

Introduction to Problems of Shift Work

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Abstract This chapter gives an overview of the health problems associated with shift work, and the main organizational guidelines on how to protect workers' health and well-being. Working time organization is becoming a key factor on account of new technologies, market globalization, economic competition, and extension of social services to general population, involving more and more people in continuous assistance and control of the work processes over the 24 h. The strong increase of epidemiological studies on this issue demonstrates the seriousness of this risk factor for human health and well-being, at both social and psychophysical levels, starting from disruption of biological circadian rhythms and the sleep/wake cycle, ending in several psychosomatic troubles and disorders, probably including cancer, and passing through impairment of performance efficiency and family and social life. Appropriate interventions on the organization of shift schedules according to ergonomic criteria, on the one hand, and a careful health surveillance and social support to shift workers, on the other hand, are important preventive and corrective measures able to allow people to keep working without significant health and social impairment.

1 Introduction

“Shift work” means, in general, any form of organization of work, different from the normal “daily work”, in which the operating time of a company is extended beyond the usual 8–9 h (typically between 07–08 a.m. and 05–06 p.m.), to cover the entire 24 h, through the alternation of different groups of workers.

According to the most recent EU Directive (2003/88/EC of 4 November 2003), “concerning certain aspects of the organization of working time”:

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- “Shift work” means any method of organizing work in shifts whereby workers succeed each other at the same work stations according to a certain pattern, including a rotating pattern, and which may be continuous or discontinuous, entailing the need for workers to work at different times over a given period of days or weeks;
- “Shift worker” means any worker whose work schedule is part of shift work;
- “Night time” is a period of not less than seven hours including the period between midnight and five in the morning;
- “Night worker”: (a) any worker who, during night time, works at least three hours of his daily working time as a normal course; (b) any worker who works a certain proportion of his annual working time, as defined at the choice of the Member State concerned.

There are thousands of diverse shift systems adopted worldwide, which may have different impacts on workers’ health, depending on factors such as:

- the duration of the duty period: predominantly from 6 to 8–9 h, but it can last up to 12 or be reduced to 4 h (in case of part-time work);
- the interruption or not on week-end or Sunday (semi-continuous or continuous systems);
- the presence and frequency of work in the “night time” (see above);
- the number of shifts/workers that take place throughout the day: mainly 2 (Morning and Afternoon) or 3 shifts (including the Night) of 7–9 h, or 4 shifts of six hours (Morning, Afternoon, Evening, Night, in the so-called “6 × 6” shift system);
- the start and end times of each shift: i.e. 06-14-22, 07-13-23, 07-14-21, 06-12-18-24;
- the direction of rotation: clockwise or phase-delayed (Morning-Afternoon-Night), counter-clockwise or phase-advanced (Afternoon-Morning-Night);
- the speed of rotation among the shifts: fast (every 1–3 days), intermediate (every 4–6 days), slow (7 or more days), null (in case of fixed shifts);
- the regularity/irregularity and length (i.e. from 5 days up to 6 months or more) of the entire shift cycle.

Although Bernardino Ramazzini (1633–1714), in his book “*De Morbis Artificum Diatriba*” (1713), 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”, medical and social interest in the problem started last century, between the two World Wars, and has increased over the latest 50 years.

In the modern “24-hour Society” we are both consumers and producers at the same time by requiring, at any time of the day and the night, the availability of goods and services, on the one hand, and by making it possible, on the other hand (Kreitzman 1999). Shift work, night work, irregular and flexible working hours, together with new technologies, are the milestone of this transition to the 24-h

society, of which shift workers are builders and victims at the same time. The most recent statistics say that the majority of the working population is engaged in irregular or “non-standard” working hours, including shift and night work, weekend work, split shifts, on-call work, compressed week, telework, part-time work, variable/flexible working time, prolonged duty periods.

