

Shiftwork and health

Katharine R. Parkes,

University of Oxford, UK

3995 words

KEY WORDS

Work hours; circadian rhythms; sleep; cardiovascular disease; accidents

Shiftwork and health

CURRENT TRENDS IN SHIFTWORK

Industrial and commercial activities that operate outside normal work hours have become widespread in recent years; services such as banking, communications, transport, catering, and retailing are routinely available during evening hours, and often round-the-clock. Consequently, the work patterns of a substantial proportion of the population now extend beyond 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 analyses 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), reflecting older workers' difficulties in adjusting to shiftwork.

Similarly, analyses 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 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. Global trends towards a '24-hour society' suggest that these proportions are likely to rise; thus, the implications of shiftwork for physical and mental health is not only a matter of current concern but also one that is likely to become increasingly important in the future (Costa, 2001; Rajaratnam & Arendt, 2001).

MECHANISMS UNDERLYING THE HEALTH EFFECTS OF SHIFTWORK

Shiftwork has been empirically linked to a variety of diseases although evidence does not suggest an effect on all-cause mortality (Knutsson, 2003). Three pathways have been implicated in associations between shiftwork and disease (Boggild & Knutsson, 1999; Knutsson, 1989; Knutsson & Boggild, 2000): disruption of circadian rhythms (leading to sleep/wake disturbances, desynchronisation 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 biomarkers, such as cholesterol and other lipids, plasminogen, blood pressure and cardiac activity show changes related to shiftwork, and may act as mediators of disease processes (Boggild & Knutsson, 1999).

The general pattern of findings is that shift workers, as compared with day workers, show less favorable profiles of lifestyle, behavioral, and biological risk factors (e.g. Lac & Chamoux, 2004; Morikawa *et al.*, 1999; Parkes, 2002). 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 disease endpoints. Shiftwork may also interact with individual and environmental factors (e.g. age, personality, poor physical work conditions) to increase the risk of health problems (Smith *et al.*, 2003).

SHIFTWORK IN RELATION TO PARTICULAR HEALTH OUTCOMES

Findings relating shiftwork to particular health problems and diseases are summarized in the sections below. In interpreting the findings reviewed, several methodological problems of shiftwork research should be noted. Specifically, shift workers tend to differ from day workers in factors such as age, socio-economic status, job demands, and physical/

psychosocial work environment characteristics, all of which may contribute to disease outcomes. Moreover, those selected (either by self or employer) into, and survive in, shiftwork may differ from day workers in age, personality and initial health status. Comparisons of shift workers and day workers may therefore be confounded by pre-existing differences between the groups and by environmental factors. Whilst statistical methods potentially allow control of these effects, stronger evidence of the causal role of shiftwork in relation to disease risk can be derived from prospective studies that assess baseline data prior to exposure (e.g. van Amelsvoort *et al.*, 2004).

Sleep, fatigue, and mental health

Disturbed sleep is an almost inevitable outcome of the disruption to normal circadian rhythms associated with shiftwork, 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, and sleepiness and fatigue during working hours are seen as characteristic sleep disturbances among 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 complete before a further shift change occurs; sleep disturbances and fatigue may also continue into rest days. The nature and magnitude of shiftwork 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 shiftwork, may give rise to social stress and work-family conflict, and to 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 shift workers to change to day-work jobs; Costa (1996) estimates that 20% of workers leave shiftwork after a relatively short time because of its adverse effects, that only 10% do not complain about shiftwork, and that the remaining 70% withstand shiftwork with varying degrees of tolerance.

