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The impact of shift and night work on health*

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Shift work, in particular night work, can have a negative impact on health and well-being of workers as it can cause: (a) disturbances of the normal circadian rhythms of the psycho-physiological functions, beginning with the sleep/wake cycle; (b) interferences with work performance and efficiency over the 24 hour span, with consequent errors and accidents; (c) difficulties in maintaining the usual relationships both at family and social level, with consequent negative influences on marital relations, care of children and social contacts; (d) deterioration of health that can be manifested in disturbances of sleeping and eating habits and, in the long run, in more severe disorders that deal prevalently with the gastrointestinal (colitis, gastroduodenitis and peptic ulcer), neuro-psychic (chronic fatigue, anxiety, depression) and, probably, cardiovascular (hypertension, ischemic heart diseases) functions. Besides, shift and night work may have more specific adverse effects on women's health both in relation to their particular hormonal and reproductive function, and their family roles. It has been estimated that about 20% of all workers have to leave shift work in a very short time because of serious disturbances; those remaining in shift work show different levels of (mal)adaptation and (in)tolerance, that can become more or less manifest in different times, and with different intensity. In fact, the effects of such stress condition can vary widely among the shift workers in relation to many 'intervening variables' concerning both individual factors (e.g. age, personality traits, physiological characteristics), as well as working situations (e.g. work loads, shift schedules) and social conditions (e.g. number and age of children, housing, commuting).

Keywords: shiftwork, nightwork, occupational medicine, health impairment

Although Bernardino Ramazzini (1713), in his book *De Morbis Artificum Diatriba*, formerly pointed out the harmfulness of shift work, in particular night work, as far as concerns the bakers, who '*work at night, so when the others sleep they stay awake, while trying to sleep during the day like animals who escape the light: hence, in the same town, there are men living an antithetic life in comparison with the others*', the medical interest for such a problem started between the two world wars and has increased over the last decades.

There is now quite clear evidence that shift and night work, which are often implemented for economic reasons to increase productivity and decrease production costs, can on the other hand present high human costs.

In fact, shift work, in particular that including night work, can have a negative impact on health and well-being of workers, in particular in four spheres:

(a) biological: due to disturbance of normal circadian rhythms of the psychophysiological functions, beginning with the sleep/wake cycle;

(b) working: coming from fluctuations in work performance and efficiency over the 24 hour span, with consequent errors and accidents;

(c) social: dealing with difficulties in maintaining the usual relationships both at family and social level, with consequent negative influences on marital relations, care of children and social contacts;

(d) medical: deterioration of health, that can be manifested in disturbances of sleeping and eating habits and, in the long run, in more severe disorders that deal prevalently with the gastrointestinal (colitis, gastroduodenitis and peptic ulcer), neuro-psychic (chronic fatigue, anxiety, depression) and, probably, cardiovascular (hypertension, ischemic heart diseases) functions (Harrington, 1978; ILO, 1988; Waterhouse *et al*, 1992).

This paper will focus on the last point and try to give a brief outline of the problems that the occupational physicians can face.

Psycho-physical conditions

It is common knowledge that work efficiency during the night is not the same as during the day. Man in fact is a diurnal creature, having associated his own state of wakefulness and activity to daylight, and consequently

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his rest and sleep period to the night. This social behaviour is reflected also by the rhythmic fluctuation of the body functions (respiratory, cardiovascular, digestive, renal) in the 24 hour span ('circadian rhythms'), which presents higher levels during the day and lower levels during the night. For example, the body temperature decreases during the night sleep up to a minimum of 35.5–36°C at 02.00–03.00 hrs, and increases during the day reaching a maximum of 37–37.3°C around 17.00 hrs (Minors and Waterhouse, 1986).

Shift work, in particular night work, compels the worker to invert his normal 'activity–rest' cycle forcing him to adjust his body function to the night activity period. Such 'adjustment' entails a progressive phase shift of the body's daily rhythmicity functions, which increases with the number of successive night shifts, but seldom or never reaches a complete inversion, particularly in the case of the more common shift schedules, e.g. weekly rotation (Knauth *et al*, 1982). In fact, the human body is exposed to a continuous stress in the attempt to adjust as quickly as possible to the new working hours, while at the same time being invariably frustrated by the continuous 'change-over'.

