vigilance test; STAI-S = Spielberger's state-trait anxiety inventory.

Table 4
Scores of sleep rating questionnaire, values are group mean ± SD

	BSF ($n = 112$)				SIS ($n = 112$)			
	Pre	Post	χ^2	Cohen's d/Cramer's V	Pre	Post	χ^2	Cohen's d/Cramer's V
Time taken to fall asleep (minutes)	30.7 ± 19.3	21.0 ± 13.9*	–	0.57[d]	30.0 ± 19.9	35.2 ± 48.9	–	0.14[d]
Duration of sleep (minutes)	275.2 ± 53.8	304.2 ± 48.0$^{\phi}$	–	0.57[d]	359.7 ± 48.2	347.6 ± 59.0	–	0.23[d]
Number of arousals during night	1.4 ± 0.9	0.8 ± 0.9$^{\phi}$	–	0.62[d]	1.5 ± 1.0	1.6 ± 0.9	–	0.09[d]
Duration of daytime naps (minutes)	66.7 ± 37.5	40.3 ± 36.6$^{\phi}$	–	0.71[d]	7.2 ± 29.4$^{\blacklozenge}$	7.5 ± 25.3$^{\bullet}$	–	0.01[d]
Feeling of rest in the morning (number of participants reported 'Yes')[a]	79	102$^{\#}$	15.23	0.26[v]	98	101	0.41	0.04[V]
Sleep in daytime (number of participants reported 'Yes')[a]	93	67$^{\#}$	14.79	0.25[v]	77	96	1.43	0.08[V]

$^{*}p < 0.01$, $^{\phi}p < 0.001$ *post-hoc* analyses with Bonferroni adjustment, post compared with pre.
$^{\blacklozenge}p < 0.001$ *post-hoc* between groups analyses with Bonferroni adjustment, pre compared with pre.
$^{\bullet}p < 0.001$ *post-hoc* between groups analyses with Bonferroni adjustment, post compared with post.
$^{\#}p < 0.001$ Pearson's chi-square test.
[a]Rest of the participants reported 'No'. [d]Cohen's d. [v]Cramer's V.
BSF = Border Security Force group, who received 9 days of yoga; SIS = Security and Intelligence Services group, who received 9 days of physical training.

Table 5
Details of the Repeated Measures ANOVA

Sl. no.	Factors	Variables	F	df	Huynh-Feldt ε	*p*-value
I	Within Subjects	Vigilance	90.06	1, 222	1	<0.001
		State anxiety	35.98	1, 222	1	<0.001
		Time taken to fall asleep	0.75	1, 222	1	0.388
		Number of arousals during night	9.27	1, 222	1	0.01
		Duration of daytime naps	28.29	1, 222	1	<0.001
II	Between Subjects	Vigilance	23.75	1, 222	1	<0.001
		State anxiety	32.57	1, 222	1	<0.001
		Time taken to fall asleep	5.35	1, 222	1	0.05
		Number of arousals during night	18.91	1, 222	1	<0.001
		Duration of daytime naps	164.36	1, 222	1	<0.001
III	States × Groups	Vigilance	0.291	1, 222 (States) × 222 (Groups)	1	0.590
		State anxiety	54.13	1, 222 (States) × 222 (Groups)	1	<0.001
		Time taken to fall asleep	8.68	1, 222 (States) × 222 (Groups)	1	0.01
		Number of arousals during night	10.62	1, 222 (States) × 222 (Groups)	1	<0.001
		Duration of daytime naps	29.67	1, 222 (States) × 222 (Groups)	1	<0.001

3.2. Post-hoc analyses

There were two *post-hoc* comparisons i.e., between groups and within groups.

3.2.1. Between groups post-hoc comparisons

The scores obtained in the digit vigilance test were significantly higher for the BSF group at pre assessment ($p < 0.001$) and post assessment ($p < 0.001$) compared to the SIS group. The post scores of Spielberger's state-trait anxiety inventory were significantly higher for the SIS group ($p < 0.001$). The BSF group reported significantly more frequent daytime naps compared to the SIS group at both pre ($p < 0.001$) and post assessments ($p < 0.001$).

3.2.2. Within group post-hoc comparisons (post-pre)

The BSF group showed a significant increase in DVT scores ($p < 0.001$) and a significant decrease in STAI-S scores ($p < 0.001$) at post assessment. Also a significant increase in total duration of sleep ($p < 0.001$) and a significant decrease in time taken to fall asleep ($p < 0.01$), number of arousals during the night ($p < 0.001$) and duration of daytime naps ($p < 0.001$) was noted. The SIS group showed a significant increase in DVT scores ($p < 0.001$) at post assessment.

3.3. Pearson's chi-square test

In the BSF group, 'feeling of rest in the morning' ($\chi^2 = 15.23$, $p < 0.001$, Cramer's $V = 0.261$) and 'daytime naps' ($\chi^2 = 14.79$, $p < 0.001$, Cramer's $V = 0.257$) differed significantly after yoga compared to before.

4. Discussion

Border Security Force (BSF) personnel showed improved performance in a vigilance test, self-rated sleep and reduced state anxiety after practicing yoga for nine days. A control group of private security personnel (SIS) who received physical training improved their performance in the vigilance task, with no change in their sleep or anxiety.

The two groups did not differ at baseline with respect to their levels of state anxiety or self-rated sleep with one exception, i.e., more frequent daytime naps in the BSF group. Also, the BSF group had better vigilance at baseline. This was possibly due to the heightened vigilance required at night by the BSF. Despite the other changes in self-rated sleep after 9 days of yoga, the BSF group continued to have more frequent daytime naps than the SIS group. Also their DVT scores remained higher compared to the SIS group after nine days.

The Border Security Force guard the country's borders, a job which involves considerable responsibility as well as remaining in a state of hyper vigilance most of the time. In psychology and cognitive science, vigilance is used to describe the ability to sustain attention to a task [25]. When a person attends to a task for a prolonged period it requires alertness and sustained attention which could influence several underlying brain processes including the sleep-wakefulness cycle [6]. Alertness and sustained attention influence parts of the brain which promote wakefulness as well as those which are required for actively inducing sleep [4]. To sustain alertness for long periods the neural systems which are essential include thalamic projections from the upper brainstem, sub-cortical cholinergic nuclei and specific hypothalamic nuclei [26]. Hence sleep-wake pathways are distinct and during tonic alertness, the activity of pathways involved in actively generating sleep may be inhibited [27].

In the Border Security Force personnel who practiced yoga there was an improvement in various aspects of sleep. These improvements included falling asleep in a shorter time (average decrease in time taken to fall asleep = 9.7 minutes), fewer episodes of day time sleep, less awakenings in the night and the feeling of being more rested in the morning.

The reasons for the improvement in sleep are probably many and complex. Dam et al. reported an association between low levels of oxygen saturation (less than 90%) while awake and poor quality of sleep [28]. Yoga practice is believed to improve the respiratory functions with resultant better tissue perfusion and improved oxygen saturation [29]. A particular yoga program (60 minutes/day for 60 days) helped Indian military personnel acclimatize sooner to altitudes of more than 3000 meters [30]. The better acclimatization could be due to an improved ability to adapt to lower levels of atmospheric oxygen at that height, possibly related to better tissue perfusion and oxygen saturation.

The yoga program in the present study included postures (*asanas*), regulated breathing (*pranayama*) and guided relaxation. Considering that BSF personnel are most often based at high altitudes, an improvement in their adaptation to rarefied oxygen may have contributed to their better sleep after yoga. In addition the yoga breathing practices used in the present study have been associated with reduced sympathetic activity and lower frequencies in the EEG [31]. Yoga postures are associated with an increase in central nervous system gamma-aminobutyric acid (GABA) levels measured through Nuclear Magnetic Resonance Spectroscopy (NMRs) [32, 33] which would promote cortical inhibition and hence facilitate sleep. Guided relaxation is associated with better relaxation than lying supine without instructions and this could also facilitate sleep [34].

Yoga and meditation based interventions which influence the lifestyle reduce the severity of major depressive disorder and increase systemic biomarkers associated with positive changes in the brain [35]. The physical activity component of yoga could also be beneficial. This was observed in military personnel in Iran, in a comparison between physically active versus inactive persons showing higher cardiovascular risk factors in those who were inactive [36]. While a systematic review did not report sufficient evidence to consider yoga as a definite treatment for diagnosed anxiety disorders the result of the eight studies reviewed was considered encouraging [37]. As mentioned above, the practice of yoga postures (*asanas*) increases the level of GABA in the cortex, while yoga breathing and guided relaxation have been separately shown to reduce sympathetic nervous system activity [34, 38]. Hence yoga practice can be said to reduce physiological arousal both centrally and in the autonomic nervous system. This reduced arousal would facilitate a decrease in anxiety.

Despite reducing arousal certain yoga breathing practices especially alternate nostril yoga breathing have been found to improve performance in the vigilance task used in the present study [19], without the expected rise in sympathetic nervous system activity which is associated with increased vigilance [4]. The present results also show that the BSF personnel performed better in the vigilance task with a decrease in state anxiety. The SIS group in contrast improved performance in the vigilance task but showed no significant change in state anxiety. The results in the BSF group suggest a possible benefit of introducing yoga for persons whose job requires prolonged periods of hyper-vigilance and periodic night shifts or disruption of sleep due to day time heightened vigilance.

The main difference between the BSF and the SIS groups was the duration of yoga practice (i.e., 2160 minutes and 180 minutes over the period of nine days respectively). Hence comparisons with earlier studies which assessed sleep, state anxiety and vigilance using the same questionnaires but where the duration of yoga was considerably less are cited here.

The BSF group showed an improvement of 31.6 percent in the time taken to fall asleep and 10.5 percent improvement in the duration of sleep after 9 days. Similarly an improvement of 8.7 percent in the time taken to fall asleep and 20.1 percent improvement in the duration of sleep occurred after 60 minutes of yoga practice over three months in a geriatric population [23]. After 240 minutes of yoga practice there was a reduction of 22.3 percent in state anxiety in the BSF personnel while in an earlier study on army personnel there was a 10.1 percent reduction in state anxiety after a single session of 45 minutes of yoga practice [19]. Vigilance was improved by 8.5 percent in the BSF personnel who practiced yoga for 240 minutes, while a single session 18 minutes of yoga improved performance in the same vigilance task by 9.4 percent [4].

5. Limitations

The main limitation of the study is in the design. It would have been ideal to randomize the BSF personnel to yoga and control (or an alternate intervention) groups. However the BSF personnel were especially deputed for intensive training in yoga for their stress-related health problems. Hence all of them had to receive the yoga intervention. As an alternative, age matched male security personnel (i.e., the SIS group) whose jobs also required vigilance were selected for comparison. This was not ideal as the levels of vigilance required for the BSF and SIS groups were not comparable. Also the BSF group received 240 minutes of yoga training a day compared to physical training for 60 minutes a day thrice in 9 days for the SIS group. It is impractical to suggest 240 minutes of yoga practice in a day. In order to make the present findings applicable to everyday situations examples are cited from the literature, where single and repeat sessions of 45 to 60 minutes duration also improved sleep, vigilance and reduced anxiety even though the magnitude of change was less than for 240 minutes of yoga.

These limitations suggest guidelines for future studies keeping in mind the regulated tight schedule and job requirements of Border Security Force personnel.

Acknowledgments

Authors acknowledge the Border Security Force personnel for their co-operation.

Conflict of interest

Authors declare no competing interests with respect to the research, authorship, and/or publication of this article.

References

[1] Lovering ME, Proctor SP, Heaton KJ. A retrospective study of anxiety disorder diagnoses in the military from 2000 to 2009. J Anxiety Disord. 2013;27(1):25-32.

[2] Redmond SA, Wilcox SL, Campbell S, Kim A, Finney K, Barr K, Hassan AM. A brief introduction to the military workplace culture. Work. 2015;50(1):9-20.

[3] Lieberman HR, Bathalon GP, Falco CM, Kramer FM, Morgan CA, Niro P. Severe decrements in cognition function and mood induced by sleep loss, heat, dehydration, and undernutrition during simulated combat. Biol Psychiatry. 2005;57(4):422-29.

[4] Telles S, Verma S, Sharma SK, Gupta RK, Balkrishna A. Alternate-nostril yoga breathing reduced blood pressure while increasing performance in a vigilance test. Med Sci Monit Basic Res. 2017;23:392-98.

[5] Subramanya P, Telles S. Performance in the Stroop task and simultaneously recorded heart rate variability before and after meditation, supine rest and no-intervention. Int J Brain Cogn Sci. 2015;4(1):8-14.

[6] Beck AT, Emery G. Anxiety disorders and phobias: A cognitive perspective. Cambridge MA: Basic Books; 2005.

[7] Chou HW, Tzeng WC, Chou YC, Yeh HW, Chang HA, Kao YC, Huang SY, Yeh CB, Chiang WS, Tzeng NS. Stress, sleep and depressive symptoms in active duty military personnel. Am J Med Sci. 2016;352(2):146-53.

[8] Mysliwiec V, McGraw L, Pierce R, Smith P, Trapp B, Roth BJ. Sleep disorders and associated medical comorbidities in active duty military personnel. Sleep. 2013;36(2):167-74.

[9] Harrison E, Glickman GL, Beckerley S, Taylor MK. Self-reported sleep during U.S. navy operations and the impact of deployment-related factors. Mil Med. 2017;182(S1):189-94.

[10] Ministry of Law (Legislative Department), Government of India. The Border Security Force Act, 1968. 1968 [cited 2018 Mar 17]. Available from: http://bsf.nic.in/doc/bsfActRules.pdf.

[11] Border Security Force [Internet]. Role of the BSF [cited 2018 Mar 17]. Available from: http://bsf.nic.in/en/introduction1.html.

[12] Wikipedia [Internet]. Border Security Force [cited 2018 Mar 17]. Available from: https://en.wikipedia.org/wiki/Border_Security_Force.

[13] More BSF men dying of mental illness, lifestyle diseases rather than operations [Newspaper article]. Hindustan Times [cited March 21 2017]. Available from: https://www.hindustantimes.com/india-news/more-bsf-men-dying-of-mental-illness-lifestyle-diseases-rather-than-operations/story.

[14] Sharma S. Occupational stress in the armed forces: An Indian army perspective. IIMB Manag Rev. 2015;27(3):185-95.

[15] Telles S., Gupta RK, Bhardwaj AK, Singh N, Mishra P, Pal DK, Balkrishna A. Increased mental well-being and reduced state anxiety in teachers after participation in a residential yoga program. Med Sci Monit Basic Res. 2018;24: 105-12.

[16] Telles S, Singh N, Yadav A, Balkrishna A. Effect of yoga on different aspects of mental health. Indian J Physiol Pharmacol. 2012;56(3):245-54.

[17] Khalsa SB. Treatment of chronic insomnia with yoga: A preliminary study with sleep–wake diaries. Appl Psychophysiol Biofeedback. 2004;29(4):269-78.

[18] Gupta N, Khera S, Vempati RP, Sharma R, Bijlani RL. Effect of yoga based lifestyle intervention on state and trait anxiety. Indian J Physiol Pharmacol. 2006;50(1):41.

[19] Telles S, Bhardwaj AK, Kumar S, Kumar N, Balkrishna A. Performance in a substitution task and state anxiety following yoga in army recruits. Psychol Rep. 2012;110(3):963-76.

[20] Kelland DZ, Lewis RF. The digit vigilance test: Reliability, validity, and sensitivity to diazepam. Arch Clin Neuropsychol. 1996;11(4):339-44.

[21] Seok, CB, Hamid HA, Mutang J., Ismail R. Psychometric properties of the state-trait anxiety inventory (form Y) among Malaysian university students. Sustainability. 2018;10(9):3311.

[22] Dias R, Baliarsing L, BArnwal BK, Mogal S, Gujjar P. Role of pre-operative multimedia video information in allaying anxiety related to spinal anaesthesia: A randomised controlled trial. Indian J Anaesth. 2016;60(11):843.

[23] Manjunath NK, Telles S. Influence of Yoga & Ayurveda on self-rated sleep in a geriatric population. Indian J Med Res. 2005;121(5):683.