The classical working day, 7–8 a.m. to 5–6 p.m., Monday to Friday, is nowadays a condition affecting a minority of workers (27 % of employed and 8 % of self-employed people in Europe (Costa et al. 2004), and working time arrangement has become a key issue of work organization and a basic condition linking human capacities with production means. It is associated with the increasing economic competition among companies and countries, due to the globalization of labour markets, the development of new technologies and productive strategies, as well as the extension of basic services to the general population, requiring continuous human assistance and control over the 24 h.

Therefore, the borders between working and social times are no longer fixed and rigidly determined by the normal diurnal working day. Not only are waking hours extended to evening and night hours, and also to weekend days, but hours of duty have become more variable (e.g. part-time, 6-h and 12-h shifts, irregular shift schedules, split shifts).

Now, thanks to new technologies, not only the link between work place and working times has been broken (e.g. telework), but also the value of working time changes according to the different economic/productive/social effects it can have at different hours/periods of the worker’s life. Moreover, the more the modern economy transfers its interest from tangible to intangible goods, the more time becomes the main criterion of evaluation and profit (“time is money”).

According to the World Health Organization definition, “health is a state of complete physical, emotional, and social well-being, not merely the absence of disease or infirmity”. Shift work and related problems fit well with this definition, as it interferes with all those dimensions, namely:

- (a) it perturbs the physiological homeostasis, due to disturbance of the circadian rhythms of the psychophysiological functions, starting from the sleep/wake cycle;
- (b) it decreases work ability, due to fluctuations in work performance and efficiency over the 24-hour span, with consequent errors, accidents and injuries;
- (c) it hampers human relations at both family and social level, with consequent negative influences on marital relations, care of children and social contacts;
- (d) it deteriorates health and well-being both in the short-term, through disturbances of mood, sleeping and eating habits and related complaints, and in the long run, through more severe troubles and illnesses, dealing prevalently with the gastrointestinal, neuropsychological, metabolic, cardiovascular and reproductive functions and, probably, cancer.

All that leads to increased morbidity and absenteeism, with consequent high economic and social costs for the individual, the enterprise, and the whole society.

2 Biological Functions and Sleep/Wake Cycle

At the biological level, the perturbation of the sleep/wake cycle, connected with the modified activity/rest pattern, is a significant stress for the endogenous regulation of the “circadian” (about 24 h) rhythms of biological functions, which are driven by the body clock, located in the suprachiasmatic nuclei of the encephalon, and synchronised by environmental cues, the light/dark cycle in particular, through non-vision-related photic stimuli from retinal ganglion cells with high sensitivity to light (Reppert and Weaver 2002; Roenneberg et al. 2007).

Staying awake at night and trying to sleep during the day is not a physiological condition for diurnal creatures as we humans are. Workers are subjected to a continuous stress to adjust as quickly as possible to variable duty periods, which, in most cases, is only partial and invariably frustrated by continuous changeovers.

The misalignment of circadian rhythms of body functions is responsible for the so-called “jet lag” (or more properly “shift lag” in this case) syndrome, characterized by feelings of fatigue, sleepiness, insomnia, digestive troubles, irritability, poorer mental agility and reduced performance efficiency. It recovers in a few days depending on the length and duration of the phase shift imposed, and on personal characteristics (e.g. age) and coping strategies.

It is quite obvious that the perturbation of the sleep/wake cycle has its main effect on sleep, which suffers both in quantity and quality according to the timing of shifts and rest periods, the environmental conditions, and the worker’s characteristics and behaviours. After a night shift, workers usually go to bed as soon as they get home, that is one or two hours after the end of the shift, depending on the commuting time and family commitments (see later for women). This means that they have to sleep during the normal rising phase of biological rhythms which sustains wakefulness. This makes it difficult to fall asleep and sleep longer, also because the environmental conditions are not the most appropriate, in particular as concerns disturbing noises and lighting, being linked to the diurnal activities of the general population. Also in early morning shifts, sleep can be notably reduced and disturbed, mainly in the REM phase, due to the truncation of the last part of the sleep, where it is prevalent (Åkerstedt et al. 2010; Rosa 1993).

