Original Article

COVID-19-induced Stress in Health-care Workers: Effect of 8-week Common Yoga Protocol on Autonomic Function and Inflammatory and Oxidative Stress Markers

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Abstract

Background: COVID-19 pandemic posed a huge stress on health-care givers affecting their physical and mental health. Wellness strategies like yoga can improve flexibility, resilience, and outlook. **Aim:** The present study explored the effect of 8-week standard common yoga protocol (CYP) intervention on autonomic functions, emotional stress, oxidative stress, and inflammation markers in the nurse group of health-care givers. **Materials and Methods:** It is a randomized controlled trial where 50 nurses underwent CYP and 50 participated as controls. Anthropometric parameters, cardiovascular parameters, autonomic function including time and frequency domain parameters, biochemical parameters, and psychological stress using the questionnaire were assessed before and after 8-week CYP. **Results:** Total 88 nurses completed the study with 42 and 46 participants, respectively, in the CYP and control groups. CYP intervention resulted in a significant reduction in cardiovascular parameters systolic blood pressure, diastolic blood pressure, mean arterial pressure, pulse pressure, and rate pressure product ($P < 0.001$, $P < 0.001$, $P < 0.001$, $P < 0.001$, and $P = 0.002$, respectively), perceived stress score and Depression, Anxiety, and Stress Scale psychological variables of depression, anxiety, and stress, and serum lipid parameters compared to the control group. CYP significantly increased total power, low frequency, high frequency, root mean square of successive differences between adjacent NN intervals, change in successive normal sinus (NN) intervals exceeds 50 ms, and pNN50% ($P < 0.001$, $P = 0.006$, $P = 0.006$, $P = 0.039$, $P < 0.001$, and $P = 0.013$, respectively) suggesting improved resting autonomic modulation and parasympathodominance due to higher vagal efferent activity. There were significant reductions in serum cortisol, tumor necrosis factor-alpha, interleukin (IL)-1, and IL-6 in both the groups. Serum telomerase significantly reduced ($P = 0.024$) and total antioxidant capacity ($P = 0.036$) increased in the CYP group post intervention. **Conclusion:** CYP intervention was beneficial in improving psychophysiological, autonomic, and biochemical profile of the nurse group of health-care workers.

Keywords: *Autonomic function, common yoga protocol, COVID-19, health-care worker, stress*

Introduction

Coronavirus disease (COVID-19) is an infectious disease caused by the SARS-CoV-2. COVID-19 pandemic has become a major health crisis that has affected every human being on the planet, which was responsible for severe morbidities, millions of deaths worldwide, severe economic meltdowns, and catastrophic changes.[1] Such widespread outbreaks were associated with adverse mental and physical health consequences, especially for health-care givers who were in the forefront of combating crisis.[2] Our health-care system was under huge burden. Health-care providers were also particularly vulnerable to emotional distress during the COVID-19 pandemic, given their risk of exposure to the virus, concern about infecting and caring for their loved ones, severe shortages of personal protective equipment during initial phases of the pandemic, longer work hours, involvement in emotionally and ethically fraught resource-allocation decisions, and conflicting messages from the authorities.[2,3]

It is imperative that we should address the stress of the health-care givers that include doctors and paramedical staff (nurses and technicians). Wellness incorporates mental, physical, and spiritual health to protect against burnout, which impairs both coping

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and caregiving abilities. Implementing wellness strategies can improve flexibility, resilience, and outlook.[4]

Scientific studies demonstrate that yoga practitioners generally have a healthy lifestyle and yogic practices have been associated with improved health-related variables and health behavior.[5]

Yoga-based mind–body interventions have been documented to be effective in neuropsychiatric disorders,[6] autoimmune disorders,[7] noncommunicable disorders,[8] emotional burnout, chronic primary insomnia, and other health-related conditions. Yogic mechanisms include improvement in sympathovagal balance, optimized sleep and cognition, improved psycho-neuro-immune axis and decreased systemic inflammation, improved immune function, reduced cellular aging, impacting telomere length, enhancing neuroplasticity, and decreasing levels of stress.[9-13]

COVID-19 pandemic has brought severe restriction on our social behavior and movement in open environment. Therefore, we need to find feasible yoga-based different lifestyle strategies that can be practiced by health-care workers (HCWs). In our study, we have defined HCWs/givers as those presently working as nurses in a tertiary care hospital which has also been designated as Nodal COVID Hospital in the Rajkot region of Gujarat.

In the present study, we have explored the effect of 8-week intervention of standard common yoga protocol (CYP) for health professionals on autonomic functions and emotional stress and correlated with oxidative stress and inflammation markers including telomerase levels in the nurse group of health-care givers.

Materials and Methods

Study design and setting

It is a randomized control trial study conducted with the collaboration between the Department of Physiology and the Department of Pathology of a tertiary care hospital in Gujarat. The study commenced after obtaining approval from the Institutional Ethical Committee for Human Studies. The trial was registered with the Clinical Trials Registry of India (registration number: CTRI/2021/07/034910). The study was conducted during the period of March 2021–December 2021.

