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91 Shift work and extended hours of work

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INTRODUCTION

The arrangement of working hours has become a crucial factor in work organization, and may vary with the economic and social consequences that can arise at different periods in the worker's life. Not only has the link between workplace and working times been broken (for example, through teleworking), but also the borders between working and leisure times are no longer fixed and rigidly determined by the normal working day. Working hours are extended to evening and night hours, as well as to the weekend, and hours of duty have become more and more variable (the '24-hour society').

In this context, shift work is the most common form of working time and enables round-the-clock activities not only in relation to rigid technological conditions (e.g. the chemical and steel industry, power plants) and necessary social services (e.g. hospitals, transportation, electricity, telecommunications), but also to support productive and economic choices (e.g. textile, paper, food, mechanical industry, banking), as well as the wider use of leisure time (e.g. entertainment). Shift work includes any arrangement of daily working hours that differs from standard day work. It is aimed at extending the organization's operational time from 8 hours up to 24 hours per day, by means of a succession of different teams of workers.

According to the results of the 3rd European Survey on Working Conditions outlined in [Ref. 1](#), only 24 per cent of the working population (27 per cent of employed and 8 per cent of self-employed workers) were engaged in the so-called 'normal' or 'standard' day work, that is between 07.00–08.00 (7–8 a.m.) and 17.00–18.00 (5–6 p.m.), from Monday to Friday.¹ This means that the vast majority of workers are engaged in 'non-standard' working hours, including shift and night work, part-time work, weekend work, compressed work week, extended working hours, split shifts, on-call work, etc.

Working schedules can vary widely, in particular (1) duration of duty period (i.e. from 6 to 12 hours); (2) presence and extension of night work (i.e. between 24.00 (12 p.m.) and 05.00–06.00 (5–6 a.m.)); (3) permanent or rotating shift schedules (i.e. people work regularly on one shift or alternate periodically on different shifts); (4) continuous or discontinuous shift systems (i.e. all days worked or interruption on weekend); (5) start and finish time of the duty periods (i.e. between 04.00 (4 a.m.) and 07.00 (7 a.m.) in the morning, between 20.00 (8 p.m.) and 24.00 (12 p.m.) at night); (6) number of workers/crews who alternate during the working day (i.e. two, three or four shifts); (7) speed (i.e. 'fast', every one–two or three days, or 'slow', every 15–30 days) and direction of shift rotation (i.e. 'clockwise', morning–afternoon–night, or 'counterclockwise', afternoon–morning–night); (8) number and position of rest days between shifts; (9) length of shift cycle (i.e. from six to nine days up to six months or more); (10) regularity/irregularity of the shift schedules.

According to the 4th European Survey on Working Conditions,² weekly working hours range from an average of 34 hours in the Netherlands to 55 hours in Turkey, and from a minimum of eight hours (as part-time work) to a maximum of 90 hours (as overtime work). Shift work, which includes night work, involves more than 17 per cent of the total working population, with large differences among the countries (from 6.4 per cent in Turkey to 33.5 per cent in Croatia).

In 2004, almost 15 percent of full-time salaried workers in the USA usually worked on alternating shifts including nights. In the United States, men were more likely than women to work such shifts (16.7 and 12.4 per cent, respectively); blacks were more likely than whites, Hispanics or Latinos, or Asians; and shift work decreased progressively with age.³

Extended working hours refers to working for longer than eight to nine hours per day, and 40 hours per week. According to the International Labour Organization, annual hours worked per person surpassed 1800 hours in 27 countries out of 52 monitored from 1996 to 2006, and 2200 hours in six Asian economies.⁴ In the United States, almost one-third of the workforce regularly works more than the standard 40-hour week and one-fifth more than 50 hours.³ In Europe, according to the 4th European Survey on Working Conditions, 16.9 per cent workers of the 27 EU member states worked 48 hours per week or more, ranging from 11.1 per cent in Luxembourg to 32.1 per cent in Turkey.²

Working irregular or extended hours may have negative consequences for health and well-being due to the stress derived from interference with psychophysiological functions and social life. The majority of the studies up to now have focused on shift work rather than on extended working hours since they are often confused. However, some recent studies have addressed this second aspect independently, with some contrasting results.^{5,6}

BIOLOGICAL AND SOCIAL INTERFERENCE

Circadian rhythms and psychophysical conditions

It is commonly accepted that work efficiency at night is not the same as during the day. Man is a diurnal creature, synchronized to the 24-hour light/dark cycle, who is naturally awake and active during daylight and consequently resting and sleeping at night. This behaviour is determined by the regular oscillation of bodily functions ('circadian rhythms'). For example, core body temperature decreases during the night when people are asleep down to a minimum of 35.5–36.0°C in the early hours of the morning, and increases during the waking day to reach a maximum (acrophase) of about 37.0–37.3°C at around 17.00 (5 p.m.). This rhythmicity is controlled by a strong endogenous oscillator (or body clock), located in the suprachiasmatic nuclei, and is influenced by environmental factors (synchronizers), such as work, activity, sleep, meals and, in particular, light exposure.^{7,8,9}

Night work forces the individual to change their normal sleep/wake cycle and to attempt to adjust to the nocturnal activity by a progressive phase shift of circadian rhythms that may be more or less complete depending on the number of successive night shifts. However, circadian rhythms very seldom show a complete inversion, rather there is a flattening of their amplitude and a dissociation between them due to differing rates of adjustment of the rhythms in the variables concerned. Indeed, even in permanent night workers, the vast

majority show insufficient adjustment of their body clocks for it to be of any real benefit.¹⁰ The general lack of circadian adjustment is due both to the continuous rotation through the different shifts on most shift systems, and to the fact that most individuals try to maintain a normal, day-oriented, social and family life during their free time and on rest days.

