

Review Article

Impact of Shift Work on Health : A Review

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In modern society, more and more people work during 'non-standard' working hours, including shift and night work, which are recognized risk factors for health, safety and social well-being. Unfortunately, humans are physiologically unsuited to inverted schedules, leading to negative consequences for shift workers, employers, and society. The circadian and homeostatic processes which govern sleepiness and alertness are improperly aligned for night workers. Shiftwork, in particular night work, causes disruption of biological rhythms, perturbation of social and family life, with a negative influence on performance efficiency and health. Deterioration of health can manifest in the short-term as sleep disorders and accidents; in the long term there is an increased risk of gastrointestinal, psychoneurotic and cardiovascular diseases, and impairment of the female reproductive function. Night work and rotating shift work disrupt the circadian timing system. This disruption may produce significant deleterious symptoms in some workers. Shift-work scheduling may aggravate certain medical conditions. Vulnerable individuals may develop clinical depression when working shifts.

Key words: Shiftwork, health hazard

The new "24-hour society" increases night work and the diversity of flexible work-hour patterns. Together with new experimental and epidemiologic data on the alarming relationship of shift work to fatigue, performance, accidents, and chronic health effects like coronary heart disease, there is reason to believe that shift work may become a major occupational health and safety problem in the near future¹. Shift workers may develop symptoms of 'Intolerance Syndrome', i.e. psychoneurotic, digestive, circulatory, and those of chronic fatigue^{2,3,4,5}. The ill effects of shift work can range from mildly annoying to potentially deadly. Excessive sleepiness associated with it can increase the risk for work-related injuries, and equipment and automobile accidents. In fact, studies suggest that 20-30 percent of individuals working non-traditional work schedules have had a fatigue-related driving mishap. Additionally, sleep-deprived individuals have a tendency to get sick more frequently than well-rested peers, and are at greater risk for high blood pressure, weight gain and gastrointestinal problems. Together, these factors can result in increased sick days and decreased job productivity^{6,7,8,9,10,11,12,13}.

In this review, the health hazards of shift work are discussed under following headings :

1) Sleep Disorders:

Studies demonstrate that shift workers tend to sleep less than nonshift workers every day one and a half to four hours less! Many shift workers try to find time for family and friends, responsibilities and hobbies. Sleep is often last on a shift worker's "to do" list. Always desired, too little achieved, sleep becomes a seemingly impossible dream. Sleep-deprivation becomes a way of life. A large body of research shows that rotating shifts and sleep loss lead to mistakes, dips in attention, delayed reactions, accidents in the workplace, crashes on roadways, reduced productivity, and difficulties in communication^{14,15,16}.

Sleep is an active process consisting of macro- and microarchitectural rhythms, chronobiology, and neurochemical changes. Shiftworkers working on the night shift transpose their sleeping hours to the time of day which is inconvenient for sleep because of the endogenous circadian rhythm sleep wakefulness, the circadian rhythms of other body functions and the environmental schedule. As a result of this, a certain number of workers suffer from insomnia¹⁷.

Disturbed sleep and on-the-job sleepiness are widespread problems among night shift workers. The pineal hormone melatonin may prove to be a useful treatment because it has both sleep-promoting and circadian phase-shifting effects. The most troublesome acute symptoms are difficulty getting to sleep, shortened sleep and somnolence during working hours that continues into successive days off. Two explanations of the reported reduction in night-shift workers' sleep length have emerged. One argues that these reductions in sleep are related to sleep disturbances which may require medical treatment as disorders. The other argues that sleep reduction is mainly due to a sleep deficit caused by the voluntary choice to delay sleep onset and reduce the sleep duration which requires a systems approach aimed at increasing sleep length and reducing the effect of a sleep deficit at the workplace. Working at night may have persistent deleterious effects on sleep quality when the experience is long and includes a substantial number of night shifts. Disruptions in sleep chronobiology, which may occur in shift workers and the elderly or due to jet lag, often respond to exogenous melatonin^{18,19,20,21,22,23,24}. The detrimental effects of sleep deprivation on psychological performance are indicated as increased lapsing, cognitive slowing, memory impairment, decrease in vigilance and sustained attention and shift in optimum response

capability. Its effects on physical performance are manifested as decline in ability to perform maximal exercise, self-selected walking pace and increase in perceived exertion^{25,26}.

2) Fatigue:

Humans possess a circadian rhythm of approximately 24 hours, which is regulated by neural and hormonal processes. The synchronisation of this rhythm with the solar day and night is maintained through entrainment mainly by light. Dark environments completely lacking windows may have a negative effect on well-being and work capacity. During shift work the biological clock tends to maintain its normal 'diurnal' rhythm, which may lead to extreme tiredness and increased risk of accidents. Night workers and shift workers do have chronic sleep deprivation and desynchronisation of their circadian system with the entraining environment. Those phenomena are responsible for severe vigilance problems, a decrease in work productivity and deleterious health side effects^{27,28}. Chrono-fatigue is often present in patients engaged in shift or night work. Work stress, shift work, and physical workload interfere with sleep and are related to fatigue. The effects of fatigue on performance are well defined. Concentration, data processing and short-term memory are impaired. The variability of performance increases, so that normal performance alternates with periods of poor work, and astute decisions are mixed with lapses of judgment. Performance declines sharply as the duration of a task increases, and fatigued workers sacrifice accuracy to speed. Mistakes caused by fatigue are more likely to occur during routine tasks and tasks which require sustained vigilance, especially when the factors that trigger an effort of concentration are absent. Fatigue mistakes characteristically involve failure to recognise the existence of a serious problem^{29,30,31}.