[24] Ramacharaka Y, Atkinson WW. Hatha Yoga: or, the yogi philosophy of physical well-being, with numerous exercises. Martino Fine Books; 2017.

[25] Tucha L, Tucha O, Walitza S, Sontag TA, Laufkötter R, Linder M, Lange KW. Vigilance and sustained attention in children and adults with ADHD. J Atten Disord. 2009;12(5):410-21.

[26] McGinty D, Szymusiak R. Brain structures and mechanisms involved in the generation of nrem sleep: Focus on the preoptic hypothalamus. Sleep Med Rev. 2001;5(4):323-42.

[27] Bonnet M, Arand D. Sleepiness as measured by MSLT varies as a function of preceding activity. Sleep. 1998;21(5):477-83.

[28] Dam TT, Ewing S, Ancoli-Israel S, Ensrud K, Redline S, Stone K. Association between sleep and physical function in older men: The osteoporotic fractures in men sleep study. J Am Geriatr Soc. 2008;56(9):1665-73.

[29] Soni R, Munish K, Singh K, Singh S. Study of the effect of yoga training on diffusion capacity in chronic obstructive pulmonary disease patients: A controlled trial. Int J Yoga. 2012;5(2):123-7.

[30] Himashree G, Mohan L, Singh Y. Yoga practice improves physiological and biochemical status at high altitudes: A prospective case-control study. Altern Therapies. 2016;22(5):56-61.

[31] Telles S, Gupta RK, Yadav A, Pathak S, Balkrishna A. Hemisphere specific EEG related to alternate nostril yoga breathing. BMC Res Notes. 2017;10(1):306.

[32] Streeter CC, Jensen JE, Perlmutter RM, Cabral HJ, Tian H, Terhune DB, Ciraulo DA, Renshaw PF. Yoga Asana

sessions increase brain GABA levels: A pilot study. J Altern Complement Med. 2007;13(4):419-26.

[33] Streeter CC, Whitfield TH, Owen L, Rein T, Karri SK, Yakhkind A, Perlmutter R, Prescot A, Renshaw PF, Ciraulo DA, Jensen JE. Effects of yoga versus walking on mood, anxiety, and brain GABA levels: A randomized controlled MRS study. J Altern Complement Med. 2010;16(11):1145-52.

[34] Neuendorf R, Wahbeh H, Chamine I, Yu J, Hutchison K, Oken BS. The effects of mind-body interventions on sleep quality: A systematic review. Evid Based Complement Alternat Med. 2015;2015:902708.

[35] Tolahunase MR, Sagar R, Faiq M, Dada R. Yoga- and meditation-based lifestyle intervention increases neuroplasticity and reduces severity of major depressive disorder: A randomized controlled trial. Restor Neurol Neurosci. 2018;36(3):423-42.

[36] Naghii MR, Almadadi M, Zarchi AA. Regular physical activity as a basic component of lifestyle modification reduces major cardiovascular risk factors among male armored force personnel of Shabestar army installation in Iran. Work. 2011;40(2):217-27.

[37] G Kirkwood, H Rampes, V Tuffrey, J Richardson, K Pilkington. Yoga for anxiety: A systematic review of the research evidence. Br J Sports Med. 2005;39(12):884-91.

[38] Joshi A, Kiran R, Singla HK, Sah AN. Stress management through regulation of blood pressure among college students. Work. 2016;54(3):745-52.

Telles et al. BMC Res Notes (2017) 10:306
DOI 10.1186/s13104-017-2625-6

BMC Research Notes

RESEARCH ARTICLE

Open Access

Hemisphere specific EEG related to alternate nostril yoga breathing

Shirley Telles*, Ram Kumar Gupta, Arti Yadav, Shivangi Pathak and Acharya Balkrishna

Abstract

Background: Previously, forced unilateral nostril breathing was associated with ipsilateral, or contralateral cerebral hemisphere changes, or no change. Hence it was inconclusive. The present study was conducted on 13 normal healthy participants to determine the effects of alternate nostril yoga breathing on (a) cerebral hemisphere asymmetry, and (b) changes in the standard EEG bands.

Methods: Participants were randomly allocated to three sessions (a) alternate nostril yoga breathing (ANYB), (b) breath awareness and (c) quiet sitting, on separate days. EEG was recorded from bilaterally symmetrical sites (FP_1, FP_2, C_3, C_4, O_1 and O_2). All sites were referenced to the ipsilateral ear lobe.

Results: There was no change in cerebral hemisphere symmetry. The relative power in the theta band was decreased during alternate nostril yoga breathing (ANYB) and the beta amplitude was lower after ANYB. During quiet sitting the relative power in the beta band increased, while the amplitude of the alpha band reduced.

Conclusion: The results suggest that ANYB was associated with greater calmness, whereas quiet sitting without specific directions was associated with arousal. The results imply a possible use of ANYB for stress and anxiety reduction.

Keywords: EEG, Alternate nostril yoga breathing, Cerebral hemisphere symmetry, Breath awareness, Quiet sitting, EEG relative power, EEG bands

Background

The nasal cycle is an ultradian rhythm characterized by alternating congestion and decongestion of opposite nostrils [1]. The nasal mucosal membrane has innervation from the autonomic nervous system so that sympathetic dominance on one side results in nasal mucosal vasoconstriction hence increasing nostril patency on that side. On the contralateral side there would be parasympathetic dominance and nasal mucosal vasodilation resulting in partial or complete occlusion of the nostril on that side. The nasal cycle varies widely in periodicity. When a continuous recording of nostril dominance was made, time series analysis detected periods of the nasal cycle at 280–275, 165–210, 145–160, 105–140, 70–100 and 40–65 min bins [2, 3].

Werntz et al. [4] showed that the nasal cycle was also related to the function of the central nervous system. The finding that forced uninostril breathing has selective effects on the EEG of the cerebral hemispheres was first shown in 1983 and later on with greater rigor in 1987 [5]. This is believed to be due to a neural connection arising from the superior nasal meatus [6]. Activation of the upper nasal cavity could be produced by air insufflation without inflation of the lung [6]. Also local anesthesia of the local mucosal membrane prevented the cortical changes which follow upper nasal cavity activation.

In a comparison between forced uninostril breathing and bilateral breathing, the peak power of beta2 in the frontal EEG was lower during uninostril compared to bilateral breathing [7].

The effects of forced alternate nostril breathing on the EEG were studied in 18 trained persons who practiced forced alternate nostril breathing for 10 min [8]. The study aimed at differentiating between forced alternate nostril breathing which began with inhalation through

*Correspondence: shirleytelles@gmail.com; officeprfms@gmail.com
Patanjali Research Foundation, Patanjali Yogpeeth, Maharishi Dayanand Gram, Bahadrabad, Haridwar, Uttarakhand 249402, India

the left nostril compared to forced alternate nostril with right nostril inhalation to begin with [8]. No difference was reported. However the average power in the beta and alpha bands increased during both types of forced alternate nostril breathing. Also during the latter half of the ten minutes of forced alternate nostril breathing there was a decrease in hemisphere asymmetry in the beta 1 band, which the authors described as 'a balancing effect on the functional activity of the left and right hemisphere.'

Yoga voluntarily regulated breathing (*pranayama*) allows a practitioner to breathe through one nostril at a time, effortlessly and selectively [9]. Alternate nostril breathing is also a common yoga breathing practice [10]. In Indian medicine importance is given to uninostril and alternate nostril breathing [11]. The effects of uninostril breathing are described in detail, with left nostril breathing described as 'cooling and 'calming', while right nostril breathing is described as 'heat generating' and energizing', and alternate nostril breathing has been described as 'harmonizing' [11].

A previous study showed that 18 min of alternate nostril breathing lowered the systolic and diastolic blood pressure in persons with essential hypertension controlled by medication [12].

The present study was planned as a preliminary study to assess the effects of alternate nostril yoga breathing on the EEG.

The hypothesis of the present study was that alternate nostril yoga breathing would reduce hemisphere asymmetry in EEG as was observed for forced alternate nostril breathing.

Methods

Participants

Thirteen healthy males with ages between 18 and 45 years residing in a yoga center in north India participated in the study. They were recruited by flyers on the notice boards of the yoga center. To be included in the trial, participants had to meet the following criteria: (a) the participants had to have experience of yoga breathing (*pranayama*) of at least 45 min a day, practiced for at least 15 days per month, over a minimum period of 6 months, and (b) the participants all had to be right hand dominant based on a standard handedness questionnaire [13]. The exclusion criteria were (1) persons on any medication, and (2) the presence of any illness, particularly psychiatric or neurological disorders. None of the participants were excluded based on these criteria. The baseline characteristics of the participants are given in Table 1.

The experimental procedure was approved by the ethical committee of Patanjali Research Foundation and signed informed consent was obtained from each participant before beginning the study.

Table 1 Baseline characteristics of the participants (n = 13)

Age in years (group mean ± SD)	24.2 ± 4.7 years
Average years of education (group mean ± SD)	13.8 ± 1.6 years
Experience of yoga breathing including ANYB (group mean ± SD)	38.8 ± 32.6 months
Experience of ANYB exclusively	29.2 ± 22.8 months

ANYB alternate nostril yoga breathing

Design of the study

The participants were assessed before, during and after the intervention. Each participant was assessed in three sessions, conducted on 3 separate days, keeping the time of the day constant for a particular participant. The three sessions were (a) alternate nostril yoga breathing (ANYB), (b) breath awareness (BAW), and (c) quiet sitting (QS). Participants were randomly assigned to the three sessions using a standard randomizer [14], hence the order of the three sessions was different for different participants.

The total duration of each session was 28 min, i.e., 5 min before the practice, 18 min during the practice, and 5 min after the practice. During the practice the participants practiced ANYB, BAW or quiet sitting for 15 min with 1 min of rest after every 5 min of practice, so that the duration was 18 min. Hence the 15 min were divided into three epochs of 5 min each. Throughout the session participants were seated on a chair with their spine straight and eyes closed. Recordings were taken continuously in the pre, during 1, during 2, during 3 and post periods of 5 min each as shown in Fig. 1.

Recording procedure

EEG was recorded using Ag/AgCl disc electrodes. The scalp was prepared using Nuprep skin preparation gel (Weaver and Co., USA). Electrodes with Ten20 conductive EEG Paste (Weaver and Co., USA) were placed at FP_1, C_3, and O_1 referenced to the left ear lobe (A_1), and at FP_2, C_4, and O_2 referenced to the right ear lobe (A_2); based on the standard 10–20 system for electrode placement [15]. Participants were seated in a dimly lit, sound and electrical-noise attenuated cabin adjacent to the recording room. Participants were able to receive instructions or communicate with the examiner using a two way intercom. Throughout a session participants were observed on a closed circuit television, which they were informed about prior to the session.

EEG was recorded using Neurotravel LIGHT (ATES Medica Device, Italy). The sampling frequency was 250 samples per second. The low cut filter was set at .2 Hz and the high cut filter at 30.0 Hz. This had the obvious limitation of not including gamma frequencies, which could not be recorded with this equipment.

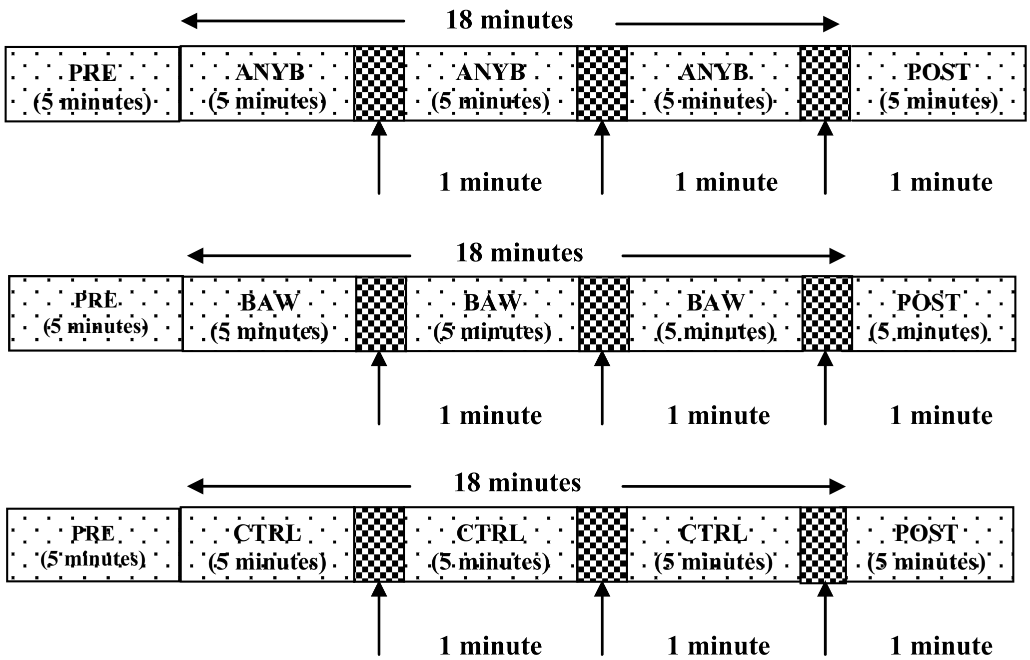

Fig. 1 A schematic representation of the study design. The *stippled area* represents pre, during, and post periods. The *gray area* represents gaps between practice epochs

Interventions

Alternate nostril yoga breathing

The participants sat comfortably with their spine erect and shoulders relaxed with eyes closed. ANYB involves breathing through left and right nostrils alternately without retention of the breath. In this practice the thumb and the ring figure of the right hand were used to manipulate or occlude the nostrils [16]. Participants were asked to sit erect in either the half-lotus posture (*ardha-padmasana*) or complete lotus posture *(padmasana*). They were asked to keep their eyes closed, gently, without effort. After this they were asked to keep their non-dominant hand (the left hand in all participants) on their left knee. They flexed the right arm at the elbow and raised their right hand to the level of their nose. The index and middle fingers of the right hand were flexed to rest their fingertips on their palms, using their thumb and ring figure of the right hand to manipulate or occlude the nostrils [16]. Occlusion of the nostrils was gentle. Participants were asked to begin the breathing practice by exhaling through the left nostril with the right nostril occluded with the right thumb; then inhaling slowly through the left nostril; followed by exhaling through the right nostril with the left nostril occluded with the right ring finger; then inhaling through the right nostril and exhaling through the left nostril. With this exhalation one cycle was complete. The approximate duration of 1 cycle was 6 s; with the ratio of inhale:exhale as 1:1.5 [9]. Participants were asked to continue breathing like this for 5 min. This was timed by the yoga instructor. They were then given 1 min gap during which participants were asked to remain with their eyes closed and to rest their right fingers on their right knee. This (5 min followed by 1 min) was repeated thrice in the session.

Breath awareness

During breath awareness, the participants maintained awareness of the breath without manipulation of the nostrils. Participants were asked to sit erect in either the half-lotus (*ardha padmasana*) or complete lotus (*padmasana*) posture and keep their eyes closed. During this time both arms were extended and the hands were placed on the respective knees. The instructor asked the participants to direct their attention to the movement of air into and out of their nostrils and also direct their awareness to the movement of air through the nasal passages. The period of breath was 5 min, timed by the instructor, followed by instructions to allow attention to wander for 1 min. This (5 min followed by 1 min) was repeated thrice in the session.

Quiet sitting

Participants were asked to sit with their spine erect and shoulders relaxed with eyes closed. Participants were asked to keep their eyes closed and to sit in either the half-lotus (*ardha padmasana*) or complete lotus posture (*padmasana*). They were asked to stretch their arms out to rest the fingers of each hand on the respective knees. Participants were told to allow their thoughts to wander without restrictions. After 5 min they were told there was a 1 min gap, though the instructions during the 1 min gap did not differ from the 5 min preceding it. This (5 and 1 min gap) was repeated thrice in the session.

