

Shift and Night Work Management in European Companies

Javier FIZ PEREZ¹, Veronica TRAVERSINI², Massimo FIORITI³,
Giulio TADDEI⁴, Manfredi MONTALTI⁵, Eleonora TOMMASI⁶

¹Department of Human Sciences, European University of Rome, Rome, Italy; E-mail: javier.fizperez@unier.it

²Corresponding author, Department of Experimental and Clinical Medicine, University of Florence. 23, Largo Piero Palagi, I-50139 Florence, Italy; E-mail: veronica.traversini@unifi.it

³Department of Experimental and Clinical Medicine, University of Florence, Italy; E-mail: m.fioriti@unifi.it

⁴Department of Experimental and Clinical Medicine, University of Florence, Italy; E-mail: giulio.taddei@unifi.it

⁵Department of Experimental and Clinical Medicine, University of Florence, Italy; E-mail: manfredi.montalti@gmail.com

⁶Department of Experimental and Clinical Medicine, University of Florence, Italy; E-mail: eleonora.tommasi@unifi.it

Abstract

In Europe, until half a century ago, shift work was used almost exclusively to provide essential services such as health, transport, communications and public safety or to facilitate particular technological processes in the steel and chemical industries. Today, following the globalization of products and services and the need for competitiveness among companies there has been a change in working hours, in order to guarantee continuous work cycles for 24 hours. The disruption of circadian rhythms related to shift and night work may favor the onset of the "shift work sleep disorder", a disease characterized by insomnia and excessive sleepiness. These alterations represent, in turn, a risk factor for other health issues, injuries, accidents, lower productivity. EU and national legislations on occupational health and safety provide for a series of protection measures of shift workers including risk assessment, information and training, health surveillance and health promotion. Moreover, occupational health promotion assumes a strategic value for companies, especially if it is linked to the reduction of additive or synergistic effects on the health of both occupational and lifestyle risks. The integration of economic sciences, life sciences and ergonomics in the organization of shift systems is an emerging need for companies. The literature provides evidence that strategic health promotion interventions in the workplace lead to a return on investment. Therefore, in the context of the future of work, the organization of shifts according to ergonomic criteria must be seen by the companies more as an opportunity than as a cost.

Keywords: night-work; shift-work; management; European companies; organizational psychology.

Shift work may be considered a way of organizing working time in which the operating hours of a company are extended beyond the usual 8 hours, even covering the entire 24 hours (including, therefore, also a night shift), thanks to the rotation of several groups of workers.

Until half a century ago, in the industrialized countries, shift work was used almost exclusively to provide essential services such as health, transport, communications and public safety or to facilitate technological processes in the steel and chemical industries (Garbarino, 2006; Costa 2008).

Today's society and labor market are rapidly changing in economic and productive strategies. Following the globalization of products and services and the need for competitiveness among companies there has been a change in working hours, in order to guarantee continuous work cycles for 24 hours (Kecklund, 2012). Therefore, shift work has become, common to almost all occupational sectors (Arcangeli et al., 2018; Arcangeli et al., 2019). The schedules represent, therefore, a determining element in the planning of the work, with significant economic and social repercussions for the company, the individual and the community.

In the 24-hour society temporal references that were able to reduce human activities have disappeared: every single worker can perform any work and social action at any time of the day or night.

In Italy, in 1,700 Bernardino Ramazzini published his most famous work, "De Morbis Artificum Diatriba", followed by second, more extensive, edition in 1,713. It includes his clinical, social and "epidemiological" observations and a description of nearly all the illness that are caused by different trades.

Ramazzini, over three centuries ago, wrote about bakers:

«I fornai, per lo più, lavorano di notte sicché, mentre gli altri, compiuto il lavoro della giornata, prendono sonno e rinnovano le forze consumate, loro sono in piena attività e poi, per quasi tutto il giorno, come gli animali che hanno paura del sole, debbono dormire. Nella stessa città abbiamo così uomini che vivono una vita antitetica a quella di altri» (Ramazzini, 2010).