Gastrointestinal disorders

Gastrointestinal complaints are among the most frequently reported health problems of shift workers; these problems are estimated to be 2 to 5 times more common among night shift workers as compared with those not working nights (Costa, 1996). Circadian disturbance affecting the intake, digestion, and absorption of food, are thought to play a major aetiological role, but sleep loss, fatigue, and the social stress of shiftwork may also be implicated. Typically, shift workers have higher levels of gastric symptoms (e.g. indigestion, heartburn, constipation, loss of appetite, and nausea) than day workers, even with control for demographic, job, and lifestyle variables (e.g. Caruso *et al.*, 2004; Costa *et al.*, 2001; Parkes, 1999). Evidence also links shiftwork to peptic ulcers (Knutsson, 2003). In particular, in a study based on endoscopic examination of suspected cases, the prevalence of gastric ulcers among Japanese workers was 2.38% among current shift workers, 1.52% among past shift workers, and 1.03% in day workers (Segawa *et al.*, 1987). Duodenal ulcers also showed higher prevalence among shift workers in this study.

Cardiovascular disease

Evidence accumulated over the past two decades suggests that shiftwork is a significant risk factor for cardiovascular disease. Thus, a recent review by Knutsson (2003) concluded “To summarize, there is rather strong evidence in favour of an association between shiftwork and coronary heart disease” (p.105). Findings from a meta-analysis of 17 studies of cardiovascular disease in relation to shiftwork (Boggild & Knutsson, 1999) support this view. Overall, shift workers were found to have a 40% excess risk for cardiovascular disease relative to day workers, although there was wide variation across studies. Findings of two major studies included in this analysis are outlined below.

In a 6-year prospective study of cardiovascular (CHD) risk, Tenkanen *et al.* (1997) followed up 1806 industrial workers, assessing life-style factors, blood pressure and serum lipid levels, and identifying CHD cases from official health records. Overall, the relative risk of CHD among shift workers as compared with day workers was 1.5 (CI 1.1- 2.1), decreasing to 1.4 (CI 1.0-1.9) with control for physiological and lifestyle variables. Among blue-collar employees, day workers, 2-shift, and 3-shift workers had relative risks of 1.3 (CI 0.8-2.0), 1.9 (CI 1.1-3.4), and 1.7 (CI 1.1-2.7) respectively. Shiftwork was also found to interact with smoking and obesity to increase CHD risk (Tenkanen *et al.*, 1998).

Kawachi *et al.* (1995) examined the incidence of CHD over a four-year period among 79,109 female nurses in relation to the total years of rotating night shiftwork. The age-adjusted relative risk was 1.38 (95% CI, 1.08 -1.76) in women who reported ever doing shiftwork compared with those who had never done so. This excess risk remained significant after adjustment for cigarette smoking and other cardiovascular risk factors. The analyses also demonstrated a dose-response relationship between CHD risk and duration of shiftwork (greater risk being associated with longer durations), consistent with earlier findings (Knutsson *et al.*, 1986).

Cancer

Empirical studies demonstrate associations between night work and elevated risk of breast cancer (e.g. Hansen, 2001; Tynes *et al.*, 1996). In each of these studies, shiftwork was associated with an overall risk ratio for breast cancer of 1.5, but the risk increased with age and length of exposure to night work. Similarly, in a prospective study of nurses, positive associations were found between breast cancer and extended periods (>30 years) of intermittent night work (Schernhammer *et al.*, 2001); among postmenopausal women, the risk ratio also increased for 1-14 years and 15-29 years of rotating night work. One mechanism by which shiftwork may lead to breast cancer is that the normal production of melatonin during hours of darkness is disrupted by working at night; suppression of melatonin is thought to lead to an increase in reproductive hormones (particularly oestrogen), acting to increase hormone-sensitive cells in the breast (Schernhammer & Schulmeister, 2004). However, other pathways may also exist; for instance, Bovbjerg (2003) suggests that alterations in immune function associated with circadian disruption may be implicated.

Evidence linking night work and cancer is largely specific to breast cancer; little is known about other types of cancer in this context, or about the possible mechanisms involved. Although Taylor and Pocock (1972) reported an increased incidence of cancer among shift workers, Tynes *et al.* (1996) found that cancer incidence among female shift workers was not different from that of the general female population. However, increased risk of colorectal cancer among female nurses working rotating night shifts for >15 years has recently been reported (Schernhammer *et al.*, 2003).