Data extraction

EEG records were visually inspected for artifacts due to eye or body movements. The recordings were all free from artifact and no part of the records had to be excluded for analysis. The artifact-free data were spectrally analyzed using fast Fourier transform analysis (FFT). This analysis provided the relative power for each band as a percentage of the total power. This was provided for the delta (.5–3.5 Hz), theta (4–7.5 Hz), alpha (8–12) and beta (13–30 Hz) bands. Also, the actual values of the average amplitude within a band for a specific period (e.g., before alternate nostril yoga breathing) were obtained. These values were used for analysis.

Data analysis

Statistical analysis was carried out using SPSS (Version 18.0). Repeated measures analyses of variance (RM-ANOVA) were performed with two within subjects factors, i.e., Sessions (ANYB, BAW and QS), and States (pre, during, and post). An ANOVA was followed by post hoc tests for multiple comparisons with Bonferroni adjustment.

The Bonferroni adjustment was carried out for each of the multiple post hoc comparisons. The comparisons which were considered were the 'during' and 'post' values compared with the 'pre' values of a specific session. This was separate for each EEG band. With the SPSS software Bonferroni adjustment multiplies the uncorrected p value by the number of comparisons; hence α remains unchanged [17].

Results

Repeated-measures analysis of variance

(1) Energy of the EEG bands as a percentage of the whole
The theta energy (%) at $C_4 - A_2$ and $O_2 - A_2$ showed a significant difference between States ($p < .05$; $F = 2.730$, $df = 1, 48$; $p < .05$; $F = 1.868$, $df = 1, 48$ respectively). The beta energy (%) at $FP_2 - A_2$ showed a significant difference between States ($p < .05$; $F = 4.482$, $df = 1, 48$).

(2) Amplitudes of the EEG bands
The beta amplitude at $O_2 - A_2$ showed a significant difference between States ($p < .05$; $F = 8.400$, $df = 1, 48$). The alpha amplitude at $C_4 - A_2$ showed a significant difference between States ($p < .05$; $F = .676$, $df = 1, 48$).

For all comparisons the Huynh–Feldt epsilon was equal to 1.000, hence sphericity was assumed.

Post-hoc analyses with Bonferroni adjustment

The theta energy (%) was significantly reduced at $C_4 - A_2$, and $O_2 - A_2$ during the practice of ANYB compared to the values before the practice ($p < .05$), for both comparisons. In contrast there was a significant increase in the beta energy (%) at $FP_2 - A_2$ sites during QS compared to before QS ($p < .05$).

There was a significant reduction in the beta amplitude at $O_2 - A_2$ after the practice of ANYB compared to before ANYB ($p < .05$). During the QS session there was a significant reduction in the alpha amplitude at $C_4 - A_2$ compared to before QS ($p < .05$).

There were no significant changes following breath awareness. The mean values ± SD for energy (%) and amplitude at $FP_1 - A_1$, $FP_2 - A_2$, $C_3 - A_1$, $C_4 - A_2$, $O_1 - A_1$, and $O_2 - A_2$ electrode sites pre, during and post ANYB, BAW and QS are provided in Tables 2, 3 and 4. Significant changes in EEG energy (%) and EEG amplitude are shown in Figs. 2 and 3, respectively.

Discussion

Contrary to the hypothesis of the study alternate nostril yoga breathing was not associated with any change in cerebral hemisphere EEG symmetry. The relative power in the theta band reduced during alternate nostril yoga breathing (ANYB), while the amplitude of beta waves was lower after ANYB. During the control period of quiet sitting (QS) the relative power in the beta band increased, while the amplitude of the alpha band reduced.

Hemispheric symmetry was determined (1) based on coherence as calculated by the software (Neurotravel, Italy), and (2) based on changes in the EEG amplitude recorded at symmetrical pre-frontal, vertex, and occipital sites over the left and the right hemispheres. As mentioned contrary to the hypothesis, alternate nostril yoga breathing did not alter hemispheric symmetry.

Changes in the relative power in the EEG bands occurred during ANYB and during quiet sitting. There was a decrease in the relative power in the theta band during ANYB at the vertex on the right side. Frontal theta activity has been related to working memory [18] and increased frontal and midline theta were related to a positive emotional state [19]. In general, variations in the power of theta and alpha bands of the EEG are related to complex cognitive functions and memory performance [20]. Hence the decrease in relative theta power may be associated with a better ability to perform certain

Table 2 Energy (%) of the four EEG bands (μV^2) pre, during and post, ANYB, BAW and QS sessions

Sl. no.	Bands	ANYB					BAW					QS				
		Pre M ± SD	During			Post M ± SD	Pre M ± SD	During			Post M ± SD	Pre M ± SD	During			POST M ± SD
			D1 M ± SD	D2 M ± SD	D3 M ± SD			D1 M ± SD	D2 M ± SD	D3 M ± SD			D1 M ± SD	D2 M ± SD	D3 M ± SD	
$FP_1 - A_1$	Delta	31.5 ± 9.6	29.4 ± 12.3	28.9 ± 13.9	28.5 ± 12.2	27.5 ± 11.2	25.2 ± 10.4	24.0 ± 10.4	21.5 ± 10.1	25.5 ± 10.2	26.0 ± 10.4	29.6 ± 10.5	28.0 ± 11.9	28.9 ± 13.9	33.5 ± 15.9	30.8 ± 12.8
	Theta	4.2 ± 2.7	2.8 ± 1.5	4.4 ± 4.0	3.5 ± 2.2	5.0 ± 4.1	3.6 ± 3.2	3.8 ± 2.8	4.0 ± 3.9	3.9 ± 2.6	3.7 ± 2.0	4.0 ± 3.5	4.2 ± 4.1	4.4 ± 4.0	4.3 ± 3.2	4.1 ± 3.3
	Alpha	2.6 ± 1.5	2.9 ± 2.6	2.1 ± 1.5	3.7 ± 4.0	3.0 ± 2.3	3.4 ± 5.5	3.3 ± 4.8	3.6 ± 6.7	4.4 ± 7.2	3.7 ± 5.1	2.4 ± 2.0	2.2 ± 1.7	2.1 ± 1.5	2.3 ± 1.5	.2 ± 1.3
	Beta	.8 ± .4	.8 ± .4	.8 ± .6	1.0 ± .5	1.2 ± .8	.8 ± .8	.8 ± .6	.8 ± .6	1.0 ± .7	.9 ± .7	.7 ± .5	.7 ± .6	.8 ± .6	.7 ± .5	.8 ± .6
$FP_2 - A_2$	Delta	28.4 ± 11.4	26.0 ± 11.1	27.3 ± 14.2	26.7 ± 12.9	25.6 ± 10.3	25.7 ± 9.0	24.2 ± 10.7	21.8 ± 11.3	25.0 ± 11.0	25.7 ± 11.5	27.8 ± 9.4	26.3 ± 12.2	27.3 ± 14.2	29.3 ± 12.1	30.1 ± 12.6
	Theta	3.8 ± 2.4	2.8 ± 1.2	4.8 ± 4.4	4.0 ± 2.5	4.8 ± 3.6	4.1 ± 3.1	4.8 ± 3.6	4.6 ± 4.8	4.7 ± 3.4	4.3 ± 2.6	4.5 ± 3.6	4.8 ± 5.1	4.8 ± 4.4	5.0 ± 3.4	4.8 ± 3.5
	Alpha	2.8 ± 1.8	3.2 ± 2.7	2.4 ± 1.8	4.6 ± 5.0	3.2 ± 2.5	3.7 ± 4.4	3.8 ± 4.0	3.5 ± 4.9	4.7 ± 6.1	4.1 ± 4.6	3.0 ± 2.6	2.6 ± 2.1	2.4 ± 1.8	2.8 ± 1.7	2.8 ± 1.7
	Beta	.6 ± .2	.7 ± .2	.7 ± .5	.2 ± 1.0	.9 ± .5	.7 ± .4	.8 ± .5	.8 ± .6	.9 ± .5	.9 ± .6	.7 ± .4	.7 ± .5	.7 ± .5	.8 ± .5*	.8 ± .5
$C_3 - A_1$	Delta	22.7 ± 6.1	21.5 ± 6.2	24.3 ± 5.5	20.9 ± 7.5	23.7 ± 6.5	21.3 ± 5.7	20.8 ± 7.3	21.7 ± 7.4	22.5 ± 8.1	24.2 ± 8.9	21.9 ± 5.0	23.4 ± 4.0	24.3 ± 5.5	24.7 ± 5.8	23.9 ± 5.3
	Theta	9.6 ± 4.2	8.0 ± 3.0	10.4 ± 4.1	8.6 ± 3.3	10.4 ± 3.0	10.3 ± 6.6	9.4 ± 4.3	9.7 ± 4.4	9.8 ± 4.3	10.5 ± 4.9	9.1 ± 4.2	10.0 ± 4.2	10.4 ± 3.0	10.0 ± 4.1	8.6 ± 3.3
	Alpha	14.3 ± 12.2	13.6 ± 11.6	13.5 ± 11.3	16.5 ± 16.4	16.3 ± 15.1	16.1 ± 15.0	15.6 ± 16.2	16.2 ± 16.8	16.3 ± 16.8	17.2 ± 17.4	15.1 ± 14.1	14.8 ± 12.5	13.5 ± 11.3	13.3 ± 10.4	13.4 ± 11.6
	Beta	2.7 ± 1.5	2.6 ± 1.4	2.9 ± 1.5	3.1 ± 1.6	2.9 ± 1.4	2.6 ± 1.4	2.5 ± 1.5	2.6 ± 1.4	2.7 ± 1.5	2.7 ± 1.4	2.6 ± 1.8	2.8 ± 1.4	2.8 ± 1.5	2.8 ± 1.4	2.9 ± 1.5
$C_4 - A_2$	Delta	24.6 ± 8.1	22.2 ± 8.1	26.8 ± 6.1	21.1 ± 8.9	24.7 ± 7.4	23.7 ± 4.9	23.0 ± 7.0	24.9 ± 7.2	26.1 ± 7.8	26.1 ± 7.8	24.7 ± 5.7	24.8 ± 5.5	26.8 ± 6.1	26.3 ± 5.3	26.6 ± 6.1
	Theta	10.4 ± 4.2	8.2 ± 3.4*	11.5 ± 4.2	8.2 ± 3.4	10.6 ± 2.5	10.9 ± 4.1	11.0 ± 4.6	11.3 ± 3.9	11.8 ± 4.4	11.6 ± 4.6	4.2 ± 10.7	4.2 ± 11.0	3.0 ± 11.5	11.0 ± 3.8	11.1 ± 4.0
	Alpha	15.4 ± 13.0	14.9 ± 13.5	13.2 ± 10.2	15.9 ± 14.3	14.7 ± 11.8	17.6 ± 15.2	16.1 ± 14.5	17.0 ± 15.2	16.8 ± 15.5	17.0 ± 16.2	14.8 ± 12.5	13.3 ± 10.6	13.2 ± 10.2	12.6 ± 10.0	12.5 ± 8.9
	Beta	3.3 ± 1.8	3.7 ± 1.7	2.8 ± .9	4.2 ± 2.8	3.6 ± 1.9	3.2 ± 1.7	2.9 ± 1.3	2.9 ± 1.2	2.8 ± 1.3	2.9 ± 1.2	2.8 ± 1.1	3.0 ± 1.4	2.8 ± .9	2	2.8 ± 1.0
$O_1 - A_1$	Delta	17.8 ± 5.3	17.2 ± 6.5	19.1 ± 6.6	17.5 ± 6.5	20.0 ± 8.2	16.8 ± 6.4	19.6 ± 10.2	18.3 ± 8.9	18.7 ± 9.0	20.1 ± 9.0	17.7 ± 6.3	17.5 ± 5.4	19.1 ± 6.6	19.2 ± 7.2	20.1 ± 6.8
	Theta	6.7 ± 2.9	5.8 ± 3.4	7.2 ± 3.9	6.0 ± 2.9	7.7 ± 2.9	6.5 ± 3.2	7.2 ± 4.0	7.1 ± 4.1	7.5 ± 4.2	7.8 ± 4.2	7.0 ± 3.8	6.7 ± 3.4	7.2 ± 3.9	6.9 ± 3.7	7.2 ± 3.7
	Alpha	21.1 ± 18.2	18.3 ± 17.4	15.4 ± 14.4	21.2 ± 21.0	19.1 ± 18.1	19.1 ± 18.2	18.1 ± 20.2	18.0 ± 20.1	18.5 ± 21.4	18.7 ± 20.8	19.2 ± 17.1	17.3 ± 15.6	15.4 ± 14.4	16.5 ± 15.8	17.2 ± 15.0
	Beta	2.9 ± 1.6	2.9 ± 2.1	2.4 ± 1.0	2.9 ± 2.0	3.2 ± 1.8	2.6 ± 1.3	2.7 ± 1.6	2.7 ± 1.5	2.6 ± 1.4	2.6 ± 1.3	2.5 ± 1.2	2.5 ± 1.2	2.4 ± 1.0	2.4 ± 1.0	2.4 ± .9
$O_2 - A_2$	Delta	19.7 ± 8.8	18.1 ± 7.9	20.9 ± 7.3	18.1 ± 7.4	21.5 ± 8.4	17.7 ± 5.1	19.5 ± 7.6	19.5 ± 5.6	20.1 ± 8.4	19.8 ± 7.5	20.3 ± 7.1	20.1 ± 5.6	20.9 ± 7.3	20.9 ± 7.6	20.7 ± 7.3
	Theta	7.2 ± 2.7	5.8 ± 2.8*	8.6 ± 4.7	6.1 ± 2.2	9.3 ± 4.2	7.0 ± 3.3	7.8 ± 3.6	7.9 ± 2.6	8.1 ± 3.6	7.7 ± 3.2	8.0 ± 3.7	9.0 ± 5.0	8.6 ± 4.6	7.9 ± 4.4	8.2 ± 4.3
	Alpha	20.8 ± 17.9	18.7 ± 17.2	16.3 ± 15.8	20.8 ± 17.4	19.0 ± 14.7	19.8 ± 21.1	17.5 ± 19.8	19.7 ± 20.1	18.3 ± 20.4	17.8 ± 20.0	18.6 ± 17.1	19.0 ± 17.8	16.3 ± 15.8	16.9 ± 16.6	17.7 ± 16.9
	Beta	2.8 ± 1.3	2.8 ± 1.2	2.6 ± 1.4	2.9 ± 1.1	2.8 ± 1.1	2.5 ± 1.2	2.7 ± 1.5	2.8 ± 1.5	2.6 ± 1.4	2.5 ± 1.4	2.6 ± 1.2	2.7 ± 1.3	2.6 ± 1.4	2.4 ± 1.1	2.4 ± 1.1

Comparisons were of post and during values compared with the pre values of the respective session, i.e., ANYB, BAW and QS. $p < .05$, RM ANOVA, followed by post hoc tests with Bonferroni adjustment

ANYB alternate nostril yoga breathing, *BAW* breath awareness, *QS* quiet sitting

Table 3 Amplitudes of the four EEG bands (in µV) pre, during and post, ANYB, BAW and QS sessions

