Original Article

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Physiology Section

A Study to Assess Changes in Cortisol Level and Heart Rate Variability between Fixed Duty and Shift Duty Health Care Providers in a Tertiary Care Hospital- A Cross-sectional Study

SAPTARSHI ROY[1], SOMA GUPTA[2], SURANJANA SUR MUKHERJEE[3], MAUMITA DAS[4]

ABSTRACT

Introduction: Increased demand of service 24 hours around the clock has divided the workers into 2 domains as "Fixed duty" and "Shift duty". Personals associated with shift duty are increasing in numbers day by day. Shift duty or more specifically night duty is associated with increased stress which results in high morbidity and decrease in work efficiency. Cortisol hormone and Heart Rate Variability (HRV) are useful parameters to determine the effects of stress.

Aim: To find any change in cortisol levels, HRV, Athens score among the fixed duty and shift duty healthcare providers.

Materials and Methods: A descriptive cross-sectional comparative study was conducted in a tertiary care hospital at Kolkata between July, 15th to Sept, 15th 2021. Predesigned and pretested questionnaire was made and ethical clearance was taken from institutional IEC. Then after taking consent total 120 (60 fixed duty and 60 shift duty) healthcare providers were recruited for the study. Subjects of the study filled up a questionnaire {including Athens Insomnia Scale (AIS)}. After applying exclusion criteria (any cardiovascular, neurological, psychological, sleep disorder) 120 health individuals were taken five minutes short-term HRV (time and frequency domain) recording in supine posture and 4 PM blood sample (for cortisol) were obtained from the participants which was further analysed in Chemiluminescence Immunoassay (CLI). Data was analysed in SPSS version 20.0. Statistical tests like student t-test, Cronbach's alpha and Chi-square tests were applied significant $p<0.05$ (95% CI).

Results: After analysis, shift duty workers showed a significant ($p<0.001$, Odd's 10.706) higher chance of having insomnia (Athens score >6) than fixed duty workers. Blood test showed that shift duty workers had significantly high evening cortisol level than fixed duty workers ($p=0.036$). The time domain of HRV showed that the parameters like Standard Deviation all NN interval (SDNN) ($p=0.001$), Mean HR ($p=0.037$), RMSSD ($p<0.001$), NN50 ($p=0.006$), pNN50 ($p=0.002$) were significantly different in the two groups. Whereas the frequency domain of HRV showed that HF power was lower and LF power ($p=0.002$), LF/HF ratio ($p<0.001$) were significantly higher in shift duty workers.

Conclusion: The study showed that shift duty workers had comparatively higher stress levels resulting in significantly high sympathetic drive and increased risk of insomnia. This can be associated with morbidity and ill-health in the shifting duty workers.

Keywords: Occupational health, Rotational duty, Sleep irregularity, Stress

INTRODUCTION

Stress is an omnipresent experience which everyone faces in their daily life. In a workplace, it is one of the most common health problems and therefore a lot of workplaces are introducing active intervention to lower the stress level of the workers [1].

In the work place, two types of work schedules exist. One is "Fixed" duty, which includes a fixed time schedule from 10 AM-5 PM Monday to Friday 8 hours per day for 40 hours in week [2]. The other one is "Shift" duty which means three shifts of duty throughout 24 hours as morning, afternoon and night shift with a rotation of 5 days/2 days (e.g., five nights and two off then five mornings 2 off) [3].

Now, the modern society demands employees to work around the clock for 24 hours duration in industries, healthcare and transportation sector. This increases the demand of all time services which is responsible for increased number of shift duty workers. Medicine is one of the branches with most hectic work schedules causing increased amount of stress [4].

Shift duty increases that stress due to lack of night sleep. The main disadvantage of shift work with stressful life is sleep irregularity and sleep deprivation. As a lack of healthcare staffs, health staffs are overworked everywhere [5]. There is increasing rate of fatigue among health workers which leads to many health problems as well as economic burden and absenteeism [4].

Chronic stress impulse is related with stimulation of Hypothalamic-Pituitary-Adrenal axis [6]. Cortisol has a diurnal variation being high at morning and low at mid night. Depending upon the stress factors, the amount and frequency of cortisol secretion are altered which can be an area of research among the fixed and shift duty workers.