Recruitment of the participants

Study population

In this study, consenting and volunteering 100 nurses, in the age group of 18–45 years of both genders, working in a tertiary care hospital, Rajkot, Gujarat, were recruited after meeting the inclusion and exclusion criteria of the study [Figure 1]. which were as follows:

Inclusion criteria

Participants who were willing for the intervention of administration of Standard CYP for Health Professionals (CYP) by the Ministry of AYUSH three times per week for the duration of 8 weeks were included in the study.

Exclusion criteria

Participants with a history of hypertension, cardiovascular disease, diabetes mellitus, or any other endocrine disorder and those who were on medications for any acute or chronic condition were excluded from the study.

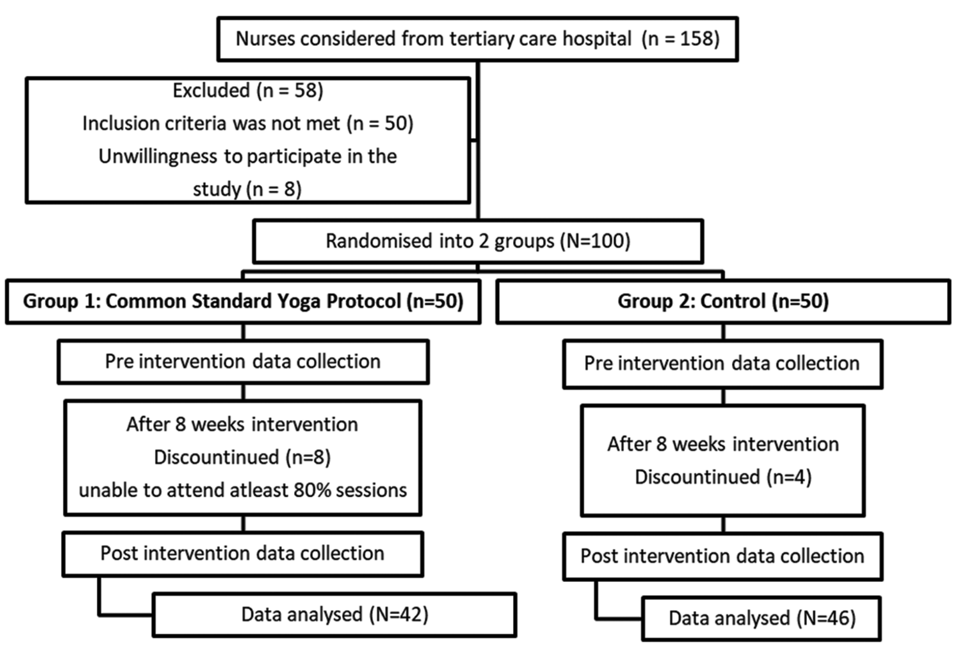

Figure 1: Study flowchart

Written informed consent was obtained from all the participants involved in the study. We explained the study details to all the recruited participants.

Randomization and allocation

Based on computer-generated randomization method, study participants were allocated to the following groups:

Group 1 ($n = 50$): Participants were administered supervised Standard CYP for Health Professionals three times per week for the total duration of 8 weeks (CYP group).

Group 2 Control ($n = 50$): Participants did not receive any intervention.

Interventions to CYP (Group 1) participants were administered by a heart fullness (HFN) certified yoga trainer. Furthermore, these participants were encouraged to continue unsupervised regular practice at home also on all other days.

Parameters measured

We collected the demographic and personal details of all the participants including age, gender, E-mail id, and mobile contact number. On the day of the examination, subjects were asked to report between 7 and 8 am in fasting condition and 5 ml of venous blood was withdrawn from the anterior cubital vein in vacuum tubes without anticoagulant to separate serum. The separated serum was labeled and stored at −80°C. The following biochemical tests were done on stored serum in the Department of Microbiology. Lipid profile: Serum cholesterol was measured by cholesterol oxidase p-aminophenazone (CV%: 3.9), serum triglycerides by glycerol phosphate oxidase p-aminophenazone (CV%: 3.6), and high-density lipoprotein (HDL) cholesterol by precipitation method (CV%: 4.2). Low-density lipoprotein (LDL) cholesterol and very LDL (VLDL) were calculated with Friedewald's formula. The Adult Treatment Panel III criteria were used to classify plasma lipid levels. Interleukins (IL): IL-6, IL-10, and IL-1beta were measured by the sandwich-based ELISA (ELISA kit supplied and manufactured by RUO, Novosibirsk, Russia, respectively). The method of detection was based on the three-stage "sandwich" solid phase using mono- and polyclonal antibodies with regard to respective ILs. During the first incubation stage, IL in the test sample interacts with monoclonal antibodies to IL immobilized on the surface of the plate wells. During the second stage, bound IL interacts with conjugate biotinylated polyclonal antibodies to respective human IL. During the third incubation stage, bound conjugate interacts with streptavidin with horseradish peroxidase. On similar principles, alpha-tumor necrosis factor (TNF) was quantified using alpha-TNF-specific antibody. Human serum telomerase: It was measured by the principle of sandwich-based ELISA using the manufacturer's guidelines (ELISA kit supplied and manufactured by Sincere™, Shinya, Beijing, China, respectively). Purified human telomerase antibody was coated on the wells to make a solid-phase antibody for detection using spectrophotometer at a wavelength of 450 nm. Human malondialdehyde (MDA) and total antioxidant status: It was measured by quantification of MDA using sandwich-based ELISA (supplied and manufactured by Sincere™, Shunyi, Beijing, China, respectively). After an MDA-specific antibody-antigen-enzyme-antibody complex is formed, the concentration was determined by comparing the OD of the samples to the standard curve. Similar principles were employed for the measurement of total antioxidant status barring the fact that total antioxidant capacity (TAOC)-labeled antibody was used (supplied and manufactured by Sincere™, Shinya, Beijing, China, respectively). High-sensitivity C-reactive protein was measured by ELISA kit supplied and manufactured by Xema, Shinya, Aichwald, Germany, respectively) as per the manufacturer guidelines.