Such perturbation of the rhythmic structure plays an important role in influencing health and work capacity. For example, people can suffer to a greater or lesser extent from a series of symptoms commonly known as 'jet lag' or, more properly, 'shift-lag' syndrome, characterized by feeling of fatigue, sleepiness, lethargy, insomnia, digestive problems, poorer mental agility and performance (Folkard *et al*, 1985; Comperatore and Krueger, 1990).

Sleep and psychoneurotic troubles

On shifts, particularly night shifts, the main function altered is sleep, which undergoes a reduction in duration and an alteration in its quality (Kogi, 1982; Rutenfranz, 1982; Åkerstedt, 1984; 1990).

As concerns the sleep length, a reduced number of hours' sleep is recorded both during the morning shift period, in relation to early-morning wake, and during night shifts, due to the inversion of the normal 'sleep–wake' cycle and the difficulty involved in sleeping during the day in unfavourable environmental conditions, such as overcrowded built-up areas, proximity to main roads, noises made by electric household appliances, crying and screaming of children, ringing of door-bells and telephones (Knauth and Rutenfranz, 1975).

From the qualitative point of view, a marked interference in the distribution of the various phases of sleep is recorded. In the day-sleep during the night shift periods, a reduction of the 'deep-sleep', which is essential for recovering from physical fatigue, is observed. On the other hand, during the morning shift periods, because of the early wake-up that cuts off the last hours of sleep, a significant reduction of the 'paradoxic sleep' can be recorded, which is prevalent during the second part of the sleep period and is essential for the maintenance of the psychic well-being.

Such conditions in the long run can not only give rise to permanent and severe disturbances of sleep, but may also be implicated in troubles of the nervous system, such as chronic fatigue, changes in behaviour patterns, persistent anxiety or depression, which often require medical treatment with administration of psychotropic drugs (Costa *et al*, 1981; Koller, 1983; Gordon *et al*, 1986).

Taking into consideration the complex interactions between the above mentioned disruption of psycho-physiological and social conditions, these manifestations appear a logical consequence of the shift worker's status; moreover, closing a vicious circle, they can in turn act as a risky or aggravating factor for other psychosomatic complaints or diseases (i.e. gastro-intestinal and cardiovascular).

However, particularly in this field where the borders between 'normal' and 'abnormal' manifestations are often not well-defined and detectable, it is really necessary to adopt standardized methods and homogeneous procedures in order to define more exactly the effective relation between such important troubles and shiftwork.

Eating habits and gastrointestinal disorders

Meal times are important synchronizers of the human life. They have both physiological and social contents: therefore, they represent a crucial point of the shift worker's life. The digestive disorders, which are often complained of by shift workers, are certainly favoured by the derangement of normal eating habits, particularly on night shift. Although the calorie intake remains substantially unaltered, the quality of food eaten by shift workers changes: on night shift they usually have quick meals, consisting of pre-packed food, and increase the intake of 'pep' drinks, such as coffee, wine and tea. Also, during the day shifts the timetable of at least one of the two main meals has to be shifted by some hours or taken in the canteen at work, often in a hurry in a short-break, and not always of good quality. Such situations in the long run can give rise to troubles and disorders of the digestive system.

According to the different studies (see Rutenfranz, 1982) from 20 to 75% of shift workers doing night work, in comparison to 10–25% of day workers and shift workers without night work, complain of disturbances of appetite, irregularity of the bowel movements with prevalent constipation, dyspepsia, heartburn, abdominal pains, grumbling and flatulence. Many workers may also develop serious diseases such as chronic gastritis, gastroduodenitis and peptic ulcer.

Table 1 synthesizes the results of the largest epidemiological enquiries on this topic.