Disrupted sleep cycle is an occupational health hazard and it affects work performances. Cortisol secreted from adrenal cortex affects many bodily functions including metabolism and immune system [7]. Imbalances in cortisol level are associated with a variety of mental and physical disorders like fatigue, depression, obesity and immune dysfunction [7]. Night shift workers mostly sleep during the day but high cortisol secretion and high body temperature during the day can affect the quality of sleep and also decrease the number of hours slept. So, it decreases the duration of Rapid Eye Movement (REM) sleep [8-10].

On the other hand, sleep disorders are associated with cardiological complications, increased morbidity and mortality. The relationship

between deprivation of REM sleep with heart disorders is not yet explored. As a consequence, the association between day time sleeping and heart disorders is yet to be established.

The HRV is a useful but simple tool to assess cardiological disorders. It measures variation in time between each heartbeat. The HRV parameters are regulated mainly by Autonomic Nervous System (ANS). ANS has two components i.e., sympathetic and parasympathetic [11].

The ANS is also coordinated with hypothalamo-pituitary -adrenal axis. In resting condition, the parasympathetic tone is high and during stress sympathetic tone becomes higher. This is due to the reason that sympathetic nerve flow is related with fight or flight response. During stress, PNS withdraws its effects so that sympathetic system can work properly [12]. So, parasympathetic tone measurement can be a potential method to determine stress among shift workers [13].

Healthcare workers throughout the world face tremendous workloads due to high load of patients and emergencies which is causing increase in shifting duties and night duties which can have an ill-effect on themselves. And there is scarcity of data about the long-term effects of shifting duty for healthcare workers and hence this study was conducted.

Among professionals demanding 24 hours round the clock service few require the 1st line workers. Among them healthcare system is a special one. Health status of healthcare workers is a very ignored topic in present time too. And there is scarcity of database on relation between duty type, hours and health of them. The effects of shifting duty are poorly known among the health workers. The present study opened up new aspects on the health of the healthcare providers to take precautionary action beforehand to prevent ill-effects further due to the work schedules because the health workers are the strong pillar of healthcare in society. The present study aims to assess the diurnal variation of cortisol level and pattern of HRV in fixed-duty and shift-duty healthcare providers. The primary objective of the study to find out whether there is any change in the level of cortisol and alteration in HRV between fixed duty and shift duty healthcare providers. The secondary objective of the study was to detect any difference of scores in AIS between the two groups.

MATERIALS AND METHODS

This cross-sectional study was conducted under Department of Biochemistry and Department of Physiology, NRS Medical College and Hospital, Kolkata, West Bengal, India in a duration of two months (July 15th, 2021- September 15th, 2021). The study population of the study were health professionals engaged in different tiers at NRS Medical College and hospital, working from 9 AM to 5 PM and in different shifts.

Inclusion criteria: As per the inclusion criteria health workers of both sex, age between 30-60 years physically and mentally healthy doing regular duties (fixed schedule/shifting rotational) were taken. Staffs like faculties, Resident Medical Officers (RMOs), nurses, staffs of central laboratory, blood bank were included. It was fixed that rotational duty workers should have two morning (6 AM-2 PM), two evening (2 PM-10 PM) and two night duties (10 PM-6 AM) per week.

Exclusion criteria: Persons who refused to give consent and persons with any kind of cardiovascular disorders, metabolic, neurological disorders or any kind of sleep disorders, anxiety or psychiatric complications were excluded.

After fulfilling all the criteria a total of 120 healthcare providers (who were physically and mentally healthy) with a work experience of minimum of eight years were included in the study via simple random sampling.

Sample size calculation: Sample size was determined by formula: ($n=\frac{Z^2PQ}{d^2}$, n=sample size, Z=statistical correspondence to confidence. P=expected prevalence, Q=1-P, d=precision) (Here, Z=2 for 95% Confidence interval, p=53%, d=13%). So the value comes 57 and after considering standard deviation 60 individuals of each group were taken [14].

There were few tools which were used in the study are:

i. Questionnaire: The questionnaire is added which contains many demographic questions and 8 AIS scale questions [Annexure-1].