The text above, written in a sought archaic Italian language, can be translated as follows:

«Most bakers work and are in full swing during the night – unlike the other workers who, once the day's work is done, sleep and renew the forces consumed – and then, for most of the day, they have to sleep, just like those animals afraid of the sun. Therefore, in the same city there are men who live a life that is antithetical to that of others».

Nowadays, it is well established that shift work, especially if

it includes night work, represents a potential cause of stress with possible consequences on the worker's health (Kecklund and Axelsson, 2016).

In fact, the humans are "diurnal animals" in which the sleep-wake rhythm harmonizes normally with the light-dark alternation and is controlled by the morning activation of the hypothalamus-hypophysis-adrenal axis and by the nocturnal increment of melatonin from the pineal gland. This process is governed by one or more endogenous biological clocks (pacemakers), mainly located in the suprachiasmatic nucleus of the hypothalamus (NSI), stimulated by photopic impulses coming from the retina. Therefore, under physiological conditions, many biological functions – such as the regulation of body temperature or the secretion of certain hormones (GH, cortisol, melatonin, etc.) – have a circadian rhythm, which oscillates in synchronism with the sleep-wake rhythm (Hastings et al., 2018).

The environmental factors play the role of "metronomes", providing reference signals so that the endogenous rhythms are positioned in the most appropriate way to the social needs of life. In other words, the synchronizers do not create the rhythm but are able to influence it; therefore, the rhythm assumes a harmonious trend with respect to the environmental synchronizer.

In the case of night work, a conflict arises between the internal pacemaker and the external synchronizer (light/dark), which causes a phase shift of the biological circadian rhythms, whose speed and adequacy depend on numerous factors, in particular the following: direction of the transition from day shifts to the night shift and vice versa (clockwise or counter-clockwise), the number of consecutive nights of work, the different physiological functions, the individual characteristics (age, chronotype, etc.) (Cajochen et al, 2006). This difficult "adjustment" is evidenced by ailments like the "jet-lag syndrome", that is, a general sense of tiredness, insomnia, dyspepsia, disturbances in the body and mood, drowsiness and decreased performance. (Costa G., 2008).

The difficulty in getting to sleep and sleep long and well during the day, after the night shift, is linked to both the chronobiological conditioning, as the phase of falling asleep at the stage of increase of circadian rhythms, and environmental interference (noise and lighting) (Arcangeli et al., 2013; Erren et al., 2017; Hewart and Fethney, 2016; Arcangeli et al., 2015).

In physiological conditions, vigilance oscillates in the 24 hours describing a curve in function of time with a two moments of minimum level: one greater at night ("main sleep gate", around 11 pm) and a minor one in the early afternoon ("secondary sleep gate", around 2 pm). The habit of afternoon rest (as well as *siesta*) is an expression of this physiological tendency to fall asleep. There are also periods of high vigilance: 11 am and 7 pm approximately. The level of drowsiness is regulated by homeostatic factors, such as quantity and quality of waking before sleep (process S), and by circadian factors (process C) (Garbarino, 2006; Lopez-Minguez et al., 2017). The need to rest is gradually determined during the wake and is discharged during the next sleep, restoring the normal starting balance. The level of vigilance is also influenced by other factors, such as the abundance or lack of incentives, and by the fatigue resulting from work activity. Normally, the homeostatic and circadian factors harmonize with each other.

Nevertheless, within certain limits, it is possible to increase the waking state beyond the "sleep gates" by forcing, within some limits, the circadian rhythms of tendency to fall asleep, thus causing an extraordinary accumulation of homeostatic factors. Therefore, the restorative capacity of the daytime sleep is much reduced, registering modifications of the same both in quantitative (because of the decrease of its duration) and in qualitative terms (Colquhoun, 1970; Garbarino, 2006).

In the contemporary world of work there are many psychosocial risks (Arcangeli et al., 2018), especially in the light of the current economic and employment crisis (Giorgi et al., 2015a; Giorgi et al., 2017; Mucci et al., 2016c). In this context,

in recent years the literature has showed not only an emergence of work-related stress (Giorgi et al., 2014; Mucci et al., 2015a) but also an increase in competitiveness, workload, and workplace bullying (Arcangeli et al., 2014; Arenas et al., 2015; Giorgi et al., 2016a; Giorgi et al., 2016c). One of the main aspects that must be considered in the *future of work* for the prevention of psychosocial risks is precisely the 24-hour society.

