90 Shift Work and Long Work Hours

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A significant number of Americans are exposed to shift work and long work hours. Broadly defined, shift work involves work at times other than daytime hours of approximately 7:00 A.M. to 6:00 P.M. According to the U.S. Bureau of Labor Statistics, almost 15% of full-time workers (or 15 million Americans) work on evening, night, rotating, split, or employer-arranged irregular shifts (1). Estimates of the number of workers exposed to long work hours depend on how the term is defined. Based on a minimum of 50 hours per week, Jacobs and Gerson (2) estimated that over 26% of U.S. men and 11% of U.S. women worked long hours in 2000.

Both social needs and economic factors promote the use of shift work and long hours. Shift workers provide critical services around the clock, including police and fire protection, health care, transportation, communications, public utilities, and military service. Other industries require continuous processing or operations to maximize the financial yield from capital investment in machinery and other production materials. There are also a multitude of economic factors driving long work hours including shortages of workers with specialized skills, temporary surges in workload, desire to avoid expenses connected with hiring additional staff, and worker desire for higher income.

The relationship between work schedules and health and safety is complex and is influenced by characteristics of the work schedule itself as well as characteristics of the job, the worker, and the work environment (3). Ergonomic and organizational factors, job demands, workers' personalities, sociodemographic characteristics, geographic location, recreational resources, housing arrangements, sociometric patterns, and social support may act to influence or modulate the effects. Some studies of work schedules and health or safety outcomes have not accounted for these factors, which may partially explain the combination of positive, negative, and null effects reported in the literature. Some of these inconsistencies may also be attributed to limitations inherent in field research designs, but others reflect the subtleties and complexities of the work schedule's impact on worker adjustment (4,5). In addition, studies may be contaminated by crossover effects (e.g., when a shift worker moves to day shift and adverse effects continue on the day schedule) and selective attrition (the "survivor" or "healthy worker" effect) (6). Nonetheless, perusal of the literature suggests that some generalizations can be made about the risks potentially associated with demanding work schedules.

Researchers theorize that shift work exerts adverse effects by disturbing three factors: circadian rhythms, sleep, and personal (family and social) life (7). Circadian rhythms refer to biologic rhythms that show a cyclic rise and fall about once a day (8). Numerous physiologic phenomena exhibit these circadian rhythms, which are synchronized by pacemakers in the brain to prepare humans and other organisms for regular daily environmental cycles such as light and darkness, temperature, food availability, and activity of predators. In humans, these pacemakers promote wakefulness during the day and sleepiness and sleep at night. The timing of the circadian rhythms are slow to change and generally take several days to readjust after abrupt changes in

[1]The findings and conclusions in this chapter are those of the authors and do not necessarily represent the views of the National Institute for Occupational Safety and Health.

timing of activity and sleep induced by shift work. Disturbances in circadian rhythms lead to reductions in the length and quality of sleep and may increase negative mood and gastrointestinal (GI) symptoms. In addition, working at unusual times may make it difficult to interact with family and maintain other social contacts. Overall, these disturbances have important implications for work scheduling because working at night and in the evening requires coping with physiologic, psychological, and social processes that are not in synchrony with a nighttime work schedule (9). Consequently, shift work potentially can affect diverse aspects of worker health, efficiency, and well-being.

Researchers theorize that long work hours may influence health and safety through several mechanisms (10–12). Long work hours may reduce the time available for sleep, thereby leading to sleep deprivation or disturbed sleep and incomplete recovery from work. Sleep disturbances, in turn, may adversely affect nervous, cardiovascular, metabolic, and immune functioning. Time available for family and social contacts may also be reduced, impairing ability to carry out family responsibilities and maintain nonfamily relationships. This, in turn, may lead to physiologic responses associated with stress. Long hours may also increase exposure times to workplace hazards such as chemicals, hot or cold environments, noise, and physical, mental, and emotional demands. The consequences of extended exposures and reduced recovery time are not fully known. Health behaviors may also be adversely affected by reducing time available for physical exercise or preparing nutritious meals. Added job stress may increase caffeine use, smoking, and alcohol intake.

RISKS ASSOCIATED WITH SHIFT WORK

Sleep, Sleepiness

The most direct and consistent effect of shift work is the reduction in the length and quality of sleep (13). Both retrospective cross-sectional surveys and prospective sleep-diary types of studies have indicated that night and rotating shift workers consistently obtain less sleep than day- or evening-shift workers. Furthermore, night-shift workers often report their daytime sleep to be lighter, more fragmented, and less restful than sleep at night (14). Electroencephalographic (EEG) studies of shift workers' sleep have confirmed the self-reports (15). The general pattern of decreased total sleep time during the day (when working nights) is apparent whether the worker has a permanent night schedule or rotates shifts. However, workers who rotate shifts obtain less sleep, overall, than their counterparts on permanent schedules. Increasing experience with shift work apparently does not result in adaptation of sleep patterns because older shift workers still show decreased daytime sleep (16).