The questions were mixture of both open and closed ended containing three sections. It has three major sections. 1st is the demographic details (like name, age, sex, height (in cm), weight (in Kg), BMI on Asian BMI Scale [15] etc.,) with the vitals like pulse rate (Normal 60-100/min) Blood pressure (Normal: 120/80 to 140/90 mm Hg) 2nd is the medical history, disease history, treatment and surgical history with sleep habits and the 3rd part contains AIS (based on ICD 10) [14] having eight questions. The first five questions indicate sleep induction, awakenings during the night, final awakening time, total duration of sleep and quality of sleep and the last three tells about well-being, functioning capacity, and sleepiness during the day. Responses with insufficient and irrelevant data were excluded from the study. The scale has a score range of 0 to 3 for each question. Minimum possible score is zero which roughly indicate no problem, the score 1 indicates slight/mild issue, score 2 indicate moderate/marked/considerable problem and Maximum score 3 indicate serious issue for each question. Total minimum score can be zero and max attainable total score is 24. Total score >6 indicates insomnia and score ≤6 is normal [16].

ii. IX-TA-220 with Lab scribe V3 Recorder with popular sensors having iwire-B3G Bi potential Module plus A-GC-7165 electrodes for digital Electrocardiography (ECG).

iii. CLI for blood cortisol analysis.

iv. Other instruments were Aneroid Sphygmomanometer {For blood pressure (in mmHg)}, bathroom weighing machine {(for weight (in Kg)}, height measuring tape {for height (in cm)}, stopwatch etc.

Study Technique

After obtaining approval from Institutional Ethics Committee (Approval no: No/NMC/2863) and informed consent from the subjects, the predesigned and pretested proforma was applied. Content validation of the proforma was done by 10 experts and the content validity index calculated was 0.80 [17]. The proforma was designed by the authors (after including AIS) under guidance of HOD of Community Medicine. The proforma was bilingual (both English and regional language). The questions were both open and closed ended questions based on the response of the participants. Information was obtained from each subject stating their personal demographic details, nature and hours of work, time and duration of sleep, any medication or surgical history etc. Language validation was done by backward and forward translation of the proforma. Height and weight were measured for each of them and BMI was calculated using ASIAN BMI scale. Initially, 124 subjects were enrolled. Out of which four subjects were excluded from the study due to the exclusion criteria like someone having artificial pacemaker at or clinically diagnosed psychopathology, insomnia. Finally, the subjects were divided into fixed duty and shift duty workers at a ratio of 1:1.

The shift duty workers were asked to come to the Dept. of Physiology after end of their night shift for recording digital ECG for getting the HRV analysis. The fixed duty workers were also asked to come to the Dept. of Physiology at the end of their duty for digital ECG with three limb leads for HRV analysis. At first some parameters like BP {Normal range of Systolic Blood Pressure (SBP) <140 mmHg and Diastolic Blood Pressure (DBP) <90 mmHg}, Pulse rate (Normal: 60-100/min), Respiratory rate (Normal 12-16/min) were measured. Then ECG recordings were taken in IX-TA-220 recorder machine and was analysed in the "Kubios HRV" software. Recordings were obtained for five minutes in supine position at rest (short-term).

The HRV has two components i.e., time domain and frequency domain. The time domain contains parameters like Mean RR (Mean of all RR intervals), SDNN, Mean HR (Mean Heart Rate), Standard Deviation of Heart Rate (STD-HR), Square Root of t Mean of the Sum of the Squares of Differences between adjacent NN intervals (RMSSD), NN50 (Number of pairs of adjacent NN intervals differing by more than 50 ms in the entire recording; three variants are possible counting all such NN intervals pairs or only pairs in which the first or the second interval is longer), pNN50 (NN50 count divided by the total number of all NN intervals) whereas frequency domain contains mainly Low Frequency (LF) power, High Frequency (HF) power, LF/HF ratio.

Then the subjects were asked to attend the Department of Biochemistry for collection of blood. Blood collections were done at 16.00 hours of the same day. Ideally cortisol is measured first at 8 AM and the more samples like after 4 hours, 8 hours (4 PM) and 16 hours taken, as it has diurnal variation [18]. Since the fixed duty workers were not available at 8 AM, the authors measured cortisol at 4 PM only. The reference range of 3-10 microgram/dL was considered as normal value of cortisol at 4 PM [19].