Shift work is a strategy that allows companies to strengthen their business. However, what has been discussed so far highlights the need for companies' stakeholders to have adequate knowledge and skills for the management of this kind of work organization and for the related health and safety (H&S) policies.

2. Shift work in the main European productive sectors

In the healthcare sector, the needs connected to the provision of services within 24 hours have required, from historical times, night work. At that time, this type of shifts involved almost exclusively medical and nursing staff. Today, the main areas of health in which the presence of shift and night-time workers is required are the following: first aid, emergency medicine and surgery, medical and surgical multi-specialist hospitalizations, laboratory or radiological diagnostics, territorial emergency, etc. The shift systems and the duration of each shift are multiple, variable, and established independently by each Healthcare Agency. The most widespread shift schedule is the following: three 8-hour shifts (of which one is nocturnal) followed by rest, with a rapid (1-3 days) or weekly rotation (Griffiths and Dall'Orta, 2017; Lin et al., 2014).

Police forces have always been at the service of the community twenty-four hours a day and seven days a week, with an increase of night time activities in the last few years. The work, as well as being organized in shifts, is characterized by tasks that require high psycho-physical efficiency, involving operating conditions such as patrolling, emergency response, life protection services, etc. (Ledda et al., 2018). The shift schedules are multiple, variable, and independently determined by each branch of Police. For example, the Italian State Police operates with a six-hour shift schedule, with rapid and fixed rotation, divided into four working days and one day of rest (Garbarino, 2007). Specifically, this schedule is the following: day 1 – evening (7 pm to 1 am); day 2 – afternoon (1 pm to 7 pm); day 3 – morning (7 am to 1 pm); day 4 – night (1 am to 7 am); day 5 – rest. However, the real time of rest is 60 hours and runs from 7 am on the day 4 to 7 pm on the day 1.

Despite the rapid progress that has characterized remote surveillance systems in recent years, the use of human resources in the private security sector is still widespread. Above all, banking institutions and large companies use the security guards for protection of both corporate assets and industrial secrets. Usually, shift systems are not adopted: security guards perform their tasks almost exclusively during the night, (Godinho et al, 2016, Mucci et al, 2012). Workers can perform their tasks both on a specific production site and an itinerant service by car (*mobile work*).

In the Hotellerie-Restaurant-Catering sector (Ho.Re.Ca.), traditional night-time services in hotels have now been accompanied by numerous production requirements that require an ever-increasing use of shift work. On the one hand, several restorative services have extended their opening hours most of the night (if not all of it), such as coffee and fast-food restaurants. On the other hand, the demand for breakfast products with higher quality and freshness characteristics has increased, with the consequent need for work in the hours immediately preceding the early morning. In addition, the hotels – once places for night rest in moments of vacation or business travel – became structures with activities performed throughout all day,

including most of the night hours. The shift schedules and the duration of each shift are various, and independently determined by each employer. Moreover, in the Ho.Re.Ca. sector, recourse to night work is mainly concentrated at weekends as well as at specific times of the year (summer, Christmas holidays, etc.).

In the 24-hour society, the demand of night-time entertainment has significantly increased. Night-time activities in night clubs, theaters, discos, and cinemas have undergone rapid development, particularly in the last decade. The shift schedules and the duration of each shift are various, and independently determined by each employer, often considering the requests of the public. Furthermore, in this productive sector, recourse to night work is mainly concentrated at weekends as well as at particular times of the year, such as the summer season.

The current production of bread is very different compared to the times in which Bernardino Ramazzini lives: most bread products are produced on an industrial scale. Today, only few artisanal bakeries are remained, in which shift systems are usually not adopted: the owner and his assistants work exclusively during the night-time, possibly except for the Saturday. Conversely, in the bakery industry, the work is distributed within 24 hours; the shift schedules and the duration of each shift are various, and independently determined by each employer.

