

Effect of Shift work on Health: A Review

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Abstract:

This study was designed to examine the adverse effect of shift work on the health of shift worker. The primary reason that these health problems occur is due to the disruption of the normal sleep-wake cycle. The aim of this study was to explore the effect of shift work related health problems on shift.

Key-words- *Shift work, Health problem, Sleep problem, Cancer, Psychosocial Impact, IBS (Irritable Bowel Syndrome).*

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1.0 Introduction

Industrial and commercial activities that operate outside the normal work hours have become widespread in recent years. Services such as banking, communications, transport, catering and retailing are routinely available during evening hours. Consequently, the work patterns of a substantial proportion of the population now extend beyond the regular day-work hours. Variable schedules (often including evening or night work) and rotating shifts are both widespread. In a recent European survey, 28% of the workforce had variable work patterns, 10% had evening or night schedules, while 17% worked two-shift or three-shift rotating schedules (Boisard et al., 2003). Further analysis also showed that the proportion of shift workers remained relatively constant up to age 45 years, but fell sharply at higher ages, particularly over 55 years (European Foundation for the Improvement of Living and Working Conditions, 2003). It reflected the older workers' difficulties. Similarly, the analysis of U.S. survey data showed that in 1997, 27.6% of the workforce had flexible work schedules, while 16.8% of full-time employees had alternative schedules involving the work outside normal day time hours (06.00-18.00 hrs), 6.4% of whom worked night or rotating shifts (Beers, 2000). These proportions varied by occupation; rotating shifts were particularly common in security services (16.3%), mining (12.5%) and catering (8.7%), but infrequent among professionals and managers (1.7%). Night work was prevalent in health care, manufacturing, and manual occupations. The Global trends towards a '24-hour society' suggest that these proportions are likely to rise. Thus, the implications of shift work for physical and mental health is not only a matter of current concern but also one that is likely to become increasingly important in future (Costa, 2001; Rajaratnam & Arendt, 2003). Shift work

has been empirically linked to a variety of diseases (Knutsson, 2003). Three pathways have been implicated in associations between the shift work and diseases (Boggild & Knutsson, 1999; Knutsson, 1989; Knutsson & Boggild, 2000). Those are; disruption of circadian rhythms (leading to sleep/wake disturbances, desynchronization of internal processes and increased susceptibility to disease), disturbed socio-temporal patterns (resulting from atypical work hours leading to family problems, reduced social support and stress) and unfavorable changes in health behaviors (increased smoking, poor diet and irregular meals). Moreover, there is evidence that the biomarkers such as cholesterol and other lipids, plasminogen, blood pressure and cardiac activity show changes related to shift work and may act as mediators of disease processes (Boggild & Knutsson, 1999).

The general pattern of findings are; shift workers as compared to day workers show less favorable profiles of lifestyle, behavioral and biological risk factors (e.g. Lac & Chamoux, 2004; Morikawa et al., 1999; Parkes, 2002). The psychosocial factors are also relevant. For instance, Smith et al. (1999) found that chronic fatigue and ineffective coping behavior acted to mediate the process by which sleep loss and social disruption led to the disease endpoints. Shift work may also interact with individual and environmental factors (e.g. age, personality, poor physical work conditions) to increase the risk of health problems.

2.0 Shift work

The work which is scheduled outside “normal” daylight hours (i.e. 9 am to 5 pm) is called “shift work”. ‘Shift work’ is a form of work schedule involving a process in which a group of workers succeed each other at the same work station in shifts. The shifts can be organized either in a rotating, a continuous or a discontinuous fashion. The shift work schedules can vary from one work place to another. The workers may rotate through shifts or remain on a single shift (i.e. permanent nights). It allows for continuous services and production, 24 hours per day. Many manufacturing and seasonal workplaces also work 24 hours a day to maximize efficiency and productivity.

