EFFECT OF CIRCADIAN BLOOD PRESSURE AND HEART RATE IN MALES AS FUNCTION OF WORK TYPE

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ABSTRACT

Background: BPV is one of the recognized risk factor for different types of cardiovascular diseases. Circadian patterns of blood pressure and heart rate gets alterd as a function of job type. Night shift workers have altered circadian pattern of blood pressure and heart rate. Due to this variation, night shift worker suffers from various cardiovascular disorders and hormonal disturbances.

Methods: The Present Study Was Aimed to Investigate the Effects of Circadian Blood Pressure and Heart Rate in males as a function of work type on 24 hours BP/HR .Total 57 healthy professionals, aged 20-55 year, performing day and night shift duties were taken. Out of 57 males, eight were shift workers performing 10 hrs job , eighteen were students (hrs) and thirty one were day workers(8hrs). Circadian Mesor, amplitude and Acrophase of SBP, DBP, MAP, DP and Heart Rate in males were calculated.

Results: Ambulatory BP and HR were recorded at every 30 min intervals in day time and each hour in night time synchronically during their duties. Highly Significant difference was found in double amplitude (2DA) of blood pressure between night and day shift ($p<0.001$). In night shift, hyperbaric index (HBI) of mean systolic blood pressure was found to be increased at 12-03 am (midnight) while during day shift, peak was found at 06-09 am.

Conclusions: The present study concluded that variabilities in BP may be associated with factor type to some extend.

Keywords: ABPM, Blood Pressure, Heart Rate, Circadian rhythm, night shift, students, day shift

INTRODUCTION

All the developing countries Hypertension is a frequent alarm, irrespective of their stage of health alteration. Circadian rhythms is one of the most challenging & exciting area in present day science medicine. In general, blood pressure (BP) is also modulated in a circadian rhythm: over a 24-h cycle. The dipper pattern shows high BP in the daytime and low BP at night. It has been suggested that the rhythm closely follows the sleep-wakefulness cycle.1

Night shift work is associated with a disruption of circadian rhythms, where a person's internal body clock is in conflict with the rotating shift schedule. The difference between waking and sleeping SBP and DBP was greater than 20%. The circadian rhythm of the human body is characterized with an alternating sleep-wake cycle.2 Shift work has been associated with increased risk of cardiovascular disease. Those who work in night shift may attempt to sleep when their body clock is adjusted for the awakening phase.3 This attempt disturbs the body clock resulting in a contradictory relationship between sleep time and circadian schedule. There is evidence that shift work affects both sleep and awakening by disrupting the circadian regulation which has adverse effects on family and societal life.4 The average sleep cycle for night shift workers is sleep during the day which may be 2-4 hrs shorter than that of the day worker sleeping at night. However, in humans, BP dips significantly during sleep and remains elevated during the waking period with a characteristic flow in early morning hours.5 Hypertensive patients whose BP remains high at night (non-dippers) are at greater risk for cardiovascular morbidity than dippers.6

MATERIALS AND METHODS

Fifty seven randomly selected males (age range: 20–55 years), participated in the present study. Data were collected from Panchkula region. The subjects were day active and did not report any obvious clinical complications. Various biographical information, such as age, height (cm) and weight (kg), smoking and alcohol habits, work type, range of sleep (22:00–02:00 hrs) and awake timings (05:00–09:00 hrs) of each subject were recorded. All subjects gave a written informed consent. The study obtained the approval of the Institutional Ethics Committee on Human Research of university for Assessment of characteristics of circadian rhythms in blood pressure and heart rate. Circadian variability in BP (SBP and DBP) and HR were monitored noninvasively using ABPM in each subject. Mean arterial pressure (MAP) and double product (DP) were derived from the SBP, DBP and HR. ABPM is a completely automatic device and works on the basis of the oscillometric technique. It is worn on a belt, which is connected to the adult cuff on the upper left arm by a plastic tube. Measurements were taken every 30 min during the day (7-22)and every 1 hr at night(22-7). All subjects were instructed to keep their arm relatively stationary during the recording. The subjects filled in diary, where they noticed their activities, body position during measurements, time of sleep and working hrs. During the period of study, subjects followed their normal activities and maintained a sleep log on a daily basis.