Therefore, sleep deteriorates both in quantity and quality, and the severity may vary according to timing of shifts (on night and early morning shifts in particular), position and duration of rest periods and associated environmental conditions (exposure to light and noise in particular), workers’ characteristics and life styles.

In fact, it has to be taken into account that the type of shift rotation can significantly affect resting and rising times as well as sleep duration. For example, in case of the classical semi-continuous shift system at forward, weekly rotation “5/2” (5 morning shifts, 2 rest-days, 5 afternoon shifts, 2 rest-days, 5 nights 2 rest-days), the interval between two night shifts is always 16 h, and there are 48 or 56 h between the last night shifts and the following morning or afternoon shift period. On the other hand, in case of a fast, backward-rotating shift system (1 afternoon shift, 1 morning shift, 1 night shift, 2 rest days), having the morning shift

immediately after the afternoon shift and the night shift in the same day (“quick return”), the rest intervals between the shifts last only 8 h, and the night shift starts in the same day as the morning shift, thus combining the truncation of the sleep preceding the morning shift with its curtailment before the night shifts. Moreover, in case of continuous shift schedules, it was found that sleepiness decreases passing from a backward- to a forward-rotating shift system, as there are longer rest intervals among shifts (Vittasalo et al. 2008).

As a matter of fact, about 10 % of night and rotating shift workers, aged between 18 and 65, have been estimated to have a clinical “shift-work sleep disorder” according to the International Classification of Sleep Disorders (Drake et al. 2004).

More recently other large epidemiological studies reported far higher numbers of shift workers screened positive for excessive wake time sleepiness and insomnia related to work schedule, such as 53.9 % of 4957 sworn police officers in North America (Rajaratnam et al. 2011), 32.1 % night workers versus 10.1 % day workers in 1163 Australian employees (Di Milia et al. 2013), and 35.7 % among 1533 Norwegian nurses (Waage et al. 2014).

3 Performance Efficiency, Errors and Accidents

The combination of circadian disruption and sleep deprivation can be responsible for high levels of sleepiness and fatigue during the work periods, with consequent higher proneness to performance impairment, inducing or favoring errors and accidents, both at the work site and during commuting from home to work and vice versa.

Hence, 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 psycho-physical performance over the waking day, and even more so at night.

Sleepiness, sleep disturbances, chronic fatigue and oscillatory fluctuations of alertness and vigilance are key factors in causing human errors, and consequent work accidents and injuries, by interacting with organisational factors, such as environmental conditions, job content, workload, and time pressure.

Some studies that estimated the relative risk of incidents in the morning, afternoon and night shifts of 8-hour shift systems, in comparable working conditions, showed an increased risk of 18 % in the afternoon shift, and of 30 % in the night shift, as compared to the morning shift. Moreover, other studies reported that the risk increases over successive shifts, being about 6 % higher in the second night, 17 % higher in the third night, and 36 % higher in the fourth consecutive night (Folkard and Tucker 2003).

Also the length of hours on duty is a key factor for fatigue-related accidents. An aggregated analysis of several studies carried out in English industries (Folkard 1996) showed an almost exponential increase of accidents after the eighth hour of

work; this has been also evidenced in Sweden (Åkerstedt 1995), examining the national database of work accidents, and in Germany through the insurance registries on industrial accidents (Haenecke et al. 1998). According to these studies it is possible to estimate a double risk of accident when working in a 12-h shift as compared with a 8-h shift. Also a recent survey of more than 75,000 US workers over a 4-year period (Lombardi et al. 2010) confirmed a higher risk of injury strictly related to a progressive increase of working hours and reduction of sleep duration.

4 Health Disorders

Shift workers frequently complain of irritability, nervousness and anxiety, in relation to more stressful working conditions and greater difficulties in family and social life. In association with persistent disruption of circadian rhythms and sleep deficit, they may lead to chronic fatigue, mood disorders, neuroticism, as well as to chronic anxiety and/or depression, favoring absenteeism and often requiring the administration of psychotropic drugs (sedatives and hypnotics) (Colquhoun et al. 1996; Nakata et al. 2004).