These rhythmic disturbances may have negative effects on health and well-being. In the short term, people may suffer from symptoms similar to those of jet lag and characterized by feelings of fatigue, sleepiness, insomnia, digestive troubles, and reduced mental ability and performance efficiency. In the longer term, such rhythmic disturbances may, often in combination with other factors, eventually result in the manifestation of a wide range of complaints and illnesses (see under Effects on health).^{11,12,13,14}

Performance efficiency

Human error is often cited as an important factor in work-related accidents and depends on sleep and sleep-related factors, as well as on circadian rhythms in alertness and performance capabilities. Alertness can be substantially reduced by irregular rest/activity patterns and by prolonged physical and mental effort. In general, performance efficiency appears to parallel the circadian rhythm in body temperature, but it can peak earlier or later in the day depending on the demands of the task (e.g. physical, cognitive or memory-loaded), on the length of time that has elapsed since the individual's last proper sleep, and on their general level of arousal and motivation.

The dissociation of circadian rhythms in combination with the associated sleep deficit and fatigue may significantly impair work efficiency, in particular at night, making the worker more vulnerable to errors. This pattern has been reported for many groups of shift workers including train and truck drivers, nuclear power workers, nurses, switchboard operators and seamen. A 'post-lunch dip' has also been noted which appears to be only partially dependent on the meal itself, and which may also reflect 12-hour or shorter 'ultradian' rhythms in alertness and wakefulness superimposed on the 24-hour circadian cycle.^{15,16}

In addition, sleepiness due to the truncation of sleep by an early start to the morning shift has been shown to cause a higher frequency of errors and accidents in train and bus drivers, while increased sleepiness and changes in electroencephalogram (EEG) ultradian rhythms (bursts of alpha and theta power density) have been recorded on the night shift, indicating a high propensity for the workers concerned to fall asleep 'on the job'.¹⁷

Family and social life

People engaged in shift work or extended working hours can face greater difficulties in their social lives since most activities are arranged according to the day-oriented rhythms of the general population. In addition, weekend work may interfere with various social activities, such as sports events, religious ceremonies, travel and entertainment. Shift workers thus face more difficulties in combining their time budgets (work hours, commuting and leisure times) with the complex organization of social activities, particularly when these require regular contacts and involve a great many people. Hence, shift work can lead to social marginalization.¹⁸

Shift work and extended working hours may also hinder the already complex coordination of family timetables, with the extent of any such hinderance depending on factors such as family composition and duties (e.g. marital status, number and age of children, housework, moonlighting and illnesses) and the organization of social services (e.g. school and shop hours and public transport). 'Time pressure' is a constant condition among those who have pressing family responsibilities (e.g. women with small children). These complaints may be further complicated when both partners have the same working conditions (i.e. as shift workers or with long working hours), and this can have negative effects on marital relationships, parental roles and children's education. Complaints from shift workers about family and social difficulties are more frequent than those related to biological adjustment, and are often the main cause of shift work intolerance.^{19,20}

On the positive side, shift work can give more flexibility to those who enjoy solitary activities and to those who give a higher priority to family and domestic duties than to personal leisure. Consequently, shift work is sometimes popular since it provides greater opportunities to use daytime hours to meet particular needs (e.g. access to public offices), or simply allows longer spans of rest days between shift cycles. For this reason shift systems that include 'quick returns' (working two shifts in one day) and compressed working weeks (e.g. three or four days of 12 hours per day) are often preferred because of the longer spans of rest days, despite the clear negative effects of such systems on sleep and performance efficiency.

EFFECTS ON HEALTH

Sleep, chronic fatigue and psychoneurotic troubles

Sleep is the main function that is disrupted by shift work. Sleep duration is typically reduced before morning shifts, depending on their start time, and between night shifts because the individuals are trying to sleep when their body clocks expect them to be awake. People may have difficulty in falling asleep and remaining asleep during the day, while the environmental conditions (lighting and noise in particular) are also often far from ideal. Some interference occurs with the daytime sleeps between night shifts (in particular a reduction in stage 2 and rapid eye movement (REM) sleep, whereas slow wave sleep (SWS) sleep is unaffected, although irregularly distributed) and for the truncated night sleeps before morning shifts (again with a loss of stage 2 and REM sleep due to the early wake up).^{17,21,22}

The decreased length of main periods of sleep and early awakenings are strongly associated with increased sleepiness during the rest of the day and a higher recourse to napping. Naps may partially compensate for sleep deprivation and have a prophylactic effect in counteracting the fall in alertness if properly taken before or during the work shifts. The length of the nap seems less important (20 minutes and two hours may have the same value) than its temporal position in relation to the duty period.