Result are expressed as the mean±SD. Significance of difference in age, body mass index(BMI),body surface area(BSA),weight, height, B.P, Heart rate were determined. Significances of differences in BP and Heart rate between daytime and nighttime were determined by the students t test.

RESULT

Daytime and nighttime averages of BP variables and heart rate: Table 1.2 represents the averages of SBP, DBP, MAP and HR during daytime and nighttime in males. These data were taken from the A&D software from each subject. Results of t-test indicate that averages of SBP, DBP, and MAP were significantly higher in day workers ($p<0.01$, $p<0.001$), irrespective of time, i.e., daytime and nighttime. Dietary level and life style was also surveyed among these males. It was observed that most of the males did not change their dietary patterns with age. Their life style due to age and retirement is sedentary. They had less physical activity.

Circadian 24-h average (Mesor):

The results of Cosinor rhythmometry indicated inter-individual differences in the level of 24-h average for **Systolic blood pressure (SBP)**. With reference to work type, When the male subjects were categorized , the highest circadian Mesor was noticed in day workers (125.03 ± 1.80 mmHg) and the lowest (116.79 ± 4.43 mmHg) in shift workers (Table 2.6). in case of **Diastolic blood pressure (DBP),** the circadian Mesor was highest in day workers (76.65 ± 1.23 mmHg) and the lowest in shift workers (73.99 ± 2.91 mmHg) (Table 2.6). The results depict that the **Mean arterial pressure (MAP),**of males increases as a work type, the circadian Mesor was noticed to be the highest in day workers (92.58 ± 1.40 mmHg) and the lowest (88.26 ± 3.29 mmHg) in shift workers (Table 2.6). Work wise categorization for **Double product (DP),**showed that, circadian Mesor was the highest in day workers (98.06 ± 2.15 mmHg) and the lowest in shift workers (90.58 ± 5.36 mmHg) (Table 2.6). Futher, circadian Mesor of **Heart rate (HR) ,** varied from day workers (80.09 ± 1.24 beats/ min) which was and the lowest in shift workers (78.87 ± 2.37 beats/ min) (Table 2.6).

Circadian Amplitude: The results of Cosinor rhythmometry indicated inter-individual differences in circadian amplitudes of SBP, DBP, MAP, DP and HR rhythms. At the group level the circadian amplitudes of these rhythms are presented in Tables 2.4-2.8 as function of work type .Howerver in case of males, **Systolic blood pressure (SBP):** With reference to work type, the circadian amplitude was observed between 14.13 ± 1.41 (students) and 10.33 ± 1.60 (shift workers) (Table 2.6).Futher, **Diastolic blood pressure (DBP),** in male students showed the highest amplitude (11.21 ± 0.72) and the lowest (8.09 ± 1.20) was observed in shift workers (Table 2.6). Effects of factors, namely work type were validated using one-way ANOVA. **Mean arterial pressure (MAP),** As function of work type, for male, the circadian amplitudes were observed between 8.64 ± 1.24 (shift workers) and 11.90 ± 0.87 (students) (Table 2.6). The Amplitude of **Double product (DP),** had a range between 19.91 ± 2.68 (shift workers) and 24.33 ± 1.68 (students) (Table 2.6). **Finally, Heart rate (HR),** according to Distribution of the subjects on the basis of work type in males showed that the circadian amplitude was the highest (15.76 ± 1.26) in students and the lowest (13.21 ± 1.10) in shift workers (Table 2.6).

Interestingly, results of ANOVA demonstrated that none of the factors produced any significant effect on amplitude of HR (Tables 2.4, 2.6-2.8).

Circadian peak (Acrophase): The results of Cosinor rhythmometry indicated inter-individual differences in the level of acrophase of SBP, DBP, MAP, DP and HR. At the group level the circadian acrophases of these rhythms are presented in Tables 2.4-2.8 as function of work type.