Digestive troubles are the most frequently complained of by shift workers (20–75 vs. 10–25 % of day workers), being connected with phase displacements between mealtimes and normal circadian phases of gastrointestinal functions, as well as to changes in food quality and composition (i.e. more pre-packed food and ‘pep’ and soft drinks) (Lennernas et al. 1994; Knutsson and Boggild 2010).

Several epidemiological studies have recently reported a higher prevalence of nutritional and metabolic disturbances in shift workers, such as metabolic syndrome and diabetes, emphasizing their role in the pathogenesis of coronary heart disease (Karlsson et al. 2003; Biggi et al. 2008; De Bacquer et al. 2009; Suwazono et al. 2009; Lowden et al. 2010; Van Drongelen et al. 2011; Tucker et al. 2012; Wang et al. 2014; Gan et al. 2015).

According to some authors, shift workers have a 40 % excess risk for ischemic heart disease as compared to day workers. It has been suggested that these associations are due to the combination of the stress connected with perturbed cardiac autonomic control, sleep deprivation, work/family conflicts, and life style changes (e.g. diet and smoking) (Boggild and Knutsson 2000; Puttonen et al. 2010; Esquirol et al. 2011).

A higher incidence of altered menstrual cycle, pre-menstrual syndrome and menstrual pains has been reported in many groups of women shift workers, such as nurses, air crews, and blue collar workers in industry. Some studies also reported a higher incidence of miscarriage and impaired fetal development, including pre-term birth and low birth weight (Nurminen 1998; Mozurkewich et al. 2000; Zhu et al. 2003).

In 2007, the International Agency on Research on Cancer (IARC) classified “shiftwork that involves circadian disruption” as “probably carcinogenic to

humans”, on the basis of “limited evidence in humans for the carcinogenicity of shift-work that involves night work”, and “sufficient evidence in experimental animals for the carcinogenicity of light during the daily dark period (biological night)”. The mechanisms by which circadian disruption may favor the induction and/or promotion of malignant tumors are complex and multi-factorial. The multi-level endocrine changes, caused by circadian disruption with melatonin suppression by exposure to light at night, lead to the oncogenic targeting of the endocrine responsive breast in women and possibly prostate in men. Repeated phase shifting with internal desynchronization may lead to defects in circadian cell cycle regulation, thus favoring uncontrolled growth. Moreover, sleep deprivation leads to suppression of immune surveillance which may permit the establishment and/or growth of malignant clones (Straif et al. 2007; Costa et al. 2010; Ijaz et al. 2013).

5 Family and Social Problems

People engaged in irregular or “atypical” working hours, such as shift and night workers, are frequently out of phase with the society, as most family and social activities are arranged according to the day-oriented rhythms of the general population. Work, leisure and sleep times usually assume different “values” according to social timetables: the late afternoon and evening hours, as well as week-ends are the most desirable for social contacts and leisure activities.

Shift workers experience directly the conflicts between their time budgets and the complex synchronization of the social activities, both in primary individual duties (e.g. work hours, commuting times, school timetables, etc.) and leisure and social services. Therefore, shift workers have more difficulties in combining their “productive” and “consuming” times, particularly when their leisure activities involve the integration of many people into organized groups, such as sports teams, civic groups, and political and cultural organizations requiring constant and regular contacts. Thus shift work can lead to some degree of social isolation or marginalisation (Colligan and Rosa 1990; Loudoun and Bohle 1997).

Shift work may also interfere with the already complex co-ordination of individual times of family members, particularly since family life can vary greatly according to different phases of the family cycle (e.g. marital status, number and age of children, presence of old people, illnesses), distribution of work among its members (official job, housework, moonlighting) and the availability of community services (i.e. shop hours and transports).

Stress, “time pressure” and related complaints are a constant condition for those who have high family burdens or complementary duties (Beerman and Nachreiner 1995; Gadbois 1981). These problems are further complicated when both partners are shift workers, and have negative effects on marital relationships, parental roles and children’s education.