Following the globalization of the markets and the increasing demand of competitiveness from the companies, night work has become widespread in manufacturing, in particular in the following fields: pharmaceutical industry, plastics industry, metal industry, paper industry, etc. Also worthy of note is the field of construction and road construction works, often concentrated at night, in order to reduce the inconvenience for daytime drivers. The shift schedules and the duration of each shift are various, and independently determined by each employer. The work is usually divided amongst teams, that operate in the same role during a three-shift workday. Normally, the third shift is the night one (from 10 pm to 6 am) (Lewkowski, 2018). It should be remembered that in extraordinary building works, shift systems are not usually employed: workers perform their duties almost exclusively during the night-time.

In the United States, the first supermarket open to the public 24 hours a day was inaugurated in the 1960s. In the early '90s the phenomenon spread also in Europe, starting from the United Kingdom, until spreading to almost all other countries in the following decade (Richbell and Kite, 2007). During the night, supermarkets typically offer fewer services, such as closing the fresh produce section. However, there are still human resources employed both in the sales area and in the cash desks. More recently, self-service experiences are offered, in which there are no staff available to the public and payment is made exclusively through automated cash machines. In any case, regardless of opening hours, large-scale retail trade is a sector in which the use of night work is widespread, with regard to procurement logistics, rack reassembly, environmental sanitation and everything related to facility management. All of the above is done at night in order not to interfere with the flow of sales during the day and occurs not only in supermarkets but in all forms of "large retail" (large clothing stores, electronics, DIY, etc.). The shift schedules and the duration of each shift are various, and independently determined by each employer, according to the market needs of each store.

Nowadays, the global transportation of people and goods is now continuous over the 24 hours (Lecca et al., 2018). Shift work in this sector involves all commercial routes: land (road and rail), sea and air. This sector includes tasks requiring a high psycho-physical efficiency, particularly during transportation of people and dangerous goods as well as during the supervision of routes, (e.g. managers of the railway lines and flight controllers). This is particularly evident in those workers who periodically perform their duties abroad, in geographical areas very far from the usual residence. In fact, in these subjects, the symptoms of jet-lag syndrome are added to the problems of shift

work (Giorgi et al, 2016b). The shift schedules and the duration of each shift are various, and independently determined by each employer, according to the viability of routes and market demands.

The night-time activities of sanitation service operators can take place both in public contexts, such as in urban hygiene services, and in private contexts, such as cleaning services within companies. The private sector, in particular, has experienced a rapid development in recent years, especially within larger companies, where there is a need for cleaning activities non-interfering with production. A similar scenario has also been seen in large-scale retail trade, where daytime cleaning activities occur only in case of extraordinary needs in order to interfere as little as possible with commercial flows. The shift schedules and the duration of each shift are various, and independently determined by each employer, according to the needs of the client companies. Moreover, cleaning operators may also have the need to move from a production site to another one (*mobile work*), by car.

The high level of informatization and automation that has characterized the telecommunications sector in the last decade has primarily led to a reduction in jobs and, consequently, to a lower use of shift work. Currently, night time work is almost exclusively limited to ordinary and extraordinary maintenance of network lines. The shift schedules and the duration of each shift are various, and independently determined by each employer. Often, only night-time availability is required for workers.

In a 24-hour society the competitiveness of a company also lies in responding to its customers over 24 hours, through call centers (telephone and online), often outsourced. The shift schedules and the duration of each shift are various, and independently determined by each employer, based on the characteristics of both the services and the customers.

The credit industry deserves special attention due to the significant changes it has undergone over the last few years and has led to the production of a wide range of scientific literature on the health and well-being of workers (Giorgi et al, 2017). The most studied issues concern work-related stress and bank robberies (Giorgi et al, 2015b, Mucci et al, 2015b, Giorgi et al, 2018 in press). However, it is also interesting to consider the aspects related to shift work. In fact, the globalization of markets and the development of online technologies to perform financial and banking transactions have favored the development of professional specialized in 24-hour investments in international Stock Exchanges.