Sl. no.	Band	ANYB					BAW					QS				
		Pre M ± SD	During D1 M ± SD	During D2 M ± SD	During D3 M ± SD	Post M ± SD	Pre M ± SD	During D1 M ± SD	During D2 M ± SD	During D3 M ± SD	Post M ± SD	Pre M ± SD	During D1 M ± SD	During D2 M ± SD	During D3 M ± SD	Post M ± SD
$FP_1 - A_1$	Delta	35.3 ± 16.8	35.0 ± 12.1	35.6 ± 19.5	31.2 ± 12.5	30.0 ± 15.1	34.3 ± 17.9	30.3 ± 15.4	32.2 ± 21.6	28.9 ± 14.8	28.7 ± 13.4	39.0 ± 20.0	35.4 ± 17.1	35.6 ± 19.5	37.4 ± 27.2	35.7 ± 19.1
	Theta	12.1 ± 7.3	10.3 ± 3.2	12.3 ± 9.2	10.5 ± 3.5	11.1 ± 5.4	11.7 ± 8.7	11.8 ± 7.2	11.2 ± 6.1	9.9 ± 3.9	9.8 ± 4.6	12.8 ± 8.3	12.0 ± 8.0	12.3 ± 9.2	12.5 ± 8.8	11.7 ± 7.0
	Alpha	9.1 ± 4.0	9.3 ± 4.3	8.3 ± 4.8	9.9 ± 5.3	8.5 ± 5.2	8.8 ± 4.4	8.4 ± 4.7	9.0 ± 6.0	8.6 ± 5.1	8.0 ± 4.5	9.1 ± 4.4	8.4 ± 4.5	8.3 ± 4.8	8.3 ± 4.7	8.3 ± 4.4
	Beta	5.0 ± 1.9	5.3 ± 1.9	5.0 ± 3.0	5.7 ± 2.8	5.5 ± 3.3	4.9 ± 2.3	4.8 ± 1.9	5.3 ± 3.1	4.9 ± 2.3	4.8 ± 2.2	5.1 ± 2.7	5.1 ± 3.1	5.0 ± 3.0	4.9 ± 2.9	5.0 ± 2.7
$FP_2 - A_2$	Delta	31.0 ± 13.7	30.8 ± 11.6	32.6 ± 19.2	27.0 ± 10.9	26.8 ± 13.3	28.6 ± 12.3	24.8 ± 9.8	29.4 ± 21.1	24.9 ± 12.7	24.5 ± 10.3	34.4 ± 15.8	32.9 ± 17.6	32.6 ± 19.2	33.1 ± 24.6	31.7 ± 16.6
	Theta	11.3 ± 5.9	10.0 ± 2.9	12.2 ± 8.5	10.0 ± 3.2	10.5 ± 4.8	10.6 ± 6.1	10.2 ± 4.1	11.2 ± 6.0	9.8 ± 3.7	9.4 ± 3.6	12.4 ± 7.2	11.9 ± 7.4	12.2 ± 8.5	12.1 ± 7.8	11.5 ± 6.4
	Alpha	9.0 ± 3.9	9.4 ± 4.3	8.6 ± 5.2	10.0 ± 5.4	8.5 ± 5.1	8.8 ± 4.4	8.5 ± 4.7	9.2 ± 6.3	8.9 ± 5.6	8.1 ± 4.4	9.6 ± 4.9	8.9 ± 4.9	8.6 ± 5.2	8.7 ± 5.1	8.7 ± 5.1
	Beta	4.4 ± 1.1	5.0 ± 1.4	4.8 ± 2.2	5.8 ± 2.4	4.8 ± 2.9	4.6 ± 2.0	4.3 ± 1.2	4.8 ± 2.5	4.4 ± 1.7	4.3 ± 1.3	4.9 ± 2.0	5.0 ± 2.5	4.8 ± 2.2	4.8 ± 2.3	4.8 ± 2.1
$C_3 - A_1$	Delta	14.3 ± 2.0	15.4 ± 3.1	14.8 ± 2.8	14.6 ± 2.1	14.0 ± 1.8	14.1 ± 2.2	14.1 ± 2.4	14.7 ± 4.4	14.1 ± 2.9	13.9 ± 3.0	15.7 ± 2.9	14.8 ± 2.4	14.8 ± 2.8	15.0 ± 3.4	14.8 ± 2.8
	Theta	9.4 ± 1.6	9.2 ± 1.9	9.7 ± 2.5	9.6 ± 2.1	9.4 ± 1.9	9.2 ± 1.9	9.5 ± 2.1	9.8 ± 3.3	9.4 ± 2.3	9.0 ± 1.8	9.9 ± 2.5	9.6 ± 2.7	9.7 ± 2.5	9.6 ± 2.6	9.7 ± 2.8
	Alpha	10.1 ± 5.6	10.8 ± 6.2	10.6 ± 6.8	11.9 ± 7.4	11.0 ± 7.1	10.5 ± 5.8	10.6 ± 6.5	11.2 ± 7.4	10.9 ± 6.9	10.1 ± 6.2	11.6 ± 6.9	10.9 ± 6.6	10.6 ± 6.8	10.6 ± 6.2	10.7 ± 6.7
	Beta	4.8 ± 1.3	5.2 ± 1.5	5.1 ± 2.1	5.7 ± 1.7	4.9 ± 1.6	4.9 ± 1.5	4.9 ± 1.6	5.1 ± 2.1	4.8 ± 1.6	4.6 ± 1.5	5.2 ± 2.0	5.1 ± 1.8	5.1 ± 2.1	5.1 ± 1.9	5.2 ± 1.9
$C_4 - A_2$	Delta	14.7 ± 2.0	15.3 ± 2.8	14.9 ± 3.3	15.1 ± 2.9	14.1 ± 2.5	14.7 ± 2.2	14.9 ± 3.3	14.8 ± 3.5	15.0 ± 3.1	14.4 ± 2.4	15.1 ± 3.1	14.9 ± 3.4	14.9 ± .3.3	15.1 ± 4.8	15.0 ± 3.6
	Theta	9.5 ± 1.8	9.3 ± 2.1	9.7 ± 2.5	9.7 ± 2.0	9.4 ± 1.8	9.9 ± 2.3	10.1 ± 2.6	10.2 ± 3.1	10.2 ± 2.8	9.6 ± 2.1	9.8 ± 2.3	9.7 ± 2.5	9.7 ± 2.5	9.5 ± 2.4	9.5 ± 2.4
	Alpha	10.8 ± 5.2	11.9 ± 5.8	10.3 ± 6.0	13.0 ± 6.7	10.7 ± 6.1	11.5 ± 6.4	11.5 ± 7.2	12.0 ± 7.9	11.6 ± 7.6	10.9 ± 6.8	11.2 ± 6.0	10.5 ± 5.7	10.3 ± 6.0	10.2 ± 5.6*	10.2 ± 5.6
	Beta	5.6 ± 2.6	6.8 ± 3.4	5.2 ± 1.6	7.6 ± 5.1	5.5 ± 2.2	5.2 ± 1.4	5.1 ± 1.8	5.2 ± 1.9	5.0 ± 1.9	4.9 ± 1.6	5.2 ± 1.8	5.2 ± 1.9	5.2 ± 1.6	4.9 ± 1.5	5.0 ± 2.0
$O_1 - A_1$	Delta	12.9 ± 3.7	16.0 ± 7.8	14.0 ± 4.8	17.1 ± 7.6	12.8 ± 3.4	13.0 ± 2.9	13.2 ± 3.8	13.1 ± 3.8	13.1 ± 4.4	12.1 ± 2.5	13.3 ± 14.7	14.7 ± 6.4	14.0 ± 4.8	14.5 ± 6.2	14.4 ± 5.7
	Theta	8.0 ± 2.7	8.8 ± 4.3	8.4 ± 2.8	9.3 ± 4.0	7.9 ± 2.8	8.1 ± 2.6	8.3 ± 2.6	8.1 ± 2.5	8.2 ± 2.8	7.8 ± 3.1	8.5 ± 2.5	8.4 ± 2.7	8.4 ± 2.8	8.2 ± 2.6	8.3 ± 3.0
	Alpha	13.5 ± 10.1	14.7 ± 11.2	12.3 ± 9.6	15.6 ± 12.3	12.6 ± 11.0	12.9 ± 8.6	12.5 ± 9.9	13.0 ± 9.8	12.5 ± 10.2	11.7 ± 9.7	13.5 ± 9.2	13.6 ± 9.8	12.3 ± 9.6	12.2 ± 8.9	12.5 ± 9.1
	Beta	5.2 ± 2.2	6.3 ± 3.9	5.0 ± 2.0	6.2 ± 3.0	5.1 ± 2.7	5.2 ± 1.8	5.1 ± 1.9	5.1 ± 2.2	4.9 ± 2.0	4.6 ± 2.0	5.2 ± 2.1	5.1 ± 2.0	5.0 ± 2.0	4.9 ± 1.9	4.9 ± 2.0
$O_2 - A_2$	Delta	13.2 ± 3.7	15.0 ± 6.0	13.9 ± 4.2	14.1 ± 4.1	12.3 ± 2.7	12.3 ± 1.7	12.1 ± 2.1	12.0 ± 2.8	12.5 ± 3.1	11.8 ± 1.8	14.1 ± 3.7	13.7 ± 4.0	13.9 ± 4.2	14.0 ± 4.9	14.2 ± 5.0
	Theta	8.3 ± 2.5	8.6 ± 2.9	8.7 ± 3.3	8.5 ± 2.6	8.2 ± 2.4	7.7 ± 1.7	7.8 ± 2.1	7.9 ± 2.4	7.9 ± 2.1	7.6 ± 2.0	8.7 ± 3.1	8.6 ± 3.4	8.7 ± 3.3	8.3 ± 3.0	8.5 ± 3.4
	Alpha	13.7 ± 9.2	15.0 ± 10.4	11.9 ± 10.5	15.3 ± 10.7	12.2 ± 9.1	11.6 ± 7.1	10.9 ± 7.1	11.4 ± 7.4	11.1 ± 7.3	10.6 ± 6.9	13.3 ± 9.9	12.5 ± 9.9	11.9 ± 10.5	11.7 ± 9.1	12.2 ± 9.8
	Beta	5.2 ± 2.4	6.2 ± 3.3	4.8 ± 2.0	5.9 ± 2.5	4.7 ± 2.1*	4.6 ± 1.4	4.5 ± 1.5	4.5 ± 1.7	4.5 ± 1.6	4.3 ± 1.4	5.2 ± 2.2	4.9 ± 1.9	4.8 ± 2.0	4.7 ± 1.9	4.7 ± 2.1

Comparisons were of post and during values compared with the pre values of the respective session, i.e., ANYB, BAW and QS. $p < .05$, RM ANOVA, followed by post hoc tests with Bonferroni adjustment

ANYB alternate nostril yoga breathing, *BAW* breath awareness, *QS* quiet sitting

Table 4 Left right coherence as a measure of hemisphere asymmetry, recorded at prefrontal, vertex and occipital sites in ANYB, BAW and QS sessions

Sl. no.	$FP_1 - A_1$ and $FP_2 - A2$ (max)		$C_3 - A_1$ and $C_4 - A_2$ (max)		$O_1 - A1$ and $O_2 - A_2$ (max)		$FP_1 - A1$ and $FP_2 - A_2$ (2-peck)		$C_3 - A1$ and $C_4 - A_2$ (2-peck)		$O_1 - A_1$ and $O_2 - A_2$ (2-peck)	
	Mean	SD	Mean	SD	Mean	SD	Mean	SD	Mean	SD	Mean	SD
ANYB												
Pre	.92	.04	.89	.03	.79	.07	.87	.05	.86	.04	.72	.07
D1	.90	.05	.87	.05	.76	.10	.85	.08	.84	.05	.69	.10
D2	.90	.05	.88	.03	.78	.07	.85	.07	.85	.04	.71	.07
D3	.90	.05	.88	.04	.77	.09	.85	.08	.84	.05	.70	.09
Post	.91	.04	.90	.03	.79	.07	.91	.18	.87	.03	.73	.06
BAW												
Pre	.90	.06	.89	.03	.78	.06	.87	.07	.86	.04	.72	.07
D1	.89	.06	.88	.03	.78	.05	.90	.23	.85	.03	.73	.06
D2	.90	.05	.89	.03	.79	.06	.86	.06	.86	.03	.73	.05
D3	.89	.05	.89	.03	.78	.05	.85	.05	.85	.03	.72	.05
Post	.89	.06	.95	.22	.79	.05	.85	.06	.96	.41	.73	.05
QS												
Pre	.93	.05	.89	.03	.80	.06	.89	.06	.85	.03	.74	.05
D1	.91	.05	.89	.03	.80	.06	.87	.06	.85	.04	.75	.05
D2	.91	.05	.88	.04	.80	.05	.87	.06	.85	.04	.74	.06
D3	.91	.05	.88	.03	.79	.06	.87	.06	.85	.03	.74	.06
Post	.92	.06	.89	.03	.80	.06	.88	.07	.85	.05	.75	.06

ANYB alternate nostril yoga breathing, *BAW* breath awareness, *QS* quiet sitting

cognitive tasks, though the connection is not strong. The theta activity increases in several conditions including drowsiness associated with a decreased ability to perform specific tasks [20].

The increase in relative power of the beta band of the EEG during quiet sitting over the right prefrontal region could suggest increased alertness, arousal and excitement, which are associated with increased beta wave activity [21]. Conversely, the amplitude of the beta wave band was lower after ANYB recorded over the right occipital region. Beta wave activity is not well understood, and its functional role remains only partially explained [22]. For instance research has shown that increased beta wave activity generated in the motor cortex is related to slow motor behavior [23]. A decrease of beta wave power (i.e., desynchronization) is believed to be an indicator of movement preparation, execution, and motor imagery [24, 25]. An arousal based theory [26] may help explain the changes in beta activity found in the present study. The arousal theory suggests that increased beta activity is associated with increased mental activity or arousal [26]. This suggests that after ANYB there is a decrease in arousal consistent with descriptions of yoga breathing as calming [8]. During the quiet sitting session, in contrast, the decrease in alpha amplitude over the right vertex could suggest greater arousal associated with random thinking in the absence of specific instructions [27]. This finding of increased activation during quiet sitting has been found in other studies [28]. It was suggested that the mental state during quiet sitting may be comparable to the state of mind wandering and self-referential processing [29].

Most of the changes described above (during and after ANYB, and during QS) occurred on the right side. These results may be considered comparable to those of an earlier study which assessed cerebral hemisphere specific task performance in 135 participants, aged between 10 and 17 years [30]. Participants were randomly assigned to (1) left nostril breathing, (2) right nostril breathing, (3) alternate nostril breathing, (4) breath awareness or (5) a control state. Hence there were 5 groups ($n = 27$ each) who practiced the intervention they were assigned to for 10 days. At the beginning and end of the 10 day period participants were assessed using verbal and spatial memory tasks, considered specific for left and right hemispheric functions, respectively. All four active intervention groups (left, right and alternate nostril yoga breathing as well as breath awareness) showed a significant increase by 84% in spatial memory scores at the end of 10 days. These results suggested that yoga breathing

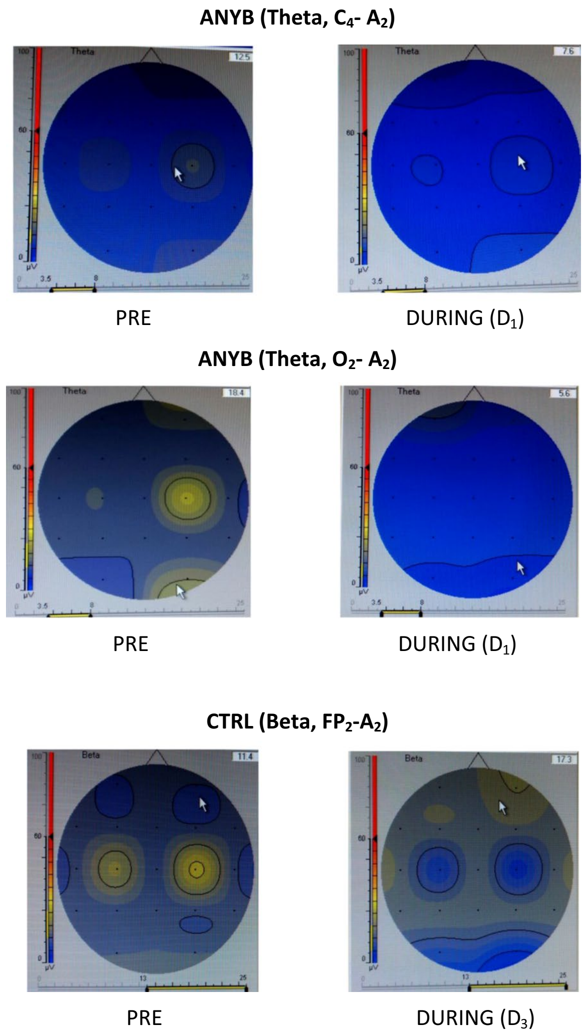

Fig. 2 Energy of the theta and beta bands (μV^2). Energy of the theta band (μV^2) showing a significant reduction at $C_4 - A_2$ and $O_2 - A_2$ during alternate nostril yoga breathing compared to before. Energy of the beta band increased during quiet sitting compared to before at $FP_2 - A_2$

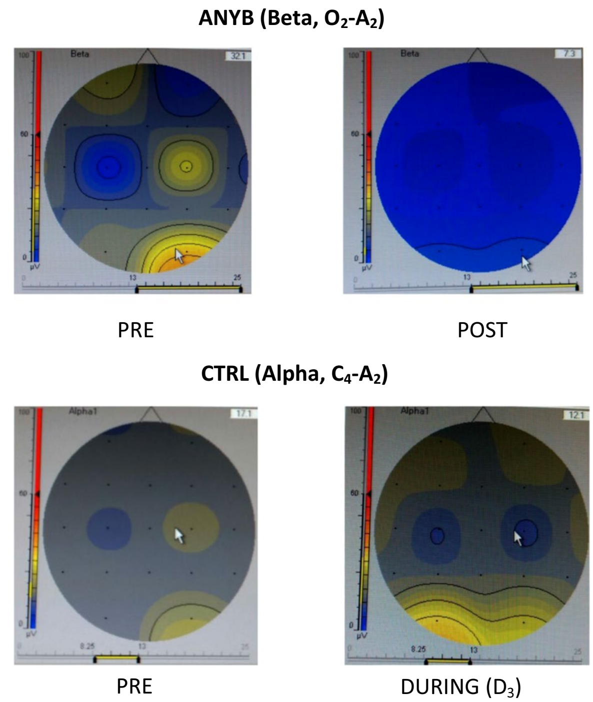

Fig. 3 Amplitudes of the beta and alpha bands (μV). Amplitude of the beta band (μV) showing a significant reduction at $O_2 - A_2$ during alternate nostril yoga breathing compared to before. Amplitude of the alpha band decreased during quiet sitting compared to before at $C_4 - A_2$

increases right hemisphere task performance. In the present study it is possible that during quiet sitting the participants who were trained in *pranayama* practiced yoga breathing inadvertently. It remains unclear why the breath awareness sessions showed no change unlike the study cited above. A possible reason is the small sample size which is a limitation of the study. Also, the present study assessed EEG, while the study cited above [30] assessed verbal and spatial memory task performance. It would have been ideal to record both measurements simultaneously. Hence simultaneous recording of the EEG and cognitive tasks could be a definite direction for future research.