Sleep loss makes people sleepier while awake, which may affect the shift worker's ability to perform activities safely and efficiently, both on and off the job. Increased sleepiness (or decreased alertness) in shift workers on the job has been demonstrated with subjective reports (17), objective performance testing (18), and EEG recordings showing brief, on-the-job sleep episodes (19). As would be expected, sleepiness is most apparent during the night shift, and poor daytime sleep appears to be a contributing factor (20).

Circadian Rhythms, Performance, and Safety

In addition to sleep loss, the nighttime downturn in other endogenous circadian processes also can contribute to reduced alertness and performance in shift workers. In the normal diurnal situation, these circadian processes are in synchrony with the sleep–wake cycle. Consequently, alertness and arousal are highest and performance is most efficient during the day. During the night, on the other hand, alertness is lowest, which allows for optimal sleep (21–22). In shift workers, these processes may become desynchronized with the sleep- wake cycle and may not adapt to night work at the same rate as the sleep–wake cycle (9). Therefore, there are some night shifts when the worker will experience decreased alertness and performance efficiency both from sleep deprivation and from the asynchrony of other circadian rhythms. There will be other night shifts when a normal amount of sleep is obtained, but loss of alertness and compromised performance will be experienced because other circadian rhythms have not adapted to the nighttime orientation. Consequently, night workers experiencing a combination of sleep deprivation and unadapted circadian rhythms are likely to be at higher risk for operational errors or accidents than day workers.

In support of this proposition, a meta-analysis combining injury data from several studies indicated that injury risk increased by 18% during the afternoon/evening shift and 34% during the night shift compared to the morning/day shift (23). Relative risk also increased across consecutive shifts, with a more precipitous increase in risk observed across the night shift compared to the morning/day shift. These results are consistent with worksite observations of increased subjective sleepiness and decreased reaction time during night shifts and progressive decreases in total sleep time from early to late in the workweek (24).

Social and Familial Disruptions

Because shift workers often work in the evening and sleep during the day, they frequently must sacrifice participation in social and family activities that commonly occur at those times. Furthermore, because most shift

workers work in continuously operating organizations, they regularly are required to work weekends and holidays, when much social and family interaction occurs (25,26). Consequently, too little time with family and friends is the most frequent and most negatively rated complaint among shift workers. The extent to which such disruptions occur depends both on the worker's schedule, type of family, gender of the worker, presence of children, and the degree of flexibility in the worker's social contacts and leisure pursuits (25–27). Solitary or time-flexible pursuits, such as gardening or woodworking, would be less disrupted by night work or rotating shift work than participatory or time-inflexible activities such as team sports. For families, shift work often conflicts with school activities and the times when formal childcare services are available, making arranging for the care of children more challenging (27). Thus, the work schedule affects not only the worker's social adjustment, but also the family's adjustment.

Long-term Effects and Vulnerable Groups

Drake et al. (28) indicate that 32% of night workers and 26% of rotating shift workers experience long-term insomnia and excessive sleepiness and are unable to adapt their sleep adequately on these shifts. When compared to the symptomatic day worker population, the study reported that shift work was associated with a 10% increase in the number of persons with these sleep disturbances.

Although the specific contribution of shift work to other illnesses is not clear, several diseases have been associated with these work schedules. GI complaints are common in shift workers and could be due to changes in circadian rhythms of GI function, sleep deprivation leading to stress response and changes in immune function, or the types of foods that are available during these shifts (29,30). Psychological complaints are frequently reported, including depression and other mood disturbances, personality changes, and difficulties with personal relationships (31). A review of 17 studies suggests that shift work increases workers' risk for cardiovascular disease by 40% compared with day workers (32). Possible mechanisms for cardiovascular findings include decreased glucose tolerance, insulin resistance, elevated cortisol levels, and increased sympathetic activity. A systematic review of epidemiologic studies of reproductive outcomes by Frazier and Grainger (33) concluded that shift work was associated with a modest increase in spontaneous abortion, preterm birth, and reduced fertility in women. The effect on reproduction in men was not analyzed due to an inadequate number of studies. A meta-analysis of 13 studies examining night work and breast cancer reported that night work was associated with a moderately elevated risk among women (combined estimate for 13 studies = 1.48; confidence interval, 1.36 to 1.61) (34). The authors hypothesized that exposure to light at night reduces levels of melatonin, which increases risk for cancer. Studies examining associations with other types of cancer have been limited to date. One study by Schernhammer et al. (35), however, reported an increased risk of colon cancer in nurses associated with working three or more nights per month for 15 or more years.