Despite the existence of software able to perform multiple automated operations, human intervention is still essential to obtain the best financial performances. Keeping in mind the time zones of the different countries (in particular emerging markets), bankers and brokers make a variable part of their operations at night. This activity can be carried out as a freelance, with a direct relationship with customers, or on behalf of a brokerage company. In the first case, the freelance professional plans their working hours based on the investment needs of customers and the dynamics and opportunities of the markets; in the second case, the shift schedules and the duration of each shift are various, and independently determined by each employer. Unfortunately, to date there is still no specific literature on these new professional figures of the credit industry.

3. The impact of shift work on H&S

Shift work sleep disorder (SWSD) (2018 ICD-10-CM Diagnosis Code G47.26) has been defined as a circadian rhythm sleep disorder characterized by insomnia and excessive sleepiness affecting people whose work hours' overlap with the typical sleep period. There are, as discussed above, numerous shift work schedules, and they may be permanent, intermittent, or rotating; consequently, the manifestations of SWSD are quite variable.

Over time, this condition promotes the emergence not only of sleep disorders but also of neuro-psychic disorders, (chronic fatigue, anxiety, depression), which often require the administration of hypnotic and/or psychotropic drugs (Morin CM et al., 2012). Shift workers report sleep impairments also during the morning shifts, especially if they start very early, as the anticipated awakening is usually not preceded by a corresponding advance of bedtime: sleep is then reduced in its final and more restorative phase.

One of the most important consequences of sleep disruption is excessive daytime sleepiness (EDS), which is influenced by both the circadian and ultradian rhythms of the brain activity, and the waking hours spent (homeostatic component) (Boulos and Murray, 2010). EDS at work is underestimated: many subjects with this condition are not aware of the severity of the disorder, since it is established slowly and progressively, often being experienced as a normal situation (Pylkkönen et al., 2018). Moreover, EDS can be accentuated by environmental conditions (temperature, noise), work (monotony, repetitiveness) and personal (age, motivation, nutrition, diseases, drugs) and is an important risk factor for errors, accidents and injuries, such as widely documented both in industrial work and in transport activities (Lee et al., 2017).

The alterations of circadian rhythms and sleep can be, in turn, a risk factor for other disorders, such as cardiovascular, and gastrointestinal ones (Magnavita and Garbarino, 2017; Garbarino et al., 2016; Cupelli and Mucci, 2010; Mucci et al., 2012; Graziani et al., 2012; Mucci et al., 2016b).

In certain production environments, exposure to chemicals, both during the day and at night, can interfere with workers' vigilance. Furthermore, the toxic effects of some chemicals can be exacerbated by a disruption of circadian rhythms (Casale et al., 2016; Havet et al., 2017; Peplowska et al., 2013).

Several studies have shown that overweight, obesity and metabolic syndrome are more common conditions among night workers than daytime (Biggi et al., 2008; Buss, 2012). Furthermore, consequences on the health of women have been described, especially in relation to their particular hormonal and reproductive activity (eg. menstrual alterations, lower frequency of pregnancies, greater frequency of preterm and small for dates births) (Nurminen, 1998; Chau et al., 2014; Wang et al., 2016). More recently, in adult women, an association between night work and ovarian cysts, traditionally considered almost exclusively adolescent diseases (Spinelli et al., 2009a; Spinelli et al., 2009b), has been described (Lim et al., 2016).

The circadian decrease in psychophysical performance during the night hours, in association with sleep debt and fatigue, may reduce work efficiency and increase the probability of occurrence of errors and accidents (Alali et al., 2018; Oriyama and Miyakoshi, 2018). The so-called "human error" can be linked to sleep as well as to oscillatory mechanisms of attention and performance. In this context, night work and the related sleep deprivation have been invoked as contributing factors of serious disasters, such as the nuclear accidents of Three Mile Island (1979) and Chernobyl (1986), the explosion of a pesticide industry in Bhopal (1984), the sinking of the oil tanker Exxon Valdes (1989) and the explosion of the Challenger Space Shuttle (1986) (Costa, 1998; Costa, 2008; Garbarino, 2007).

It is necessary to consider the individual differences in the regulation of sleep and waking. First, with the increase of the age, the subjects are more predisposed to develop sleep disorders and incur accidents (Cajochen et al., 2006). The role of fatigue is also important: in addition to excessive drowsiness, it may increase the risk of human error (Niu et al., 2011).