Both homeostatic (time elapsed since prior sleep termination) and circadian (sleep/wake cycle) components interact in determining the extent of the reduction in alertness and psychophysical performance over the waking day, and even more so at night. This may be further aggravated by features of the work schedule, and in particular the number of night

shifts in succession, the start time of morning shifts, and shorter rest periods between shifts (i.e. 'quick returns').

The disturbances of sleep can be both severe and long lasting, and may eventually lead to an increased incidence of symptoms of chronic fatigue, nervousness, persistent anxiety, and depression, which may require the administration of psychotropic drugs.²³ This has been confirmed in both cross-sectional and longitudinal survey studies using standardized psychological health questionnaires. Rather fewer studies have reported the incidence of those clinically diagnosed as suffering from psychological health problems, and those that have suffer from problems of adequate, matched control groups. Nevertheless, stress-related symptoms are relatively common in people working extended hours, particularly if associated with high work loads or monotonous, repetitive jobs. There is also some evidence that these symptoms may act as a risk or aggravating factor for other psychosomatic complaints or diseases including symptoms of gastrointestinal and cardiovascular health.

Digestive and metabolic disorders

Many shift workers complain of digestive disorders, reflecting on both the irregularity of meal timing and the poor quality of the food consumed, namely an increased consumption of prepacked meals and caffeinated drinks. Studies carried out over the last 50 years have shown that 20–75 per cent of night and shift workers, compared to 10–25 per cent of day workers, complain of disturbances of appetite, irregular bowel movements, constipation, dyspepsia, heartburn, abdominal pains and flatulence. In the longer term, many workers also develop more serious disorders, such as chronic gastritis, gastroduodenitis and peptic ulcers. A review of epidemiological studies found a generally higher prevalence of such disorders (from two to five times higher on average) amongst shift workers whose work schedule included night work.²⁴ However, improved diagnostic methods (endoscopy), better aetiopathological definition of peptic ulcer (i.e. *Helicobacter pylori*) and more appropriate therapies have recently changed the course of the disease, and hence its prevalence, as well as allowing people to continue shift working without major problems.

In recent years, an increased prevalence of metabolic disturbances in shift workers has also been emphasized.^{25,26} It has been suggested that these may reflect several factors, and in particular (1) a mismatch of circadian rhythms of anabolic and catabolic phases; (2) changes in daily lifestyle (i.e. unbalanced diet, irregular timing of food intake, nibbling carbohydrates and increasing consumption of caffeinated or alcoholic drinks at night); and (3) disturbed sociotemporal patterns (i.e time pressure, work–non-work conflicts) with consequent higher stress levels.²⁷

A higher prevalence of overweight and obesity and increased blood triglycerides levels has been found in several studies of both shift work^{26,27,28,29} and extended hours,^{30,31} whereas somewhat inconsistent findings have been reported for total and HDL cholesterol levels. With respect to glucose intolerance, a higher prevalence (two-fold) of type 2 diabetes in shift workers compared to day workers has been reported by two studies,^{32,33} while a single study has reported an increased risk (RR = 3.73) for type 2 diabetes associated with a >50 hour/week overtime.³⁴

Cardiovascular diseases

A number of epidemiological studies have indicated an association between shift work and cardiovascular diseases. More specifically, there is (1) an increased prevalence of cardiovascular risk factors among shift workers; (2) a higher morbidity due to cardiocirculatory and ischaemic heart diseases with increasing age and shift work experience; and (3) an increased relative risk of myocardial infarction in occupations with a high proportion of shift workers.^{25,35}

It is worth noting that several possible confounding factors may also act as mediators or modifiers of the effect, such as age, smoking, diet and social class. The conclusion of a review of 17 cohort and longitudinal studies of shift work was that shift workers have a 40 per cent excess risk for cardiovascular disease compared to day workers, but that in the age group of 45–55 years, the relative risk rises to 1.6 in men and 3.0 in women.³⁶ Moreover, the relative risk for coronary heart disease increases to 2.3 when shift work is associated with obesity, and to 2.7 when associated with smoking (which alone has a RR of 1.6).³⁷ Furthermore, since smoking is often increased in shift workers, it can be viewed not only as a confounding variable, but also as an intermediary between shift work and ischaemic heart disease.^{35,38}

With respect to extended hours, Japanese studies have indicated a two-fold increase of myocardial infarction in people working more than 60 hours per week³⁹ or 11 hours per day,⁴⁰ but the findings for hypertension have been inconsistent.⁴¹

