

Effect of Altered Sleep Rhythm on Body Mass Index

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ABSTRACT:

Objective: To assess the influence of de-synchronized sleep rhythm caused by rotatory shift work on Body Mass Index (BMI) in health care providers.

Methodology: This cross-sectional study was conducted in Dow university hospital Karachi, from November 2013 to May 2015. To outline underlying risk factor for obesity, a universal sample of all eligible health care providers working in split shifts (service across 24 hours of the clock, each day of the week)(n=91) were enlisted. We used the BMI calculator of heart foundation Australia. However, Asian cutoff points by WHO were also taken into consideration (BMI classification Global data base on BMI, WHO 2006) whereby BMI above 25 was considered to be obese in the Asian countries (WPRO criteria). BMI was determined by using metric system. Height was recorded in centimeters and weight was obtained in kilograms. Gender based BMI was calculated for adult men and women. The healthy range of BMI was 18.5-25. Exclusion criteria included pregnant women, age less than 18 years and chronic illness.

Results: Results revealed an increased BMI amongst the shift workers. However, female health care providers far outnumber the male health care providers as it was observed that 16 women (43.2%) were found to have BMI more than 25 as compared to 9 (16.7%) men.

Conclusion: Split shift work was identified as independent risk factor for obesity. Identification of irregular sleep cycle as an underlying mechanism leading to obesity necessitates further evaluation.

Keywords: Sleep, Obesity, Body mass index, Split shift work, Weight gain

INTRODUCTION:

Diseases are now considered to be multifactorial in origin. Mere presence of one factor is not sufficient to initiate a disease process. Currently there is a growing interest in job-related trauma; one such risk factor is working in irregular timings. Sleep wake timing in the human body is controlled by a complex interplay of a biological clock regulating the transition between dark and light cycle (day/night). Sleep rhythm is uniform in all human beings, which is maintained by the endogenous clock. Suprachiasmatic nucleus in the anterior hypothalamus plays a major role besides the peripheral oscillators in the organs.¹ Sleep cycle (Day/Night) of an individual which maintains body hemostasis results in a state when body metabolic pathways are operational and oscillating to storage pathways during sleep. However, this alternate swing between storage, metabolism and overnight fast are regulated by certain hormones namely insulin/Glucagon ratio, which in turn is influenced by day and night oscillation; this sleep wake time are distressed due to rotatory/split shift work.²

Obesity has now become a pandemic dilemma, according to WHO, obesity is the most overlooked public health problem.³ It is currently a worldwide challenge, having multiple determinants, nevertheless job related factors are drawing major attention from research community. The prevalence of elevated body mass index and obesity in several Asian countries is about 3.0%.⁴ The computer age has led to many changes in life style; several workers are now working online in night shifts, students with part-time jobs, 24-hours-economy, video-game shops, all

have influenced daily life at the expense of sleep shape. The perfunctory glance illustrates the complexity of changed life-style and behavioral cycle that has been found to be variably associated with the change in disease pattern. Rotatory shift workers are frequently found to be obese. Multiple studies have linked linear association between short sleep duration and weight gain. It was observed that increased intake and decreased energy utilization seen in split sleep pattern as in irregular shift worker is one of the factor associated with weight gain.^{5,6} Proximate research postulated that intentional variations to natural sleep duration effect BMI, and familial pattern did not seem to play any role.⁷ Prior researches with major focus on sleep/wake parameters suggested a positive relationship between sleep cycle and obesity.⁸ BMI, which stands for body mass index is a precise bench mark to draw a conclusion if the individual is normal, overweight or underweight. It is valuable because if BMI ascends or descends from the ideal range, it has a linear association with the health issues.⁹ It was also witnessed that irregular shift workers were unable to participate in programmed sports and exercise which might have further contributed to elevated body mass index.¹⁰ Chronic diseases, for instance diabetes, hypertension and cardiovascular disease now appear as new challenge which are mostly prevalent in overweight individuals.¹¹

With this background, aim of the study was to assess the impact of the irregular sleep/wake oscillation on body mass index and to determine relationship between sleep configuration and obesity.