The consequences of a reduction in the level of vigilance appear particularly relevant when shift work require a high psycho-physical efficiency. These conditions are frequent for the shift staff of police forces (patrolling, emergency assistance, escorted services, etc.) (Garbarino et al., 2007). It was also noted that road accidents on the journey back home, after a

night shift, affect up to 20% of shift workers (more those with rotating shifts than those with a fixed night). (Costa, 2008).

EDS is a certain cause of road accidents (Garbarino et al., 2011, Garbarino et al., 2007, Vennelle et al., 2010). Most accidents involving professional drivers appear to be related to obstructive sleep apnea syndrome (OSAS) (Lichtblau et al., 2010; Guglielmi et al., 2018; Garbarino and Magnavita, 2015; Garbarino et al., 2015). In fact, a peculiar characteristic of this syndrome is the presence of a complex comorbidity that determines a significant impairment of quality of life, cognitive and behavioral, and a reduction in work efficiency (Garbarino, 2017). Therefore, OSAS presents a variegated diurnal symptomatology, whose most characteristic and disabling element is EDS. In this light, a study by Philip (2005) is eloquent in which a significantly higher percentage of people with a history of one or more incidents was found in patients with OSAS compared to control subjects.

Shift and night work can make a workplace more vulnerable to discrimination phenomena (Di Marco et al., 2016). The most important protective factor is an efficient organization of work (Di Marco et al., 2018). This is a subject of the highest interest for European companies, since legislations on equal rights have existed since the foundation of the EU.

More recently, some studies have suggested a possible association between shift work and cancer, particularly breast tumors. The hypothesized mechanisms by which circadian disruption may favor the induction and/or promotion of tumors are multifactorial and particularly complex (Costa et al., 2010).

4. The EU regulatory framework

This examination of the EU legislation starts with Council Directive 93/104/EC, which, focusing on some aspects of the temporal organization of work, has clearly placed itself on the path traced by the Treaty that founded the European Community. In fact, the latter provides for the adoption, through a Directive, of minimum requirements aimed at promoting the improvement of the working environment and at ensuring a higher level of protection of the safety and health of workers.

After all, the above-mentioned Directive recalls, in the Recitals, the "Community Charter of the Fundamental Social Rights of Workers" adopted in 1989 by a declaration of all Member States, except for the United Kingdom. Among the objectives to be attributed to the realization of the internal market, it has placed the improvement of the living and working conditions of the workers, which should be realized above all through the analysis of the problems concerning the duration and organization of working time (as well as the types of contract other than work indefinitely), highlighting the right to weekly rest and paid leave.

Therefore, it seems clear that the pervasive ratio of the Directive 93/104/EC consists in the belief that the improvement of safety, hygiene and health of workers is a preeminent goal, that is independent of considerations of a purely economic nature. Moreover, in order to achieve this goal, it is necessary to adequately organize working hours and to guarantee minimum vacation periods – on a daily, a weekly, and an annual basis – and adequate breaks, as well as a maximum limit for the weekly duration of work.

Moreover, the logic underlying the Directive in question is supported – as highlighted by its Recitals – with reference to scientific studies that support the greater sensitivity of the human organism to nocturnal periods with harsh environmental factors as well as to certain forms of work organization, and the harmfulness of long periods of night work.

Therefore, the Directive, in line with the aforementioned ratio, clearly expresses a an auspice for a protection mainly based around a temporal limitation of night work and a careful evaluation of the health conditions of night workers. Article 8

states: "Member States shall take the measures necessary to ensure that: 1. normal hours of work for night workers do not exceed an average of eight hours in any 24-hour period; 2. night workers whose work involves special hazards or heavy physical or mental strain do not work more than eight hours in any period of 24 hours during which they perform night work", while, pursuant to art. 9, paragraph 1, it provides that the "Member States shall take the measures necessary to ensure that: (a) night workers are entitled to a free health assessment before their assignment and thereafter at regular intervals; (b) night workers suffering from health problems recognized as being connected with the fact that they perform night work are transferred whenever possible to day work to which they are suited". Furthermore, Article 12 argues that the Member States must take all the necessary measures to ensure that shift and night workers benefit from a level of health and safety protection adapted to the peculiar nature of their work.