Blood was collected in the clotted vial and serum was separated in centrifuge machine. Then it was used to estimate cortisol level by CLI technique.

STATISTICAL ANALYSIS

First of all, the data was compiled in MS excel 2013. Then it was analysed in SPSS 2021 software (SPSS Inc. Released 2007. SPSS for windows, version 16.0. Chicago, SPSS Inc.). Student's t-test and Chi-square tests were used for analytical statistics and p-value <0.05 was considered significant.

RESULTS

In the fixed duty groups, 60% individuals were doctors and 40% were other health staffs (including nursing personnel and laboratory workers), in the shift duty group, 55% individuals were doctors and 45% were other health professional. Among 60 fixed duty healthcare workers, most of the participants 44 (73.3%) were male and rest 16 (26.7%) were female. As per the Asian-Indian BMI scale, 21 participants were in the normal range, 21 overweight, seven preobese, one obese. Majority 55 (91.7%) of the persons were Hindu by religion and 5 (8.3%) were Muslim. The religions have been included because two religions have their own customs like in Ramdan months Muslims wake up very early for meal and sleep early too. Almost equal numbers of participants in the study were either single or married. A majority of the percentage {43(71.7%)} were living in a nuclear family while rest of the persons were from joint family. Almost everyone 59 (98.3%) (except one) stated that the participants of the study slept only at home at night. A total of 53 (88.34%) of the fixed duty individuals had regular sleep pattern whereas 7 (11.67%) had irregular sleep pattern [Table/Fig-1].

Variables	Attribute	Fixed	Shift
Sex	Male	44 (73.3%)	42 (70%)
	Female	16 (26.7%)	18 (30%)
BMI scale (On ASIAN BMI scale) (In Kg/m^2)	18.5-22.9 (Normal)	21 (35%)	20 (33.3%)
	23-24.9 (overweight)	21 (35%)	14 (23.3%)
	25-29.9 (Obese type 1)	17 (28.3%)	26 (43.3%)
	≥30 (Obese type 2)	1 (1.7%)	0
Religion	Hindu	55 (91.7%)	52 (86.7%)
	Muslim	5 (8.3%)	8 (13.3%)
	Others	0	0
Marital status	Single	31 (51.7%)	14 (23.3%)
	Married	29 (48.3%)	46 (76.7%)
Type of family	Nuclear	43 (71.7%)	46 (76.7%)
	Joint	17 (28.3%)	24 (23.3%)
Place of sleep	Home+workplace	1 (1.7%)	26 (43.3%)
	Home	59 (98.3%)	34 (56.7%)
Sleep time regularity	Fixed	53 (88.34%)	24 (40%)
	Variable	7 (11.67%)	36 (60%)

[Table/Fig-1]: Distribution of participants as per few characteristics.
No statistical tests were done for this table because both the two variables are independent variable

The average age of the fixed duty workers was 38.07±9.7 years with the height of 166.62±6.99 cm and weight 65.6±8.61 kg. So, the average BMI of fixed duty population was 23.59±2.47 which means overweight according to Asian-Indian BMI scale. The average SBP (123.77±8.49) and DBP (81.17±4.68) were in the normal range. The average pulse rate was 85.03±24.78. Average family members of the participants were 4±1.14 [Table/Fig-2].

Variables	Fixed (Mean±SD)	Shift (Mean±SD)	p-value
Age (years)	38.07±9.7	39.3±10.01	0.548
Height (cm)	166.62±6.99	165.02±6.95	0.595
Weight (kg)	65.6±8.61	66.27±8.64	0.86
BMI (kg/m^2)	23.59±2.47	24.3±2.59	0.731
SBP (mmHg)	123.77±8.49	126.57±10.8	0.1
DBP (mmHg)	81.17±4.68	82.6±6.12	0.046
Pulse rate (bpm)	85.03±24.78	83.33±18.7	0.04
No of family member	4±1.14	4.03±0.781	0.001