Then, they were asked to report to the Department of Physiology, AIIMS, Rajkot, between 9 and 10 am following 2 h of light breakfast. Anthropometric parameters like height (meters) were recorded on wall mounted stadiometer (BHH6, Easy Care, Mumbai, India) and body weight (kg) using digital weighing scale (Eagle EEP1007A) to the nearest 100 g. Body mass index (BMI) was calculated by Quetelet's index (BMI = Weight [kg]/Height [m]^2). Waist circumference (cm) and hip circumference (cm) were recorded with measuring tape, and waist/hip ratio was calculated. The following parameters were recorded after 10 min of rest in sitting posture with backrest using automated blood pressure monitor (BPL 120/80 B 18, BPL Medical Technologies Pvt. Ltd., Kerala, India) – heart rate (HR) (beats/min), systolic blood pressure (SBP) and diastolic blood pressure (DBP), mean arterial pressure (MAP) as DBP + 1/3 of pulse pressure (PP) (SBP − DBP), and rate pressure product (RPP) = (HR × SBP)/100.

Short-term HR variability (HRV) with time and frequency domain parameters was recorded as per the guidelines adopted by the European Society of Cardiology and the North American Association of Electrophysiology on the equipment BrainTap-HRV, manufactured by Dinamika Medicine Technologies, Russia.[14] Time domain parameters recorded were mean Heart Rate (mean RR interval), root mean square of successive differences between adjacent NN intervals (RMSSD), standard deviation of normal-to-normal interval (SDNN), the number of pairs of successive NN intervals that differ by more than 50 ms in the entire recording, expressed in counts (NN50), the percentage of NN50 counts, given by NN50 count divided by total number of all NN intervals (pNN50). Frequency domain parameters recorded were Total power (TP) of HRV, low-frequency (LF) power, high-frequency (HF) power, very low-frequency (VLF) power, normalized LF power (LFnu), normalized HF power (HFnu), ratio of low-frequency to high-frequency power (LF-HF ratio).

All participants completed the Perceived Stress Scale questionnaire-10 Items[15] and the Depression, Anxiety, and Stress Scale (DASS-21 Items).[16]

All the recorded parameters were again repeated after 8 weeks of intervention period in all the participants. Data were recorded and statistically analyzed.

Intervention to both the groups

The intervention to CYP (Group 1) participants was given by an HFN certified yoga trainer. Participants were administered supervised interventions for 40–45 min three times per week for the duration of 8 weeks. At the beginning of intervention, 3-day sensitization sessions were separately conducted for the CYP group wherein all the details of the protocol were explained, both online and offline study materials were shared, and doubt clarifications were done. All the participants were encouraged to maintain personal diary and continue the unsupervised practice at home on all other days. Attendance record was maintained, and it was mandatory for all the participants to attend at least 80% of supervised sessions during 8 weeks of intervention. Furthermore, as a part of ethical commitment to all the study participants, all control group participants were given the option to attend supervised CYP sessions which were conducted after the study period.

Subjects, follow-up, and outcome

The details of CYP for health professional administered to Group 1 participants is attached as Annexure 1. It consists of sets of structured loosening exercises, yogasanas, paranayamas, meditation, and affirmations. All the relevant links (https://yoga.ayush.gov.in/public/assets/front/pdf/CYPEnglishLeaflet.pdf) were shared with the participants in English and other local languages.

Statistical analysis

Normality of the data was assessed using Kolmogorov–Smirnov tests. We expressed data in mean ± standard deviation for normally distributed data and median (interquartile range) for nonnormally distributed data. The mean difference between the two groups was compared using unpaired student *t*-test or Mann–Whitney *U*-test based on data distribution both before and after the intervention period. Effect of intervention was analyzed using paired *t*-test or Wilcoxon signed-rank test based on data distribution. Chi-square test was used to compare categorical variables. We used Epi Info version 7.2 and Jamovi (version 2.3) open-source software for data analysis. $P<0.050$ was set as statistically significant.

Results

Out of 100 participants ($n = 50$ in each group), postintervention at 8 weeks, recording of parameters could be completed for only 42 and 46 participants, respectively, for Group 1 (CYP) and Group 2 (Control) participants. There was no study-related injury or adverse events. Further, we did not change any methods following trial commencement.