METHODOLOGY:

This was a cross-sectional study conducted between November 2013 and May 2015 in Dow University Hospital Karachi. A universal sample included all health care providers working in rotatory/split shifts. Demographic characteristics including age, gender, education and vocational status was identified. Subjects exclusively working in irregular shifts who were healthy

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and fit to participate were included, while subjects with history of any chronic morbidity like diabetes, hypertension, nicotine use, drug abuse, mental illness, on any psychiatric treatment, pregnant women, and under 18-year-age were excluded. The study population was working 8-hour per day, and were rotated every ten days; the direction was from morning to evening-shift and finally night shift. The study was preceded by a pilot study examining 12 subjects.

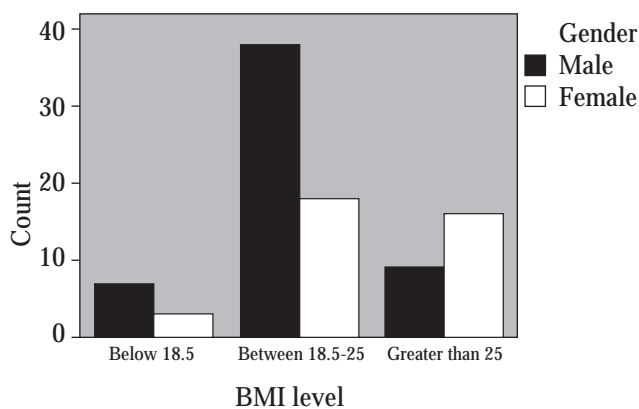
Then final study was initiated after obtaining written informed consent from the enrolled subjects, and a formal written permission from the hospital management. The measuring tool was BMI calculator from Heart foundation Australia using the formula, Body weight (kg) divided by squared height (m²). Anthropometric measurement included height and weight. Height was recorded in centimeter and weight was obtained in kilogram. Calculated BMI was split in to three categories; underweight, normal weight, and overweight, based on recommended age and gender. BMI of female and male participants was segregated. Healthy BMI range was between 18.5-25. Obesity was defined as a body mass index = 25 kg/m² for Asian countries(WPRO criteria), and underweight below 18.5. These categories have been proven useful measurement for most people over 18 years. All data analysis was carried out on SPSS version 20. Quantitative variables were presented by their mean ± SD while qualitative variables were presented by frequency and percentages.

RESULTS:

Participants in the current study were 104; however, 91 complete data forms were received. Response rate was 87.50 %. Most of the subjects in the current study were males, 54 (59.30%), whereas female subjects were 37 (40.70%). Mean age was 27.78±5.78. The number of subjects within the healthy BMI range were 56 (61.5%), which included 38 males (70.4%), and 18 females (48.6%). The obese category comprised 25 (31.9%) participants and amongst them 16 women (43.2%) and 9 (16.7%) men were included. The number of underweight subjects were 10 (13.8%) and included 3 (8.10%) females and 7 (13.0%) males (Figure-1).

Figure: 1

Graphical presentation of BMI among health care providers



DISCUSSION:

Our results did not reveal a correlation between rotatory/split shift work and increased body mass index, however, more women shift workers were observed to be overweight as compared to males shift workers. Many chronic diseases, such as Type-2 diabetes and metabolic syndrome have been known to be directly related to overweight.¹² A new window was unlocked with the introduction of graded cutoff points to determine BMI by WHO in Asian population, the objective of the cut off points was to classify on a continuum the level where the subjects should be placed on BMI scale, still BMI and those cutoff points could not correlate overweight and chronic diseases in isolation without considering other risk factors.¹³ Prior research had revealed that direction of shift work and its frequency were related to negative health consequences,¹⁴ hence, split shift work must be addressed from various perspectives including duration and frequency of night shifts.¹⁵ Newer approach of introducing healthy shift schedule had a promising health influence.^{16,17} It was observed in the current study that our subjects were mostly sleep deprived. Anthropometric measurement included height and weight. Waist to hip ratio was not included in our study since it was witnessed from prior data that waist to hip ratio might result in false inference, as waist measurement was influenced by the parity of the women.¹⁸