Most of the surveys reported a higher incidence of gastrointestinal disorders (including peptic ulcer) among shiftworkers. In some studies, the incidence of peptic ulcer has been calculated to be from two to five times higher among shift workers with night shifts, compared to day workers or shift workers without night shift. Other studies also found a shorter interval between start of work and diagnosis of peptic ulcer among shift and night workers. Some other authors, on the contrary, did not find any difference between shift and day workers, while only one has found a higher incidence of gastrointestinal troubles among day workers.

To understand better the meaning of such different,

Table 1 Epidemiological studies on gastrointestinal disorders among shiftworkers

Author (year)	No persons	Work sector
(A) Prevalence among shiftworkers		
*Aanonsen (1959)	1106	metal-chemical
*Andersen (1957)	897	various
*Angersbach *et al* (1980)	640	chemical
*Bjerner *et al* (1948)	4607	various
*Bonnevie (1953)	900	various
Brandt (1969)	5470	various
*Bruusgaard (1949)	1120	paper mill
*Costa *et al* (1981)	573	textile
*Duesberg and Weiss (1939)	13 015	various
*Ensing (1969)	697	railway
Godard *et al* (1973)	300	steel industry
Graf *et al* (1958)	305	metal, textile
Hakkinen (1969)	343	electricity
Koller *et al* (1978)	260	oil refinery
Koller (1983)	301	oil refinery
*Kolmodin and Swensson (1975)	183	railway
Leonard (1979)	535	metallurgy
*Lesniak *et al* (1970)	354	coal mine
Nachreiner and Rutenfranz (1975)	942	chemical
*Rietschel (1978)	208	metal
*Segawa *et al* (1987)	11 657	various
Stein (1963)	812	various (women)
*Thiis-Evensen (1958)	14 348	various
Werner *et al* (1980)	523	various
*Zahorski *et al* (1977)	8302	coal mine
(B) No difference between shift and day workers		
*Demaret and Fialaire (1974)	2364	various
Dirken (1966)	1782	various
*Doll and Jones (1951)	4871	various
*Gaulthier *et al* (1961)	16 350	metallurgy
*Jacquis (1963)	919	textile
Loskant (1970)	200	chemistry
*Michel-Briand *et al* (1981)	192	various
*Mott *et al* (1965)	1045	various
Seibt *et al* (1987)	542	textile (women)
*Taylor (1967)	1383	oil refinery
(C) Prevalence among dayworkers		
*Leuliet (1963)	564	textile

*Including peptic ulcer

and sometimes contrasting, findings we must consider some *confounding factors* connected with the epidemiological studies in this field, that concern not only the gastrointestinal disorders but also the neuropsychic already mentioned and the cardiovascular that will be presented later.

First, the reports are quite different as far as concerns: (a) methods of investigation (e.g. questionnaires, personal or telephone interviews, indirect medical reports, health insurance data, direct medical examinations with or without X-rays or endoscopy); (b) the groups of shift workers examined (e.g. in age, length of shift work experience, shift work schedules, working situations, job activity, socio-economic conditions); (c) the kind of study (whole population or sample, cross-sectional or longitudinal, retrospective or prospective, cohorts or case-reports).

Second, there is a limitation that is often declared in these studies, namely the process of self-selection which occurs among these workers. The cross-sectional studies in fact often consider a sample of workers from whom a more or less relevant part of them had left shift work because of troubles or diseases, or social problems ('healthy worker effect'); also the longitudinal studies, up to now almost exclusively retrospective, have shown the impossibility of following-up the same population of shift workers for a long period (for example the Leuliet (1963) sample has almost halved in 12 years).

Third, another confounding factor which can alter the statistics, sometimes present in these studies, is the presence on day work of former shift workers transferred because of such troubles, or multiple change-overs from shift work to day work along the working life.

Cardiovascular disorders

The possible association between shift work and cardiovascular diseases is under discussion. In fact, stress caused by shiftwork may have adverse effects on the cardiovascular system both through direct mechanisms as well as by indirect influences. The first ones concern neurohormonal and neurovegetative activation, in relation to active and/or passive coping behaviours, with increased secretion of catecholamines and cortisol, and consequent effects on blood pressure, heart rate, thrombotic processes, lipid and glucose metabolism. The second ones refer to less favourable living conditions, personality traits, eating and sleeping disorders, and tobacco smoking, that often play an important role in conditioning the risk for cardiovascular diseases.