The groups were comparable based on age, height, weight, BMI, and waist–hip ratio [Table 1]. Table 2 shows the comparison of basic cardiovascular parameters between the groups. Before intervention, cardiovascular parameters were comparable between the groups. After 8 weeks of intervention, we observed a significant reduction in SBP, DBP, mean arterial blood pressure, and RPP in the CYP group. A decrease in PP was noted only in CYP. A borderline significant decrease in DBP with a rise in PP

Table 1: Comparison of anthropometric parameters

Parameters	Mean±SD		*P*
	Group 1 CYP (*n*=42)	Group 2 Control (*n*=46)	
Female/male*	37/5	38/8	0.57
Age (years)	37.43±3.60	36.39±6.65	0.65
Height (cm)	155.76±8.95	155.62±8.13	0.08
Weight (kg)	62.70±7.66	64.72±12.61	0.35
BMI (kg/m^2)	26.08±4.70	26.78±5.14	0.74
Waist/hip ratio	0.92±0.08	0.93±0.06	0.36

*Comparison was done using Chi-square test. Comparison was done using unpaired Student's *t*-test. The significance was set at $P<0.05$. BMI: Body mass index, SD: Standard deviation, CYP: Common yoga protocol

Table 2: Comparison of cardiovascular parameters

Parameters	Intervention	Mean±SD		*P*
		Group 1 CYP (*n*=42)	Group 2 Control (*n*=46)	
Heart rate (beats/min)	Pre	79.26±9.18	80.48±6.67	0.44
	Post	77.02±5.11	80.72±4.69	<0.001
Pre–post comparison *P*		0.15	0.79	
SBP (mmHg)	Pre	127.00±5.55	123.8±6.70	0.059
	Post	122.52±5.63	124.02±6.62	0.91
Pre–post comparison *P*		<0.001	0.38	
DBP (mmHg)	Pre	78.79±4.00	78.13±6.11	0.61
	Post	77.07±3.32	77.74±6.10	0.81
Pre–post comparison *P*		<0.001	0.05	
PP (mmHg)	Pre	48.21±5.91	45.76±8.05	0.29
	Post	45.45±5.94	46.28±8.06	0.81
Pre–post comparison *P*		<0.001	0.03	
MAP (mmHg)	Pre	94.86±3.63	93.38±5.04	0.20
	Post	92.22±3.17	93.17±5.00	0.53
Pre–post comparison *P*		<0.001	0.12	
RPP (mmHg)	Pre	100.71±12.78	99.73±10.11	0.72
	Post	94.34±7.21	100.09±7.72	<0.01
Pre–post comparison *P*		0.002	0.76	

Between-group comparison was done using unpaired Student's *t*-test. Within-group comparison was done using paired Student's *t*-test. The significance was set at $P<05$. SBP: Systolic blood pressure, DBP: Diastolic blood pressure, MAP: Mean arterial pressure, RPP: Rate pressure product, SD: Standard deviation, CYP: Common yoga protocol, PP: Pulse pressure was observed in the control group. RPP which denotes the cardiac workload was significantly less in the CYP group as compared to controls after intervention.

Table 3 shows the comparison of depression, anxiety, and stress scores between the groups. Before intervention depression, anxiety, stress, and perceived stress scores were comparable between the groups. After 8 weeks of intervention, we observed a significant reduction in anxiety scores, stress scores, and perceived stress in the CYP group. In addition, a significant reduction in depression scores was noted only in the CYP group. There was no change in the psychological parameters in the control group during the intervention period. Stress scores and perceived stress scores were significantly less in the CYP group as compared to controls after intervention.

Table 4 shows the comparison of cardiac autonomic function test frequency domain parameters between the groups. Before intervention, the groups were comparable based on frequency domain parameters. After 8 weeks of intervention, we observed a significant increase in LF power and TP in the CYP group. We also observed a near-significant decrease in LF/HF ratio in the CYP group. In addition, HF power was significantly increased only in the CYP group.

Table 5 shows the comparison of cardiac autonomic function test time domain parameters between the groups. Before intervention, the groups were comparable based on time domain parameters. After 8 weeks of intervention, we observed a significant increase in RMSSD, NN50, and pNN50 and a near-significant increase in SDNN in the CYP group. There was no significant change in these parameters in the control group.

Tables 6 and 7 show the comparison of lipid profile and derived parameters between the groups. Before intervention, the groups were comparable based on lipid profile. After 8 weeks of intervention, we observed a significant decrease in total cholesterol (TC), triglycerides (TGs), LDL, VLDL, TC/HDL, TG/HDL, LDL/HDL, and non-HDL and a significant increase in HDL in Group 1. In the control group, there was no change.

Before intervention, the groups were comparable based on inflammatory markers. After 8 weeks of intervention, we observed a significant decrease in TNF alpha, IL-1, and IL-6 in the CYP group. There was no change in the control group [Table 8].

Table 9 shows the comparison of telomerase, oxidative stress, antioxidant, cortisol, urea, and creatinine values between the groups. Before intervention, the groups were comparable on the above parameters. After 8 weeks of intervention, we observed a significant decrease in cortisol in the CYP group. In addition, telomerase was significantly decreased (P = 0.024) and TAOC (P = 0.036) was significantly increased in the CYP group.