Accidents

As mentioned under Biological and social interference (p. 1234), shift workers may be more prone to errors and work accidents due to reduced vigilance and performance capabilities, than their day-working counterparts. However, while some studies have reported a higher overall incidence of injuries and accidents on the night shift, others studies have found inconsistent effects.²⁴ These inconsistencies reflect a large number of potentially confounding factors, such as differences in the work sector studied or jobs examined, which may influence the relative risk of accidents. The most important factors relate to the manner in which work is organized on the different shifts. For example, maintenance and supervision are often largely confined to the day shift(s), while long, 'easy', runs of a particular job may be saved for the night shift. Furthermore, the day shift may be 'augmented' by permanent day workers, thus increasing the likelihood of accidents on the day shift. It is noteworthy that in the studies in which the a priori risk appeared to be constant across the 24-hour day, industrial injuries were higher on the night shift, and also showed a bigger increase over successive night shifts than over successive day shifts.^{42,43,44}

Other studies have shown peaks in accidents at around 10.00–11.00 (10–11 a.m.) and 15.00–16.00 (3–4 p.m.) which probably reflect peaks in work activity since performance capabilities due to circadian rhythms should be relatively high at these times. There is, however, evidence that both long working hours and an early start time to the morning shift may be associated with an increased accident risk.⁴⁵ It is clear that careful attention needs to be paid to the potential accident risk when considering work schedules and other organizational factors. Indeed, it is noteworthy that the nuclear incidents at Three Mile

Island and Chernobyl, the Bophal disaster, and many air accidents including the Challenger space shuttle, all occurred at night. Furthermore, in each case, shift scheduling and fatigue due to sustained operation were cited as important contributory factors.⁴⁶

Absenteeism

Despite inconsistencies, a number of authors have cited the influence of aspects of shift scheduling on absenteeism rates, including the speed of rotation, the amount of overtime, and the shift start and finish times.^{47,48} It should be noted that, in addition to the 'healthy worker effect', there are a number of reasons why shift workers may show lower absenteeism rates despite higher frequencies of complaints and illnesses. These may include (1) a higher solidarity with colleagues since an unexpected absence may cause more problems for shift handovers than for normal day work; (2) a higher threshold in the reporting of complaints and symptoms since shift workers more often accept them as 'part of the job' (e.g. digestive and sleep disorders); and (3) a higher punctuality rate since shift workers are less likely to have to travel to work during rush hours and have fewer problems accessing public offices during working hours. Finally, data on absenteeism are also inconsistent for extended work hours, probably due to confounding factors, such as motivation, work pacing and type of job.^{41,49}

Women's reproductive function

There is good reason to assume that shift work may be a peculiar problem for women's health. This follows both from the potential disruption of their hormonal cycles and from the increased stress caused by the conflict between their irregular working schedules and their domestic duties. Disorders of the menstrual cycle, reproductive function and pregnancy outcomes have been reported in many groups of women shift workers, including a higher incidence of menstrual pains and abortion and interference with fetal development, such as premature births and/or low birth-weight.^{50,51,52,53} A meta-analysis of six studies carried out between 1987 and 1997 also suggested a weak but significant (RR = 1.24) association between extended working hours and preterm birth.⁵⁴ Women shift workers, especially those married with small children, may also have more difficulties in combining their irregular working schedules with their additional domestic duties, and may thus suffer more from sleep troubles and chronic fatigue than their male colleagues.^{20,55} Indeed, some national legislation protects shift working women, e.g. exemption from night work when pregnant, and the possibility to transfer to day work during the first two to three years of age of their children.

Toxicological risk

Shift workers may be particularly susceptible to xenobiotics due to (1) potential fluctuations in the environmental concentrations of pollutants and a concomitant increase in risk at certain times of day; (2) the reduced interval between shifts; (3) pronounced circadian rhythms in the metabolism and excretion of toxic substances; and (4) the potentially detrimental consequences of circadian disturbances. Experimental chronotoxicology studies have demonstrated circadian rhythmicity in the activity and effectiveness of some toxic compounds (i.e. mercurials, cyanides and organophosphate pesticides), as well as variations

in susceptibility after changes to the light–dark regimen. Thus, the balance between the ‘biokinetics’ of the substance and the ‘chronoesthesia’ of the biological system is more likely to be unfavourable at night when metabolic function is slowing down. This was dramatically demonstrated by the Bhopal disaster when, surprisingly, none of the night workers died from the vapours of methyl isocyanate, but thousands of inhabitants of the near villages died in their sleep. At the same time, thousands of cattle died while nocturnally active rats were observed to be scurrying around the corpses and carcasses.⁵⁶

Risk assessment and biological monitoring should take into account circadian fluctuations in physiological responses (in terms of absorption, metabolism and excretion) and the consequent severity of the toxic effect. This should be evaluated not only with reference to environmental threshold limit values (TLVs) and biological exposure indices (BEI), but also for evening and night shifts, as has been suggested for prolonged, 12-hour shifts. Indeed, some studies have already shown a circadian excretion pattern of toxic substances or metabolites that can be used for better strategies in workers’ biomonitoring.^{57,58}