3) Cardiovascular system:

Shift work is an important part of the occupational gradient in coronary heart disease(CHD) risk among industrial workers; some evidence was found for the hypothesis that a direct stress-related mechanism explains part of the increased CHD risk. Shift work seems to trigger the effect of other, lifestyle-related risk factors of CHD^{32,33,34}. The incidence of premature ventricular contractions (PVC) increased significantly in shift workers over the 1 year follow up, compared with daytime workers. The frequency of ventricular extrasystoles increased in 48.9% of the shift workers, and in 27.3% of the daytime workers. A change in arrhythmogeneity, but not in cardiac autonomic control, might explain the increased risk of cardiovascular disease in shift workers³⁵⁻³⁸. A prospective study of 25 male shift and day workers, who were followed for six months, indicated that the diet of shift workers might be responsible for changes in the ratio between apoB and apoA-1, a ratio which is related to risk of coronary disease. The analyses of spontaneous changes in the diet showed that the shift workers tended to decrease the intake of

dietary fibre and increase the intake of saccharose. The change in the ratio between apoB and apoA-1 correlated inversely with the change in intake of dietary fibre. It is concluded that spontaneous changes in the diet of shift workers might be responsible for changes in serum lipoproteins. Three major disease pathways from shift work to CHD are proposed: (i) disturbed physiological rhythm and/or a collision between the circadian rhythm and myocardial performance, (ii) changes in behaviour, and (iii) disturbed sociotemporal rhythmicity, which might lead to distress reactions³⁹.

4) Gastrointestinal system :

Shift work involving sleep disturbances may play an important role in the development of peptic ulcers^{40,41}. Gastrointestinal complaints including, indigestion, heartburn, loss of appetite, constipation are believed to be associated and enhanced by shift work (SW). Serum gastrin (G) and group I pepsinogen (PGI) are thought to play a role in the pathogenesis of peptic ulcer and may be considered a useful test of the gastric function. SW causes a prominent change in the gastrin/acidopepsin secretion system. An excess risk of gastric ulcer (GU) has formerly been found in shift workers and ex-shiftworkers but little is known about the risk of GU associated with other forms of non-daytime work^{42,43,44,45,46}.

5) Shift Work and Endocrine responses:

Insulin, pancreatic polypeptide(PP), thyroid stimulating hormone(TSH), free thyroxine(FT4), cortisol and leptin responses to meal intake differed with respect to time of day. Meal intake decreases cortisol concentration after meals at 0800, 1200 and 0400 but not at 1600, 2000 and 0000 h. The PP's postprandial increase is greater during 0800-1600 h compared to 2000-0800 h. The decrease in evening/nocturnal responses of cortisol and PP to meal intake indicate that nocturnal eating and night work might have health implications^{47,48}.

6) Shift Work and Reproductive system:

Shift work has been associated with various unfavorable pregnancy outcomes (i.e., pregnancy loss, spontaneous abortion, low birth weight, etc). The suggested underlying mechanism is the interference of shift work with the circadian regulation of human metabolism and, in particular, with the temporal pattern of endocrine function^{49,50,51}. Nonstandard workhours may disturb normal body functions. Newly published studies suggest an association between rotating shift work and prolonged waiting time to pregnancy. Seven of nine studies on spontaneous abortion suggest that some forms of shift work may be associated with increased risk. Four studies indicate that shift work including night schedules may be related to preterm birth. Moreover, some results have related rotating schedules to intrauterine growth retardation shift work as a potential risk to reproduction. A slightly, but not significantly, increased risk of miscarriage was found in women who worked irregular hours or rotating shifts compared with women who worked only

during the day. Infants of non-smoking mothers who worked irregular hours had significantly lower birth weights than infants of non-smoking women working day time only. Stressors as subtle as night work or shift work can lead to irregular menstrual cycles, and changes in reproductive hormone profiles can adversely affect bone health^{52,53,54,55}.

7) Infections:

Results from the multilevel analyses showed that, compared to day work, shift work was associated with a higher risk for common infections like colds, coughs, sore throats and flu that are floating around in the work place⁵⁶.

8) Shift Work and Risk Of Developing Cancer:

Visible light of sufficient intensity and duration inhibits melatonin biosynthesis, and experimental studies suggest that melatonin may protect against cancer^{57,58}. From a public health point of view it is important to verify or falsify the hypothesis that artificial light--or even sunlight itself--suppresses melatonin production sufficiently to increase the risk of developing cancers of internal organs in man. Melatonin levels are reduced among shift-workers. Light exposure during darkness increases the risk of cancer progression via elimination of the nocturnal melatonin signal and its suppression of tumor suppression of the pineal gland or melatonin deficits should stimulate mammary tumorigenesis. Epidemiological observations on increased risk of breast cancer in night shift workers, flight attendants, radio and telegraph operators and on decreased risk in blind women are in accordance with the results of experiments in rodents^{59,60,61,62}.

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