[Table/Fig-2]: Distribution of participants according to anthropometry and few other characteristics.
Student's t-test was done for these parameters and was found to be significant for DBP and pulse rate

Among 60 shift duty healthcare workers, most of the participants 42 (70%) were male and rest 18 (30%) were female. As per the Asian-Indian BMI scale 20 participants were in the normal range, 14 overweight, 26 preobese. So, majority 26 (43.3%) of the participants were obese. Majority 52 (86.7%) of the persons were Hindu by religion and 8 (13.3%) were Muslim. Majority of the shift duty participants were married. 14 (23.3%) persons were single and 46 (76.6%) were married. Majority of the participants 46 (76.7%) were living in a nuclear family while rest of the persons belong to a joint family. Although 34 persons (56.7%) stated habit of only sleeping at home, a lot of persons 26 (43.3%) stated the habit of sleeping both at home and workplace. As a finding 40% of the shift duty individuals had a regular sleep pattern whereas 60% had irregular sleep pattern [Table/Fig-1].

The average age of the fixed duty workers was 39.3±10.01 years with the height of 165.02±6.95 cm and weight 66.27±8.64 kg. So, the average BMI of fixed duty population was 24.3±2.59 which means overweight. The average SBP (126.57±10.8) and DBP (82.6±6.12) were in the normal range. The average pulse rate was 83.33±18.7 bpm. Average family members of the participants were 4.03±0.781 [Table/Fig-2].

After doing student t-test the difference of means among DBP, heart rate and number of family members of fixed and shift duty were found to be significant (sig=0.046; 0.04; 0.001, respectively). Whereas SBP means difference was not significant [Table/Fig-2].

Cronbach's alpha test was done for the responses of AIS separately for fixed duty and shift duty. And the vale for both the groups came between 0.5-0.8 i.e., fixed duty Cronbach's alpha 0.748 (standardised 0.755) and for shift duty 0.739 (standardised 0.725). The values are in good to acceptable range so these values indicate that the scale is reliable for both the group and the questions are sufficient for the test.

From the AIS, it was spotted that max persons of the fixed duty gave a score of zero in almost every question with a total score of zero. But for the shift duty the scores for individual questions were received as 0-2 for maximum persons in maximum questions [Table/Fig-3,4].

Fixed duty				
Questions	0	1	2	3
1	43 (71.7%)	11 (18.3%)	4 (6.7%)	2 (3.3%)
2	53 (88.3%)	5 (8.3%)	2 (3.3%)	0
3	50 (83.3%)	10 (16.7%)	0	0
4	52 (86.7%)	5 (8.3%)	2 (3.3%)	1 (1.7%)
5	50 (83.3%)	10 (16.7%)	0	0
6	56 (93.3%)	3 (5%)	1 (1.7%)	0
7	59 (98.3%)	1 (1.7%)	0	0
8	49 (81.1%)	10 (16.7%)	1 (1.7%)	0

[Table/Fig-3]: Scores recorded in Athens Insomnia Scale (AIS) individual question.
Responses in Athens Insomnia Scale (AIS) for fixed duty workers; Cronbach's alpha= 0.748 (standardised): 0.755

Shift duty				
Questions	0	1	2	3
1	10 (16.7%)	32 (53.3%)	16 (26.7%)	2 (3.3%)
2	42 (70%)	10 (16.7%)	8 (13.3%)	0
3	26 (43.3%)	28 (46.7%)	6 (10%)	0
4	18 (30%)	28 (46.7%)	12 (20%)	2 (3.3)
5	14 (23.3%)	26 (43.3%)	10 (16.7%)	10 (16.7%)
6	38 (63.3%)	8 (13.3%)	12 (20%)	2 (3.3%)
7	30 (50%)	24 (40%)	6 (10%)	0
8	34 (56.7%)	20 (33.3%)	6 (10%)	0

[Table/Fig-4]: Scores recorded in Athens Insomnia Scale (AIS) individual question.
Responses in in Athens Insomnia Scale (AIS) for shift duty workers; Cronbach's alpha=0.739 (standardised): 0.725

After analysing serum cortisol level, the average cortisol level for fixed duty workers was found to be 3.74±1.7 mcg/dL and for shift duty workers was 9.4±2.36 mcg/dL. So, the cortisol level of shift duty workers was significantly higher compared to fixed duty workers (p-value=0.036) [Table/Fig-5].