The term “shift work” means different things to different people. Shift work is popularly regarded as a work in which employees’ “shift” schedules on some regular basis from day time to evening or night time. Many researchers define shift work as an employment in which two or more groups of employees work at different times of a 17-hour or 24-hour time-span, including a so-called “day” shift. The industrialized societies are increasingly requiring shift work. In modern societies, many companies and organizations stay open 24 hours a day, requiring people to work shifts. Shift work is becoming increasingly prevalent in contemporary life, affecting 20% to 25% of the employees in manufacturing industries and a growing number in service industries. However, shift work, which requires alterations in sleeping and waking hours.

According to Williams (2008) one can identify the following categories of shift work:

- regular evening schedules (beginning after 3 p.m., ending before midnight)
- regular night (beginning after 11 p.m., ending before 11 a.m.)
- rotating (day to evening and/or night)
- split (two or more distinct work periods each day)
- on call (no pre-arranged schedule)
- irregular shifts.

3.0 Shift work and Health

Disruption of the body's circadian rhythm is thought to be the main pathway for adverse health effects from shift work, particularly for work schedules which include night work. Circadian rhythm is the body's biological cycle that recurs at 24-hour intervals including sleep-wake patterns, body temperatures and hormone levels. Haus and Smolensky (2006) reviewed several possible effects of the disruption in circadian rhythm in shift workers. It can result in insomnia or non-restorative sleep during the period of adjustment to a new schedule. It can also lead to the changes in hormone levels, which can influence cell growth and division. Moreover, the workers rarely become completely habituated to unusual shifts. Even after a long time on night shifts, only a minority of workers show adaptation of their circadian system to the nocturnal activity pattern, in part because night workers usually revert to the usual sleep/ wake cycle on days off. Shift work can also have adverse health effects through its potential impact on behaviour such as; poorer quality diet or increased smoking or alcohol consumption. Bøggild and Knutsson (1999) reported that shift workers are more likely to be smokers than the regular day workers. Finally, shift work may disrupt social and family relationships, by putting the worker's daily pattern of work and rest out of phase with that of family, friends and the social life of the community. This social disruption can also contribute to stress and thereby to adverse health outcomes.

In the rest of this paper, we look at the research findings about the possible link between shift work and the following health problems.

- Circadian Rhythm,
- sleep problem
- cancer,
- pregnancy complications,
- gastrointestinal disorders,
- cardiovascular disease,
- diabetes.

Findings relating shift work to particular health problems and diseases are summarized in the following section.

4.0 . Effect of Shift Work on Health

4.1 Circadian Rhythm

Shift work (working shifts) can affect health. In shift system, we have to work in night when our body wants to sleep. We have to sleep when our body expects to be awake. Our sleep and wake times are much different from our internal body clock. This internal clock controls circadian rhythm in our body. Circadian Rhythm means something to occur in a cycle of 24 hours. These circadian rhythms make us alert or feel sleepy in regular time periods every day. The body is synchronized to night and day by a small part of the brain known as the circadian clock. A shift worker confuses his circadian clock, by working when his body is programmed for sleeping. Common health problems include sleep disorders, digestive upsets, obesity and heart disease. Research findings show that, shift work can be hazardous to our health. Body functions

such as heart rate, blood pressure, and temperature, digestion and brain activity fluctuate over each 24-hour period, under the guidance of the circadian clock.

In the evening, when the light starts to wane, our clock notices and prompts a flood of a brain chemical called melatonin, which gives signal to the body to fall asleep. Overnight, the melatonin levels remain high. They drop at daybreak and remain low during the day. During the day, other chemicals (neurotransmitters) such as noradrenalin and acetylcholine – increase in the body and keep us awake. This system keeps us synchronized through the day–night cycle. Many other functions of the body including temperature, digestion, heart rate and blood pressure fluctuate through the day, tuned by the activity of the circadian clock. This changing rate of activity over each 24-hour period is known as circadian rhythm (from the Latin 'circa' = about, and 'dia' = a day). Our metabolism at night is an important body function which follows the circadian rhythm and it is the internal body temperature. This temperature increases through out the day. It reaches the low level in the early hours of the morning and reaches the maximum level in the late afternoon.