As is known, the Directive 93/104/EC was amended by the subsequent Directive 2000/34/EC of the European Parliament and of the European Council, which mainly had the aim to consider those sectors and activities excluded from the previous framework.

Finally, it is necessary to clarify that Directive 93/104/EC was repealed by Art. 27 of Directive 2003/88/EC of the European Parliament and of the European Council which concerns certain aspects of the organization of working hours. Particularly, Article 8 of this Directive states the following:

- normal hours of work for night workers do not exceed an average of eight hours in any 24-hour period;
- night workers whose work involves special hazards, or heavy physical or mental strain do not work more than eight hours in any period of 24 hours during which they perform night work;
- work involving special hazards, or heavy physical or mental strain shall be defined by national legislation and/or practice or by collective agreements or agreements concluded between the two sides of industry, taking account of the specific effects and hazards of night work.

5. The strategic role of health promotion

National laws on occupational health and safety – which derive from the EU Directives discussed in the previous paragraph – provide for a series of protection measures including risk assessment, information and training, health surveillance and health promotion.

The promotion of health in the workplace is a complementary measure to the more traditional health protection (Pristerà et al., 2012). Its specific objective is to prevent or to modify harmful behaviors at risk for the most frequent chronic diseases (cardiovascular diseases, tumors, respiratory diseases, diabetes, etc.). It assumes a strategic value in the workplace, especially if it is linked to the reduction of additive or synergistic effects on the health of both occupational and lifestyle risks. The main targets of occupational health promotion initiatives in Europe mainly concern actions aimed at tobacco smoking, alcohol consumption, drugs consumption, physical inactivity and vaccinations (Bini et al., 2018; Flahr et al., 2018; Pristerà et al., 2012). There have been, however, also some specific experiences regarding shift and night work.

The occupational physician is the figure who may better support the corporate stakeholders in a managerial approach of synergistic governance between health promotion and health protection is the occupational physician. Thus, the occupational physician can evaluate the health issues related to shift and night work both individually and in groups (Mucci et al., 2016a). The first step is an active participation in the risk assessment process, helping to quantify the extent of the problem and to plan appropriate prevention and protection measures. On a

collective level, it is necessary that the organization of the schedules is carried out on the basis of criteria respectful of the biological adaptation, the work performance, and the health and well-being status. At the individual level, thanks to such an integrated approach, every aspect of health surveillance can be tailored on the actual working conditions. Therefore, the main objectives of health surveillance for shift and night workers are as follows (Mucci et al., 2016a):

- define an initial framework for comparison with future health conditions;
- identify any major health condition that could contraindicate or limit shift and night work, especially if associated with other factors (fatigue, heat, noise, stress, etc.);
- identify any other health condition that could be aggravated, to be monitored over time;
- verify the suitability for shift night work over time and intercept any signs and symptoms suggestive of interference from the disruption of circadian rhythms on the state of health.

It may be useful to consider also the workers' chronotype. In simple terms, it may be considered as the behavioral manifestation of underlying circadian rhythms of myriad physical processes. A person's chronotype is the propensity for the individual to sleep at a particular time during a 24-hour period. Eveningness (delayed sleep period) and morningness (advanced sleep period) are the two extremes with most individuals having some flexibility in the timing of their sleep period (Kalmbach et al., 2017). So, the chronotype, despite the inter-individual variability, can help identify the aptitude of each worker to work at night, rather than early in the morning or late in the afternoon. This is a strategic aspect of policies aimed at maximizing the productive performance of each worker, while also optimizing his or her health protection.

It is also important to distinguish the health conditions compatible with a modest and transient disturbance of sleep from those of a more severe degree, for which it is most likely necessary to intervene both at an operative (e.g. a fixed daytime shift) and a clinical level.

The medical examination can be supplemented by laboratory tests, instrumental examinations and specialist consultations, provided they are aimed at specific occupational risks. The medical history can be easily integrated with questionnaires (Mucci et al., 2012).