Shift work may exacerbate pre-existing chronic diseases, making it difficult to control symptoms and disease progression. Shift work also may interfere with treatment regimens that involve maintaining regular sleep times, avoiding sleep deprivation, controlling amounts and times of meals and exercise, and careful timing of medications that have circadian variations in effectiveness. Sood (36) suggests several conditions that are particularly vulnerable: unstable angina or history of myocardial infarction; hypertension requiring regular medications; insulin-dependent diabetes mellitus; asthma requiring regular medication; psychiatric illnesses requiring regular medication; alcohol or drug abuse; GI diseases; sleep disorders; taking medications that have circadian variations in effectiveness; and epilepsy requiring medication within the past year. To this list, Costa (37) adds chronic renal impairment, thyroid and suprarenal pathologies, malignant tumors, and pregnancy.

Aging is also associated with less tolerance of shift work, which may be due to age-related changes in sleep that may make it more difficult for older people to initiate and maintain sleep at different times of the day (38). These sleep changes may begin as early as the 30s and 40s, so some workers who initially adapted well to shift work during their younger years may show more symptoms as they grow older.

RISKS ASSOCIATED WITH LONG WORK HOURS

The number of studies examining long work hours is less extensive, but a growing number of findings suggest possible adverse effects. A meta-analysis by Sparks et al. (10) reports that overtime was associated with small but significant increases in adverse physical and psychological outcomes. A review by Spurgeon et al. (11) concluded that the adverse overtime effects were associated with greater than 50 hours of work per week, but little data are available about schedules with less than 50 hours. An integrative review by Caruso et al. (39) reported that overtime was associated with poorer perceived general health, increased injury rates, more illnesses, or increased mortality in 16 of 22 more recently published studies. A study by Dembe et al. (40) examining data from the National Longitudinal Survey of Youth is one of the first reports of a possible dose-response

relationship; as number of work hours increased, injury rates increased correspondingly. Overall, these studies indicate caution in implementing schedules with extended work hours. Determining the number of work hours critically associated with risk in a specific job, however, must examine how extended hours interact with other factors contributing to fatigue, such as work load, competing responsibilities away from the job, or opportunities for rest and recovery.

COUNTERMEASURES

Efforts to promote adaptation to or ease the difficulties of coping with shift work and long work hours include strategies for employers and strategies for workers. Most suggestions to date were written for shift work, but they may also be relevant for long work hours. A sampling of strategies discussed in reviews by Rosa et al. (41), Monk (42), Knauth and Hornberger (43), and Revell and Eastman (44) includes designing new work schedules and rest breaks during work, devising sleep strategies, altering circadian rhythms with bright light or blue light, optimally timing physical activity or other work demands, improving physical conditioning, introducing pharmacologic aids or using caffeine, planning dietary regimens, applying stress reduction techniques, organizing social support groups, and providing family counseling. Empirical evaluations and applications of some techniques have begun and will be useful for some workers, but more research is needed to develop strategies that can be easily applied by workers in a wide range of demanding work schedule situations.

With respect to work schedule design, there are ongoing debates about the relative advantages of fixed versus rotating shifts (45), which speed of shift rotation is best comparing rapid (changes every few days) versus slow (changes every 2 weeks or more) rotations (46), shift timing (47,48), and the use of compressed workweeks (49,50). In the compressed workweek schedule, longer (i.e., 10- to 12-hour) shifts are used so that fewer consecutive shifts are needed to complete a week's work. These schedules are popular due to the extra off-duty days, but there are persistent concerns about excessive fatigue from the longer shifts (especially 12-hour night shifts) (49–52).

Sleep strategies involve creating an environment that is conducive to sleep (i.e., blocking light, noise, and interruptions) and napping either before or during the night shift (43,53). Opportunities for napping while working night shifts have been permitted in other countries, but this is not usually the case in the United States.

Laboratory studies using appropriately timed exposure to bright or blue light have indicated that circadian rhythms can be "phase-shifted" (i.e., the time of peak activity can be shifted) more rapidly than usual (44). Although only a few workplace applications have been attempted and more study is needed, some workers may benefit from current suggestions (44,54,55).

Intense physical activity can also phase-shift circadian rhythms (56), but it is not clear whether the effective level of exercise is agreeable to the average worker. Improved physical conditioning has beneficial effects on worker well-being, but more study is needed to examine whether physical activity directly influences adaptation to shift work (57,58).

Various pharmacologic compounds reliably induce sleep or alertness at desired times (59) or shift circadian rhythms (60), but the potential for adverse side effects in some compounds makes long-term use questionable. Dietary routines to promote alertness or relaxation have been proposed, but little data are available testing the effectiveness in shift workers (61,62). Stress reduction, social support, and family counseling generally have beneficial effects on well-being, but organized treatment plans and outcome studies for shift workers have yet to be devised (63). In conclusion, more research is needed to develop strategies to help workers adapt to the multiple physiologic and social challenges that result from demanding work schedules, but current findings will provide a measure of improvement for some workers.

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