Studies show that the shift work and shifts with extended hours can have significant adverse effects on health, workplace accident rates, absenteeism and a worker's personal life. Human beings are by nature diurnal (day orientated) as opposed to nocturnal (night orientated). It means that our physiological functions are geared towards the day time activity and night time rest. Research has shown that our physiological functions fluctuate in cycles or rhythms, which are regulated by an internal biological clock in the brain. Studies have shown that the main physiological functions such as the core body temperature, hormone production, heart rate, blood pressure, gastric activity and the sleep/wake cycle; all have cycles or rhythms of approximately 25 hours.

The most common health problems are gastrointestinal complaints including constipation, diarrhoea, excessive flatulence, abdominal pain and heartburn. These ailments are two to three times more frequent among the shift workers than others. The causes are due to poor eating or diets high in saturated fats. Other factors include disturbed sleep, poor eating habits, overeating, excessive tea or coffee drinking, smoking and psychological stress.

4.2 Sleep Problems

Shift workers get, on average, two to three hours less sleep than the other workers. They often sleep a few hours in the morning and then an hour or so before going to work at night. Night workers can find it difficult to sleep during the day. It is difficult to keep the environment dark as well as free of noise during the day time. The rotating shift workers find it difficult to sleep during daytime due to the noises at home and in the residential community. Sleep is not a passive process. It is actually an active restorative process. We need sleep to function well. If we are sleep-deprived, we won't function well. They have trouble in sleeping due to the different shift work schedules. The quality of sleep is also poor. They do not feel refreshed, when they wake up from sleep. Due to the poor sleep, their performance is affected. It can also make them less attentive. The study confirms that there is a link between shift work and sleep problems, while lending new insights into the course of those problems over time.

Insomnia is a sleep disorder which is characterized by difficulty in falling and staying asleep. Night shift work results in acute partial sleep deprivation. One night sleep deprivation impairs the performance in choice reaction time and simple reaction time. Continuous work in the night shift may lead to chronic partial sleep deprivation. Chronic sleep deprivation may lead to many other clinical complications. It has been reported that, the total sleep deprivation may

lead to fatal/devastating consequences such as death. The association between shift work and sleep disruption results in adverse medical and psychological consequences. Chronic insomnia can lead to anxiety and depression. For most of the people, insomnia lasts only for a few days and goes away without treatment. However, the factors such as stresses can cause a higher level of insomnia.

4.2.1 Sleepiness

Poor sleep, both quantitative and qualitative leads to sleepiness. Sleepiness has been defined as a drive towards sleep. It has been documented that the main causes of sleepiness in workers are due to the working in irregular work hours, the amount of prior wakefulness, the length of shift and the speed of rotation etc. Several investigators have documented a significant circadian rhythm of subjective drowsiness/sleepiness in healthy human subjects. However, in case of shift workers the rhythm in sleepiness desynchronizes externally as well as internally. Shift workers have problems with sleep management especially because; they attempt to sleep at unsuitable time of the day. The problems include difficulty in initiating sleep and staying asleep. In day time, the body temperature becomes high and at night the body temperature becomes low. So, there is a good relationship between the disturbed sleep and increased sleepiness.

When the starting time of the morning shift is advanced, more sleepiness is experienced during the day. This also decreases the sleep length and sleep quality. A number of studies demonstrated that the sleep quality and quantity seems to be poorer for the rotating shift workers in compared to the permanent day workers (Siebenaler, M. J. et al. 1991). Tilley et al. (1982) and Fischer et al. (1985) concluded that the quantity and quality of sleep are degraded and deteriorated as a result of working at night.

4.2.2 Sleep Length

Several studies on experienced night-shift workers have repeatedly revealed that the night work decreases sleep length and may result in an increase in sleep complaints (Tilley, A. J. et al., 1982). The reduction in sleep length found among night-shift workers is one of the most important findings. According to Kripke et al. (1979) the short sleep lengths are associated with decreased life expectancy. Tepas and Carvalhais (1990) reported that the permanent night-shift workers sleep longer on their days off, but they still sleep almost 4 hours less per week than the day workers do. Similar results have been reported in so many studies. Studies from several laboratories have shown that sleep duration is dependent on the time of sleep onset. Reduction in sleep length is associated with the decrements in performance (Fröberg, J. E. et al. 1975), decreased alertness and higher incidence of accidents and increased probability of precipitation of health problems among the night workers (Thiis-Evensen E. et al. 1958). Changes in mood state, increased feelings of fatigue, sleepiness and irritability, inability to concentrate and periods of misperception also occur on account of the reductions in sleep length in night-shift workers (Tepas, D. I. et al. 1990).