Mortality

Apart from the first negative report in 1949 (cited in [Ref. 59](#)), there have been only three well-controlled studies that have examined the mortality rates of shift workers. The first study was of 1578 deaths in 8603 male British industrial workers from 1956 to 1968.⁶⁰ The overall number of deaths was very close to that expected from national mortality rates, and no significant excess mortality was found in either the shift (722 versus 711.4) or ex-shift (120 versus 100.9) workers. Shift workers in some age groups had a significant excess (e.g. in those under 60 years old for arteriosclerotic heart diseases), but this was not consistent across work organizations and types of shift work. However, a recent re-analysis of the mortality rate ratios, adjusted for age, showed that former shift workers had a slight, but significantly, increased mortality risk compared with day workers (RR = 1.24; 95 per cent CI, 1.03–1.51).⁶¹

The second, Danish, study followed 1123 shift workers and 4084 day workers over a 22-year period. The relative death risk was 1.1 (95 per cent CI, 0.9–1.3) for shift workers after adjustment for age and social class.⁶² The third study was based on a Swedish survey of 22 411 individuals between 1979 and 2000. The results, adjusted for age, stress, physical work load, disease at the outset of the study and smoking, showed no significant difference between shift and day workers in general, but an increased hazard ratio for female white-collar shift workers (HR = 2.61; 95 per cent CI, 1.26–5.41).⁵⁹

With respect to extended hours, a Swedish survey of 2632 workers carried out from 1973 to 1996 reported that more than 5 hours/week overtime increased all-cause mortality in men (RR = 2.0) at 5-year follow up, and women (RR = 1.92) at 24-year follow up, when controlling for the other most important risk factors.⁶³

Cancer and shift work

Several recent epidemiological studies have examined the association between cancer and shift work. A slightly higher incidence of breast cancer in women engaged in shift work, including night work has been reported in four studies of nurses (OR or RR 1.36–2.21), in

four studies of flight attendants (standardized incidence ratio between 1.42 and 2.0), and in one study of sea radio and telegraph operators (OR = 1.5). These studies controlled for several important confounding factors (i.e. age, menarche, parity, menopausal status, family history, body mass index (BMI), contraceptives) but were limited with respect to the quantification of the exposure (both in terms of the definition of night work and the characteristics of the shift schedules), and with respect to the potential exposure to other proven carcinogens, i.e. antineoplastics, x-rays, cosmic radiation and electromagnetic fields).^{64,65}

Possible explanations for such an association are based on perturbations of melatonin secretion and changes in gonadotropin axis resulting from the disruption of both dark–light exposure and sleep–activity patterns, with a consequent deregulation of circadian genes involved in cancer-related pathways (i.e. inactivation of *Per2* and inhibited expression of *Period* genes) and reduced immune defences (suppression of natural killer-cell activity and changes to the T-helper 1/T-helper 2 cytokine balance), such as has been found in rodents.⁶⁶

The International Agency on Research on Cancer (IARC) recently classified ‘shift work that involves circadian disruption’ as ‘probably carcinogenic to humans’ (Group 2A) on the basis of ‘limited evidence in humans for the carcinogenicity of shift-work that involves nightwork’, and ‘sufficient evidence in experimental animals for the carcinogenicity of light during the daily dark period (biological night)’.⁶⁷

Ageing and shift work

Ageing is associated with a decreased ability to adjust to night work and an increase in sleep disturbances, such that night work may become less and less bearable with advancing age.⁶⁸ More difficulties have also been reported in changing from 8- to 12-hour shifts in those aged over 50 years.^{69,70} Moreover, as people grow older, they tend to become more ‘morning type’, making it both more difficult to sleep during the day after night work, and more difficult to maintain alertness during the waking period.^{71,72}

In general, health deterioration with increasing age may be more pronounced in shift workers than in day workers due to sleep problems and chronic fatigue, with a consequent reduction in work ability, and an increase in sick leave, sleep disorders and gastrointestinal and cardiovascular diseases.^{73,74,75,76} Moreover, older people obviously suffer more health problems, quite independently of shift work, and these may hamper their adaptation and tolerance to irregular and/or extended hours. On the other hand, it should be noted that the greater experience of older workers may have resulted in their having better coping strategies and countermeasures. This is particularly true in terms of work commitment, regular life regimen, more satisfactory job positions, better housing conditions and fewer domestic constraints.

FACTORS AFFECTING TOLERANCE TO SHIFT WORK AND EXTENDED WORKING HOURS

It has been estimated that about 15–20 per cent of workers do not like shift work and suffer from serious problems that force them to leave, mainly due to circadian disruption and severe sleep problems. In contrast, around 10 per cent have no complaints since they are able to satisfactorily combine their personal attitudes and behaviours to their peculiar

demands. The majority (70–75 per cent) simply tolerate shift work, showing various levels of (in)tolerance, that may be more or less manifested at different times and with different severity. Indeed, it is abundantly clear that a number of moderating variables, including individual differences, situational factors and social conditions, may significantly influence both the short-term circadian adjustment to, and the longer-term tolerance of night and shift work.^{12,77,78}

Individual characteristics have been widely investigated in an attempt to determine which psychological and physiological factors are associated with either adverse health effects or a better tolerance, and hence may have important practical applications. Individuals who have a small amplitude of their circadian rhythms may have a less stable circadian structure (i.e. show larger phase shifts on abnormal work schedules) and may be more prone to internal desynchronization, thus having more long-term problems.^{57,79} Morning types ('larks') and evening types ('owls') also differ in their circadian adjustment to night work: the former appear to be less tolerant to night work since they have an earlier phase of their circadian system, while the latter have a later circadian phase, face greater problems in waking up early in the morning, and may suffer from an even greater truncation of their night sleeps taken before morning shifts.