The findings of the present study are limited by (a) the small sample size (n = 13; effect size = .11 (low), and (b) the inability to record and report the gamma band of the EEG with the equipment used.

Despite these limitations, this may be considered a pilot study which has results suggesting that ANYB may be calming and may possibly influence cognitive functions.

Conclusions

Contrary to the hypothesis of the study there was no change in cerebral hemisphere asymmetry during alternate nostril yoga breathing. Alternate nostril yoga breathing resulted in a decrease in theta band energy at the vertex and occipital sites on the right side. There was a decrease in the amplitude of the beta band after alternate nostril yoga breathing at the right occipital site, while the amplitude of the alpha band reduced during sitting quietly without specific instructions at the right vertex site. Also during sitting quietly without specific instructions there was an increase in energy in the beta band at the right prefrontal site.

Importance and relevance

Airflow through the nostril can impact the EEG. In this case alternate nostril yoga breathing had effects on the EEG suggesting that the practice can be calming and reduce arousal.

Abbreviations

A_1: reference (left ear lobe); A_2: reference (right ear lobe); ANYB: alternate nostril yoga breathing; BAW: breath awareness; C_3: vertex, left side; C_4: vertex, right side; QS: quiet sitting; EEG: electroencephalography; FFT: fast Fourier transform; FP_1: left pre-frontal; FP_2: right pre-frontal; M: mean; O_1: left occipital; O_2: right occipital; RM-ANOVA: repeated measures analysis of variance; SD: standard deviation.

Authors' contributions

ST conceptualized and designed the study, interpreted the data, reviewed the literature and prepared the manuscript. RKG assisted in compiling the manuscript and completing the revision. AY collected the data, analyzed it statistically, carried out the literature review and assisted in manuscript compilation. SP collected the data and assisted in the review of literature. AB conceptualized and designed the study. All authors read and approved the final manuscript.

Acknowledgements

The authors gratefully acknowledge the funding from Divya Yog Mandir Trust to conduct the study.

Competing interests

The authors declare that they have no competing interests.

Availability of data and materials

The original data of individual participants are available in spread sheets and can be accessed on request. At present we have no repository for these data generated on individual participants.

Consent to publish

Written informed consent was obtained from participants to participate in the study and to share images or data if required.

Ethics approval and consent to participate

The experimental procedure was approved by the ethical committee of Patanjali Research Foundation and signed informed consent was obtained from each participant before beginning the study.

Funding

The research was funded by Divya Yog Mandir Trust, Haridwar, India.

Publisher's Note

Springer Nature remains neutral with regard to jurisdictional claims in published maps and institutional affiliations.

Received: 28 July 2016 Accepted: 13 July 2017
Published online: 24 July 2017

References

1. Shannahoff-Khalsa D. Unilateral forced nostril breathing: basic science, clinical trials, and selected advanced techniques. Subtle Energ Energy Med J. 2001;12(2):79–106.
2. Shannahoff-Khalsa DS, Kennedy B, Yates FE, Ziegler MG. Ultradian rhythms of autonomic, cardiovascular, and neuroendocrine systems are related in humans. Am J Physiol. 1996;270(4 Pt 2):R873–87.
3. Shannahoff-Khalsa DS, Kennedy B, Yates FE, Ziegler MG. Low-frequency ultradian insulin rhythms are coupled to cardiovascular, autonomic, and neuroendocrine rhythms. Am J Physiol. 1997;272(3 Pt 2):R962–8.
4. Werntz DA, Bickford RG, Bloom FE, Shannahoff-Khalsa DS. Alternating cerebral hemispheric activity and the lateralization of autonomic nervous function. Hum Neurobiol. 1983;2(1):39–43.
5. Werntz DA, Bickford RG, Shannahoff-Khalsa D. Selective hemispheric stimulation by unilateral forced nostril breathing. Hum Neurobiol. 1987;6(3):165–71.
6. Kristof M, Servit Z, Manas K. Activating effect of nasal air flow on epileptic electrographic abnormalities in the human EEG. Evidence for the reflect origin of the phenomenon. Physiol Bohemoslov. 1981;30(1):73–7.
7. Stancák A, Hönig J, Wackermann J, Lepicovská V, Dostálek C. Effects of unilateral nostril breathing on respiration, heart rhythm and brain electrical activity. Neurosciences. 1991;17:409–17.
8. Stancák A Jr, Kuna M. EEG changes during forced alternate nostril breathing. Int J Psychophysiol. 1994;18(1):75–9.
9. Ramdev S. Pranayama Rahasya. Haridwar: Divya Prakshan; 2009.
10. Telles S, Naveen KV. Voluntary breath regulation in yoga: its relevance and physiological effects. Biofeedback. 2008;36(2):70–3.
11. Muktibodhananda S. Swara yoga: the tantric science of brain breathing. Munger: Bihar School of Yoga; 1999.
12. Telles S, Yadav A, Kumar N, Sharma S, Visweshwaraiah NK, Balkrishna A. Blood pressure and purdue pegboard scores in individuals with hypertension after alternate nostril breathing, breath awareness, and no intervention. Med Sci Monit. 2013;19:61–6.
13. Oldfield RC. The assessment and analysis of handedness: the Edinburgh inventory. Neuropsychologia. 1971;9:97–114.
14. Research Randomizer. https://www.randomizer.org/. Accessed 10 Oct 2015.
15. Jasper HH. The ten-twenty electrode system of the International federation. Electroencephalogr Clin Neurophysiol. 1958;10:371–5.
16. Telles S, Raghavendra BR. Yoga physiology and applications in therapy and rehabilitation. In: Tandon OP, Tripathi Y, editors. Best & Taylor's physiological basis of medical practice. Philadelphia: Lippincott Williams & Wilkins; 2011. p. 1217–30.
17. Telles S, Sharma SK, Gupta RK, Bhardwaj AK, Balkrishna A. Heart rate variability in chronic low back pain patients randomized to yoga or standard care. BMC Complement Altern Med. 2016;16:279.
18. Jensen O, Tesche CD. Frontal theta activity in humans increases with memory load in a working memory task. Eur J Neurosci. 2002;15:1395–9.
19. Aftanas LI, Golocheikine SA. Human anterior and frontal midline theta and lower alpha reflect emotionally positive state and internalized attention: high-resolution EEG investigation of meditation. Neurosci Lett. 2001;310:57–60.
20. Klimesch W. EEG alpha and theta oscillations reflect cognitive and memory performance: a review and analysis. Brain Res Rev. 1999;29(2–3):169–95.
21. Steriade M, Gloor P, Llinas RR, Da-Silva FHL, Mesulam MM. Basic mechanisms of cerebral rhythmic activities. Clin Neurophysiol. 1990;76:481.
22. Jensen O, Goel P, Kopell N, Pohja M, Hari R, Ermentrout B. On the human sensorimotor-cortex beta rhythm: sources and modeling. Neuroimage. 2005;26(2):347–55.
23. Pogosyan A, Gaynor LD, Eusebio A, Brown P. Boosting cortical activity at beta-band frequencies slows movement in humans. Curr Biol. 2009;19(19):1637–41.
24. Pfurtscheller G, Neuper C. Motor imagery activates primary sensorimotor area in humans. Neurosci Lett. 1997;239(2–3):65–8.
25. Zhang Y, Chen Y, Bressler SL, Ding M. Response preparation and inhibition: the role of the cortical sensorimotor beta rhythm. Neuroscience. 2008;156(1):238–46.
26. Andreassi JL. Psychophysiology. Human behavior and physiological response. London: Lawrence Erlbaum Associates; 2000.
27. Neznamov GG, Bochkarev VK, Reutova MA, Shabanova AA, Siuniakov SA. Ladasten versus placebo effect self-evaluated by neurasthenia patients with different EEG alpha rhythm types. Eksp Klin Farmakol. 2012;75(5):7–13.
28. Telles S, Gupta RK, Singh N, Balkrishna A. A functional near-infrared spectroscopy study of high-frequency yoga breathing compared to breath awareness. Med Sci Monit Basic Res. 2016;22:58–66.
29. Whitfield-Gabrieli S, Moran JM, Nieto-Castañón A, Triantafyllou C, Saxe R, Gabrieli JD. Associations and dissociations between default and self-reference networks in the human brain. Neuroimage. 2011;55:225–32.
30. Naveen KV, Nagarathna R, Nagendra HR, Telles S. Yoga breathing through a particular nostril increases spatial memory scores without lateralized effects. Psychol Rep. 1997;81(2):555–61.

Psychology Research and Behavior Management

ISSN: (Print) (Online) Journal homepage: https://www.tandfonline.com/loi/dprb20

Psychological Impacts of COVID-19 in Dental Patients are Moderated and Mediated by Hospital-Infection-Control-Policy and Satisfaction-with-Life: A Prospective Observational Dental-COVID Study

Acharya Balkrishna, Kuldeep Singh, Gurpreet Oberoi, Pratima Singh, Preeti Raj & Anurag Varshney

To cite this article: Acharya Balkrishna, Kuldeep Singh, Gurpreet Oberoi, Pratima Singh, Preeti Raj & Anurag Varshney (2022) Psychological Impacts of COVID-19 in Dental Patients are Moderated and Mediated by Hospital-Infection-Control-Policy and Satisfaction-with-Life: A Prospective Observational Dental-COVID Study, Psychology Research and Behavior Management, , 913-925, DOI: 10.2147/PRBM.S351948

To link to this article: https://doi.org/10.2147/PRBM.S351948

Published online: 17 Nov 2022.

Psychology Research and Behavior Management

Dovepress
open access to scientific and medical research

Open Access Full Text Article

ORIGINAL RESEARCH

Psychological Impacts of COVID-19 in Dental Patients are Moderated and Mediated by Hospital-Infection-Control-Policy and Satisfaction-with-Life: A Prospective Observational Dental-COVID Study

Acharya Balkrishna[1,2], Kuldeep Singh[3], Gurpreet Oberoi[3], Pratima Singh[1,4], Preeti Raj[1], Anurag Varshney[1,2,5]

[1]Clinical Research Division, Patanjali Research Institute, Haridwar, Uttarakhand, India; [2]Department of Allied and Applied Sciences, University of Patanjali, Haridwar, Uttarakhand, India; [3]Dental Clinic & Research Center, Patanjali Bharatiya Ayurvigyan Evam Anusandhan Sansthan, Haridwar, Uttarakhand, India; [4]School of Public Health, University of Alberta, Edmonton, Canada; [5]Special Centre for Systems Medicine, Jawaharlal Nehru University, New Delhi, India

Correspondence: Anurag Varshney, Email anurag@prft.co.in

Introduction: COVID-19 pandemic has imposed nation-wide lock-downs which severely impacted day-to-day lifestyle and caused anxiety, stress and fear among patients taking medical care including dental treatments. These psychological behaviors have also been observed during the strategic relaxation of social restrictions (Unlock). However, potential effect of these psychological behavior in endodontic cases have not been probed. Here, it is of great interest to explore the magnitude and buffering effect of two important psychological resources: satisfaction-with-life, and confidence in hospital-infection-control-policy in relation with COVID-19 risk perception on psychological impact due to fear for COVID-19.

Methods: Patients visiting Dental Clinic & Research Center for endodontic procedures were randomly asked to fill survey questionnaire, and were later enrolled as per the study criteria. The study carried out in two phases: from 15 Sept 2020 to 15 Dec 2020 (restrained confinement; Unlock 1.0); and from 16 Dec 2020 to 12 Feb 2021 (mild confinement; Unlock 2.0) with total sample size of 136. We used data collection tools such as fear-of-COVID-19 scale (FCV-19), perceived-stress-scale (PSS), modified-dental-anxiety-scale (MDAS), satisfaction-with-life scale (SWLS), COVID-19 risk perception, and confidence in hospital-infection-control-policy for COVID-19.

Results: A double moderation and dual moderated mediation structured model were used to establish the correlation of various parameters using SPSS (version 25.0) software suite. Confidence in hospital-infection-control-policy and SWLS were negatively correlated with FCV-19, MDAS, and PSS. Risk perception of COVID-19 was found to positively associated with FCV-19, MDAS, and PSS.

Discussion: Patient's confidence in hospital-infection-control-policy for COVID-19 and SWLS acted as independent moderator for FCV-19 and mental distress. FCV-19 and risk perception were found to be lower during mild confinement (Unlock 2.0), and were also the positive predictors of PSS; and negative predictors of SWLS. The higher SWLS correlated very well with lower COVID-19 risk perception, concerning PSS and MDAS.

Keywords: fear for COVID-19, risk perception of COVID-19, perceived stress, dental surgical procedures, satisfaction with life

Introduction

Our society, and the world as we know it, have been transformed in unprecedented ways by the COVID-19 pandemic. With finite resources and no evidence-based antiviral therapy, the COVID-19 outbreak created havoc, leading to severe

Received: 30 December 2021
Accepted: 12 March 2022
Published: 16 April 2022

mental insecurity and panic-like situation.[1] In order to manage the rapidly spreading infection and exponentially rising death tolls, the Government of India issued a 21-day nationwide lockdown on 25th March 2020. This put both healthy and unhealthy citizens, into an extemporaneous situation disrupting their day-to-day life. The situation soon led to widespread anxiety and stress, calling for mental health management, particularly, among the patients.[2] There were subsequent extensions of the lockdown, but with strategic lifts of certain restrictions, particularly, those pertaining to medical assistance and procurement of medical products and essential supplies. Dental clinics were declared essential services under the annex of the advisory order DE-22-BDS (Academic)- 2020/16042020 dated 16th April 2020. In this regard, the Dental Council of India, prioritized endodontic cases of "dental pain from pulpal inflammation, extensive dental caries or defective restorations" as imperative dental care, while suspending all others as nonessential procedures.