As concerns women in particular, although no relevant differences between sexes in terms of chronobiological adjustments to temporal changes are detectable, some studies pointed out that women shift workers have lower fertility and higher abortion rates than their day worker colleagues not only because of the interference on the hormonal rhythms, but also for a personal choice of avoiding or limiting pregnancies or new babies, due to the more complex and difficult organization of their life caused by the conflicts between irregular work schedules and home commitments.

Such social problems are often more frequent than those related to the biological problems, and they are also the main cause of mal-adaptation to shift work and may have a clear influence on the development of psychosomatic disorders (Pisarski et al. 2008).

On the other hand, shift workers may also be forced to learn how to use daytime periods more positively; this gives more flexibility to those who enjoy solitary activities (hobbies) or in the case of women who give a higher priority to family and domestic duties than to personal leisure. As a consequence, it is found that shift work can be fully accepted by some shift workers as it provides them more opportunities to use daytime hours to comply with private needs (e.g. access to public offices, banks, the doctor's), or simply to enjoy longer intervals of free time between the shift cycles. For these reasons some shift systems based on a backward fast rotation, having "quick returns" (double shift in one day) and long off-duty periods, are often preferred by some groups of shift workers despite their clear negative effects upon circadian rhythms and sleep (Loudoun 2008).

6 Tolerance to Shift Work and Health Surveillance

There is a high inter-individual variability in tolerance to shift work, which can be due to the interaction among individual characteristics, working and social conditions.

Among the former, some authors suggested morningness/eveningness, neuroticism, rigidity/flexibility of sleeping habits, hardiness, neuroticism, and stability of circadian rhythms (Costa 2003; Van Dongen 2006; Reinberg and Ashkenazi 2008; Saksvik-Lehouillier et al. 2012). Subjects having the characteristics of "morningness" generally face more difficulties in short-term adjustment to night work compared to the "evening" types. Moreover, people who present high levels of neuroticism, or the characteristics of rigidity of sleeping habits and lower ability to overcome drowsiness, have more difficulties in their adaptation to irregular work schedules. On the other hand, good physical health and a strong commitment to shift work could favour a better tolerance (Härmä 1996).

The critical age for increasing intolerance to shift and night work seems to be about 45-50 years of age, due to chronobiological factors, psycho-physical aspects and to social conditions. Ageing is associated with a more difficult adjustment of circadian rhythms to night work, to increased sleep disturbances, and to reduced

tolerance for longer work hours, such as in the case of 12-h shifts. The difficulty in achieving adequate circadian adjustment is due to several factors including (a) a weakening of the circadian system resulting from molecular and functional changes in the suprachiasmatic nuclei that makes the organism more prone to internal desynchronisation; (b) an earlier phasing of circadian rhythms; (c) a slower circadian adjustment over successive night shifts; (d) a reduced sleep duration with a consequent increased sleepiness during waking hours. There is evidence to suggest that the alertness and performance efficiency of older workers suffers more from the homeostatic sleep process (that is, the duration of the previous waking period) than the circadian process, compared with younger workers. Moreover, health deterioration with increasing age may be more pronounced in shift workers than in day workers due to chronic fatigue and problems with sleep (Härmä 1996; Costa and Sartori 2007; Costa and Di Milia 2008).

As already mentioned, women's tolerance is often more related to family and social determinants: women shift workers in fact (in particular those with small children) have more difficulties in combining their irregular working schedules with their additional domestic duties, and thus suffer more from sleep problems and chronic fatigue. Therefore, consequent actions have not only to guarantee a higher protection for women shift workers by proper legislation (i.e. exemption from night work when pregnant), but also to support them by means of suitable social services (i.e. kindergartens, school and shop timetables) and working time arrangements (i.e. flexible working hours).

Moreover, atypical and irregular working hours may also be differently associated with diverse types of employment and work sectors. Workload and work content may notably differ between temporary and permanent workers even within the same work activity, particularly with regards to job demand, job control and autonomy, and work-life conflicts. All this has a significant impact on work satisfaction, psychological well-being and work-family balance.