A positive correlation between the magnitude of sleep problems and age is a natural phenomenon (Marquie, J. C. et al. 1999). These authors reported that older the age, poorer was the sleep quality. Pavard et al. (1986) documented that sleep length may decline with age and the rate of decline is largest among the night workers. Female shift workers have been reported to experience more sleep disturbances than men. They suffer from drowsiness more frequently during the work. The problems of drowsiness become severe when they work in the morning shift. Sleep length was also reported to be shorter in case of female night-shift workers.

4.2.3 Sleep Disturbance

Sleep quantity and quality is often disrupted, when the sleeping time is shifted from night to day. It is generally found that the day sleep lasts no longer than seven hours. Of course, the hours of sleep differ from person to person and by age, because the sleep requirements lessen as one grows older. Sleep problems in shift workers occur primarily because the sleeping period is transferred to day time which is not conducive to sleep either in terms of circadian rhythms or environmental conditions.

Thus, it is evident that the night shift workers experience greater problems with sleep disturbance than the other workers. Environmental conditions play an important role in this problem. The quality of sleep is also affected by night shift. The quality of sleep is generally accepted to be indicated by the different sleep stages that have been identified by electroencephalograms. Changes in mood state, increased feeling of fatigue, sleepiness and irritability, inability to concentrate and the periods of misperception also occur on account of the reductions in sleep length in night-shift workers.

Disturbed sleep is an inevitable outcome of the disruption to normal circadian rhythms associated with shift work, particularly night work. The fundamental problem is the mismatch between the need for wakefulness and work activity during night hours when circadian rhythms are conducive to sleep and for sleep during daylight hours, normally the time of wakefulness and activity (Akerstedt, 1998; Akerstedt, 2003; Smith *et al.*, 1999). This reversal of the usual diurnal pattern underlies many of the sleep problems experienced by shift workers; environmental conditions (e.g. domestic and traffic noise, presence of children, normal social activities) may also contribute to disturb shift workers' daytime sleep. Consistent with the empirical evidence (e.g. Harma *et al.*, 2002; Ohayon *et al.*, 2002), delayed onset of sleep, reduced sleep duration, sleepiness and fatigue during working hours are seen as characteristics of sleep disturbance among the night shift workers (Akerstedt, 1990). Adaptation to a new sleep/wake pattern occurs at a rate of ~1hr per day (Akerstedt, 2003). Thus, for rotating schedules, adaptation to one shift may not be completed before a further shift change occurs; sleep disturbances and fatigue may also continue into rest days. The nature and magnitude of shift work effects depend on the type of schedule particularly, the direction and speed of rotation (Akerstedt, 2003). These factors combine to influence sleep, fatigue and performance differently during morning, afternoon, and night shifts, but productivity tends to be most adversely affected during night work (Folkard & Tucker, 2003).

The combination of chronic fatigue resulting from sleep disturbances and the disruption of family life and leisure activities associated with shift work, may give rise to the social stress and family conflict, psychological distress; particularly anxiety and depression (e.g. Gordon *et al.*, 1986; Jamal, 2004; Jansen *et al.*, 2004; Parkes, 1999; Pisarski *et al.*, 2002). Impairment of psychological health often leads the shift workers to change to day-work jobs; Costa (1996) estimates that 20% of workers leave shift work after a short time because of its adverse effects. Only 10% do not complain about shift work and that the remaining 70% withstand shift work with varying degrees of tolerance.