Discussion

The study groups did not differ in baseline characteristics such as age, gender proportion, and BMI. Although waist and hip circumference were higher in the CYP group, the waist/hip ratio was not significantly different, indicating comparability between the groups. Cardiovascular, biochemical, and autonomic parameters were similar in both the groups at baseline.

CYP intervention resulted in significant improvements in all cardiovascular parameters measured in the CYP group participants, including decreased SBP, DBP, MAP, PP, and RPP. In the control group, diastolic pressure decreased and PP increased compared to baseline, but no other changes in cardiovascular parameters were observed.

Sympathovagal imbalance marked by cardiac sympathetic overactivity and/or parasympathetic underactivity leads

Table 3: Comparison of Depression, Anxiety, and Stress Scale and Perceived Stress Scale questionnaire scores

Parameters measured	Intervention	Median (IQR)		P
		Group 1 CYP (n=42)	Group 2 Control (n=46)	
DASS depression scores	Pre	8.00 (4.00)	8.00 (4.50) 0	0.37
	Post	6.00 (2.50)	8.00 (4.00)	0.22
Pre–post comparison P		<0.001	0.55	
DASS anxiety scores	Pre	12.00 (6.00)	14.00 (4.00)	0.84
	Post	10.00 (4.00)	11.00 (11.00)	0.21
Pre–post comparison P		<0.001	0.80	
DASS stress scores	Pre	20.00 (6.00)	18.00 (6.50)	0.11
	Post	10.00 (6.00)	18.00 (18.50)	<0.001
Pre–post comparison P		<0.001	0.53	
Perceived stress scores	Pre	17.50 (10.25)	20.50 (9.00)	0.47
	Post	10.50 (2.75)	19.50 (12.50)	<0.001
Pre–post comparison P		<0.001	0.94	

Between-group comparison was done Mann–Whitney U-test. Within-group comparison was done using Wilcoxon signed-rank test. The significance was set at P<05. DASS: Depression, Anxiety, and Stress Scale, IQR: Interquartile range, CYP: Common yoga protocol

Table 4: Comparison of cardiac autonomic function test–frequency domain parameters

Parameters	Intervention	Median (IQR)		*P*
		Group 1 CYP (*n*=42)	Group 2 Control (*n*=46)	
HF (ms²)	Pre	209.50 (300.25)	135 (206.25)	0.12
	Post	271.50 (336.50)	118.00 (254.00)	<0.001
Pre–post comparison *P*		0.01	0.79	
LF (ms²)	Pre	411.50 (452.50)	342.50 (493.75)	0.62
	Post	617.00 (547.25)	289.50 (508.75)	<0.001
Pre–post comparison *P*		0.01	0.72	
VLF (ms²)	Pre	386.50 (309.75)	402.50 (499.25)	0.60
	Post	454.50 (462.25)	330.00 (453.75)	0.21
Pre–post comparison *P*		0.22	0.80	
Hfnu	Pre	31.04 (31.71)	30.48 (38.43)	0.59
	Post	35.88 (29.75)	32.67 (44.33)	0.53
Pre–post comparison *P*		0.44	0.72	
Lfnu	Pre	68.97 (31.71)	69.53 (38.43)	0.59
	Post	64.12 (29.75)	67.33 (44.33)	0.53
Pre–post comparison *P*		0.45	0.71	
LF/HF ratio	Pre	2.22 (3.62)	2.29 (6.50)	0.59
	Post	1.79 (2.64)	2.07 (5.62)	0.53
Pre–post comparison *P*		0.06	0.86	
TP (ms²)	Pre	1056.50 (952.00)	1050.50 (1028.00)	0.71
	Post	1486.00 (1154.25)	863.00 (988)	<0.01
Pre–post comparison *P*		<0.001	0.76	

Between-group comparison was done using Mann–Whitney *U*-test. Within-group analysis was done using Wilcoxon signed-rank test. The significance was set at *P*<0.05. HF: High frequency, LF: Low frequency, VLF: Very low frequency, TP: Total power, Lfnu: LF normalized units, Hfnu: High-frequency normalized units, IQR: Interquartile range, CYP: Common yoga protocol

Table 5: Comparison of cardiac autonomic function test–time domain parameters

Parameters	Intervention	Median (IQR)		*P*
		Group 1 Common yoga protocol (*n*=42)	Group 2 Control (*n*=46)	
SDNN (ms)	Pre	28.25 (21.03)	32.50 (17.28)	0.73
	Post	33.10 (21.68)	32.35 (21.75)	0.27
Pre–post comparison *P*		0.07	0.94	
RMSSD (ms)	Pre	17.80 (14.65)	19.00 (14.33)	0.11
	Post	21.50 (14.03)	20.40 (15.08)	0.05
Pre–post comparison *P*		0.04	0.33	
NN50 (count)	Pre	5.00 (17.25)	4.00 (18.00)	0.66
	Post	9.00 (16.50)	4.50 (18.50)	0.04
Pre–post comparison *P*		<0 0.001	0.82	
pNN50 (%)	Pre	2.00 (8.00)	1.00 (7.00)	0.31
	Post	5.00 (10.00)	1.00 (7.00)	0.04
Pre–post comparison *P*		0.01	0.44	