Pregnancy and reproductive disorders

Two review articles (Costa, 1996; Scott, 2000) summarize evidence linking shiftwork 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 (OR

1.24) for pre-term birth (Mozurkewich *et al.*, 2000). In the light of the evidence, Knutsson (2003) recommended that women should avoid shiftwork during pregnancy. Recent studies (using data from the Danish National Birth Cohort) also indicate that shiftwork, especially fixed night work, is associated with adverse pregnancy outcomes (e.g. Zhu *et al.*, 2004).

Other aspects of reproductive dysfunction (e.g. irregular menstruation) have also been linked to shiftwork (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), is thought to be the most likely cause of menstrual problems among shift workers (Costa, 1996; Smith *et al.*, 2003).

Accidents and injuries

Sleep loss and fatigue associated with circadian disruption impairs cognitive performance, particularly in tasks requiring vigilance, concentration, and decision-making (e.g. Meijman *et al.*, 1993); this impairment potentially increases the risk of accident and injury incidents. However, in many work situations, the number of personnel exposed, the nature of the work done, the level of supervision, and the likelihood of an accident being reported, differ across the 24 hour workday; thus, incident rates cannot be directly compared across shifts (Folkard & Tucker, 2003). Nonetheless, a few studies in which confounding factors are adequately controlled do allow such comparisons.

Smith *et al.* (1994) found that, relative to the morning shift, the overall risk of an injury incident during the night shift was 1.23 (CI 1.14-1.31), with a higher risk for self-paced work at night, 1.82 (CI 1.30-2.34). Folkard & Tucker (2003), combining five data sets, found that risk increased approximately linearly across the three shifts. Relative to the morning shift, the increase was 18.3% for afternoon shifts, and 30.4% for night shifts. More generally, Smith *et al.* (2003) note that the disasters of Three Mile Island, Chernobyl, and the Challenger space shuttle all occurred during the night.

Use of statistical methods to estimate risk from large-scale exposure data provides an alternative (although less precise) method of studying accidents in relation to shift patterns. For instance, Williamson and Feyer (1995) examined 1020 work-related fatalities in Australia over a two-year period, deriving exposure rates from national survey data; 25% of the fatalities occurred to the 11.2% of the employed population estimated to work at night, while 75% occurred to the 88.8% working during the day. Thus, work-related fatalities were more than twice as likely at night as during the day. However, Laundry and Lees (1991) found no evidence of elevated rates of minor accidents during night work, although they did find a circadian pattern of accident frequency with morning (0800-1000 hrs) and afternoon (1400-1600 hrs) peak periods. Using more complex statistical methods, Hanecke *et al.* (1998) found that, beyond the 8th or 9th hour of work, there was a marked increase in relative risk particularly for afternoon and night shifts.

TOLERANCE TO SHIFTWORK, AND INTERVENTION STRATEGIES

Shiftwork tolerance

Individual variation in the ability to adjust to shiftwork has been widely noted (e.g. Costa, 2003; Smith *et al.*, 2003). Age is a particularly important factor. Individuals older than ~45 years experience increasing difficulty in adjusting to altered sleep-wake cycles; reduced fitness, decreased restorative powers of sleep, and greater proneness to internal desynchronization of circadian rhythms, all contribute to decreased shiftwork tolerance. However, other individual factors, including circadian type (morningness versus eveningness), and personality traits (e.g. extraversion) also affect shiftwork adaptation. These traits are related to circadian cycle characteristics that influence preferences for morning or evening activities (Tankova *et al.*, 1994); however, in the absence of validation data, Smith *et al.* (2003) caution against the use of such measures for selection purposes.

