ASSESSMENT OF CARDIOMETABOLIC RISK AMONG STAFF NURSES ON ROTATIONAL SHIFT WORK AT A TERTIARY CARE HOSPITAL IN PUDUCHERRY.

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Abstracts: **Background & Objectives:** The cardiovascular disease is one of the major risk factors that account for mortality and morbidity worldwide, more so among the sleep deprived. The aim of this study is to assess cardio metabolic risk among shift working staff nurses at a medical college hospital. **Methods:** This hospital based cross sectional study was conducted to assess the cardio-metabolic risk among 100 rotational shift workers (staff nurses). A questionnaire was given to collect socio demographic details and sleep duration of the subjects. Anthropometric measurements and biochemical profile namely fasting blood sugar and lipid profile were assessed to identify the cardio-metabolic risk. **Results:** All the parameters showed significance ($p < 0.05$) in subjects with shorter sleep duration and increased shift work experience. **Interpretation & Conclusion:** As the cardio-metabolic risk among shift workers in India is underreported, this study may help in identifying the subjects at risk and provide them with adequate counseling on lifestyle modification.

Key words: Cardio- metabolic risk, Rotational shift workers, Sleep deprivation, Lifestyle modification

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Introduction:

Cardiovascular disease (CVD) is accountable for around one-third of deaths globally. This number will continue to rise as the risk factors like dyslipidemia, diabetes, hypertension, obesity, physical inactivity, poor dietary pattern, smoking and alcoholism continue to increase. A high-risk strategy for cardiovascular disease prevention could very much reduce the load of disease in the forthcoming decades. Many initiatives are working, but many more are needed.[1]

Studies state an increased cardiovascular risk among those individuals who have performed more than six years of night shift work. Also, increased occurrence of diseases such as coronary heart disease, metabolic syndrome, mental and behavioral disorders are found among sleep deprived individuals.[2] Cardiovascular risk occurs more frequently among shift workers because of the clash between the frequently changing work hours and output of the biological clock.[3]

The present study aimed to assess cardio metabolic risk among shift working staff nurses at a medical college hospital.

Material and Methods:

Study area and setting: Sri Manakula Vinayagar Medical College and Hospital (SMVMCH), Pondicherry, is a multi-speciality tertiary care teaching hospital offering a wide range of curative and therapeutic services. **Study design:** Hospital Based Cross Sectional study. **Sample size and Sampling:** Considering the prevalence of diabetes among employees in a hospital was to be 5.8%,[4] at 95 % confidence interval, 80% power the minimum sample needed for the study was calculated to be 73.The sample size was inflated to cover the non response rate. The final sample size was taken as 100.The simple random sampling technique was used to recruit the participants. **Selection criteria:** Rotational shift workers (staff nurses), with an experience of more than one year, aged between 25 to 45 years were included in the study. Pregnant employees and those with any diagnosed non-communicable disease were excluded from the study. **Data collection:** Data collection was done among the respondents after the night shift was over. After obtaining informed consent**,** a questionnaire was administered to collect the data. The questionnaire covered information on socio-demographic information, duration of employment and duration of sleep. Anthropometric

measurements like Weight, Height and Waist circumference were measured; Body Mass Index was calculated. Fasting blood samples were collected to measure blood sugar and lipid profile (triglyceride, high density lipoproteins and serum cholesterol). Low density lipoproteins and Very low density lipoproteins were calculated by Fried Wald's formula. **Analysis:** The data was entered and analysed by using Epi-info (version 6.04d) software package. The frequencies and percentages were prepared for all the independent variables. Continuous variables were expressed as mean ± standard error. Student t test was used to calculate test of significance, p value of less than 0.05 was considered to be statistically significant. **Ethical Issues:** Clearance from the Institutional Review committee was obtained prior to beginning of the study. All samples were collected by the trained investigator, under strict aseptic precautions after obtaining an informed consent. Privacy and confidentiality of the participants was maintained by assigning codes.

Result:

Table 1 shows, among the 100 participants in the study, 25 had an experience of 1-5 years, while 27 participants had experience between 6 to 10 years. Majority (48) had an experience of more than 10 years. Among the respondents with experience up to 5 years, all of them were aged between 25 and 30. Majority (84%) of the participants were female. Mixed diet was the most common (84%) dietary pattern. Around 52% of the respondents had sleep duration less than or equal to 6 hours. Among the 27 respondents with higher experience of 6 to 10 years, 26 were within the age group of 35. Majority (78%) of them were female and Mixed diet was opted (81%). In this category, significant number (70%) of them had sleep duration of 6 hours or below.