4.3 Cardiovascular Complications

In industrialized countries, one of the most common causes of death is cardiovascular disease (CVD). Several studies have reported the circadian periodicity in myocardial infarctions, angina pectoris and sudden cardiac death (National Inst. of Health, Public Health Service, 1968) with a

peak in the morning hours. Knutsson (1989) found a higher risk of CVD among shift workers compared to the day workers. Similar findings have been documented in many other studies (Harrington, J. M. et al. 1994; Chan, O. Y. et al. 1994; Costa, G. et al. 1999). Koller et al. (2006) carried out a cross-sectional study and they have reported a higher prevalence of cardiovascular symptoms and complaints among the shift workers. The difference has been shown to be statistically significant between shift workers and day workers. Results obtained by Knutsson et al. (1986) indicated that shift work is associated with the increased risk of ischemic heart disease (IHD), at least during the first two decades of shift work. There are several factors that may increase the risk of developing CVD. The major risk factors are: smoking, hypertension and high blood cholesterol.

Knutsson and Zamore (Knutsson, A. et al. 1982) and Koller et al. (1978) have demonstrated an increased prevalence of risk factors for CHD in shift workers. Several studies demonstrated that the smoking habit seems to be more common among shift workers than the day workers (Tarquini, B. et al., 1980; Knutsson, A. et al., 1982). Shift schedules may also influence the smoking behaviour and in later, a shift worker is more prone to cardiac complications. The cholesterol level has been witnessed to be higher in shift workers than the day workers. It has been found that the rotating shift workers have abnormally elevated norepinephrine levels which if not controlled, may lead to higher cardiovascular risks. Lennernäs et al., (1994) documented that the dietary intake is lower during night shifts than during morning and afternoon shifts. According to them, the redistribution of food intake from diurnal eating to nocturnal eating is related to serum total cholesterol, LDL cholesterol and HDL cholesterol which may increase the risk for CVD. This makes the night workers vulnerable to CVD (Tüchsen, F. et al. 1993).

Frost, Kolstad and Bonde (2009) in a systematic review examined 14 articles including two from the two previous reviews. They found that the “relative risk estimates varied from 0.64 to 2.25 [36 per cent decrease in risk to 125 per cent increase], with most estimates around unity.” They concluded that there was “limited evidence of a causal association between shift work and ischemic heart disease.” They raised methodological concerns about all of the studies including Possible selection bias, problems of lumping different types of shift work together, inadequate controls for other influences on heart disease and failure to look at the duration of exposure.

4.4 Gastrointestinal complications

It is well known that the dietary intake is of immense importance to the nutritional status and health. In addition to a balanced intake, the time of the day for consumption and the frequency of intake are also equally important. In fact, the time of the day for consumption may affect uptake, digestion and metabolism depending on the phase of the individual's circadian rhythms. Meal timing is considered as an important socio-environmental synchronizer of the circadian rhythms and it influences the human metabolism. Further, the temporal distribution of food intake has also an influence on human performance (Graeber, R. C. et al. 1978). Rotating shift work has well-known harmful effects on human health and well-being. It disturbs sleep, wakefulness, eating patterns and social life. In the long run, it often results in the gastrointestinal diseases. Several authors have documented an association between the shift work and gastrointestinal disorders (Rutenfranz, J. et al. 1982; Costa, G. et al. 1999). This association may be mediated by many factors. One may be the irregular eating habits of shift workers, since there are some indications that the temporal distributions of food intake as well as the qualitative and quantitative food intake may affect health. It can be argued that the gastrointestinal disturbances

result from eating food at the wrong time, with abnormal patterns of gut motility and gastric acid secretion. All of these changes have been observed in night workers and might play some role in increasing the prevalence of gastrointestinal disorders (Folkard, S. et al. 1985). Gastrointestinal complaints of gastric upset, disturbed appetite, gas, constipation, diarrhoea, poor eating, dyspepsia, epigastric pain, gastroduodenitis, peptic ulcer etc. are strongly correlated with the shift work in a number of studies. The reported poor eating satisfaction in shift workers (Duchon, J. C. et al. 1990) probably reflects the irregular meal times rather than the malnutrition. However, there are contradictory reports suggesting no link between shift work, eating habits and associated complications. Shift work causes a prominent change in the pattern of secretion of gastrin/acidopepsin (Tarquini, B. et al. 1994). This may be one of the causes of frequent occurrence of peptic ulcer in night workers than the day workers. An earlier occurrence of gastrointestinal disease has also been reported among the rotating shift workers than the day workers. The nocturnal eating in connection with night work may have negative consequences.