Variation in circadian peak of **Systolic blood pressure (SBP)** was also observed at group level. However, the average peak of the SBP occurred mostly in the afternoon hours, irrespective of a work type (Tables 2.4-2.8). The acrophase spread for SBP was 19.4 h in male shift workers and 17.4 h in male day workers with a spread of 5.0 h (Table 2.6) However, acrophase occurred earlier in older subjects than their younger counterparts (Table 2.4).Variation in circadian acrophase of **Diastolic blood pressure (DBP)** was observed at group level. With reference to work type in males, the acrophase occurred at 17.6 h in day workers, whereas it appeared at 18.4 h in shift workers and student with a spread of 3.8 h (Table 2.6).Variation in circadian acrophase of **Mean arterial pressure (MAP)** was also observed, the acrophase of MAP rhythm occurred between 14.7 h (day workers) and 15.8 h (shift workers) with a spread of 4.1 h (Table 2.6). Difference in circadian acrophase of **Double product (DP)** was also observed With reference to work type, The acrophase timings appeared with a spread equal to 4.4 h when the male subjects were categorized on the basis of work type. The acrophase of DP rhythm occurred between 17.7 h (day workers) and 19.1 h (shift workers) (Table 2.6). Variation in circadian acrophase of **Heart rate (HR),**rhythm was also noticed , work type. Further, the earliest acrophase (17.9 h) was noticed in day workers and the latest (18.9 h) in shift workers with a spread of 4.0 h.

Relationship of daytime & nighttime BP variables and heart rate with demographic & anthropometric variables, and sleep parameters

Pearson's correlation coefficients of daytime and nighttime SBP, DBP, MAP, and HR with demographic & anthropometric variables (age, height, weight, BSA and BMI) and sleep parameters (awake time, sleep time and sleep length) at group level.

Results showed that SBP was statistically significantly positively correlated with age, height, weight, BSA and BMI, irrespective of the time. The daytime DBP exhibited significant positive association with weight, BSA and BMI, and nighttime DBP showed positive correlation with age, weight, BSA and BMI. A statistically significant positive relationship of MAP was validated with height, weight, BSA and BMI both during daytime and nighttime. MAP also exhibited positive association with age during nighttime only. Further, daytime HR displayed significant negative relationship with weight and BSA, and positive relationship with BMI. HR also demonstrated positive association with sleep length, irrespective of the time. However, significant association of SBP, DBP and MAP could not be validated with sleep parameters. However, in males, daytime SBP and MAP displayed significant positive correlation with weight and BMI. A significant negative correlation of daytime HR with age and BMI was also validated. Daytime SBP, DBP, MAP and HR did not reveal any significant association with sleep parameters. During nighttime in males, a significant positive correlation of SBP with age, weight, BSA & BMI, and MAP with age, weight & BSA was observed. Nighttime HR did not display any significant relationship. Further, none of the BP variables showed significant association with sleep parameters (Table 1.2).

Table 1.1 Demographic & anthropometric characteristics in males

Sample size	57
Weight (Kg)	63.93 ± 1.19
Height (cm)	167.84 ± 1.03
BSA (m^2)	1.71 ± 0.02
BMI (kg/m^2)	25.83 ± 0.45
Systolic BP	124 ± 1.74
Diastole BP	78 ± 1.42

[BSA]Body surface area; [BMI]Body mass index

Table 1.2 Circadian Mesor, amplitude and acrophase of SBP, DBP, MAP, DP, and HR as function of work type of male subjects (shift worker, N = 8; student, N = 18; day worker, N = 31)

Variable	Shift worker	Student	Day worker	f-value; df; p
Mesor				
SBP	116.79 ± 4.43[*,a]	118.38 ± 2.38[a]	125.03 ± 1.80[a]	03.41; 2, 57; <**0.05**
DBP	073.99 ± 2.91[a]	074.30 ± 1.28[a]	076.65 ± 1.23[a]	03.96; 2, 57; 0.39
MAP	088.26 ± 3.29[a]	088.58 ± 1.68[a]	092.58 ± 1.40[a]	04.95; 2, 57; 0.15
DP	090.58 ± 5.36[a]	092.23 ± 2.94[a]	098.06 ± 2.15[a]	04.84; 2, 57; 0.17
HR	078.87 ± 2.37[a]	079.51 ± 1.67[a]	080.09 ± 1.24[a]	03.11; 2, 57; 0.89
Amplitude				
SBP	10.33 ± 1.60 [a]	14.13 ± 1.41 [a]	12.42 ± 0.92 [a]	04.47; 2, 57; 0.24
DBP	08.09 ± 1.20 [a]	11.21 ± 0.72 [b]	10.48 ± 0.60 [ab]	05.59; 2, 57; 0.08
MAP	08.64 ± 1.24 [a]	11.90 ± 0.87 [b]	10.81 ± 0.66 [ab]	05.20; 2, 57; 0.12
DP	19.91 ± 2.68 [a]	24.33 ± 1.68 [a]	21.59 ± 1.34 [a]	04.02; 2, 57; 0.37
HR	13.21 ± 1.10 [a]	15.76 ± 1.26 [a]	14.04 ± 0.80 [a]	04.14; 2, 57; 0.33