Out of the total sample size of 100, 48 of them had experience of 10 years or above. Amongst them 77% of them belonged to age group of 36 to 45. Here too, Majority (81%) were female and a reduction in mixed diet consumption of 79%. 43 of them experienced sleep duration of 6 hours or below which is close to 90% of 48 respondents in this category.

Table 1: Socio-demographic factors of the study participants (n=100)

	Experience 1-5 years (n=25)	Experience 6-10 years (n=27)	Experience >10 years (n=48)
Age (years)			
25 - 30	25 (100)	12 (44.4)	1 (2.1)
31 - 35	-	14 (51.9)	10 (20.8)
36 - 40	-	1 (3.7)	17 (35.4)
40 - 45	-	-	20 (41.7)
Sex			
Male	4 (16.0)	6 (22.2)	9 (18.8)
Female	21 (84.0)	21 (77.8)	39 (81.3)
Diet			
Veg	4 (16.0)	5 (18.5)	10 (20.8)
Mixed	21 (84.0)	22 (81.5)	38 (79.2)
Sleep duration			
≤ 6 hrs	13 (52.0)	19 (70.4)	43 (89.6)
> 6 hrs	12 (48.0)	8 (29.6)	5 (10.4)

Table2: Cardiovascular risk factors of the study participants (n=100)

Variables	Sleep duration	Experience 1-5 years (n=25)	Experience 6-10 years (n=27)	Experience > 10 years (n=48)	p value
		Mean ± SE	Mean ± SE	Mean ± SE	
Age	≤ 6 hrs	26.54 ± .433	30.74 ± .753	39.77 ± .547	0.001
	> 6 hrs	26.25 ± .372	31.5 ± .945	33.00 ± 1.975	
Waist Circumference	≤ 6 hrs	88.85 ± 1.69	94.05 ± 1.54	95.67 ± 1.09	0.001
	> 6 hrs	83.92 ± 1.54	93 ± 3.92	90 ± 4.42	
SBP	≤ 6 hrs	116.31 ± 2.97	124.21 ± 2.95	134.84 ± 1.02	0.001
	> 6 hrs	105.17 ±1.58	114.25 ± 3.15	112 ± 3.74	
BMI	≤ 6 hrs	25.23 ± 0.72	28.32 ± 0.40	28.16 ± 0.26	0.001
	> 6 hrs	22.67 ± 1.01	25.62 ± 0.68	24.6 ± 1.43	

Table 3: Cardiovascular risk factors (Biochemical profile) of the study participants (n=100)

Table 2 shows the Mean values of the variables (Age/Waist circumference/BMI/SBP) amongst all the 100 respondents with experience category of 1 to 5years, 6 to 10 years, above 10 years. For experience of above 10 years, mean is 40 years for respondents with sleep duration of 6 hours or less. For experience of 6 to 10 years and above 10 years, respondents with 6 hours or less sleep duration have their mean waist circumference of 94 and 96 cms respectively. The SBP is significantly more for all respondents who have sleep duration of 6 hours or less, when compared to respondents with sleep duration of more than 6 hours, irrespective of experience. The BMI is a concern (overweight) for respondents with sleep duration of six hours or less, when compared to respondents with sleep duration of more than 6 hours, especially for them with experience of more than 6 years. 'p' value of

Variables	Sleep duration	Experience 1-5 years (n=25)	Experience 6-10 years (n=27)	Experience > 10 years (n=48)	p value
		Mean ± SE	Mean ± SE	Mean ± SE	
FBS	≤ 6 hrs	80.69 ± 3.67	87.42 ± 2.89	101.63 ± 1.92	0.001
	> 6 hrs	72.33 ± 2.49	83.75 ± 4.98	85.00± 7.53	
TC	≤ 6 hrs	184.46 ± 7.79	210.3 ± 5.51	223.47 ± 1.63	0.001
	> 6 hrs	150.17 ± 3.64	173 ± 12.07	174± 16.78	
TGL	≤ 6 hrs	140.15 ± 8.10	161.1 ± 3.73	168.63 ± 1.76	0.001
	> 6 hrs	128.25 ± 5.12	136.5 ± 6.56	140.8± 11.37	
HDL	≤ 6 hrs	46.38 ± 2.82	40.11 ± 2.44	34.09± 1.25	0.001
	> 6 hrs	61.08 ± 3.88	56.12 ± 5.92	53.6± 5.95	
VLDL	≤ 6 hrs	28.03 ± 1.62	32.21± 0.74	33.72± 0.35	0.001
	> 6 hrs	25.65 ± 1.02	27.3 ± 1.31	28.16± 2.27	
LDL	≤ 6 hrs	110.04 ± 8.38	138 ± 6.47	155.41 ± 2.09	0.001
	> 6 hrs	63.43 ± 6.85	89.6 ± 15.52	92.24± 16.55	

<0.05 is considered significant and highlighted in bold.