Cortisol level (mcg/dL)	Fixed duty	Shift duty
Mean±SD	3.74±1.7	9.4±2.36

[Table/Fig-5]: Cortisol levels among study population.
Unpaired student t-test was done and significance was found to be 0.036

Regarding HRV parameters like Mean RR, SDNN, STD HR, RMSSD, VLF POWER (%), LF POWER (%) and LF/HF ratio, shift duty workers showed higher mean value than fixed duty workers. After application of student t-test, the following factors showed significant changes: SDNN (p-value=0.001), Mean HR (p-value=0.037), RMSSD (p-value <0.001), NN50 (p-value=0.006), pNN50 (p-value=0.002), LF POWER (%) (p-value=0.002), LF/HF ratio (p-value <0.001) [Table/Fig-6].

As the AIS says a cut-off score 6 to differentiate between insomnia patients and normal so, authors have calculated number of persons as per that. A total of 56 persons from fixed duty and 34 persons from shift duty had a score ≤6 then four persons from fixed duty and 26 persons from shift duty had a score >6. Chi-square test was found to be significant with significance <0.001 and odds ratio was found 10.706 [Table/Fig-7].

DISCUSSION

The medical profession, all over the world, have been found have high suicidal ideation [20]. A study showed moderate to severe stress level among majority of doctors. And working period more than six hours was a significant risk factor for stress [21]. Shifting duty or specifically night duty was found to be associated with stress and decreased work performance [3].

Variables	Fixed (Mean±SD)	Shift (Mean±SD)	p-value
Mean RR	814.01±135.17	826.1±141.36	0.726
SDNN	176.69±218.08	299.83±246.36	0.001
Mean HR	85.81±28.51	84.01±21.59	0.037
STD HR	29.76±42.12	39.74±46.77	0.35
RMSSD	231.96±244.48	391.53±360.47	<0.001
NN50	186.47±206.37	169.76±137.77	0.006
pNN50	31.4±27.77	30.26±19.62	0.002
VLF power (%)	29.02±16.1	40.17±20.11	0.484
LF power (%)	32.45±8.05	44.21±14.88	0.002
HF power (%)	38.348±14.37	17.51±15.61	0.919
LF/HF	1.07±0.85	4.69±3.28	<0.001

[Table/Fig-6]: Time domain variables of HRV among study population.
Student t-test of HRV parameters

Type of duty	Athens score ≤6	Athens score >6
Fixed duty	56	4
Shift duty	34	26

[Table/Fig-7]: Insomnia among study population.
Chi-square test of significance was done; Chi-sq value=21.511 and p <0.001; Odds ratio: 10.706

This study is a preliminary step towards understanding the variation between shift duty workers with fixed duty workers. Stress is induced by a huge number of known and unknown factors but here we have focussed only on duty status and sleep habits of the subjects.

Shift duty workers have a higher chance of getting ill-health like metabolic disorders including diabetes [22] and cardiovascular disorders including hypertension [23] because the shift workers have a disoriented circadian rhythm. The study showed that SBP was higher in shift duty workers and DBP was significantly (p-value=0.046) higher in shift duty workers. These findings are consistent with the previous studies. In a study by Yeom JH et al., shift duty workers had 1.51 (95% CI 1.11-2.06) times higher chance of developing hypertension than day workers [24]. Similarly another study by Suwazono Y et al., in 14 years of shift work exposure chances of increase in SBP and DBP from its early pre-exposure values was high [25].

Another study showed that shift duty workers had a high pulse rate and so 12% increased risk of atrial fibrillation than day workers and that is increased to 18% for workers who have been associated with shift duty for 10 years or more [26]. The study also showed similar results for pulse rate (p-value=0.04).

So far sleep pattern and insomnia are concerned a greater number of shift duty workers (43.33%) had insomnia than fixed duty workers (6.67%) measured by AIS. According to the Chi-square analysis, shift duty workers had a significant risk of developing insomnia than fixed duty. Odds ratio of the shift duty for developing insomnia was 10.706 indicating 10 times higher risk. One study by Chatterjee K and Ambekar P showed significantly higher Athens Insomnia score for shifting duty workers which indicate initial, intermediate and terminal insomnia [27].