In the past some large epidemiological studies concerning morbidity (Thiis-Evensen, 1958; Aanonsen, 1959; Leuliet, 1963), absenteeism (Taylor *et al*, 1972) and mortality (Taylor and Pocock, 1972) did not find significant differences between shift and day workers as concerns cardiovascular diseases, in particular angina pectoris, myocardial infarction and hypertension.

More recently, some authors have recorded data suggesting a possible relation between shift work and cardiovascular diseases, in particular: prevalence of cardiovascular complaints, particularly among shift workers transferred for health reasons; prevalence of angina pectoris and hypertension; higher morbidity for cardiocirculatory and ischemic heart diseases with increasing age and shift work experience; increased relative risk for myocardial infarction in occupations with high proportions of shift workers; prevalence of some risk factors for cardiovascular diseases among groups of apparently healthy shift workers (Alfredsson *et al*, 1982; Akerstedt *et al*, 1984; Knutsson *et al*, 1988; Koller, 1983; Kristensen, 1989).

Mortality

Studies on mortality of shiftworkers are lacking. The only relevant study was carried out by Taylor and Pocock (1972) among 8603 male manual workers of 10 organizations in various industrial sectors in England and Wales over a period of 13 years. Of the three groups considered (day, shift and ex-shift workers), the day workers had slightly fewer deaths than expected from the national rates (736 vs 756.4), while shift and ex-shift workers had slightly more (722 vs 711.4 and 120 vs 100.9, respectively). The differences were not statistically significant, and those related to the 10-years age groups were not consistent in direction;

but, as concerns differences among age groups, the figure for artheriosclerotic heart disease showed a significant excess of death among shift workers under the age of 60.

Work accidents

The circadian fall in psycho-physical performance at night, in association with sleep deficit and stronger feeling of fatigue, decreases the work efficiency of the night worker and increases the possibility of errors and accidents.

However, the studies concerning work accidents among shift workers are quite controversial: some investigations have reported more accidents on night shifts, others on day shifts, while others report accidents as less frequent, but more serious on night shifts.

Table 2, derived from the review by Carter and Corlett (1978), synthesizes the results on this subject.

Besides the interference of many other variables, the different findings can be explained considering, on one hand, the various work sectors and situations examined (whether prone to minor or major risk for accident, firm size, specific jobs), and on the other hand, taking into account that 'conditions are rarely, if ever, the same by day and by night' (Colquhoun, 1976). In fact, the reduction in psycho-physical performance at night time is not necessarily associated with a higher incidence of accidents, as many factors linked with work environment and organization can vary (i.e. night-interruption of higher-risk jobs, slowing-down of work-pace, reduction of the extraordinary maintenance to the minimum, added automation, infirmary closed).

On the other hand, many studies have pointed out that the peak hours for accidents during day shifts are around 10.00–11.00 hrs and 15.00–16.00 hrs, when the performance curve has its best levels, but also the work activity is at its peak. However, as concerns the morning shift, there is some evidence that higher frequencies of accidents are associated with earlier starting hours. Only one study reported, both in textile and automobile industry, a general higher frequency of accidents, independently from the specific shift, among three-shift workers in comparison to two-shift and day workers.

Further field research is then necessary on this important aspect, also in relation to the recent introduction of new technologies which require more alertness and vigilance, and are then more vulnerable to errors than are manual work activities. It may be a coincidence, but it is worth mentioning that the two recent nuclear accidents at Three Mile Island (1979) and Chernobyl (1986), and the Bophal disaster (1984), started during the night hours (at 04.00, 01.25 and 00.57 hrs, respectively). The 'human error', that is often claimed as an important factor, can be related to sleep and sleep-related factors, as well as to oscillatory mechanisms of vigilance and performane (Mitler *et al*, 1988). Besides, Kelly and Schneider (1982) assessed the risk of accidents in a nuclear power plant working on 12 hr shifts to be 70% higher than on 8 hr shifts.