Table 3 shows the Mean values of the biochemical parameters amongst all the 100 respondents with experience category of 1 to 5years, 6 to 10 years, above 10 years. The rate of increase of FBS mean for respondents with sleep duration of 6 hours or less across increasing experience is significantly higher when compared to the rate of increase of FBS mean with sleep duration of more than 6 hours within each category of experience levels of respondents. The TC level too indicates a wide difference in means of respondents with increasing levels of experience, irrespective of sleep pattern. Here too the mean rate of increase of TC level for respondents with sleep duration of 6 hours or less is higher when compared to mean rate of increase of TC level of those whose sleep pattern is for more than 6 hours, over increasing experience of work. Also, the TGL level is a concern for respondents with over 6 years of experience whose sleep pattern is less than 6 hours. It can also be seen that the HDL level is significantly reduced over reducing sleep patterns together with increasing years of experience. The VLDL mean level for respondents with sleep duration of less than 6 hours is higher when compared to respondents with sleep pattern of more than 6 hours. Also, the VLDL mean level increases as the experience increases. The rate of change in LDL mean level for respondents with sleep duration of less than 6 hours across increasing experience is higher when compared to the rate of change of LDL level within each category of experience for sleep patterns of less than 6 hours and more than 6 hours. The last column indicates the 'p' value for each variable. 'p' value less than 0.05 was considered to be statistically significant.

Discussion:

This study was conducted to assess the cardio-metabolic risk among the shift working staff nurses and we found that there is a significant increase in cardio metabolic risk based on their shift work experience and sleep duration. Subjects with shorter sleep duration and increased shift work experience showed positive correlation with various parameters. The accurate mechanisms by which shift work causes cardio metabolic disease are still not entirely studied, but the important factors that contribute are disturbed circadian rhythms, and confounding factors like smoking, dietary pattern, and other social problems.[5,6] Dyssomnia is a set of disorders which cause extreme sleepiness or, complexity in initiating or maintaining sleep. Among the three types of dyssomnias, shift work sleep disorder comes under circadian rhythm sleep disorders. Shift work sleep disorder includes insomnia or extreme sleepiness that occurs as momentary phenomena with respect to the work schedules. Staff nurse, with their rotational shift work schedule have insufficient and haphazard sleep pattern which falls under shift work sleep disorder.[7]

Body Mass Index:

From the results of our study, prevalence of overweight was found to be higher based on the BMI of the respondents. BMI was found to be increased with increasing years of shift work experience and sleep deprivation. They found that the prevalence of obesity was high among shift workers while waist circumference was not significant.[8,9,10,11,12] On the contrary, a study conducted by Pasqua et al, concluded that there was no noteworthy difference in BMI among shift workers and day workers.[6] Amelsvoort et al, conducted a study and concluded that, subjects involved in rotational shift work for more than 5 years had appreciably higher BMI than those individuals with no shift work experience.[13] It was also suggested that, individuals who sleep less than 7 hours had an increased BMI and were more obese than those who sleep for 7 hours and more.[11] A recent study has stated that, there are at least three pathways i.e., alterations in pathways of glucose metabolism, up-regulation of appetite and decreased energy expenditure.[14] Various studies have established that the increase in adiposity found in sleep-deprived population is due to the alterations in the plasma Leptin and Ghrelin levels. [15,16] A crossover clinical study suggested that sleep deprivation was associated with a decrease in the levels of leptin, the anorexigenic hormone, and an increase in ghrelin, the orexigenic factor, and also increased urge to consume high calorie foods with high carbohydrate content.[15] The pathophysiology of increased BMI in shift workers can also be explained by several mechanisms, like high calorie intake,[17] changes in the circadian

distribution of food intake,[18,19] decreased physical activity,[20] and altered sleep habits.[17] The dietary pattern of shift workers is poor in fibers and rich in food with high glycemic index and animal proteins and fat which can cause a considerable increase of body fat among shift working individuals.[20] In addition, rotational shift work increases the daily cortisol secretion [21] and causes dissociation of the cortisol circadian rhythm, with a gradual increase in cortisol levels during sleep.[22,23]This is one of the important aspects, if it is considered that central obesity has a hypothalamic neuro endocrine origin, with elevated ACTH and cortisol secretion.[20,21]

Waist Circumference:

According to our study, sleep duration and shift work experience affect waist circumference significantly. There are studies in support with our study that states when sleep duration decreases; there is an increase in waist circumference and sagittal abdominal diameter.[24, 25]