There are a number of other personality traits and/or behavioural characteristics, including neuroticism, locus of control, rigidity of sleeping habits and the ability to overcome drowsiness, that may influence the degree of circadian adjustment and hence have a potential impact on long-term tolerance. In addition, physical fitness can improve sleep, lessen fatigue and increase performance, and may thus improve tolerance to night work, as may a strong 'commitment to shift work', since this is associated with more stable sleep timings and other circadian behaviours.^{80,81,82,83}

With respect to family and social conditions, marital status, number and age of children, living with old and/or ill people, housing location and comfort (e.g. rooms, protection from disturbing noises) have all been shown to influence tolerance to shift work.^{84,85,86} For women in particular, the partner's job (whether a shift worker as well), the presence of small children, the organization of social services (i.e. school timetables, shop hours, public transport) and family support, are factors that may be important. It is well documented that married women with small children suffer from shorter and more fragmented sleep and from cumulative fatigue, and that they are obliged to significantly reduce their social relations and leisure activities.^{55,87,88,89}

Absenteeism, work accidents, fatigue and the disruption of social and family life, are certainly enhanced by local factors, such as low social support, a lack of basic services, and long and uncomfortable commuting hours. Support from family and friends at home, and from co-workers and supervisors at work have been proved to enhance shift work adaptability and tolerance.^{90,91} Indeed, many surveys in developing countries have shown that the effects of night work on health and safety are often aggravated by less than favourable social conditions (e.g. low nutrition, education and salary; poor housing, community services and social protection, labour market restrictions and discrimination), that are also often connected with poor working conditions (environmental pollution, heavy work) and long working hours.^{92,93,94,95}

Even on the same work schedule, the cultural background and the socioeconomic conditions of each country or community may make the impact on health, safety and well-being quite different. In industrialized countries with high immigration levels, minority ethnic groups are often engaged in jobs with low pay and poor working conditions, including more shift and night work, with consequent negative effects on social integration.⁹⁶ Furthermore, the specific arrangement of shift schedules is of paramount importance (see under Preventive and compensatory measures). The problem of tolerance to shift work is therefore multifaceted, with a high interindividual variability in terms of both clinical and temporal manifestations, due to the various complex interactions between personal characteristics, working and social conditions.

It is also noteworthy that the health troubles reported by shift workers are predominantly psychosomatic disorders that are quite common in the general population and have a multifactorial origin. They reflect the influence of several risk factors including genetic and family heritage, psychological characteristics, life styles, social conditions and intervening illnesses. Furthermore, their chronic degenerative nature makes their manifestation more likely to occur after long-term exposure and with increasing age. In this context, shift work may act as a further stress factor or a trigger as it combines conflicts between endogenous rhythms and social synchronizers with demanding working conditions and interferences with family and social life.

Consequently, the process of maladaptation, or intolerance, to shift work is variable in its speed of onset and intensity, depending on the differences in personal, working and social circumstances. Thus, health problems and disorders may manifest themselves at different life periods, with different degrees of severity and duration, and sometimes in an alternating or fluctuating way, thus further increasing the interindividual and intraindividual variability.^{97,98}

It is, as yet, unclear as to the extent to which the disturbance of biological rhythms influences long-term tolerance. However, it is commonly presumed that circadian disturbances, including those of sleep, are the main causes of intolerance to night work in the first years of shift work, whereas longer-term intolerance may be more related to other personal, working and social circumstances. An important confounding factor in this respect, is the process of self-selection that occurs in shift workers. Most of the epidemiological studies in this field have been cross-sectional and have considered workforces in whom an unknown number of individuals may have previously left shift work because of illness or social problems. Indeed, longitudinal studies have found it virtually impossible to follow up the same sample of shift workers over a prolonged period, due either to transfers to day work because of problems, or to multiple change-overs from shift work to day work during the working life. This can lead to a serious underestimation of the problems associated with shift work, since the shift workers available for investigation are those who have 'survived' (i.e. there may be a 'healthy worker effect'). In contrast, studies of former shift workers may overestimate the complaints of shift workers on the whole.