Increased public awareness on the risk of transmission of infective agents amongst dental patients and care providers has been shown to add extra preventative measures to clinical practices, during COVID-19 pandemic times.[3] Previous studies have registered a pooled prevalence of anxiety levels, due to both endodontic procedures related and unrelated factors.[4] Such endodontic procedures related to psychological effects are influenced mainly by prior experiences. In a pandemic situation, these psychological effects were compounded by the additional fear of contracting COVID-19.[5] The majority of psychosocial researches reported until now are in context of medical conditions unrelated to emergency and elective dental treatment. Thus, studies addressing the magnitude of mental health burden in dental patients in correlation with a pandemic as an unrelated contributing external factor will prove extremely informative. From a public health perspective, such organized studies can provide insights and clarity for dealing with psychological burdens in patients, who are under the influence of fear factors from more than one unrelated medical source. Aligning with this rationale, in the present study a double moderation and a dual moderated mediation model has been tested. In this model, patient satisfaction and confidence from emergency dental health services were expected to buffer the fear arising from the COVID-19 pandemic (Figure 1A). Satisfaction due to improved medical assistance experienced by the patients at the time of endodontic procedures helped in managing mental stress arising from the COVID-19 pandemic. This demonstrated how alleviation of stress from one medical condition could help in co-managing the mental burden from an unrelated medical cause. The above model was based on the postulation that COVID-19 fear could expand the risk perception, adding to the likelihood of mental distress. So, we also hypothesized that Satisfaction-with-Life would attenuate the association between risk perception and mental distress. Therefore, we further included the survey group (Unlock 1.0 and Unlock 2.0) as a moderator between fear for COVID-19 and risk perception. This is based on the fact that the COVID-19 is expressly circumstance related, while satisfaction of life is more steady and therefore likely to follow different temporal dynamics (Figure 1B).

Materials and Methods

Study Setting and Design

The present study was a prospective observational repeated cross-sectional study with a longitudinal design, which has been conducted as per STROBE (Strengthening the Reporting of Observational Studies in Epidemiology) guidelines (Appendix Table 1). The study was carried out in two phases, from 15 Sept 2020 to 15 Dec 2020 (restrained confinement); and from 16 Dec 2020 to 12 Feb 2021 (mild confinement). For the purpose of comparatively analyzing the psychological impacts of COVID-19, these time periods have been labeled as "Unlock 1.0" and "Unlock 2.0", respectively. Study was conducted at Dental Clinic and Research Centre, Patanjali Bharatiya Ayurvigyan Evam Anusandhan Sansthan, Haridwar, Uttarakhand, India.

Participants

Dental patients visiting Dental Clinic and Research Centre, Patanjali Bharatiya Ayurvigyan Evam Anusandhan Sansthan, Haridwar, Uttarakhand, India for endodontic procedure were randomly asked to fill survey questionnaire, and were later enrolled on the basis of study criteria. Inclusion criteria for the study were ≥18 years of age, complaints of dental pain with over-sensitization and discomfort with a confirmed diagnosis for need of endodontic or dental extraction procedures. The lockdown restrictions and the contextual requirement for recruitment time frame had a significant impact on the

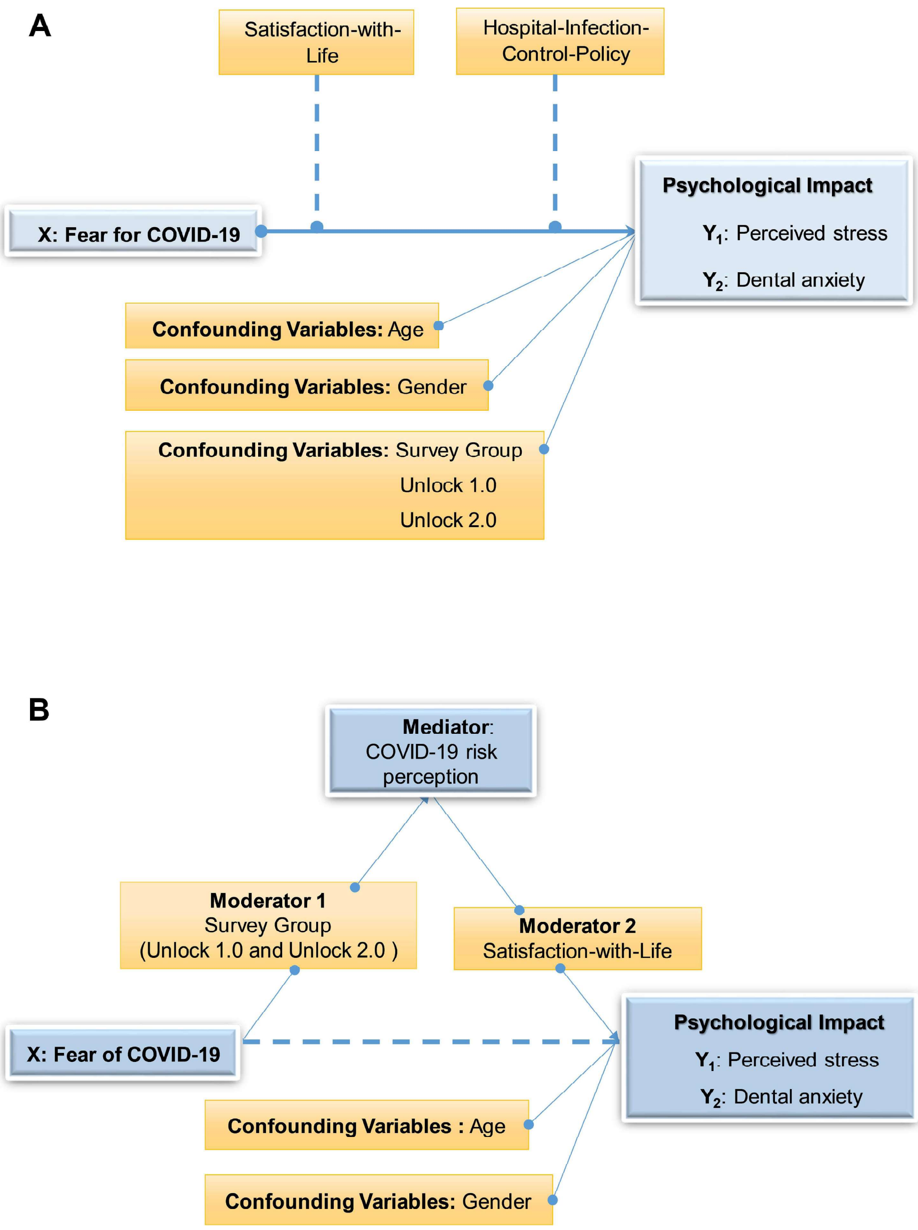

Figure 1 The hypothetical schema for dental-COVID study. (**A**) Confidence on hospital-infection-control-policy and satisfaction-with-life (SWL) moderate relationship between fear of COVID-19 (FCV-19) and psychological impact (dental anxiety perceived stress). (Double moderation process model 2). (**B**) COVID-19 risk perception mediates the relationship between fear for COVID-19 (FCV-19) and psychological impact (dental anxiety, perceived stress) with survey group and satisfaction-with-life (SWL) as a moderator. (Dual moderated mediation, process model 21).
Abbreviation: CV, covariates.

sample size of the study. Total of 72 participants were enrolled during restrained confinement (Unlock 1.0); whereas 64 participants were enrolled during mild confinement (Unlock 2.0), taking the study sample size to 136 dental patients.

Study Construct and Outcome Measures

Patient information was extracted through forward and backward translation of the filled questionnaires, that included two sections. The information on demographic features (age, gender, education, type of diet and co-morbid) and COVID-19 were collected from the first section, whereas the second section provided study measures and variables. The first section also collected information on frequency of dental visits per year, last visit for dental check-up, number of decayed teeth, and last diagnosis. Information pertaining to individual COVID-19 infection and infection/death in the family was also obtained from this section.

An individual's COVID-19-related fear was measured from a seven-itemed, fear for COVID-19 Scale (FCV-19),[6] giving a total score between 7 and 35, with higher score indicating greater fear for COVID-19. Global level of stress felt by the participants was evaluated on a ten-itemed Perceived-Stress-Scale (PSS) questionnaire that assessed thoughts and feelings from the previous month, on a five-point Likert scale (1 = never, 2 = rarely, 3 = sometimes, 4 = often, and 5 = always).[7,8] The score ranged from 10 to 50, with a higher score indicating increased perceived stress.[9–11] Prior to treatment, dental-related psychological construct was created on a five-itemed Modified-Dental-Anxiety-Scale (MDAS), with a minimum-maximum range of 5–25, and a cut-off of ≥19, empirically accepted as indicative of high dental anxiety.[12–15] The Satisfaction-with-Life scale (SWLS) appraised the global cognitive judgments of one's life satisfaction,[16] based on the total scores (sum of all five items) ranging from 5 to 35, with higher scores suggesting greater life satisfaction.[17] A two-part questionnaire for COVID-19 Risk Perception and Hospital-Infection-Control-Policy for COVID-19 was designed in-house, reviewed, revised and validated by epidemiologists. The four-itemed first part on COVID-19 risk perception determined the magnitude of the uneasiness experienced by the participants upon personal or family exposure/diagnosis of COVID-19, with a Cronbach alpha (α) reliability score of 0.74. The second part, Hospital-Infection-Control-Policy for COVID-19, assessed a patient's confidence in infection-control measures practiced by hospital management, with a high internal reliability coefficient of 0.90.[18]

Statistical Analysis

SPSS Version 25.0 (PROCESS 3.5) was used to conduct a double moderation and a dual moderated mediation at <0.05 significance level, through bootstrapping of 5000 samples. The pattern of data distribution was identified from the Kurtosis and skewness coefficients.[19] Analysis of co-variance (ANCOVAs) were used to assess for differences between two categorical groups. Pearson correlation coefficient analysis was used to determine the relationships between the variables.

Results

Descriptive Statistics

All variables were found to be continuous in nature except for gender, survey group, and COVID-19 testing. Close to 60% of respondents were men. The age and education categorization, showed no significant differences in the demographic parameters between the two groups (Appendix Table 2).

It was observed that patients were affected by their synergistic dental and COVID-19 conditions. During Unlock 1.0, 16.2% of patients reported moderate; whereas 34.6% stated severe stress symptoms. These dynamics were different during Unlock 2.0, with 34.6% and 5.6% moderate and severe stress symptoms, respectively. Almost 50% reduction was observed in these dynamics from Unlock 1.0 to Unlock 2.0, as evident from 22.4% to 12.9% patients having cut-off beyond 19 on MDAS. Confidence in Hospital-Infection-Control-Policy also increased from 27.9% during Unlock 1.0 to 44.1% in Unlock 2.0 in the patients. SWLS showed a similar upward trend during Unlock 2.0 with a 24.3% increase from Unlock 1.0 (Figure 2 and Table 1).

Correlation matrix of all the six study variables, namely, COVID-19 risk perception, Confidence in Hospital-Infection-Control-Policy, FCV-19, MDAS, PSS and SWLS, from both Unlock 1.0 and Unlock 2.0 revealed that the data was coherent with its distribution well within the respective confidence limits (Figure 3A and B). The regression correlation coefficient (r) was observed to be at an optimal level ($0.05 < r < 0.6$) (Table 2). Confidence in Hospital-Infection-Control-Policy and SWLS were negatively correlated with FCV, MDAS, and PSS. COVID-19 risk perception had a positive association with FCV, MDAS, and PSS. We also conducted a multi-collinearity test on all the study data. Commonly, there could be a multi-collinearity skew when the correlation coefficient (r) is above 0.9, so a correlation coefficient of less than 0.6, as observed in our study, would be an acceptable baseline for validated analysis.[20] In addition, variance of inflation (VIF) is directly proportional to multi-collinearity. More specifically, multi-collinearity is not a problem if the tolerance value is greater than 0.10 or VIF is less than 10. In our study, the lowest tolerance value is 0.63 and the highest VIF is 3.78, confirming no bearing of multi-collinearity on our datasheet and its analysis.

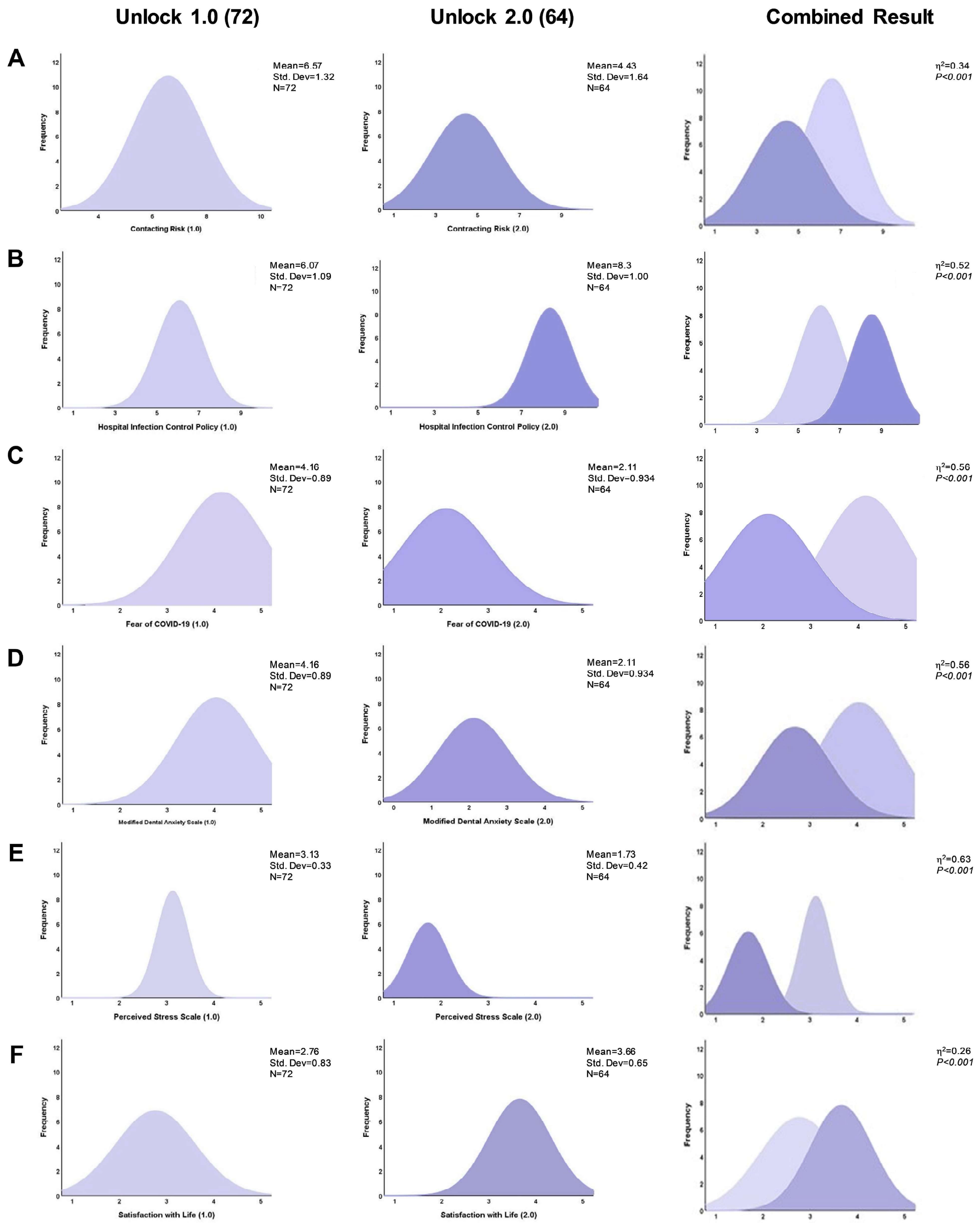

Figure 2 Difference [mean, standard deviation, effect size, and significance (p < 0.05)] in Unlock 1.0 and Unlock 2.0 for all the study variables: (**A**) COVID-19 risk perception; (**B**) hospital-infection-control-policy; (**C**) fear for COVID-19 (FCV-19); (**D**) dental anxiety; (**E**) perceived stress; (**F**) Satisfaction-with-life (SWL). [Std Dev: standard deviation; η^2 (effect size) which measures the strength of relationship between two variables].

https://doi.org/10.2147/PRBM.S351948

Table 1 Cut-off Distribution of All Study Variable (COVID-19 Risk Perception, Hospital Infection Policy for COVID-19, Fear of COVID-19, Dental Anxiety, Perceived Stress, and Satisfaction with Life) Based on Demographic Factor (Age, Gender), Dental Procedure (Extraction and Root Canal Treatment; RCT) and Survey Group (Unlock 1.0); Restrained Confinement; (Unlock 2.0) Mild Confinement

Variable	Total	Gender		Age Group				Type of Dental Procedure		Survey Group		p (chi)*
		Male (%)	Female (%)	19–29 (%)	30–39 (%)	40–49 (%)	>50 (%)	Extraction (%)	RCT (%)	Unlock 1.0 (%)	Unlock 2.0 (%)	
COVID-19 risk perception												
Beyond cutoff of 60%	50.7	41.9	26.5	13.2	19.1	11.8	24.3	43.4	25	**45.6**	**22.8**	**<0.001***
Dental hospital infection control policy for COVID-19												
Beyond cutoff of 60%	72.1	40.4	31.6	15.4	23.5	11.0	22.1	51.5	20.6	**27.9**	**44.1**	**<0.001***
Fear of COVID-19												
Beyond cutoff of 47.14%	72.8	44.9	27.9	13.2	20.6	12.5	26.5	48.5	24.3	50.7	22.1	0.185
Dental anxiety												
% Beyond cutoff 19	35.3	14.0	21.3	5.1	7.4	8.1	14.7	24.3	11.0	**22.4**	**12.9**	**<0.001***
Perceived stress												
Medium	50.7	23.5	27.2	8.8	14.7	7.4	19.9	30.9	19.9	**16.2**	**34.6**	**<0.001***
High	40.4	14.7	25.7	8.8	12.5	6.5	12.5	33.1	7.4	**34.6**	**5.9**	**0.016***
Satisfaction with life												
Extremely dissatisfied	50.7	30.1	20.6	11.8	19.9	5.1	14.0	38.2	12.5	**13.2**	**37.5**	**<0.001***

Notes: *p value was considered significant at <0.05 between survey group (unlock 1.0 and unlock 2.0), significance level analysis was performed through chi-square (chi) test. All significant values have been marked in bold text.