Table 2 Higher frequency of accidents in relation to the work shift (D = Day shifts; M = Morning; A = Afternoon; N = Night)

Author (year)	Work sector	Shift
Abelsdorff (1910)	industry	D
Adams *et al* (1981)	steel industry	M
Andlauer (1960)	industry	M = A = N*
Andlauer and Metz (1955)	mining, metal	M A
Andlauer and Metz (1967)	mining, metal	N*
ARPES (1979)	metallurgy, oil	M A
Costa *et al* (1978)	textile	M A
Hill and Trist (1955)	metallurgy	A
Kohegyi and Bedi (1962)	mining	A
Langlois *et al* (1985)	truck driving	N
Menzel (1950)	railway, food	N
Pokorny *et al* (1981)	bus driving	M
Pradham (1969)	industry	N
Quaas and Tunsch (1971)	metallurgy	N
Richer (1973)	industry	D = N
Smith *et al* (1979)	hospital	N
Vernon (1923)	munition	N
Wanat (1962)	mining	N*
Wyatt and Marriott (1953)	industry	D = N

*More severe at night

Absenteeism

Absenteeism may be an indirect way to assess the worker's health status, though it is often not a reliable measure of morbidity (Koller, 1983). A lot of studies have been reported on this subject (see Fischer, 1986), also in this case differing as concerns methodology (i.e. questionnaires, insurance data, management records, medical certified or not certified absences) and results: some reported more absenteeism among day workers, some others among shift workers, others found no difference.

Some studies pointed out the influence of factors connected both to organizational aspects (e.g. job differences, overtime, rest days, environmental conditions, supervision, turnover) and to socio-economic conditions (e.g. financial needs, unemployment rate, incentive payments), as well as to individual characteristics (e.g. age, motivation). Some others have stressed the importance of temporal factors, such as: shift schedules, frequency of rotation, time of beginning and end of shift, former shift work.

It is very difficult to draw any general conclusion, this being a very complicated matter to interpret in general. As far as concerns shift workers, besides the above mentioned variables and the always present factor of self-selection, other confounding or masking factors can arise.

It is worth reporting a common finding expressed by many authors, that is: while rotating shift workers may show a higher frequency of troubles and illnesses, they are less inclined to stay absent from work than day workers. This behaviour has been widely interpreted by several authors. Some consider that many absences among the day workers may be due to more late arrivals at work, as they usually have to travel in rush hour traffic. Others think they can be influenced by the necessity for some private appointments (i.e. dentist, solicitor), that can be done only during daytime working hours. On the other hand, some believe that shift workers have higher solidarity, which often compels them to be present, as the unexpected absence causes more problems for shift hand-overs than for normal daywork. Others emphasize differences in

perception, labelling, and reporting of complaints and symptoms, that shift workers often accept as 'part of the job', while day workers are more likely to consider them worthy of medical treatment.

Specific risks for women

It is legitimate to presume that shift work, in particular night work, may have more, or more specific, adverse effects on women's health, above all in relation to their periodical hormonal activity, as well as their reproductive function.

Moreover, women shift workers may have to face more stressful living conditions in relation to the time pressures determined by the irregular working schedules and their additional domestic duties, particularly for those married and with children.

It has been, in fact, documented that married women night workers with children have a shorter and more frequently interrupted sleep in the daytime (Gadbois, 1981; Kolmodin-Hedman, 1982; Gersten *et al*, 1986; Dekker and Tepas, 1990) and complain more of cumulative tiredness than men and women without children (Brown and Charles, 1982; Uehata and Sasakawa, 1982; Estryn-Behar *et al*, 1990).

Moreover, among some groups of women shift and night workers significantly higher frequencies of perturbation of the menstrual cycle and menstrual pains (Uehata and Sasakawa, 1982; Colligan *et al*, 1979), as well as of abortions and lower rates of pregnancies and deliveries (Uehata and Sasakawa, 1982; Axelsson *et al*, 1984; Heidam, 1984; MacDonald *et al*, 1988a; Nurminen, 1989) have been reported.