Between-group comparison was done using Mann–Whitney *U*-test. Within-group analysis was done using Wilcoxon signed-rank test. The significance was set at *P*<05. SDNN: Standard deviation of NN intervals, RMSSD: Root mean square of successive differences between normal heartbeats, NN50: Change in successive normal sinus (NN) intervals exceeds 50 ms, pNN50: Proportion of NN50 divided by the total number of NN (R-R) intervals, IQR: Interquartile range

to increased HR, increased SBP, and increased RPP, which indirectly reflects the amount of workload on the heart. Increased parasympathetic modulation slows HR, while increased sympathetic modulation accelerates HR. Intervention of various yoga practices improves sympathovagal balance, leading to decreased HR, blood pressure, and RPP.[17,18] The CYP group showed a significant reduction in perceived stress score and DASS psychological variables of depression, anxiety, and stress.

Tables 4 and 5 reveal significantly increased TP, LF, HF, RMSSD, NN50, and pNN50% in the CYP group, suggesting improved resting autonomic modulation and parasympathodominance due to higher vagal efferent activity ($P < 0.001$, $P = 0.006$, $P = 0.006$, $P = 0.039$, $P < 0.001$, and $P = 0.013$, respectively).[19] Time domain measures of HRV, including RMSSD, NN50, and pNN50%, were significantly improved in the CYP group.[20] This is similar to another study which aimed to assess the impact of short-term yoga practice on cardiac autonomic function where they observed a significant increase in time domain markers such as RMSSD and pNN50% after participants engaged in yoga for a duration of 1 month, indicating a shift in the balance of autonomic activity from the sympathetic nervous system toward the parasympathetic system.[21] While the CYP group also showed increased baseline autonomic modulation, the effect on baseline parasympathetic tone was not observed. The nearly significant decrease in LF/HF ratio suggests improved autonomic tone ($P = 0.057$).

Table 6: Comparison of lipid profile

Parameters measured	Intervention	Mean±SD		*P*
		Group 1 CYP (*n*=42)	Group 2 Control (*n*=46)	
TC (mg/dL)	Pre	166.81±16.13	166.22±16.45	0.89
	Post	164.86±15.88	166.55±16.24	0.66
Pre–post comparison *P*		<0.001	0.28	
TG (mg/dL)	Pre	129.16±11.19	130.25±11.12	0.34
	Post	115.70±10.48	127.51±11.84	<0.001
Pre–post comparison *P*		<0.001	0.24	
HDL (mg/dL)	Pre	40.12±6.05	39.22±6.30	0.72
	Post	43.38±4.67	41.28±6.24	0.09
Pre–post comparison *P*		0.01	0.14	
LDL (mg/dL)	Pre	100.86±17.19	100.95±17.93	0.90
	Post	98.34±18.14	99.77±18.43	0.74
Pre–post comparison *P*		0.04	0.42	
VLDL (mg/dL)	Pre	25.83±2.24	26.05±2.22	0.34
	Post	23.14±2.10	25.05±2.39	<0.001
Pre–post comparison *P*		<0.001	0.24	

Between-group comparison was done using Mann–Whitney *U*-test. Within-group comparison was done using paired Student's *t*-test. The significance was set at *P*<05. HDL: High-density lipoprotein, LDL: Low-density lipoprotein, VLDL: Very LDL, SD: Standard deviation, TC: Total cholesterol, TG: Triglyceride, CYP: Common yoga protocol

Table 7: Comparison of lipid profile-derived parameters

Parameters measured	Intervention	Mean±SD		*P*
		Group 1 CYP (*n*=42)	Group 2 Control (*n*=46)	
TC/HDL	Pre	4.25±0.74	4.35±0.82	0.83
	Post	3.87±0.70	4.14±0.85	0.12
Pre–post comparison *P*		0.01	0.18	
TG/HDL	Pre	3.28±0.52	3.40±0.61	0.35
	Post	2.71±0.45	3.17±0.66	<0.001
Pre–post comparison *P*		<0.001	0.09	
LDL/HDL	Pre	2.59±0.68	2.67±0.73	0.88
	Post	2.32±0.63	2.51±0.75	0.28
Pre–post comparison *P*		0.02	0.22	
Non-HDL	Pre	123.0±16.29	123.19±16.62	0.74
	Post	120.44±15.89	123.51±16.44	0.50
Pre–post comparison *P*		<0.001	0.36	

Between-group comparison was done using Mann–Whitney *U*-test. Within-group comparison was done using paired Student's *t*-test. The significance was set at *P*<05. TC: Total cholesterol, TG: Triglyceride, LDL: Low-density lipoprotein, HDL: High-density lipoprotein, SD: Standard deviation, CYP: Common yoga protocol

Consistent with previous studies, the observed effects can be attributed to the inhibition of the posterior or sympathetic area of the hypothalamus. This inhibition optimizes the body's sympathetic responses to stressful stimuli, facilitating the restoration of autonomic regulatory reflex mechanisms associated with stress.[22] Therefore, we can conclude that the practice of CYP significantly altered parasympathodominance and autonomic modulation.