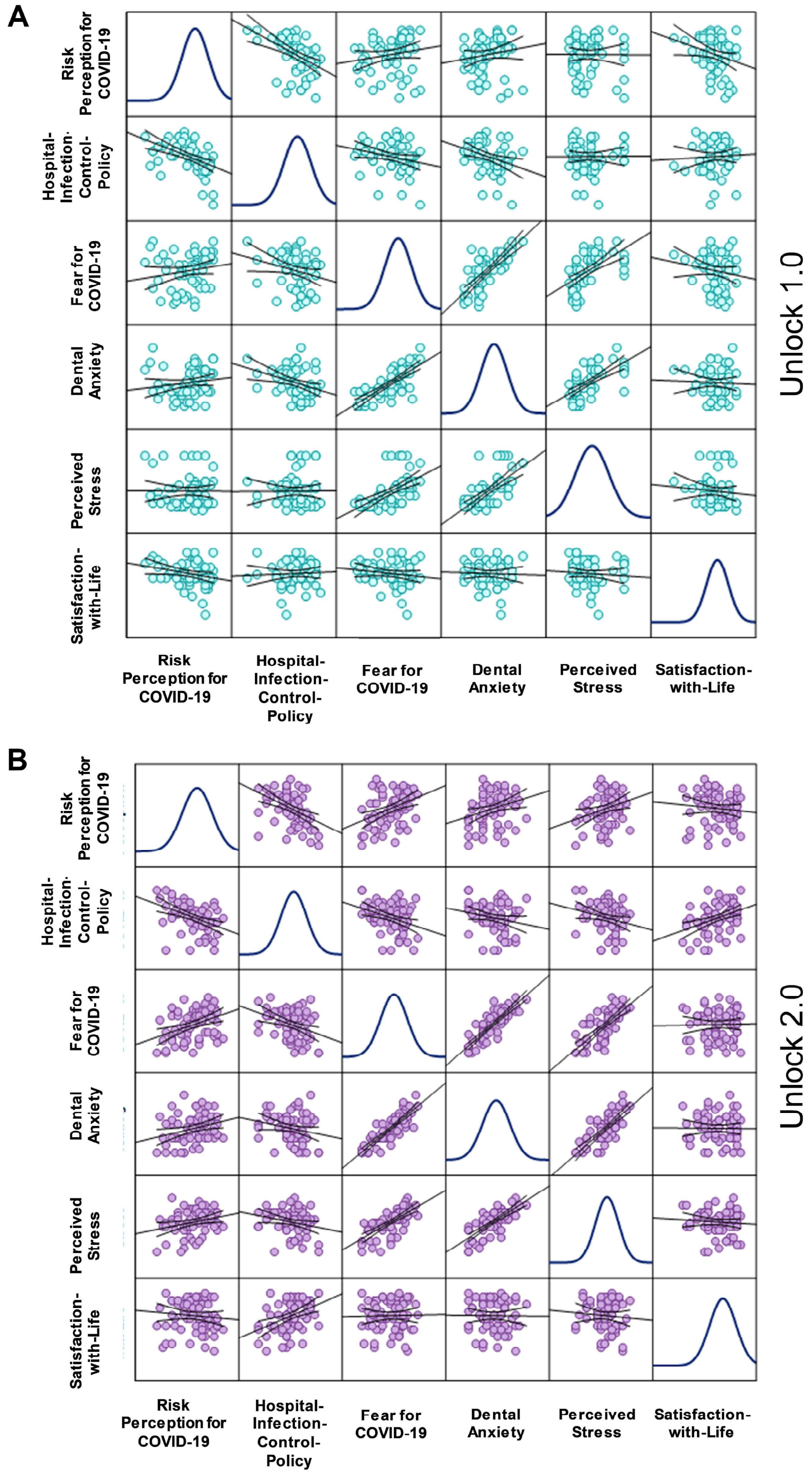

Figure 3 Pearson correlation analysis of patients included in the study with all the study variables: COVID-19 risk perception; hospital-infection-control-policy; fear for COVID-19 (FCV-19); dental anxiety; perceived stress; satisfaction-with-life (SWL) in the survey group (**A**) Unlock 1.0 (restrained confinement); (**B**) Unlock 2.0 (partial confinement).

Note: Blue colour normal distribution (bell curve) depicts perfect positive correlation between two variables.

Table 2 Summary Representation of Pearson Correlation of Significant Continuous Variables as Depicted in Figure 3

Variable	Fear for COVID-19	Dental Anxiety	Perceived Stress
COVID-19 risk perception **Dental hospital infection control policy for COVID-19**	0.547** −0.357**	0.550** −0.565**	0.460** −0.550**
Fear of COVID-19	1	0.689**	0.465
Dental anxiety	0.689**	1	0.752**
Perceived stress	0.465**	0.752**	1
Satisfaction with life	−0.254**	−0.338**	−0.482**

Note: **Correlation was significant at *p* value 0.001 level (two tailed).

Predicting Variables for Fear for COVID-19

Before testing our main hypothesis, we have reported the effect sizes (partial η^2) of potential predictors, namely, demographics and dental associated information, for increased FCV-19 (Appendix Table 3). The major effect was attributed to age ($p < 0.00$), education status ($p < 0.001$), and frequency of dental visits per year ($p = 0.002$). According to the data spread, participants in 40–49-year age group contributed most to FCV-19 variable (mean = 3.59 ± 0.34, $p < 0.001$). Based on this analysis, age was controlled during the subsequent testing of our hypothesis. We also observed that intermediate levels of education contributed to a higher level of FCV-19 (mean = 3.96 ± 0.13, $p < 0.001$). Likewise, a 3–4 dental visits were associated with raised FCV-19 (mean = 3.25 ± 0.14, $p = 0.002$).

Patient's Confidence in Hospital-Infection-Control-Policy for COVID-19 Moderated the Effects of FCV-19 on Components of Psychological Distress (MDAS and PSS)

We postulated that psychological distress is a function of personal characteristics and external stressors such as health conditions. We specifically asked whether confidence in Hospital-Infection-Control-Policy for COVID-19 and SWLS would moderate the effect of FCV-19 on psychological impact. FCV-19, confidence in Hospital-Infection-Control-Policy for COVID-19, SWLS, age, and survey group contributed to 66% of variance in PSS and 75% variance in MDAS. The pooled effect of these variables on PSS was significant with a variance (R^2) of 0.66 at F (8127) = 102.9330 ($p < 0.001$). Likewise, these variables moderated the MDAS model with a variance (R^2) of 0.75 at F (8127) = 92.84 ($p < 0.001$) (Table 3). Confidence in Hospital-Infection-Control-Policy for COVID-19 independently affected the association between FCV-19 and PSS with a variance (R^2) of 0.001 at F (1, 127) = 1.02 ($p = 0.01$). Association of FCV-19 with MDAS was also significantly affected by this variable as evident from a variance (R^2) of 0.004 at F (1, 127) = 4.26 ($p = 0.04$). SWLS also independently moderated the interactions between FCV-19 and PSS [R^2 = 0.005, F (1, 127) = 11.01 ($p = 0.008$)] and MDAS [R^2 = 0.004, F (1, 127) = 4.26 ($p = 0.04$)].

Risk Perception as a Moderated Mediator Between Fear for COVID-19 and Psychological Distress (MDAS and PSS)

The outputs of the dual moderated mediation analysis are provided in (Table 4). Our second hypothesis suggested that increased risk perception for contracting COVID-19 might jeopardize existential security and influence psychological well-being of patients.[21] This hypothesis assumes COVID-19 risk perception as a mediator between FCV-19 and psychological distress (PSS/MDAS). SWLS is assumed to reduce the probability of experiencing perceived stress and dental anxiety, thus moderating the path between COVID-19 risk perception and psychological distress. COVID-19 risk perception are lower in Unlock 2.0, making it another possible moderator of the path between FCV-19 and COVID-19 risk perception, as evident from the observed significant variance of (R^2) 0.41 [F (1, 132) = 32.44 ($p < 0.001$)]. With higher SWLS, patients experience lower levels of FCV-19, whereas patients with raised COVID-19 risk perception experience more FCV-19 post Unlock 2.0 [R^2 = 0.40, F (3, 132) = 18.44 ($p < 0.001$)]. The interaction of both of these parameters indicates a significant reduction in

Table 3 Conditional Direct Model of Satisfaction with Life and Dental Hospital Infection Control Policy Through Fear of COVID-19 and Double Moderated Effect of Psychological Impact (Perceived Stress and Modified Dental Anxiety)

Effect	Coeff.	SE	t	95% CI for Estimated Mean		p*	Coeff.	SE	t-test	95% CI for Estimated Mean		p*
				LL	UL					LL	UL	
	Perceived Stress Scale						Modified Dental Anxiety Scale					
Constant	2.14	0.62	3.45	0.92	3.37	**<0.00**	1.80	0.86	2.09	0.09	3.51	**<0.000**
Fear of COVID 19 (X)	0.28	0.14	1.95	−0.00	0.56	**<0.00**	0.56	0.19	2.81	0.16	0.95	**0.005**
Dental Hospital Infection Control Policy (Mod 1)	−0.01	0.01	−0.53	−0.03	0.02	**<0.00**	−0.53	0.02	−2.43	−0.09	−0.01	**0.010**
Interaction 1 (X*Mod 1)	0.01	0.00	0.44	−0.01	0.01	**<0.00**	0.13	0.00	2.36	0.00	0.02	**0.002**
Satisfaction with Life (Mod 2)	−0.23	0.13	−1.77	−0.49	0.02	**0.03**	−0.15	0.18	0.84	−0.20	0.51	**0.005**
Interaction (X*Mod 2)	0.02	0.04	0.68	−0.05	0.10	**0.02**	−0.53	0.05	−1.05	0.15	0.04	**0.004**
Age	0.00	0.00	0.11	−0.00	0.00	**<0.00**	−0.01	0.01	0.63	0.05	0.024	**0.002**
Gender[a]	0.01	0.05	0.25	−0.09	0.12	0.79	−0.61	0.49	1.23	1.58	0.365	0.218
Survey Group[b]	−0.88	0.08	−1.91	−1.04	−0.72	**<0.00**	−0.99	0.84	−1.18	−2.64	0.662	0.237
	R^2 =0.66, F (8127) =102.93; p < 0.00						R^2 =0.75, F (8127) =92.84; p < 0.00					

Notes: *p value was significant at <0.05. All significant values have been marked in bold text. [a]Male = 1, female = 2; [b]Unlock 1.0 =1, unlock 2.0 =2.
Abbreviations: SE, standard error; CI, confidence interval; LL, lower limit; UL, upper limit; DV, dependent variable.

Table 4 Conditional Indirect Model with Mediating Effects of COVID-19 Risk Perception and Double Moderating Effects of Satisfaction with Life and Survey Group Besides Perceived Stress as Dependent Variable

Effect	Coeff.	SE	t	95% CI for Estimated Mean		p*	Coeff.	SE	t-test	95% CI for Estimated Mean		p*
				LL	UL					LL	UL	
	Survey Group						Perceived Stress (DV)					
Constant	3.03	0.38	8.05	2.29	3.78	**<0.00**	1.62	0.42	3.88	0.79	2.44	**<0.00**
Fear of COVID-19 (X)	0.15	0.09	1.69	−0.03	0.32	**<0.00**	0.19	0.11	1.69	−0.03	0.41	**0.01**
COVID-19 Risk Perception (Med)							0.02	0.00	3.39	0.01	0.03	**<0.00**
Survey Group (Mod 1)												
Interaction (X*Mod 1)	0.07	0.05	1.30	−0.04	0.18	**<0.00**						
Satisfaction with life (Mod 2)							−0.26	0.11	−2.30	−0.48	−0.04	**0.02**
Interaction (Med*Mod 2)							0.04	0.03	1.46	−0.02	0.10	**0.05**
Age	0.001	0.004	0.46	−0.01	0.10	0.65	0.00	0.00	0.55	−0.01	0.01	0.19
Gender[a]	0.07	0.14	0.48	−0.21	0.34	0.63	0.24	0.15	1.62	−0.05	0.53	0.11
	R^2 =0.63, F (2132) =103.9; p < 0.00						R^2 =0.39, F (2132) =112.90; p < 0.00					

Notes: *p value was significant at <0.05. All significant values have been marked in bold text. [a]Male = 1, female = 2.
Abbreviations: SE, standard error; CI, confidence interval; LL, lower limit; UL, upper limit; DV, dependent variable.

SWLS after mild confinement. The pooled effect of FCV-19, COVID-19 risk perception, along with survey group as a moderator between these two, interaction between SWLS and COVID-19 risk and demographics of age and gender accounted for 63% of the variance [F (1, 127) = 103.9 (p < 0.001)]. We also found that COVID-19 risk perception decreases with a decrease in patient's fear for COVID-19 during Unlock 2.0 (Appendix Figure 1A). Likewise, the pooled effect of all these variables affected perceived stress [R^2 = 0.39, F (2, 132) = 12.90 (p < 0.001)]. Higher COVID-19 risk perception was found to be associated with lower SWLS concerning PSS [R^2 = 0.04, F (1, 132) = 0.06 (p = 0.049)].

Similar to PSS, the pooled effect of the analyzed variables moderated MDAS [R^2 = 0.39, F (2, 132) = 28.44 (p = 0.001)] (Table 5). The interaction between FCV-19 and the survey group independently also moderated MDAS [R^2 = 0.46, F (2, 132) = 32.72 (p = 0.021)].

The mediator-moderator crosstalk between COVID-19 risk perception and SWLS generated a variance (R^2) of 0.01 [F (2, 132) = 2.81 (p = 0.10)], indicating that high COVID-19 risk perception in patients with low SWLS led to increased PSS and MDAS, in contrast to patients with high SWLS (Appendix Figure 1B).

An index value of −0.09 (SE = 0.20, 95% CI = 0.2–0.02) of the moderated mediation model supported the hypothesis that the mediator, COVID-19 risk perception, modulated the effect of FCV-19 on psychological impacts through the moderators, survey group and SWLS.