Likewise, the equivocal or inconsistent association between extended working hours (i.e. 12-hour shifts) and health effects may be due, given the lack of prospective studies, to the fact that many other factors (i.e. job demands, workload and pacing, shift schedules, rest pauses, motivation, decision latitude, flexible times, commuting) may be confounded. This

may underlie the conflicting findings that in some studies long working hours are not a problem, while in others they can have severe health effects, related to higher stress, sleep deficit and fatigue.^{5,6,41,99,100}

PREVENTIVE AND COMPENSATORY MEASURES

Since shift and night work are risk factors for health and well-being, medical examinations should be carried out with the dual aims of giving the workers suggestions and guidelines on how best to cope with shift work, and of detecting the early signs of intolerance to night work.¹⁰¹ The importance of this has been emphasized recently in international directives and recommendations. Thus the ILO Night Work Convention No. 171 and Recommendation No. 178 concerning Night Work (1990)^{102,103} and the European Directive 2003/88/EC concerning 'certain aspects of the organisation of working time',¹⁰⁴ cover a number of specific measures for night workers, including health assessments prior to assignment to night work, at regular intervals thereafter, and in the case of any health complaints. They also state that night workers found to be unfit for night work for health reasons should be transferred, whenever possible, to day work.

Medical examinations should ensure an appropriate screening of workers who are going to be engaged in shift work in the first place, and then ensure that regular assessments of their continued suitability for night and shift work are conducted. With regard to the former, it should be emphasized that the ability to cope with a 'bad' shift schedule should not be used to 'select' shift workers. The primary aim should be to design shift schedules that minimize the potentially harmful consequences and to develop appropriate compensative measures. In this manner, disturbances to circadian rhythms, accumulation of a sleep debt and any marked interference with family and social life should be avoided, such that most people should be able to tolerate shift work without significant health impairment.

It would be totally inappropriate to develop a medical surveillance programme for people obliged to work an unfavourable shift system, because adoption of a better shift schedule would reduce the health complaints and the need for medical control or intervention. The main guidelines for designing better shift systems according to ergonomic criteria are:^{105,106}

- Night work should be reduced as much as possible (i.e. diluting it among workers by increasing the number of crews).
- Night shifts should be carefully planned. The greater the number of night shifts in a row, the greater the circadian and sleep disturbance and the accumulation of fatigue.
- Rotating shifts are preferable to permanent night work. Although permanent shifts may reduce circadian disturbances they are not normally acceptable for social reasons. However, if safety is paramount, permanent night shifts may improve performance levels.
- Quickly rotating shift systems (that change every one, two or three days) are preferable to slowly rotating ones (changing every five or more days), since they minimize circadian disruption and any cumulative sleep debt.

- Clockwise rotation (morning–afternoon–night) is preferable to the counterclockwise (night–afternoon–morning) since it avoids ‘quick returns’ (e.g. morning and night shift on the same day). It also parallels the natural tendency of the circadian system to delay slightly.
- Duration of shifts should be set according to psychophysical demand, with a view to minimizing sleepiness and fatigue, particularly on the night shift, while proper rest pauses should be planned throughout the duty period.
- Early starts to the morning shifts should be avoided to reduce the truncation of the previous sleep and the consequent increase in sleepiness, fatigue, and the risk of errors and accidents.
- Extended work days (9–12 hours) should only be contemplated when the nature of the work, and the workload, are suitable (adequate breaks, no overtime) and the shift system is designed to minimize the accumulation of fatigue and the exposure to toxic substances.
- Shift system should be as regular as possible to allow people to better plan their family and social life, and their coping strategies.
- Rest days should follow night shifts to allow adequate recuperation, while continuous shift systems should include as many free weekends as possible, and allow at least two consecutive days off between shift cycles.
- It is also desirable, and advantageous in terms of health and well-being, to allow flexible working time arrangements, and to encourage workers’ participation in designing tailor-made shift systems according to their needs and preferences.¹⁰⁷

In addition to the ergonomic design of shift schedules, other countermeasures that can prove beneficial include the compensatory reduction of working hours for night work, the introduction of additional rest breaks (for meals and naps), the addition of supplementary rest-days or holidays, the improvement of canteen and transport facilities, the improvement of social services (i.e. child care facilities, extended school and shop hours), specific education and training courses for shift workers, financial support for improving housing condition (i.e. sleeping rooms), transfer to day work after a certain number of years on night work, and gradual or early retirement.

MEDICAL SURVEILLANCE

It is clear that some complaints or illnesses may be a contraindication for shift work, particularly when it is associated with other stress factors such as heavy work, heat, noise, monotony or high cognitive demands. Thus, the occupational health physician needs to carry out an evaluation of both the working conditions and the health status of the individuals before assigning people to shift and night work. In the light of various suggestions given by a number of authors and institutions, it appears reasonable to propose the following strategies for medical intervention:^{11,108,109,110}

1. Consider exempting from night work all those suffering from severe complaints and disorders that could be connected to, or worsened by, shift work such as:

- a. chronic sleep disturbances;
 - b. severe gastrointestinal diseases (e.g. peptic ulcer, chronic hepatic and pancreatic diseases, Crohn's disease);
 - c. chronic heart diseases (e.g. myocardial infarction up to 12 months or with impaired heart function, angina pectoris, hyperkinetic syndromes and severe hypertension);
 - d. brain injuries with sequelae and severe nervous disorders, and in particular chronic anxiety and depression;
 - e. epilepsy requiring medication since seizures can be encouraged by sleep deficit and the efficacy of the treatment can be hampered by irregular wake–rest schedules;
 - f. spasmophilia (i.e. chronic idiopathic or constitutional tetany), as temporal changes can be a promoting factor of tetanic crisis;
 - g. insulin-dependent diabetes, thyroid (thyrotoxicosis and thyroidectomy) and suprarenal pathologies, since they require regular drug treatment that is strictly connected to the activity/rest periods;
 - h. chronic renal impairment, since the disruption of circadian rhythms can further impair renal functioning;
 - i. immunological disorders and cancers, to avoid further stress and facilitate medical treatment;
 - j. pregnancy, particularly if there is a known risk of miscarriage.
2. Evaluate carefully before assigning to night work people who are or who have:
- a. over 45–50 years of age, as it becomes more difficult to sleep at irregular hours;
 - b. digestive troubles or chronic respiratory diseases (asthma and chronic obstructive bronchitis);
 - c. alcoholism or other drug addictions;
 - d. marked hemeralopia or visual impairment, which can make night work difficult or dangerous in case of reduced illumination;
 - e. women with small children (under six years);
 - f. long distance commuters.

Particular attention should also be also paid to those who score highly on scales of neuroticism, morningness or rigidity of sleeping habits. In contrast, some individual characteristics and preferences could be considered to predispose people towards shift work (see under Factors affecting tolerance to shift work and extended working hours, p. 1238).

Regular health checks should be aimed at detecting early signs of intolerance to night work which may require prompt organizational (e.g. change the shift schedule) and/or individual (e.g. improve coping strategies or transfer to day work) intervention. Such checks should focus primarily on sleeping times and troubles, eating and digestive problems, psychosomatic complaints, drug consumption, housing and commuting problems, workload, and out of job activities, preferably using standardized questionnaires¹¹¹ or check lists in order to facilitate a comparison of the worker's health over the years. Furthermore, the use of sleep logs, diaries of daily activities, some rhythmometric recordings (e.g. body temperature, performance) or hormonal dosages (e.g. cortisol, melatonin) may be helpful in evaluating the level of an individual's (mal)adjustment.

Physicians should also bear in mind that shift work may worsen some disorders (e.g. sleep, digestive or nervous complaints) and hence hamper the efficacy of their pharmacological control, particularly when this requires a precisely timed administration and/or a stable life regimen, as is the case for diabetes, hypertension, asthma, hormonal pathologies, epilepsy and depression. In addition, people affected by seasonal affective disorders may encounter more difficulties in coping with night work, due to the lower exposure to bright light.¹¹²

The frequency of medical examinations should be set by the occupational physician and take into account factors concerning both the working conditions (e.g. shifts rotas, environmental conditions, workload, etc.) and aspects of the individual (e.g. age and health condition). Many authors have emphasized the importance of careful monitoring during the first year of assignment to night work, since it may be critical for the development of effective coping strategies. At each periodical check the individual's fitness for shift work should be re-evaluated if they complain of sleep, gastrointestinal, psychological or other related problems, or if they contracted any other illnesses that might hamper their psychophysical equilibrium and working capacity. Temporary exemption from night work should be considered in the case of transient health impairment or severe difficulties with family or social life.

It is also necessary to pay particular attention to older workers, for whom some specific recommendations can be given, such as the need to limit night work after 50 years of age, give such workers priority for transfer to their preferred shift (e.g. morning shifts), reduce work load (supplement crews), shorten working hours, increase rest pauses and increase the frequency of health checks (at least every two years).¹¹³ In addition, long-term medical surveillance (e.g. over five years) should be organized for any individual who leaves night or shift work for health reasons since there is evidence that these individuals may have a higher prevalence of sleep, gastrointestinal and cardiovascular disorders for several years after leaving shift work.

It is also desirable to give workers information and guidelines on how best to cope with night and shift work.¹¹⁴ Counselling and training should be carried out at both an individual and group level and educational programmes should be set up. They should deal with improving self-help strategies for coping, and in particular in relation to sleep hygiene, eating behaviour, stress management, physical fitness, housing conditions, transport facilities, out-of-work activities and proper exposure to bright light. Finally, the occupational health physicians should consider giving scientific and practical support to employers and

trade unions in applying preventive and compensatory measures aimed at reducing the problems arising from night and shift work.¹¹⁵

Key points

- Work schedules that disrupt the normal sleep–wake cycle and the endogenous body clock are becoming increasingly common.
- As well as disturbing sleep and family and social life, such schedules can result in impaired psychological and physical health and in an increased risk of injuries and accidents.
- The health problems associated with abnormal work schedules include anxiety, depression, gastrointestinal disturbances, cardiovascular diseases, reproductive problems and possibly cancer.
- There are substantial differences between individuals, associated with factors such as age, personality and health status, in their ability to tolerate shift work.
- Designing better work schedules and providing good medical surveillance may minimize the adverse consequences of abnormal work schedules.

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