Interventions to facilitate shiftwork adaptation

Several types of interventions can be effective in facilitating shiftwork adaptation (for reviews, see Knauth & Hornberger, 2003; Smith *et al.*, 2003). At the organizational level, shift schedule design is particularly important; although there are no ideal shift patterns, factors such as shift duration, direction of rotation, changeover times, and work/rest sequences all affect adaptation. Other recommended strategies include worker participation in the design and implementation of shift schedules, and attention to work conditions (e.g. staffing levels, workload, rest breaks, and the physical environment, especially lighting levels) that may accentuate or mitigate the effects of shiftwork.

At the individual level, recommendations for favorable adaptation include ‘sleep hygiene’ (e.g. regular sleep routine, quiet bedroom, curtains or blinds to eliminate sunlight during sleep hours, avoidance of caffeine or alcohol prior to sleep); healthy diet, and fixed meal times; active coping; and ensuring a balance between sleep and family time (Knauth & Hornberger, 2003). Exposure to bright light during specific circadian phases has also been found to speed adaptation (e.g. Bjorvatn *et al.*, 1999), but use of melatonin as a sleep medication to aid adjustment to shift changes, whilst potentially effective, is subject to some safety concerns (Smith *et al.*, 2003).

REFERENCES

- Akerstedt, T. (1990). Psychological and psychophysiological effects of shift work. *Scandinavian Journal of Work, Environment and Health*, 16 Suppl 1, 67-73.
- Akerstedt, T. (1998). Shift work and disturbed sleep/wakefulness. *Sleep Medicine Reviews*, 2, 117-128.
- Akerstedt, T. (2003). Shift work and disturbed sleep/wakefulness. *Occupational Medicine*, 53, 89-94.

- Beers, T. M. (2000). Flexible schedules and shift work: replacing the '9 - 5' workday. *Monthly Labor Review, June*, 33-40.
- Bjorvatn, B., Kecklund, G., & Akerstedt, T. (1999). Bright light treatment used for adaptation to night work and re-adaptation back to day life. A field study at an oil platform in the North Sea. *Journal of Sleep Research, 8*, 105-112.
- Boggild, H., & Knutsson, A. (1999). Shift work, risk factors and cardiovascular disease. *Scandinavian Journal of Work, Environment & Health, 25*, 85-99.
- Boisard, P., Cartron, D., Gollac, M., & Valeyre, A. (2003). *Time and work: Duration of work*. Dublin, Ireland: European Foundation for the Improvement of Living and Working Conditions.
- Bovbjerg, D. H. (2003). Circadian disruption and cancer: sleep and immune regulation. *Brain, Behavior, and Immunity, 17 Suppl 1*, S48-50.
- Caruso, C. C., Lusk, S. L., & Gillespie, B. W. (2004). Relationship of work schedules to gastrointestinal diagnoses, symptoms, and medication use in auto factory workers. *American Journal of Industrial Medicine, 46*, 586-598.
- Costa, G. (1996). The impact of shift and night work on health. *Applied Ergonomics, 27*, 9-16.
- Costa, G. (2001). The 24-hour society: Between myth and reality. *Journal of Human Ergology, 30*, 15-20.
- Costa, G. (2003). Shift work and occupational medicine: an overview. *Occupational Medicine, 53*, 83-88.
- Costa, G., Sartori, S., Facco, P., & Apostoli, P. (2001). Health conditions of bus drivers in a 6 year follow up study. *Journal of Human Ergology, 30*, 405-410.
- European Foundation for the Improvement of Living and Working Conditions. (2003). *Age and working conditions in the European Union*. Dublin, Ireland.