Furthermore, poor social and living conditions can aggravate the impact of shift and night work on health, as reported from many surveys carried out in developing countries (Ong and Kogi 1990; Fischer 2001; Fletcher 2010). Labour-market globalisation carries not only a positive interracial mixing and a wider distribution of goods and services all over the world, but also causes an increasing flow of poor people from developing to developed countries, that is very often associated with racial and social discrimination. Immigrant people are those who have to face more unfavourable working conditions, including bad shift systems, in the industrialised countries. Consequently the actions that have to be undertaken from this perspective deal not only with the psycho-physical domain, but mainly with the social one, in terms of political and economic strategies as well as ethical choices.

On the other hand, there are many pathological conditions, either directly associated with shift and night work, as above mentioned, or independent from it, that may be a potential contraindication for irregular working hours. They must be carefully evaluated both in terms of severity and possibility of appropriate therapy, in the process of assessment of fitness to work, with or without limitations and/or prescriptions, on a temporary or permanent basis (Koller 1996; Costa 1998).

This is the case, in particular, of persistent sleep disorders (i.e. chronic insomnia, obstructive sleep apnea syndrome, parasomnias), severe gastrointestinal disorders (i.e. peptic ulcer, chronic hepatitis or pancreatitis, Crohn's disease), cardiovascular diseases (i.e. ischemic heart disease and severe hypertension), neuro-psychic syndromes (i.e. chronic anxiety and/or depression, seasonal affective disorders, epilepsy), metabolic (i.e. diabetes) and hormonal disorders (i.e. thyroid and suprarenal pathologies), chronic renal impairment, and cancer.

Several etiological and/or contributing risk factors may include genetic inheritance, psychological characteristics, life-styles, socio-economic conditions, and other concurrent or pre-existent health disorders. Consequently, intolerance to shift and night work is the result of the interaction among several risk factors dealing with different domains, which can have different weight and relevance among shift workers both in terms of severity and timing of manifestation during their working life.

These factors can have different effects (e.g. physical health, mental health, social relations) according to the circumstances and ways of interaction (e.g. addition, enhancement, compensation), and the consequent result depends not only on the specific load of each factor, but mainly on how much and how long they interact and interfere with each other in relation to the peculiar conditions of each individual or group of shift workers. They may also have significant implications for productivity, company strategies and social organisation, which in turn influence individual health and well-being.

All that explains the high inter- and intra-individual variability, both in terms of short-term adaptation and long-term tolerance, as concerns the level of imbalance of well-being and the type and severity of health troubles and disorders.

7 Preventive Measures

Some international directives have emphasized the necessity of a careful organisation of shift and night work to protect the workers' health, namely the ILO Convention no. 171 and Recommendation concerning Night Work (1990) and the European Parliament Directives 1993/104/EC and 2003/88/EC concerning "certain aspects of the organisation of working time".

There are thousands of different shift schedules which may have a quite different impact on worker's health, safety and social life, in particular with reference to amount of night work, timing and duration of shifts, length of shift cycle, speed and rotation of shifts, position and length of rest days.

Hence, particular attention has to be given to the organisation of the shift schedules, to take into account not only economic reasons, but also give priority to the workers' needs, in particular as concerns the physiology of the human body, psychological and social problems, and possible negative effects on health and well-being. The main guidelines for designing shift systems according to ergonomic criteria are (Knauth 1996, 1998, 2007; Gartner et al. 2004):