Our study investigated the effects of an 8-week CYP intervention on biochemical, oxidative stress, and inflammatory markers in individuals with hyperlipidemia. The results showed a significant improvement in all measured serum lipid parameters (decreased TC, TG, LDL, VLDL, TC/HDL, TG/HDL, LDL/HDL, non-HDL, and increased HDL) (P < 0.001 in all these parameters) in the CYP group compared to the control group. These findings are consistent with previous studies that also reported improved lipid profiles with yogic interventions. In addition, our study found significant reductions in serum cortisol, TNF-α, IL-1, and IL-6 in both the CYP and control groups.[23-26] There were also a nonsignificant decrease in serum MDA level and a significant increase in TAOC (P = 0.036) in the CYP group, indicating reduced oxidative stress and increased antioxidant capacity. These findings are consistent with previous studies that documented decreased inflammation and biochemical stress with yogic interventions.[27,28] However, contrary to some studies, we found a significant reduction in serum telomerase levels (P = 0.024) following the CYP intervention. We hypothesize that this reduction is due to improved biological homeostasis, as evidenced by reduced oxidative stress, inflammation, and increased antioxidant levels, resulting in decreased need for telomerase to repair cell damage. This finding is consistent with our previous study that found a negative correlation between serum telomerase levels and oxidative stress, sympathovagal balance, and atherogenic index in individuals across the glycemic spectrum. Overall, our study provides evidence that an 8-week CYP intervention can effectively improve biochemical stress, inflammation, and lipid profiles in individuals with hyperlipidemia.[29-33] Stressful conditions may contribute to increased perceived stress, activation of the hypothalamic–pituitary–adrenal axis causing higher cortisol levels, sympathovagal imbalance, oxidative stress, and negative health consequences in HCWs.[34]

The CYP intervention in our study improved the psychophysiological, autonomic, and biochemical profile of HCWs during COVID-19 pandemic as seen in similar recent studies which showed that HCWs who were yoga practitioners had significantly lower anxiety during COVID-19 pandemic.[35-38] Further, in a recent systematic review of studies, involving the various modalities like CYP, has shown significant improvement in the perceived stress of HCWs with positive effects on psychological trauma, self-compassion, mindfulness, quality of life, resilience, burnout, insomnia, anxiety, depression, and overall well-being of the study participants.[39]

Stress can be categorized as psychological or systemic, both of which impair prefrontal cortex (PFC) functioning. The executive homeostatic network (EHN) consisting of PFC, anterior cingulate cortex, and insular cortex is the principal neurophysiological substrate for mind–body

Table 8: Comparison of inflammatory markers

Parameters measured	Intervention	Mean±SD		*P*
		Group 1 CYP (*n*=42)	Group 2 Control (*n*=46)	
TNF-α (pg/mL)	Pre	14.17±6.60	14.15±2.42	1.00
	Post	11.97±5.26	13.98±2.23	0.02
Pre–post comparison *P*		0.002	0.47	
hsCRP (mg/mL)	Pre	3.0±1.26	3.47±0.70	0.21
	Post	2.75±0.91	3.44±0.65	0.06
Pre–post comparison *P*		0.10	0.10	
Interleukin 1 (pg/mL)	Pre	4.16±1.26	4.06±0.84	0.75
	Post	3.46±0.70	3.98±0.84	0.29
Pre–post comparison *P*		0.001	0.08	
Interleukin 6 (pg/mL)	Pre	6.93±2.98	6.88±1.62	0.96
	Post	6.54±2.73	7.17±1.69	0.36
Pre–post comparison *P*		0.001	0.22	
Interleukin 10 (pg/mL)	Pre	5.99±2.84	6.04±1.39	0.89
	Post	6.59±2.08	5.84±0.87	0.20
Pre–post comparison *P*		0.07	0.39	

Between-group comparison was done using Mann–Whitney *U*-test. Within-group comparison was done using paired Student's *t*-test. The significance was set at $P<0.05$. hsCRP: High-sensitive C-reactive protein, TNF-α: Tumor necrosis factor-alpha, SD: Standard deviation, CYP: Common yoga protocol

Table 9: Comparison of biochemical parameters of cortisol, oxidative stress, telomerase, blood urea, and blood creatinine