Systolic Blood Pressure:

Our study showed significant increase in systolic blood pressure among shift workers. Supporting our study, many other studies have also stated that there is a strong relationship between sleep deprivation and hypertension. Also, they have suggested that sleep deprivation stands as an independent risk factor for development of hypertension.[9, 26, 27] Gangwisch et al, concluded that, sleep duration of less than 5 hours is expected to be an augmented risk factor for hypertension among shift workers.[11]A study conducted by Cappuccio et al, suggested that, at baseline, there was no association between sleep duration and hypertension in men[7]; but women who sleep ≤ 5 h/night had a higher risk of hypertension.[28] On the contrary, a population based Rotterdam study[29] conducted among individuals stated that there is no association found between sleep duration and hypertension in persons aged more than 58 years [30,31] while a prospective cohort study done in Spain proved that there was no connection found in prevalent or incident hypertension in older individuals , above 60 years.[32] The patho-physiology associating sleep duration and hypertension may be: When there is adequate sleep, there is a fall in BP, known as “nocturnal dipping” which is probably due to the decrease in sympathetic output. When there is an absence or decreased nocturnal dipping of BP, it may be a strong self determining interpreter of cardiovascular risk. Another expected reason for the strong association is activation of sympathetic nervous system and hypothalamic-pituitary-adrenal axis which is most commonly seen among sleep deprived individuals.[33]

Fasting blood sugar:

Fasting blood sugar was found to be a very significant tool to assess cardio metabolic risk in subjects with more than 5 years of shift work experience. Supporting our study there are many cross sectional studies and clinical trials that concluded that sleep deprivation may lead to increased fasting blood sugar levels and decreased insulin sensitivity.[34,35,36] There are also few other studies stating that sleep duration of less than 5 hours and individuals aged less than 60 years had an increased odds ratio for diabetes.[14,37] On the contrary, a study conducted in Gujarat by Patel et al, suggested that inadequate sleep at night (< 7 hrs) does not impair the blood sugar level.[38]Similarly, few other studies have also stated that sleep duration doesn’t have any association with blood sugar levels but have an impact on lipid profile.[24,39] One of the mechanisms is the up-regulation of the orexin neuron activity which is suggested to be a vital mechanism connecting sleep deprivation and metabolic derangements.[40,41,42] Also, as recommended by Thomas et al, the brain is a chief consumer of glucose, yet, brain glucose consumption is decreased after sleep deprivation, which causes impaired glucose metabolism.[43] Yet another study states that, cardiac sympatho-vagal balance could be distorted due to insufficient sleep.[44] Para sympathetic stimulation activates insulin release while sympathetic stimulation inhibits. But the lack of compensatory hyperinsulinemia in response to the decreased insulin sensitivity index, frequently found with sleep deprivation can be associated to defective autonomic beta-cell regulation.[45,46] Para sympathetic activity inhibits ghrelin secretion while leptin is inhibited by sympathetic activity. This result in decreased leptin secretion that causes meager satiety and increased ghrelin secretion that causes increased appetite.[44]One other pathway that connects sleep loss and metabolic derangement is increased levels of pro

inflammatory cytokines and minimal inflammation which in turn leads to leptin and insulin insensitivity.[45]

Fasting Lipid Profile:

According to our study, sleep duration and increasing shift work experience had a strong correlation with increase in lipid profile. Supporting our study, few other studies have also shown elevated serum triglyceride levels.[30,46, 47] Another study conducted by Lennernas et al, stated that elevated total cholesterol and LDL is associated with shift wok.54 On the contrary, few other studies have suggested that there is no change in total cholesterol and HDL levels in shift workers,[30] while Karlsson et al, have suggested that there is a decrease in HDL levels which is in favour to the results of our study.[48] Decreased leptin, insulin resistance, augmented sympathetic nervous system activation, and amplified cortisol production are the various proposed explanations.[49,50,51] Additional research is needed to reveal the pathophysiology of adipocyte function and regulation.[52] A study conducted by Lesato et al, stated that lipid breakdown involves a cascade of enzymatic reactions among which Lipoprotein lipase plays a key role in lipid breakdown by hydrolyzing triglyceride rich lipoproteins. Hence, the fall in Lipoprotein lipase activity can trigger distortion of lipid profile.[53]

Conclusion:

Though shift work has been considered as a risk factor for cardiovascular disease, a very limited data exist to show the relationship between cardio metabolic risk and shift work among rural population of India. Hence, it is very important to identify and prevent cardio metabolic risk factors among shift workers. The identified high risk population can be counseled and awareness on physical activity and diet must be made an essential program for rotational shift workers.

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