The responses came in the Athens scale for fixed and shift duty gave a Cronbach's alpha between 0.7-0.8 which is acceptable/good. In individual questions, max responders from fixed duty gave a score of 0 in almost all the questions. Whereas for shift duty, max responders gave a score of 1 in question 1,3,4,5 then zero in 2,6,7,8. So sleep induction, final awakening early than desired, total sleep duration and overall quality of sleep was problematic in shift duty workers. The results are quite similar with a study done by Chatterjee K and Ambekar P, in which shifting duty workers had lower quality of sleep, duration and sense of well-being. The shift workers had also higher day time sleepiness than day workers [27].

Regarding serum cortisol level, the study showed significantly high (sig=0.036) evening cortisol level among the shift duty healthcare providers than fixed duty workers. These findings are quite consistent with the previous studies. In a study by Li J et al., a steeper fall of cortisol was found among shift workers with significantly ($p<0.01$) higher morning cortisol levels [18]. Another study of Manenschijn L et al., found that shift workers had significantly ($p<0.001$) higher hair cortisol level due to a long time exposure [28]. Another study showed that before and after shifting duties night (22:00) cortisol values were significantly higher among them than day workers [29].

Alteration in sleep pattern in shift duty workers leads to alteration in normal psycho-physiological condition and circadian rhythm. The persons who had alternate duties of 2 days (2N, 2A, 2M) (as in the present study) were more stressed than persons doing only night duty because the shifting duty individuals could not even adjust their sleep rhythm to a particular time. Moreover, REM sleep was also disturbed. REM sleep has an inhibitory action on Hypothalamic Pituitary Adrenal (HPA) axis. If REM sleep is decreased due to irregular duty pattern, the inhibitory effect is gone which can lead to high blood cortisol level [30].

So far HRV parameters are concerned, SDNN, Mean HR, RMSSD, NN50, pNN50 showed significant changes among the two groups. This difference can be attributed to the difference in circadian rhythm of the shift workers.

The study reported high VLF and LF power and low HF power in shift workers and also a high LF/HF ratio in the participants [31]. These findings are pretty much consistent with the previous studies. In a study by Kaegi D et al., they showed that in mental stress sympathetic tone gets the upper hand which is found by increase in LF power [32]. Another study by Ludo A et al., got that mean %LF were higher in during sleep after a night shift than after day shift [33]. A study by Chung MH et al., stated that permanent night nurses had higher sympathetic drive than morning nurses which may have effects sleep pattern of night nurses and higher sympathetic drive in long run [34].

The HF is regulated mainly by parasympathetic activity and LF is regulated by both sympathetic and parasympathetic activity (predominantly sympathetic) [35]. After experiencing a stressful event, brain sends stimulus to amygdala of brain which in turn activates hypothalamus. Hypothalamus now commands the response by activating ANS. Sympathetic system being the fight response becomes activated and regulates the body [36]. So, there is a possibility that through the same mechanism shift workers have higher sympathetic drive than fixed workers.

High sympathetic outflow exaggerates many bodily responses to stress stimuli. It can increase pain perception, inflammation, decrease body immunity. It may stimulate oxidative stress, atherosclerosis excessively. So, persistent sympathetic hyperactivity is actually injurious for health causing higher morbidity among shift workers.

In the study, authors included fixed duty day healthcare providers irrespective of their age with almost equal patient and work load and. In shift duty also workers whose works are related to the emergency are included like emergency health staffs, blood bank, central lab. So the authors have tried to minimise the bias due to confounders as much as possible.

Still in future prospective cohort study with a larger and more uniform sample size should be done to determine the long-term effects of the duty status and to determine the years of exposure with associated with adverse health effects. Also, HRV recording should be taken for long-term 24 hours for more accuracy and serum cortisol at short intervals for 24 hours to know the trend better. As future perspectives a study population with all criteria matched, equal job profile should be analysed and stress should be assessed individually in some objective method.