As concerns foetal development, shift work has been found associated with preterm delivery and/or low birthweight in many studies (Mamelle *et al*, 1984; McDonald *et al*, 1988b; Armstrong *et al*, 1989; Axelsson *et al*, 1989; Nurminen, 1989).

Toxicological risk

Exposure to a toxic substance in the work environment is not always uniform being closely linked to different cycles, technologies and production organizations. Concerning the latter aspect, shift work can influence the risk both through changes in work activities as well as in desynchronization of the physiological reactions. Therefore, the dose–response model in human beings must take into consideration also the time of exposure in addition to the classical criteria concerning the chemio-physical properties of a toxic agent, the concentration and duration of exposure, and the constitutional make up of the population at risk.

Such aspects have been largely pointed out by several experiments in animals, evidencing a circadian pattern of susceptibility to toxic substances (e.g. mercurials, cyanides and organophosphate pesticides, given at different times of the day) and variations of this susceptibility after changes of the light–dark regimen (Smolensky, 1981). Also, human chronopharmacology has clearly evidenced a circadian rhythmicity in drug activity and effectiveness (Lemmer and Labrecque, 1987).

According to Reinberg (1979) and Smolensky *et al* (1985), three concepts must be taken into consideration in this respect: (a) the 'chronokinetics' of a toxic agent: including the rhythmic variations of both its 'bio-availability' and excretion; (b) the 'chronoesthesy' of a biological system to a toxic agent: that is to say the circadian variation of susceptibility of a bio-system to a xenobiotic; (c) the 'chronoergy' of a toxic substance: the interaction between the former two factors, which determines fluctuations of effect and effectiveness.

Therefore, the acrophase (peak) of the 'chronoergy' of a xenobiotic does not necessarily coincide with the chronoesthesy of the bio-system involved, or with the time of exposure or the acrophase of its plasmatic concentration.

Besides, in relation to the circadian synchronization or desynchronization occurring in the different shift schedules, the workers can present 'tempora minoris resistentiae' over the 24 hours span, that may not necessarily occur during the night. A suggestive evidence in this respect comes from the Bhopal disaster (17 December 1984), which occurred during the night and was caused by a sudden escape of a toxic gas (methyl isocyanate) from a large chemical plant. The surprising fact was that none of the active workers inside the plant died from the fumes, while outside thousands of inhabitants of the nearby villages died in their sleep and so did thousands of cattle. At the same time, nocturnal active rats, which were observed to be scurrying around the human corpses, were apparently little affected (Reinberg and Smolensky, 1985).

Unfortunately, up to now, these aspects have received scarce attention in relation to shift and night work, except for reports of recurrent nocturnal asthma in industrial workers exposed to dusts or vapours of wood, grains, resins and pharmaceuticals (Pepys and Davies, 1978).

They have also to be considered when a shift worker has to take drugs regularly (e.g. for diabetes, nervous disorders, hypertension, chronic obstructive bronchitis, hormonal disorders), so that their persistence on night work can become incompatible with an efficacious treatment of the disease.

Therefore, the assessment of the risk, which is traditionally evaluated with reference to threshold limit values (TLV) or permissible exposure levels (PEL) defined on the basis of daytime human exposures or animal experiments, should be reconsidered also in the light of evening and night working shifts, as it has been already suggested for prolonged 12-hours shifts (Brief and Scala, 1975; Roach, 1978; OSHA, 1979). Also, as concerns biological monitoring, some chronobiological studies have been published, aimed at defining the circadian pattern of excretion of toxic substances or indicators of effect, both in exposed and non-exposed workers, for a better definition of the strategies of control and protection in the field of the Occupational Medicine (Piotrowski *et al*, 1975; Vokac *et al*, 1980; Botta *et al*, 1987).