- Quickly rotating shift systems are better than slowly rotating ones, since they interfere less with circadian rhythms and minimise the extent of any cumulative sleep deficit.
- Clockwise rotation (morning/afternoon/night) is preferable to counter-clockwise (afternoon/morning/night) since it parallels the endogenous circadian rhythms (which show a periodicity slightly longer than 24 h in “free-running” experiments), avoids quick changeovers (e.g. morning and night shift on the same day) and allows longer rest periods for the immediate recovery from fatigue and sleep deficit.
- Early starts of the morning shift should be avoided in order to reduce the truncation of sleep (REM phase in particular) and consequent fatigue and risk of errors.
- Prolonged work shifts (9–12 h) should only be contemplated when the workload is suitable, there are adequate pauses, and the shift system is designed to minimise the accumulation of fatigue and the exposure to toxic substances.
- Shift systems should be as regular as possible and guarantee as many free weekends as possible, to allow people to plan and enjoy their leisure and social time more conveniently.
- Permanent night work can be acceptable only for particular working situations, which require a complete adjustment to night work in order to guarantee the highest levels of safety.
- Flexible working time arrangements should be promoted in order to meet workers’ needs and preferences.

However, it is worth stressing that there is no “best” shift system to be recommended in general, but each shift work schedule should be planned and adapted according to the different job activities and demands, as well as to the specific characteristics, social habits and cultural background of the workers involved. This implies a careful strategy for the arrangement of the shift schedules, that requires the participation of the workers in the analysis, design, implementation and assessing of the shift system chosen. This is of paramount importance, not only for taking into account the suggestions of those who have direct experience of the problem, but also for promoting the right motivation for accepting the changes and, consequently, improving their psycho-physical tolerance.

8 Compensative Measures

Interventions aimed at counteracting the inconveniences caused by shift and night work can be distinguished in “counter-weights” and “counter-values”. The first ones are only aimed at compensating for the troubles caused by shift work (i.e. monetary compensation, improved general working conditions), whereas the second ones are aimed at reducing or eliminating the possible negative effects, through reduction of working hours, restriction of night shifts, more compensatory rest days

or extra time off, additional pauses for meals and naps, sleep and canteen facilities, social support (e.g. day-nursery, transports, extended school and shop hours), financial support for better housing, medical surveillance, physical and psychological training, transfer to day work after a certain number of years, early retirement.

Proper education and counseling is another key issue on this respect. Both managers and persons in charge of working time organization, as well as workers involved, must be adequately informed of the possible negative effects of shift work. The former have to understand which may be the negative consequences of shift work on worker's health and performance, hence also on productivity, absenteeism and company costs, in order to plan the best possible countermeasures in terms of work organization and worker management. The latter have to understand which troubles and disorders are more related to shift and night work, and what are the best coping strategies to prevent or limit them, in particular with reference to sleep habits, diet, physical fitness and leisure times. It has been evidenced that good social support from co-workers and supervisors at work, as well as from family members, is able to significantly improve adaptation and tolerance (Kogi 1996, 2001; Knauth and Hornberger 2003; Knauth et al. 2006; Pallesen et al. 2010).

The search for innovative working time arrangements and the adoption of flexible working systems, taking into account not only production demands but also individual needs and preferences, must have a positive effect on shift workers' tolerance. They support an increased compatibility of the employee's professional and private life through changes and adjustment of working times (work shift duration, amount of night work, time autonomy), that may be articulated on several temporal scales (daily, weekly, monthly, annual, working life) according to different requirements workers may have. Flexible working hours can also mean that more vulnerable groups (i.e. women, aging workers) can find a way to cope with shift work without worsening their health, losing jobs or professional opportunities, and deteriorating family and social life.

The increasing interest in "temporal flexibility" is due to policies related to working time duration and employment, on the one hand, and to a progressive transfer of attention from the quantitative to the qualitative aspects of work and social activities, on the other hand.

Work-life balance is a concept with increasing importance in ergonomics, which has to take into account both diversities among groups and individuals (e.g. older workers, women, family responsibilities, income levels, expertise) and their social interactions (e.g. consumer's role, participation in social groups, leisure activities).

However, there are large differences in conceptualisation and approaches to flexible working hours; in particular there are different points of view between employers and employees. For the former ("company-based flexibility"), they are tools for a prompt adjustment of production and service systems to market demands and technological innovations (e.g. shift and night work, split shifts, week-end work, seasonal work); for the latter ("individual-oriented flexibility"), they are important tools able to improve and harmonize working and social life by

increasing employment, autonomy and time sovereignty (e.g. part-time work, shortened work week, self-determined start and end times, bank of hours).