- Folkard, S., & Tucker, P. (2003). Shift work, safety and productivity. *Occupational Medicine*, 53, 95-101.
- Gordon, N. P., Cleary, P. D., Parker, C. E., & Czeisler, C. A. (1986). The prevalence and health impact of shiftwork. *American Journal of Public Health*, 76, 1225-1228.
- Hanecke, K., Tiedemann, S., Nachreiner, F., & Grzech-Sukalo, H. (1998). Accident risk as a function of hour at work and time of day as determined from accident data and exposure models for the German working population. *Scandinavian Journal of Work, Environment & Health*, 24 Suppl 3, 43-48.
- Hansen, J. (2001). Increased breast cancer risk among women who work predominantly at night. *Epidemiology*, 12, 74-77.
- Harma, M., Sallinen, M., Ranta, R., Mutanen, P., & Muller, K. (2002). The effect of an irregular shift system on sleepiness at work in train drivers and railway traffic controllers. *Journal of Sleep Research*, 11, 141-151.
- Hatch, M. C., Figa Talamanca, I., & Salerno, S. (1999). Work stress and menstrual patterns among American and Italian nurses. *Scandinavian Journal of Work, Environment and Health*, 25, 144-150.
- Jamal, M. (2004). Burnout, stress and health of employees on non-standard work schedules: A study of Canadian workers. *Stress and Health*, 20, 113-119.
- Jansen, N. W., Kant, I., Nijhuis, F. J., Swaen, G. M., & Kristensen, T. S. (2004). Impact of worktime arrangements on work-home interference among Dutch employees. *Scandinavian Journal of Work, Environment and Health*, 30, 139-148.
- Kawachi, I., Colditz, G. A., Stampfer, M. J., Willett, W. C., Manson, J. E., et al. (1995). Prospective study of shift work and risk of coronary heart disease in women. *Circulation*, 92, 3178-3182.
- Knauth, P., & Hornberger, S. (2003). Preventive and compensatory measures for shift workers. *Occupational Medicine*, 53, 109-116.

- Knutsson, A. (1989). Shift work and coronary heart disease. *Scandinavian Journal of Social Medicine. Supplementum, 44*, 1-36.
- Knutsson, A. (2003). Health disorders of shift workers. *Occupational Medicine, 53*, 103-108.
- Knutsson, A., Akerstedt, T., Jonsson, B. G., & Orth Gomer, K. (1986). Increased risk of ischaemic heart disease in shift workers. *Lancet, 2*, 89-92.
- Knutsson, A., & Boggild, H. (2000). Shiftwork and cardiovascular disease: review of disease mechanisms. *Reviews on Environmental Health, 15*, 359-372.
- Labyak, S., Lava, S., Turek, F., & Zee, P. (2002). Effects of shiftwork on sleep and menstrual function in nurses. *Health Care for Women International, 23*, 703-714.
- Lac, G., & Chamoux, A. (2004). Biological and psychological responses to two rapid shiftwork schedules. *Ergonomics, 47*, 1339-1349.
- Laundry, B. R., & Lees, R. E. (1991). Industrial accident experience of one company on 8- and 12-hour shift systems. *Journal of Occupational Medicine, 33*, 903-906.
- Meijman, T., Van-Der-Meer, O., & Van-Dormolen, M. (1993). The after-effects of night work on short-term memory performance. *Ergonomics, 36*, 37-42.
- Morikawa, Y., Nakagawa, H., Miura, K., Ishizaki, M., Tabata, M., et al. (1999). Relationship between shift work and onset of hypertension in a cohort of manual workers. *Scandinavian Journal of Work, Environment & Health, 25*, 100-104.
- Mozurkewich, E. L., Luke, B., Avni, M., & Wolf, F. M. (2000). Working conditions and adverse pregnancy outcome: a meta-analysis. *Obstetrics and Gynecology, 95*, 623-635.
- Ohayon, M. M., Lemoine, P., Arnaud Briant, V., & Dreyfus, M. (2002). Prevalence and consequences of sleep disorders in a shift worker population. *Journal of Psychosomatic Research, 53*, 577-583.
- Parkes, K. R. (1999). Shiftwork, job type, and the work environment as joint predictors of health outcomes. *Journal of Occupational Health Psychology, 4*, 256-268.