Intervening variables

According to several authors, about 20% of all workers have to leave shift work in a very short time because of serious troubles; on the other hand, only 10% of all workers do not complain about shift work during their working life, while the remaining 70% withstand shift

Table 3 Factors influencing tolerance to shiftwork

(A)	Individual characteristics: age; sex; physical fitness; length of shift work experience; behaviour and personality traits (morningness–eveningness; introversion–extraversion; neuroticism; circadian structure); eating and sleeping habits.
(B)	Family situation: marital status; number and age of children; socio-economic level; partner's (shift)work; housing; family attitudes.
(C)	Social conditions: labour market; local shift work traditions; leisure activities; social support; community size and attitudes; commuting times and means of transport.
(D)	Working conditions: work sector; working hours; work environment; work load; job characteristics; income level; qualification; job satisfaction; career opportunities; human relations; canteen facilities; medical surveillance.
(E)	Shiftwork schedules: continuous, semicontinuous; rotating or permanent; direction of rotation (advance – delay); length of the shift cycle; number of consecutive nights; number of nights per year; free week-ends per cycle; time of start and end of shifts; number of crews.

work with different levels of intolerance, that can become more or less manifest at different times, and with different intensity in terms of discomfort, troubles or diseases.

In fact, the effects of such stress conditions can vary widely among the shift workers in relation to many intervening variables concerning both individual factors, as well as working situations and social conditions (*Table 3*).

For example, as concerns the individual differences, ageing may increase the adverse effects of shift work, as it is often associated with a greater occurrence of rhythm disturbances, sleep troubles and psychic depression.

Some authors pointed out the influence of some psychophysiological circadian factors. Subjects having a greater amplitude of the oral temperature circadian rhythms seem to tolerate nightwork better (Reinberg *et al*, 1980), while it is the opposite for those with internal desynchronization (Reinberg *et al*, 1984); on the other hand, 'evening types' show fewer sleeping problems and a better tolerance than 'morning types' (Breithaupt *et al*, 1978; Hildebrandt and Stratmann, 1979). Other authors have stressed the negative influence of some personality and behavioural aspects, such as introversion and neuroticism (Nachreiner, 1975; Colquhoun and Folkard, 1978), or rigidity of sleeping habits (Folkard *et al*, 1979; Costa *et al*, 1989).

More have evidenced the importance of living conditions, which are often crucial for adaptability to shift and night work, for instance with respect to noise (Knauth and Rutenfranz, 1975; Haider *et al*, 1988). On the other hand, as concerns the socio-economic conditions, many surveys, especially those carried out in developing countries, show that the effects of night work on health are often aggravated by several factors including insalubrious workplaces, bad working conditions, trying climatic conditions, poor and cramped housing, insufficient food or unbalanced diet (ILO, 1988).

Other factors deal with the work organization and, in particular, with the organization of the schedules (Knauth, 1993).

Therefore, most of the factors listed in *Table 3* can have both negative and positive effect on shift work tolerance according to the different circumstances; they can also interact and interfere with each other giving rise to possible additive or multiplicative, but also subtractive effects, so that it is often very difficult to evaluate the effective harmfulness of shift work in different populations and individuals.

Besides, the process of maladaptation or intolerance to shift work, that according to Haider *et al* (1988) may develop through four phases of 'adaptation', 'sensitization', 'accumulation' and 'manifestation', can have different speed and intensity among the shiftworkers, so that the manifested complaints and/or illnesses can appear in different periods of life, and this can further increase the high interindividual variability found in the adverse effects of shiftwork.

Moreover, we have to consider the multifactorial characteristic of the diseases signalled as related to shiftwork, and their chronic-degenerative trend: therefore, shift work has to be seen as one of the many risk factors and/or conditions which concur or favour their development, which is more likely to become apparent after a long-term exposure.

Besides, we have to consider that such disorders are quite common among the general population, and recognize the influence of several factors concerning genetic and family heritage, psychological characteristics, life styles, social conditions, working situations and intervening illnesses.

They are in fact typical psychosomatic disorders, that can be promoted or aggravated by excessive stress both from a physical as well as a psychic point of view. In this respect, shift work can act as a stress factor not only through the conflicts between the endogenous biological rhythms and the external synchronizers, but also by higher strain levels deriving from insufficient sleep, and difficulties in family and social life.

Therefore, since the impact of shift work may be quite different among shift workers, having both positive and negative effects, the occupational physician should pay particular attention to shift workers both as concerns pre-employment screening and medical surveillance (Scott and LaDou, 1990).

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