It can be argued that, in general, the higher the individual-based “flexibility” the better health and work satisfaction, whereas company-based “flexibility” might have more negative interference. However, due to their different possible combinations, the expected effects on health and working conditions cannot be assessed *a priori*, but they have to be carefully analysed, taking also into account several intervening personal and social factors. Moreover, the result of their interactions may depend (and largely differ) on such individual factors as the time of occurrence in the worker’s life, their duration, etc.

In a study concerning the dataset of the 3rd EU Survey on working conditions (Costa et al. 2004, 2006), lack of individually-oriented flexibility of working hours has been shown to be associated with job dissatisfaction, feeling of not being able to do the same job at the age of 60, lower health and safety, as well as with unfavourable adjustment to family and social commitments. On the other hand, lower company-based flexibility proved to be favourably associated to family and social commitments, and health and well-being. In particular, individually-oriented flexibility resulted as the first most important factor to influence work satisfaction; the second one to affect family and social commitments, overall fatigue, and the ability to do the same job at the age of 60; the third one to influence some health outcomes, such as heart disease, stomach ache, and anxiety. It is also worth noting that the “feeling of not being able to do the same job when at 60 years old” was mainly associated to poor participation in work organisation and lack of individually-oriented flexibility of working hours.

Also Janssen and Nachreiner (2004) found that a high variability in both duration and position of working hours is associated with impairment in health and well-being, particularly if it is company-controlled, while it is less pronounced if it is self-controlled.

It has also to be taken into account that the company’s demand for higher “variability” is primarily related to short-term adaptation to economic and productive pressures, whereas the individual’s demand for higher “flexibility” is more related to mid/long-term planning and harmonisation of working and non-working life.

9 Conclusions

The interferences between irregular working hours, particularly shift work and night work, on health and well-being are complex and multifaceted in their origins and temporal manifestations, dealing with several aspects of personal characteristics, working and social conditions.

Both occupational and non-occupational stressors, as well as cognitive and behavioural coping efforts and strategies, interact and testify to the complexity of

the problem and the difficulty in combining factors pertaining to different dimensions, namely:

- (a) external risk factors: i.e. work load and environment, family and social conditions;
- (b) individual aspects: i.e. age, gender, personality, attitudes, coping strategies;
- (c) outcomes and targets: i.e. circadian adjustment, sleep troubles, performance efficiency, mental health, physical health, family life, social integration, work satisfaction, work ability;
- (d) interactions among factors and effects, for example dose/response (circadian rhythms, hormonal strain, sleep), dose/effect (health troubles, family life), up/down regulation (association, enhancement, compensation), mediators/modulators, short/long-term action;
- (e) importance, priority and feasibility for the individual, companies, communities, and the whole society;
- (f) preventive and corrective actions: i.e. legislation, work organisation, working time arrangements, social support, group/individual education;
- (g) domains describing human life, such as: physiology, psychology, sociology, ergonomics, economics, politics, and ethics.

Consequently, the more holistic the approach is, the more possibilities exist for fully understanding the problem and, consequently, for adopting the best actions and countermeasures. Conversely, the more specific the appraisal is, the more detailed and deep the analysis can be, but the higher the risk is of “losing the picture” and consequently not being able to define the most congruent actions, with a more balanced integration between individual aspects and community policies. Although more difficult, this is the only way that has a chance of avoiding some uncritical evaluations of (mal)adaptation, (in)tolerance and (un)fitness to shift and night work based on particular or limited aspects (i.e. some individual characteristics and/or behaviours) not sufficiently supported by scientific data and longitudinal studies. This can lead to a risky and even dangerous (i.e. for employment) attitude for selection of shift workers, without taking into consideration the whole context in terms of (shift) work organisation and social conditions, which in many cases are the most relevant intervening factors, and towards which more profitable (both for subjects and companies, as well for society) interventions should be addressed.

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