Acrophase				
SBP	19.4 ± 0.9 [a]	18.4 ± 0.3 [a]	17.4 ± 0.6 [a]	04.85; 2, 57; 0.17
DBP	18.4 ± 0.7 [a]	18.4 ± 0.3 [a]	17.6 ± 0.5 [a]	03.75; 2, 57; 0.47
MAP	18.8 ± 0.7 [a]	18.3 ± 0.3 [a]	17.7 ± 0.5 [a]	03.72; 2, 57; 0.49
DP	19.1 ± 0.8 [a]	18.3 ± 0.2 [a]	17.7 ± 0.5 [a]	04.49; 2, 57; 0.23
HR	18.9 ± 0.8 [a]	18.3 ± 0.3 [a]	17.9 ± 0.4 [a]	03.79; 2, 57; 0.46

*-p<0.05, **p<0.01, ***-p<0.00

Table 1.3 Correlation of daytime and nighttime SBP, DBP, MAP, and HR with demographic & anthropometric variables, and sleep parameters as function of gender (male, N = 57)

Variable	**SBP**	**DBP**	**MAP**	**HR**
Daytime				
Age	0.210[†]	0.176	0.191	0.105
Height	-0.124	-0.132	-0.121	0.054
Weight	0.067	0.112	0.038	-0.064
BSA	-0.012	0.034	-0.032	-0.032
BMI	0.127	0.182	-0.098	-0.092
Awake time	-0.066	0.024	-0.012	-0.075
Sleep time	-0.154	-0.179	-0.190	0.111
Sleep length	-0.100	-0.189	-0.185	0.169

Nighttime

Age	0.293*	0.260	0.277*	0.229
Height	-0.085	-0.058	-0.043	0.152
Weight	0.101	0.286*	0.187	0.198
BSA	0.053	0.200	0.134	0.208
BMI	0.131	0.307*	0.194	0.122
Awake time	0.021	-0.040	0.045	-0.101
Sleep time	-0.052	-0.156	-0.154	-0.011
Sleep length	-0.061	-0.126	-0.184	0.093

DISCUSSION

BPV is one of the recognized risk factor for different types of cardiovascular diseases

ABP measurement has been found to be superior method of assessing the effect of BP and

Nocturnal dipping in BP is an important predictive factor of heart failure. The level of BP is decreased considerably during sleep period and suddenly elevates during early morning hours (transition period between sleep and wakefulness) resulting in cardiac surge. But in the case of non-dipping the BP remains elevated during the sleep period also, which is a higher risk of CVDs.7 Therefore, it is suggested that measuring BP with the help of ABPM for at least 24-h duration in hypertensive patients may provide beneficial outcomes. We noticed that day shift workers exhibited an increase in 24-h average of DP. However, they further emphasized that the difference in hourly means of DP was noticeable only during the sleep time. An increase in DP in night shift males was on account of increased mental stress. Further, the peak of DP occurred in the afternoon hours in all males. Our result corroborates the finding of Hermida 8 in that the highest value of DP was documented during the afternoon hours. MAP has been established as an independent predictor of ischemic stroke in hypertensive subjects.9 The normal range of MAP falls between 70 and 110mmHg. In the present study, a statistical significant difference in the Mesor and acrophase of MAP in day workers whereas in night shift males was depicted. On the basis of our findings we can conclude that variability in BP may be associated with factor of work type to some extent. ‘‘According to the World Health Report (2002), CVDs will be the largest cause of death and disability by 2020 in India. No alcohol was consumed during the 24-h monitoring period.Moderate smokers were also included in this study. Although it has been reported that smoking might influence daytime BP, the effect of smoking seems to be more relevant in heavy smokers, particularly for systolic BP, and less important in moderate smokers.10

Therefore, it is recommended that the study on BP variability should be extended to a larger human population of India.

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