4.4.1 IBS (Irritable Bowel Syndrome)

Shift workers face an increased risk of developing Irritable Bowel Syndrome (IBS) and abdominal pain compared to those working in a standard day-time schedule, says a new study. The study has been published in the American Journal of Gastroenterology. “We know that the people participating in shift work often complain of gastrointestinal symptoms such as abdominal pain, constipation and diarrhea,” says Sandra Hoogerwerf, M.D., University of Michigan Medical School. IBS is the most common functional bowel disorder. It is difficult to identify because it is diagnosed by the clinical symptoms rather than tests, says Hoogerwerf, lead author of the study. IBS symptoms include recurrent episodes of abdominal pain or cramping in connection with altered bowel habits. “Their findings suggest that the female shift workers, particularly those who participate in rotating shift work have a higher prevalence of IBS and abdominal pain.”

4.5 Cancer

4.5.1 Endometrial Cancer

The risk of endometrial cancer was significantly elevated among women with many years work on rotating night shifts, particularly the obese women. One possible factor may be the influence of melatonin. Melatonin secretion is abnormal in night workers, as the duration of secretion decreases with their typically shorter sleep duration (Burch JB. et al. 2005). A higher risk of breast, colon, and prostate cancer has been reported among the night workers (Aschoff J. et al. 1975) which is likely also mediated through altered melatonin levels.

So, the conclusion is working on rotating night shifts is associated with a 2-fold increased endometrial cancer risk among the obese female shift workers.

4.5.2 Breast cancer

Mounting evidence supports the hypothesis that the non-day shift work increases the risk of breast cancer in women. In 2007, based on limited human studies and sufficient animal experiments, the International Agency for Research on Cancer (IARC) classified “shift work that involves circadian disruption” as a probable human carcinogen. It is imperative to understand the mechanisms by which shift work may increase the risk of cancer in humans in order to design prevention and mitigation strategies. The two mechanisms gaining prominence are both linked to

exposure to light at night: (1) the suppression of melatonin, and (2) the disruption of the circadian gene function. These are not mutually exclusive and evidence exists for each from both human and laboratory research.

A number of biological mechanisms have been proposed to explain the association between night shift work and breast cancer in women and to a lesser extent, the prostate cancer in men. Suppression of the night-time production of melatonin due to exposure to light at night has been the major focus. Research has shown that the melatonin (or the lack of melatonin) may act indirectly or directly in causing cancer. Indirect effects occur because the decreased melatonin can increase the release of gonadotropins from the pituitary and estrogen from the ovaries, thereby affecting the growth of hormone-dependent tumours (such as breast cancer). Studies also show that melatonin has a direct beneficial effect in inhibiting the development and/or growth of tumours in a variety of ways. Other potential biological mechanisms possibly involved include the role of vitamin D in reducing cancer risk and the role of genetics (namely, clock-controlled genes) in adapting to circadian disruption.

4.6 Pregnancy and reproductive disorders

Two review articles (Costa, 1996; Scott, 2000) summarize the evidence linking shift work to adverse pregnancy outcomes (e.g. premature births, miscarriages, and low birth weight). For instance, a meta-analysis of 29 studies identified shiftwork as a significant risk factor (OR1.24) for pre-term birth (Mozurkewich et al., 2000). In the light of the evidence, Knutsson (2003) recommended that women should avoid shift work during pregnancy. Recent studies (using data from the Danish National Birth Cohort) also indicate that the shift work, especially fixed night work is associated with the adverse pregnancy outcomes (e.g. Zhu et al., 2004). Other aspects of reproductive dysfunction (e.g. irregular menstruation) have also been linked to shift work (e.g. Hatch et al., 1999; Labyak et al., 2002). Disruption of circadian rhythms and the resulting desynchronisation of cyclic physiological functions (including hormonal activity) are thought to be the most likely cause of menstrual problems among shift workers (Costa, 1996; Smith et al., 2003).