- Parkes, K. R. (2002). Shift work and age as interactive predictors of body mass index among offshore workers. *Scandinavian Journal of Work, Environment & Health*, 28, 64-71.
- Pisarski, A., Bohle, P., & Callan, V. J. (2002). Extended shifts in ambulance work: Influences on health. *Stress and Health*, 18, 119-126.
- Rajaratnam, S. M., & Arendt, J. (2001). Health in a 24-h society. *Lancet*, 358, 999-1005.
- Schernhammer, E. S., Laden, F., Speizer, F. E., Willett, W. C., Hunter, D. J., et al. (2001). Rotating night shifts and risk of breast cancer in women participating in the nurses' health study. *Journal of the National Cancer Institute*, 93, 1563-1568.
- Schernhammer, E. S., Laden, F., Speizer, F. E., Willett, W. C., Hunter, D. J., et al. (2003). Night-shift work and risk of colorectal cancer in the nurses' health study. *Journal of the National Cancer Institute*, 95, 825-828.
- Schernhammer, E. S., & Schulmeister, K. (2004). Melatonin and cancer risk: does light at night compromise physiologic cancer protection by lowering serum melatonin levels? *British Journal of Cancer*, 90, 941-943.
- Scott, A. J. (2000). Shift work and health. *Primary Care*, 27, 1057-1070.
- Segawa, K., Nakazawa, S., Tsukamoto, Y., Kurita, Y., Goto, H., et al. (1987). Peptic ulcer is prevalent among shift workers. *Digestive Diseases and Sciences*, 32, 449-453.
- Smith, C. S., Folkard, S., & Fuller, J. A. (2003). Shiftwork and working hours. In J. C. Quick (Ed.), *Handbook of Occupational Health Psychology*. Washington: American Psychological Association.
- Smith, C. S., Robie, C., Folkard, S., Barton, J., Macdonald, I., et al. (1999). A process model of shiftwork and health. *Journal of Occupational Health Psychology*, 4, 207-218.
- Smith, L., Folkard, S., & Poole, C. J. (1994). Increased injuries on night shift. *Lancet*, 344, 1137-1139.
- Tankova, I., Adan, A., & Buela-Casal, G. (1994). Circadian typology and individual differences: A review. *Personality and Individual Differences*, 16, 671-684.

- Taylor, P. J., & Pocock, S. J. (1972). Mortality of shift and day workers, 1956-68. *British Journal of Industrial Medicine*, 29, 201-207.
- Tenkanen, L., Sjoblom, T., & Harma, M. (1998). Joint effect of shift work and adverse life-style factors on the risk of coronary heart disease. *Scandinavian Journal of Work, Environment and Health*, 24, 351-357.
- Tenkanen, L., Sjoblom, T., Kalimo, R., Alikoski, T., & Harma, M. (1997). Shift work, occupation and coronary heart disease over 6 years of follow-up in the Helsinki Heart Study. *Scandinavian Journal of Work, Environment and Health*, 23, 257-265.
- Tynes, T., Hannevik, M., Andersen, A., Vistnes, A. I., & Haldorsen, T. (1996). Incidence of breast cancer in Norwegian female radio and telegraph operators. *Cancer Causes and Control*, 7, 197-204.
- Van Amelsvoort, L. G., Schouten, E. G., & Kok, F. J. (2004). Impact of one year of shift work on cardiovascular disease risk factors. *Journal of Occupational and Environmental Medicine*, 46, 699-706.
- Williamson, A. M., & Feyer, A.-M. (1995). Causes of accidents and time of day. *Work and Stress*, 9, 158-164.
- Zhu, J. L., Hjollund, N. H., & Olsen, J. (2004). Shift work, duration of pregnancy, and birth weight: the National Birth Cohort in Denmark. *American Journal of Obstetrics and Gynecology*, 191, 285-291.