Limitation(s)

Emotional stressors, physical or psychological stressors were not addressed at individual level. This study was a cross-sectional study with one time data. For getting the time trends prospective studies should be done in future with relatively larger study population to get more accurate and unbiased results. Short-term HRV was taken. Serum cortisol was estimated at 4 PM only.

CONCLUSION(S)

The study depicted that shift work for a long duration of time caused an elevated serum cortisol level and high LF and LF/HF ratio which may be responsible for major cardiovascular events. So, estimation of serum cortisol and performing HRV in these subjects may be helpful to predict cardiac morbidity and modify treatment strategies. Therefore, proper planning of the shifts and training programmes are required to avoid any long-term complications like cardiovascular disorders.

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PARTICULARS OF CONTRIBUTORS:
1. Final Year Student, NRS Medical College, Kolkata, West Bengal, India.
2. Professor and Head, Department of Biochemistry, NRS Medical College, Kolkata, West Bengal, India.
3. Associate Professor, Department of Physiology, Bankura Sammilani Medical College, Kolkata, West Bengal, India.
4. Assistant Professor, Department of Physiology, Bankura Sammilani Medical College, Kolkata, West Bengal, India.

NAME, ADDRESS, E-MAIL ID OF THE CORRESPONDING AUTHOR:
Dr. Maumita Das,
106/D, Narkeldanga North Road, Kolkata-700011, West Bengal, India.
E-mail: moumitadasdr@gmail.com

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[ANNEXURE-1]

Case Study Form

TITLE: Study to Assess Change in Cortisol Level and Heart Rate Variability (HRV) among Fixed Duty and Shift Duty Healthcare Providers in a Tertiary Care Hospital

Name: _____ Sex: _____ Age: _____ Date: _____

Height: _____ Weight: _____ BMI: _____

Religion: _____ Occupation: _____(Doctor/Nurse)

Marital status: _____Body temp: _____ Ph No-_____

BP: _____ Pulse Rate: _____ Respiratory rate: _____

Addiction History

Smoking (if yes, then frequency): Alcohol (if yes, then frequency):

Any other:

Family history

No. of members: Type of family: Income (p.a.):

Duty Status

Duty type (day/shift): Duty hours per day:

If shift worker: i) Time of each shift; ii) Duty per shift

Past Medical History

Hypertension: Diabetes:

Any congenital/haematological diseases: Any other:

Past Surgical History

Thoracic: Abdominal: Head/Neurosurgery: Any other:

Familial diseases: Has any blood relative had any diseases?

Hypertension/diabetes/others (Specify relation):

Current medication (with dose and frequency)

Any emotional/family stress:

Any Chief Complaints of Sleep: Snoring: Any others:

Sleep Pattern

Sleep time-more or less fixed/variable place of sleep-Home/work place/both

Smoking and drinks (e.g., alcohol) before bed:

Bedtime: _____ weekday _____weekend

Typical awakening time: _____weekday _____weekend

Hours of sleep: i) at home; ii) at work place

Athens Insomnia Scale (AIS)

(Please encircle the appropriate if they happen >3 times a week)

1. Sleep induction (time it takes you to fall asleep after turning-off the lights)

_____ 0 1 2 3

No problem Slightly delayed Markedly delayed Very delayed or did not sleep at all

Awakenings during the night

0 No problem	1 Minor problem	2 Considerable problem	3 Serious problem or did not sleep at all
3. Final awakening earlier than desired			
0 Not earlier	1 A little earlier	2 Markedly earlier	3 Much earlier or did not sleep at all
4. Total sleep duration			
0 Sufficient	1 Slightly insufficient	2 Markedly insufficient	3 Very insufficient or did not sleep at all
5. Overall quality of sleep (no matter how long you slept)			
0 Satisfactory unsatisfactory	1 Slightly unsatisfactory	2 Markedly	3 Very unsatisfactory or did not sleep at all
6. Sense of well-being during the day			
0 Normal	1 Slightly decreased	2 Markedly decreased	3 Very decreased
7. Functioning (physical and mental) during the day			
0 Normal	1 Slightly decreased	2 Markedly decreased	3 Very decreased
8. Sleepiness during the day			3 Intense
0 None	1 Mild	2 Considerable	