Discussion

The present study reports the acute psychological stress in patients seeking emergency dental services during the COVID-19 Unlock 1.0 and Unlock 2.0 phases in India. Generation of high aerosols and small distance between the patients and doctors increases the risk of infection.[22,23] Previous studies have highlighted the impact of COVID-19 on mental health on patients with different health conditions.[24] Similarly, we found a reduction in the association with SWLS and confidence in Hospital-Infection-Control-Policy for COVID-19.

Moderate FCV-19 was observed in the participants of this study, with moderate to high psychological distress levels in most cases. Such psychological distresses can be attributed to dental surgical experiences with high probability of

Table 5 Conditional Indirect Model with Mediating Effects of COVID-19 Risk Perception and Double Moderating Effects of Satisfaction with Life and Survey Group Besides Dental Anxiety as Dependent Variable

Effect	Coeff.	SE	t	95% CI for Estimated Mean		*p**	Coeff.	SE	t-test	95% CI for Estimated Mean		*p**
				LL	UL					LL	UL	
	Survey Group						Modified Dental Anxiety Scale (DV)					
Constant	0.65	0.67	0.97	−0.68	1.99	**0.033**	0.27	0.61	0.77	0.14	1.49	**0.006**
Fear of COVID-19 (X)	0.88	0.16	1.60	0.57	1.20	**0.000**	0.81	0.16	4.98	0.49	1.14	**0.000**
COVID-19 Risk Perception (Med)							0.01	0.01	1.20	0.01	0.02	**0.003**
Group (Mod 1)												
Interaction (X*Mod 1)	0.06	0.10	0.58	0.05	0.14	**0.042**						
Satisfaction with Life (Mod 2)							0.08	0.17	0.17	0.06	0.30	**0.030**
Interaction (Med*Mod 2)							0.09	0.04	0.13	0.08	0.18	**0.002**
Age	0.00	0.00	−0.79	−0.01	0.00	0.43	0.00	0.01	−0.55	−0.01	0.01	0.59
Gender[a]	−0.16	0.10	−1.64	−0.36	0.03	0.10	0.24	0.15	1.62	−0.05	0.53	0.11
	R^2 =69, F (2132) =59.01; *p* < 0.00						R^2 =0.39, F (2132) =28.44; *p* < 0.00					

Notes: *p value was significant at <0.05. All significant values have been marked in bold text. [a]MALE = 1, female = 2.
Abbreviations: SE, standard error; CI, confidence interval; LL, lower limit; UL, upper limit; DV, dependent variable.

hospital-acquired infection transmission.[25,26] In previous studies, the prevalence of FCV-19 has not been specified as other emotional states predictive of fear, such as anxiety in dental patients.[27]

Elderly patients, patients with post-graduate education status and those with dental hospital visits more than seven times during the confinement period experienced greater fear for COVID-19. The previous studies reveal that the two main factors that can generate high levels of fear and anxiety are the virulence and lethality of COVID-19, especially in aged individuals and those with existing comorbidities.[28] This finding is insightful for the predictors of critical experiences. In addition, hospital visits have also been an independent factor for increased fear for COVID-19. This new and unexpected pandemic situation has caused changes in hospital routines and protocols which could well be a speculated reason for the observed increase in fear in the population.[29]

COVID-19 risk perception has a significant association with three components: FCV-19, MDAS, and PSS. Previous studies showed that a strong correlation of risk perception with the seriousness of an endemic such as Middle East Respiratory Syndrome and H1N1 flu is an independent predictor of protective behaviors.[30] Researchers accept that a higher level of risk perception can stimulate anxiety and stress, which encourages the adoption of mediating strategies.[31] The current study has demonstrated that the confidence in the Hospital-Infection-Control-Policy of COVID-19 was negatively related to psychological distress. The present study also shows that SWLS has a negative association with psychological distress, in line with the earlier observations.[32]

Besides investigating the occurrence and complex impact of fear during the pandemic, the present study showcases positive direct and moderating effects of two psychological resources: confidence in Hospital-Infection-Control-Policy for COVID-19, and SWLS. As expected, decreased FCV-19 was associated with substantially less psychological distress, when patients had satisfaction with their lives, due to confidence in medical services for managing the pandemic. SWLS and the confidence in Hospital-Infection-Control-Policy for COVID-19 had buffering effects that attenuated the acute psychological impact due to COVID-19.

Hospital-Infection-Control-Policy for COVID-19 and SWLS were two parameters which acted as individual supportive structures in the patient's duration of a hospital visit and surgical endodontic procedures during this COVID-19 pandemic. The reduction in risk perception for COVID-19 and FCV-19 were significantly marked in Unlock 2.0 when compared to Unlock 1.0.

The findings might have a few inherent limitations. The sampling method, with a 78.8% response rate, infused a chance of bias due to non-respondents, which may limit the generalization of our findings. The correlative findings from this study should cautiously extended to cases other than endodontic procedures. Some scales were newly developed, whose suitability was preliminarily validated for the current study. Preliminary indications of its validity can be inferred from the fact that the scale correlated with demographic characteristics and study variables. Finally, the cross-sectional samples to yield insights on mental health outcomes and existential endpoints with the mediation model could be less probable as hypothesized. We tried to mitigate this problem by testing models with different implied directions. Albeit, follow-up studies are programmed to make it more representative and longitudinal research to explore the relationship between defined variables.

Conclusion

This study indicated that elderly patients had relatively higher fear of contracting COVID-19. This problem will likely be even further worsened if the hospitals are filled with COVID-19 patients, leading to interrupted access of regular healthcare to non-COVID patients. In response to this delinquency, the policymakers should put efforts to provide tele-health consultations remotely. From our findings, Hospital-Infection-Control-Policy and SWLS were independent moderators to psychological distress and fear for contracting COVID-19. Considering that as an underlying important measure for mitigation of COVID-19, availability of adequate health care facilities under designed policy should be considered at utmost priority. Robust infection control measures could be implemented as an indicator of the performance of health-care systems. We observed a relatively high psychological impact and risk perception for COVID-19 especially during the refrained confinement, suggesting that long-term negative developments are being triggered by the lockdown. Also, higher SWLS correlated with lower COVID-19 risk perception and psychological distress. Hence, mental health intervention programs would be important to increase the training activities aimed at increasing life satisfaction, in order to protect public mental health, especially for the dental patients. It would strengthen the patient's resilience, coping strategies and reduce stress, eventually resulting in overall psychological well-being.

Future Directions

Implementing robust hospital-infection-control-policy markedly reduce the possibility of nosocomial infections during these challenging times of COVID-19 pandemic. Therefore, importance of an effective implementation of Hospital-Infection-Control-Policy for COVID-19 becomes central to SWLS of dental patients, especially in the developing world. This study lays a stronger foundation for longer term psycho-somatic studies across geographical boundaries. This would hopefully direct towards better patient compliances in terms of their dental well-beings.

Ethical Consideration and Informed Consent Form

The study and the related procedures were conducted in compliance with the guidelines of "Ethical principles for medical research involving human subjects" of the Helsinki Declaration. The study was approved by the Institutional Ethics committee (IEC), Patanjali Bhartiya Ayurvigyan Evam Anusandhan Sansthan, Haridwar, Uttarakhand, India (vide approval # PAC/IEC/2021/01). The study and surgical procedures were executed according to standard local dental protocols classified as surgical procedures done in the oral and maxillofacial area. These were consistent with the hospital policy following dental advisory issued by the Ministry of Health and Family Welfare (MoHFW), India.[33] The written informed consent was obtained from each participant after the nature of the study procedures was explicitly explained.

Acknowledgments

The authors offer their heartfelt thanks to Dr. Swati Haldar for manuscript revision; Ms. Ritu Tyagi for data collection. We extend our gratitude to Ms. Priyanka Kandpal, Mr. Tarun Rajput, Mr. Gagan Kumar, and Mr. Lalit Mohan for their swift administrative supports.

Disclosure

Acharya Balkrishna is an honorary trustee in Divya Yog Mandir Trust that governs Divya Pharmacy, Haridwar; and holds an honorary managerial position in Patanjali Ayurved Ltd., Haridwar, Uttarakhand, India. Divya Pharmacy and/or Patanjali Ayurved Ltd., Haridwar were not involved in any aspects of the study reported here. All other authors declare no conflicts of interests.

References

1. Soni P. Effects of COVID-19 lockdown phases in India: an atmospheric perspective. *Environ Dev Sustain*. 2021;23(8):12044–12055. doi:10.1007/s10668-020-01156-4
2. Kuitunen I, Ponkilainen VT, Launonen AP, et al. The effect of national lockdown due to COVID-19 on emergency department visits. *Scand J Trauma Resusc Emerg Med*. 2020;28(1):1–8. doi:10.1186/s13049-020-00810-0
3. Sinjari B, D'ardes D, Santilli M, et al. SARS-CoV-2 and oral manifestation: an observational, human study. *J Clin Med*. 2020;9(10):1–14. doi:10.3390/jcm9103218
4. Doerr PA, Lang WP, Nyquist LV, Ronis DL. Factors associated with dental anxiety. *J Am Dent Assoc*. 1998;129(8):1111–1119. doi:10.14219/jada.archive.1998.0386
5. Siripraparat C, Apisarnthanarak P, Ullman M, Saengaram P, Leeprechanon N, Weber DJ. Patients' anxiety, fear, and panic related to coronavirus disease 2019 (COVID-19) and confidence in hospital infection control policy in outpatient departments: a survey from four Thai hospitals. *Infect Control Hosp Epidemiol*. 2020;1240:1–2. doi:10.1017/ice.2020.1240
6. Ahorsu DK, Lin CY, Imani V, Saffari M, Griffiths MD, Pakpour AH. The fear of COVID-19 scale: development and initial validation. *Int J Ment Health Addict*. 2020;1–9. doi:10.1007/s11469-020-00270-8
7. Cohen S, Kamarck T, Mermelstein R. A global measure of perceived stress. *J Health Soc Behav*. 1983;24(4):385–396. doi:10.2307/2136404
8. Sun Y, Gao L, Kan Y, Shi BX. The Perceived Stress Scale-10 (PSS-10) is reliable and has construct validity in Chinese patients with systemic lupus erythematosus. *Lupus*. 2019;28(2):149–155. doi:10.1177/0961203318815595
9. Torales J, Ríos-González C, Barrios I, et al. Self-perceived stress during the quarantine of COVID-19 pandemic in Paraguay: an exploratory survey. *Front Psychiatry*. 2020;11:1–6. doi:10.3389/fpsyt.2020.558691
10. Aslan I, Ochnik D, Çınar O. Exploring perceived stress among students in Turkey during the covid-19 pandemic. *Int J Environ Res Public Health*. 2020;17(23):1–17. doi:10.3390/ijerph17238961
11. Rastogi S, Narayan D, Harsh R. Since January 2020 Elsevier has created a COVID-19 resource centre with free information in English and Mandarin on the novel coronavirus COVID- 19. The COVID-19 resource centre is hosted on Elsevier Connect, the company's public news and information; 2020.

12. Corah NL. Development of a dental anxiety scale. *J Dent Res*. 1969;48(4):596. doi:10.1177/00220345690480041801
13. Humphris GM, Freeman R, Campbell J, Tuutti H, D'Souza V. Further evidence for the reliability and validity of the Modified Dental Anxiety Scale. *Int Dent J*. 2000;50(5):367–370. doi:10.1111/j.1875-595X.2000.tb00570.x
14. Humphris GM, Dyer TA, Robinson PG. The modified dental anxiety scale: UK general public population norms in 2008 with further psychometrics and effects of age. *BMC Oral Health*. 2009;9(1):1–8. doi:10.1186/1472-6831-9-20
15. Jain M, Tandon S, Sharma A, Jain V, Yadav NR. Cross-cultural adaption, validity and reliability of a Hindi version of the Corah's Dental Anxiety Scale. *Heal Promot Perspect*. 2018;8(2):120–126. doi:10.15171/hpp.2018.15
16. Diener E. *Assessing Well-Being: The Collected Works of Ed Diener*. Springer; 2009:101–102. doi:10.1007/978-90-481-2354-4
17. López-Ortega M, Torres-Castro S, Rosas-Carrasco O. Psychometric properties of the Satisfaction with Life Scale (SWLS): secondary analysis of the Mexican Health and Aging Study. *Health Qual Life Outcomes*. 2016;14(1):1–7. doi:10.1186/s12955-016-0573-9
18. Ng KYY, Zhou S, Tan SH, et al. Understanding the psychological impact of COVID-19 pandemic on patients with cancer, their caregivers, and health care workers in Singapore. *JCO Glob Oncol*. 2020;(6):1494–1509. doi:10.1200/go.20.00374
19. DS Research. Most common language spoken in India 2011. Statista; 2020. Available from: https://www.statista.com/statistics/616508/most-common-languages-india/. Accessed April 8, 2022.
20. Sun JJ, Wang P, Du YN, Liu J. Analysing the influence factors of single task pricing based on public packet system: an Empirical Study in China. *J Phys Conf Ser*. 2020;1437(1):012100. doi:10.1088/1742-6596/1437/1/012100
21. Krok D, Zarzycka B. Risk perception of COVID-19, meaning-based resources and psychological well-being amongst healthcare personnel: the mediating role of coping. *J Clin Med*. 2020;9(10):3225. doi:10.3390/jcm9103225
22. Dave M, Seoudi N, Coulthard P. Urgent dental care for patients during the COVID-19 pandemic. *Lancet*. 2020;395(10232):1257. doi:10.1111/ors.12489.Meng
23. Vázquez LMR, López ER, Centelles AV, Otero AIB, Otero FV, Centelles PIV. Stress amongst primary dental care patients. *Med Oral Patol Oral Cir Bucal*. 2008;13(4):253–256.
24. Ramasubramanian V, Mohandoss AA, Rajendhiran G, Pandian PRS, Ramasubramanian C. Statewide survey of psychological distress among people of Tamil Nadu in the COVID-19 pandemic. *Indian J Psychol Med*. 2020;42(4):368–373. doi:10.1177/0253717620935581
25. Mahdee AF, Gul SS, Abdulkareem AA, Qasim SSB. Anxiety, practice modification, and economic impact among Iraqi dentists during the COVID-19 outbreak. *Front Med*. 2020;7. doi:10.3389/fmed.2020.595028
26. Zhou Q, Gao Y, Wang X, et al. Nosocomial infections among patients with COVID-19, SARS and MERS: a rapid review and meta-analysis. *Ann Transl Med*. 2020;8(10):629. doi:10.21037/atm-20-3324
27. Olivier JG, de Espana C, Encinas M, Ruiz F, Miro Q. General anxiety in dental staff and hemodynamic changes over endodontists' workday during the coronavirus disease 2019 pandemic: a Prospective Longitudinal Study. J Endod. 2020;47(2):196–203.
28. Tannenbaum MB, Hepler J, Zimmerman RS, Saul L, Jacobs S. Appealing to fear: a meta-analysis of fear appeal effectiveness and theories. *Psychol Bull*. 2018;141(6):1178–1204. doi:10.1037/a0039729
29. Cui S, Jiang Y, Shi Q, et al. Impact of covid-19 on anxiety, stress, and coping styles in nurses in emergency departments and fever clinics: a cross-sectional survey. *Risk Manag Healthc Policy*. 2021;14:585–594. doi:10.2147/RMHP.S289782
30. Bults M, Beaujean DJMA, De Zwart O, et al. Perceived risk, anxiety, and behavioural responses of the general public during the early phase of the Influenza A (H1N1) pandemic in the Netherlands: results of three consecutive online surveys. *BMC Public Health*. 2011;11:1–13. doi:10.1186/1471-2458-11-2
31. Lombardo P, Jones W, Wang L, Shen X, Goldner EM. The fundamental association between mental health and life satisfaction: results from successive waves of a Canadian national survey. *BMC Public Health*. 2018;18(1):1–9. doi:10.1186/s12889-018-5235-x
32. Martin RA. *The Psychology of Humor: An Integrative Approach*. Elsevier; 2007; doi:10.1037/a0012776
33. Saha S. Guideline for dental college dental students and dental professional. Dental Council of India; 2020.