Parameters measured	Intervention	Mean±SD		*P*
		Group 1 CYP (*n*=42)	Group 2 Control (*n*=46)	
Telomerase (ng/mL)	Pre	5.61±2.55	6.52±2.56	0.15
	Post	5.33±2.45	6.73±2.92	0.04
Pre–post comparison *P*		0.02	0.45	
Malondialdehyde (µM)	Pre	3.42±2.22	3.53±1.12	0.87
	Post	3.14±1.51	3.52±1.15	0.16
Pre–post comparison *P*		0.36	0.92	
TAOC (mmol/L)	Pre	1.70±1.14	1.68±1.31	0.92
	Post	2.10±1.14	1.70±1.28	0.36
Pre–post comparison *P*		0.04	0.76	
Cortisol (mmol/L)	Pre	369.21±58.04	373.61±66.51	0.76
	Post	361.43±57.84	368.83±56.18	0.38
Pre–post comparison *P*		<0.001	0.47	
Creatinine (mg/dL)	Pre	0.93±0.15	0.94±0.14	0.87
	Post	0.96±0.14	0.93±0.14	0.92
Pre–post comparison *P*		0.315	0.72	
Urea (mg/dL)	Pre	17.06±3.57	17.23±3.49	0.89
	Post	17.25±3.79	17.14±3.37	0.90
Pre–post comparison *P*		0.76	0.85	

Between-group comparison was done using Mann–Whitney *U*-test. Within-group comparison was done using paired Student's *t*-test. The significance was set at $P<0.05$. SD: Standard deviation, TAOC: Total antioxidant capacity, CYP: Common yoga protocol

interventions. EHN interacts with subcortical structures involved in homeostasis and stress responses, including the limbic system, central autonomic neurons, hypothalamus, and brainstem structures.[35,40-42] Psychophysiological stress increases the coping demand on the body and can lead to autonomic dysfunction, inflammation, neurodegeneration, depression, and cognitive impairment. The beneficial effect of integrated yoga practices (CYP) is due to bidirectional top-down and bottom-up mind–body interactions at multiple neuraxis levels.[40] CYP interventions lead to increased activation of EHN structures, improved psychophysiological variables, decreased cortisol, inflammation, oxidative stress, and modulation of epigenetic regulators.[42]

Limitation

The study could include only nurses as HCWs and with a modest sample size only which could limit the generalizability of the study. Any identification of subgroups in terms of participants with any previous exposure to yoga or similar interventions could not be ensured due to limited setting and study population. Eight participants in the intervention group were considered dropouts as they could not complete 80% of attendance of sessions and four participants in the control group did not report for postintervention follow-up as strict adherence could not be enforced during COVID-19 pandemic situation. This limitation in the study should be taken care of in any future interventions.

Conclusion

Our study suggests that the CYP interventions were beneficial in improving the psychophysiological, autonomic, and biochemical profile in the nurse group of HCWs during the COVID-19 pandemic situation. CYP intervention if promoted among HCWs can be a useful tool for the prevention and management of unexpected stress in situation like COVID-19 pandemic.

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After the completion of the study, the CYP training was also provided to all the nurses participants in the control group as a part of ethical commitment.

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Conflicts of interest

There are no conflicts of interest.

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Annexure 1: Yoga intervention for Group 1 participants

Group 1 participants were administered a standard common yoga protocol (refer to DST communication) as detailed below
Standard common yoga protocol for Group 1 nurses (*n*=50)

	Practices	Name of the practice	Duration (min)
A	Starting	Prayer/silence	1
B	Loosening practices (SukṣmaVyāyāma/CālanaKriyā)	Neck bending	
		Forward and backward bending (3 rounds)	
		Right and left bending (3 rounds)	
		Right and left twisting (3 rounds)	
		Neck rotation (clock and anti-clockwise) (3 rounds)*	
		Shoulder movement	1
		Shoulder rotation (forward and backward) (3 rounds)	
		Trunk movement	1
		Trunk twisting (3 rounds)	
		Knee movement	1
		Ankle movement	1
		Ankle rotation (clock and anti-clockwise) (3 rounds)	
C	Yoga practices		
	Āsanas performed in standing posture	Tadāsana (the palm tree posture)	1
		Pada-hastāsana (the hands to the feet posture)	1
		ArdhaChakrāsana (the half wheel posture)	1
		Trikonāsana (the triangle posture)	2
		Virabhadrasana – I (warrior pose)	2
	Āsanas performed in sitting posture	Bhadrāsana (the firm/auspicious posture)	1
		ArdhaUshtrāsana (the half camel posture)	1
		Sasakāsana (the hare posture)	1
		Marjariasana (cat stretch pose)	1
		UtthanaMandukāsana (the stretched up-frog posture)	1
		Vakrāsana (the seated twist posture)	2
	Āsanas performed while lying on the Chest	Makarāsana (the crocodile posture)	1
		Bhujangāsana (the cobra posture)	1
		Shalabhāsana (the locust posture)	1
	Āsanas performed while lying on the back	Setubandhāsana (the bridge posture)	1
		Utthanapadāsana (the raised leg posture)	0.5
		ArdhaHalāsana (the half plough posture)	0.5
		Markatasana (the spine twist posture)	1
		PawanaMuktāsana (the wind-releasing posture)	1
		Shavāsana (the corpse posture)	2
D	Kriya	Kaphalabhati (the shining skull practice)	2
E	Pranayama	AnulomaViloma Pranayama (the alternate nostril breathing) (5 rounds)	2
		Ujjayee Pranayama (the hissing breathing) (5 rounds)	2
		Bhramari Pranayama (the bee sound breathing) (5 rounds)	2
F	Dhyāna	Meditation/Yoga nidra	6
	Closing	Shanti patha/silence	1
	Total duration (approximately)		40 min