Proximate researches had published various health effect of this type of split sleep structure that could initiate unhealthy practices by the employee; de-synchronization of endogenous circadian sleep rhythm made them vulnerable for irregular meals that had further increased the chances of weight gain.^{19,20} The prior researches had also evidenced that minor changes in eating habit were leading to cumulative effect.²¹ The relationship between sleep deprivation and overweight dates back to sixties, when analysts indicated a link between body weight change and sleep disorders.²² Present study was meant to further strengthen previous observation. Although mechanism of sleep architecture and weight related changes were well described in the past, however, there was scarce knowledge about the relationship between sleep and obesity. Prior research had observed that a low caloric diet might had an association with a low level of sleep-inducing gut peptide, which in turn effect the waking hormone orexin which modulates the sleep/wake cycle.²³ Previous research also observed increased prevalence of depression among split shift workers, which might in turn be responsible for increased food intake and overweight. Earlier studies had focused on depression being responsible for obesity, therefore it became necessary to identify depression as a variable when analyzing the link between split work and weight gain.²⁴ A recent study on Australian subjects revealed that the people with sedentary jobs were more active during free time as compared to the individuals engaged mostly in walking and heavy work occupation.²⁵ From sleep-wake time system perspective, human body was not meant for nocturnal eating. It was demonstrated

that feeding at night increased the LDL/HDL profile.²⁶ It was also observed that glucose balance descended from dawn to dusk.²⁷ Body clock was also evidenced to play a crucial role on plasma triglyceride level, with elevated nocturnal level which itself was an underlying risk factor for cardiovascular pathology.²⁸ For a long time, split shift-work had been vital to deliver essential services. Over the years man made environment has changed life style. Currently, the desynchronized environment and its interaction with man's endogenous rhythm imposed penalties to the human body. The new jobs opening in call centers, shopping malls, 24/7 banking, as well as early morning shifts have affected the life pattern of a common man. Many employees are currently working outside day light range which is not harmonized to the natural biological rhythm with in human body, thereby producing diseases like hypertension and glucose intolerance.²⁹ Currently irregular shift employment ranges from 13–20% in Europe and the United States. Multiple well-controlled epidemiological studies advocated irregular shift work as an independent variable of elevated BMI.³⁰ However, there were certain limitations in our study. The sample size was relatively small, and the subjects were from a multicultural slum area.

CONCLUSION:

Despite the limitation of the current study, it was observed that split shift work is an independent risk factor for increased BMI. Identification of irregular sleep cycle as an underlying mechanism leading to obesity necessitates further evaluation of rotatory shift on BMI in diverse geographical meridian since no data is available from this region.

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REFERENCES:

- Mohawk AJ, Green C, Takahashi S J. Central and peripheral circadian clocks in mammals. *Annu Rev Neurosci* 2012;35:445-62
- Green CB, Takahashi JS, Bass J. The meter of metabolism. *Cell* 2008; 134: 728-42
- WHO. Obesity: preventing and managing the global epidemic. Report on a WHO Consultation on Obesity, Geneva. Geneva, 2000
- Yoon KH, Lee JH, Kim. Epidemic obesity and type 2 diabetes in Asia. *Lancet* 2006; 368:1681-8
- Ohida T, Kamal AM, Uchiyama M. The influence of lifestyle and health status factors on sleep loss among the Japanese general population. *Sleep* 2001;24:333-8
- Stamatakis KA, Brownson RC. Sleep duration and obesity-related risk factors in the rural Midwest. *Prev Med* 2008; 46:439-44
- Watson NF, Buchwald D, Vitiello MV, Noonan C, Goldberg J. A twin study of sleep duration and body mass index. *J Clin Sleep Med* 2010; 6(1):11-17
- Watanabe M, Kikuchi H, Tanaka T, Takahashi M. Association of short sleep duration with weight gain and obesity at 1-year follow-up: a large-scale prospective study. *Sleep* 2010; 33(2):161-67
- Dahl AK, Fauth EB, Ernsth-Bravell M, Hassing LB, Ram N, Gerstoft D. Body Mass Index, Change in Body Mass Index, and Survival among Old and Very Old Persons. *J Am Geriatr Soc.* 2013;61(4):512-18
- Authersc Atkinson G, Fullick S, Grindey C, Maclaren D, Waterhouse J. Exercise Energy Balance and the Shift Worker. *Sports Med* 2008; 38(8): 671-685
- Chaput JP, Després JP, Bouchard C, Tremblay A. Association of sleep duration with type 2 diabetes and impaired glucose tolerance. *Diabetologia* 2007;50:2298-304
- Pan A, Schernhammer ES, Sun Q, Hu FB. Rotating Night Shift Work and Risk of Type 2 Diabetes: Two Prospective Cohort Studies in Women. *PLoS Med* 2011;8(12): e1001141. doi:10.1371/journal.pmed.1001141
- Nishida C. Appropriate body mass index for Asian population and its implication for policy and intervention strategies. *Lancet* 2004;363:157-63
- Van Ameisvoort LG, Jansen NW, Swaen GM. Direction of shift rotation among three-shift workers in relation to psychological health and work family conflict. *Scand J Work Environ Health* 2004;30(2):149-56
- Harrington JM. Health effects of shift work and extended hours of work. *Occup Environ Med.* 2001;58:68–72
- Knauth P. Designing better shift system. *Applied ergonomics* 1996;27:39-44
- Barton J, Folkards S. Advancing versus delaying shift system. *Ergonomics* 1993;36(1-3):59-64
- Lassek WD, Gaulin SJC. Changes in Body Fat Distribution in Relation to Parity in American Women: A Covert Form of Maternal Depletion. *American journal of physical anthropology* 2006;131:295-302
- Suwazono Y, Dochi M, Sakata K, Okubo Y, Oishi M. A longitudinal study on the effect of shift work on weight gain in male Japanese workers. *Obesity* 2008;16: 1887-93.
- Lowden A, Moreno C, Holmback U, Lennernas M, Tucker P. Eating and shift work – effects on habits, metabolism and performance. *Scand J Work Environ Health* 2010; 36: 150-62
- Weiss A, Xu F, Storer-Isser A, Thomas A, Ievers-Landis CE, Redline S. The association of sleep duration with adolescents' fat and carbohydrate consumption. *Sleep* 2010; 33(9):1201-9
- Vijayakumar M, Billington CJ, Catherine M, Jennifer A. Sleep and Obesity: A focus on animal models; *Neurosci Bio behav Rev.* 2012; 36(3): 1015-29
- Lauer CJ, Krieg JC. Sleep in eating disorders. *Sleep Med Rev* 2004; 8(2):109-18
- Goodman E, Whitaker RC: A prospective study of the role of depression in the development and persistence of adolescent obesity. *Pediatrics* 2002; 110(3):497-504
- Chau JY, van der Ploeg HP, Merom D, Chey T, Bauman AE. Cross sectional associations between occupational and leisure-time sitting, physical activity and obesity in working adults. *Prev Med* 2012;54: 195-200
- Orth-Gomer K. Intervention on coronary risk factors by adapting a shift work schedule to biological rhythmicity. *Psychosomatic Medicine* 1983;45(5)407-15
- Lennernas M, Akerstedt T, Hambraeus L. Nocturnal eating and serum cholesterol in 3 shift workers. *Scand J Work Environ Hea.* 1994; 20:401-6

28. Holmbäck U, Forslund A, Forslund J, Hambraeus L, Lennernäs M, Lowden A, et al. Metabolic responses to nocturnal eating in men are affected by sources of dietary energy. *J Nutr* 2002; 132:1892-99
29. Antunes LC, Levandovski R, Dantas G, Caumo W, Hidalgo MP. Obesity and shift work: chronobiological aspects. *Nutr Res Rev* 2010; 23: 155-68
30. Barbadoro P, Santarelli L, Croce N, Bracci M, Vincitorio D, Prospero E, et al. Rotating Shift-Work as an Independent Risk Factor for Overweight Italian Workers: A Cross-Sectional Study. *PLoS ONE* 2013; 8(5): doi:10.1371/journal.pone.0063289