Emerging data suggests that the night shift workers, particularly those on a rotating schedule are at a significantly increased risk of developing breast cancer. It has been proposed that the exposure to light at night among shift workers suppresses the nocturnal production of melatonin, which is responsible for telling all cells including cancer cells to go to sleep. Because it is difficult for epidemiological studies to uncover causal links between light at night and the risk of breast cancer and because testing the hypothesis through an experimental design among humans would be unethical, animal studies provide critical empirical evidence on the issue. Evidence from these animal studies appears to be sufficiently strong to support the link between circadian disruption (in the form of suppressed melatonin production) and the development and growth of tumours. For example, among laboratory animals exposed to constant light or light at night (including dim light), melatonin production is virtually completely suppressed and tumours proliferate at a high rate. On the other hand, the growth of tumours is slowed among lab animals exposed to regular light/dark schedules or tumours infused with melatonin. The link between melatonin levels and cancer cell growth is very strong.

Non-traditional work schedules may be detrimental to pregnant women and their fetuses. Hormonal disturbances that result from sleep deprivation or circadian rhythm disruption, as well as the increased stress as a result of work-life conflicts created by night shifts can affect the pregnancy outcomes. Bonzini, Coggon, and Palmer (2007) conducted a systematic review of the literature on the association between several possible pregnancy complications (premature delivery; low birth weight; and pre-eclampsia) and various working conditions including shift work or night work, which was grouped together. (Pre-eclampsia is characterized by high blood pressure and excessive weight gain among other symptoms.)

An updated systematic review was conducted in 2010 to look at shift work exposure during the pregnancy and the risk of preterm delivery, fetal growth retardation and gestational hypertension and pre-eclampsia. The review found that the shift work had a moderate negative effect on fetal growth (i.e. it was associated with being small for gestational age or low birth weight). No association was found for pre-term delivery (contrary to previous studies) and pre-eclampsia. Given the link between shift work and fetal growth retardation and despite the otherwise inconclusive nature of the review the women should be advised against working the non-traditional work schedules during pregnancy and should always be allowed to change to daytime work.

4.7 Diabetes

Suwazono et al. (2006) evaluated the relationship between shift work and the onset of diabetes among male workers in a Japanese steel company. They used records from the participants' medical examinations over the period 1991 to 2001. Those who had diabetes or certain other conditions before the start of the study were excluded, and other variables that could affect the risk of diabetes were controlled for in the statistical analysis. Suwazono et al. found that the risk of developing diabetes was significantly higher for workers on rotating shifts than it was for regular day workers.

5.0 Conclusion

There is a relatively large literature on possible connections between shift work and several aspects of worker health. In some of these areas, the research findings clearly point to an elevated risk of adverse health outcomes arising from shift work. In other areas, the research is less conclusive. On the other hand, in light of the prevalence of shift work in today's economy and the suggestive research to date about its possible health effects, it is clear that additional research efforts are needed to fully understand health risks and mechanisms through which they arise. The research so far leaves us with uncertainty about the magnitude of the health impacts, the mechanisms through which these impacts occur, individual differences in susceptibility to adverse health outcomes, and the particular forms of shift work that is most troublesome

In order to get a better sense of these issues, future research should: pay more attention to the mechanisms through which shift work affects worker health and safety, continue to explore whether some individuals are more susceptible (through genetic predisposition, or current or prior life experiences) to adverse health effects from shift work, and measure exposure to shift work much more carefully by clearly distinguishing different types of shift work, and measuring time spent on shift schedules more precisely.

Better exposure information is needed to determine who specifically is at risk in order to address the questions of people concerned about shift work and health. We need to develop a common approach to exposure assessment in epidemiological studies in order to determine which shift workers are more specifically is at risk. We need to continue to explore the biological mechanisms behind the effects of shift work on health. Although researchers have begun discussing common definitions of shift work and exposure assessments, the exercise is challenging

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