However, there are other health conditions – even if not properly framed in the legislation of all EU countries – where the company can request an intervention to the occupational doctor: for example, in the case of a high risk of injury due to sleep disorders or other conditions that reduce attention and ability to react.

6. Principles of management of shift schedules

In order to guarantee an appropriate management of shift work, it is necessary to consider both the production needs and the psychological, physiological and social issues. Several authors have proposed strategies to design shift schedules respectful both psychophysical integrity of workers and of their social well-being (Costa, 2008; Garbarino, 2006; Sallinen and Kecklund, 2010; Short et al., 2015). These shift schedules can be of different types and mainly differ according to the following elements:

- duration of the shift (6-12 hours);
- number of groups of workers who alternate during a working day;
- direction of shift rotation (clockwise/counter-clockwise);
- regularity of the shift schedule and speed of the whole shifting cycle;

- continuity/discontinuity of the shift (presence of weekend interruption).

For the maintenance of adequate levels of vigilance, the best shift schedule is represented by a phase-delayed rotation (morning-afternoon-night) – that favors the natural extension of biological rhythms – followed by a day of rest (Sallinen M. et al, 2010). Moreover, this rotation ensures a longer rest period with consequent optimization of psycho-physical recovery. When it is not possible to use such a schedule, the most important managerial good practices to consider are the following (Garbarino, 2006; Costa, 2008; Mucci et al., 2016a):

- adopt rapid rotation schemes, to limit the number of consecutive nights (two/three maximum);
- interpose at least 11 hours of interval between one shift and the other and guarantee the largest number of free weekends;
- plan the day or days of rest preferably after a night shift;
- define the duration of the night shift considering also the severity and the physical workload of the tasks;
- do not start the morning shift too early, to limit the loss of the last part of sleep;
- insert breaks during each night shift, to allow time for meals for a short nap;
- ensure ergonomic optimization of work environments (lighting, microclimate, noise).

Despite full compliance with Community and national legislation and with good practices, an “optimal” shift schedule from the biological point of view does not exist, and it is not possible to invent it (Niu et al., 2011). This consideration allows to understand even more clearly the strategic importance of occupational health promotion, which we mentioned above.

A health promotion program must take into consideration the specific characteristics of the company in which it is about to be realized. Therefore, it is necessary to plan all the following actions: occupational risk assessment, overall workers' health conditions assessment, information and training interventions, indication of preventive behaviors. For this purpose, the data that emerge from the mandatory health surveillance constitute a first source of evaluation and planning of the intervention itself (Mucci et al., 2016a). A special attention must be paid to particular issues (Arcangeli et al., 2009; Mucci et al., 2014) related to the age and to the gender of workers (Silva-Costa et al., 2015).

In occupational contexts involving night shifts, it may be useful, on the one hand, to prevent and combat the abuse of psychoactive substances and drugs and, on the other hand, to provide group advice for adequate sleep hygiene and, more in general, for a healthy lifestyle (Arcangeli et al., 2010; Montalti et al., 2012; Lasfargues et al, 1996). Regarding the dietary habits

– often conditioned by a life characterized by variable times in shift workers the opening of the company canteen at night (or at least a restaurant point) could provide the workers with a qualitative meal and educate them about the importance of a regular and balanced diet. In a second step, with the evaluation of individual parameters, the occupational physician may suggest to each worker preventive actions focused on individual risk factors.

Essential prerequisites for the organization of a health promotion program are the availability and sensibility of the company management, which identifies in the workers' health promotion an essential element to increase productivity. The scientific literature provides evidence that well-planned and organized interventions lead to a return on investment (Flokard and Tucker, 2003). Already many years ago, a review of 72 US scientific studies concluded that every dollar spent on a health promotion program generated an average saving in health care of \$ 3.48 and a reduction in the costs of absenteeism of \$ 5.82 for each worker; in total, every dollar spent produced a return on investment of \$ 4.30 (Zank and Friedsam, 2005).

A targeted and effective health promotion program implies undoubtedly a series of positive reflections on the organization of work, constituting a motivational stimulus among the workers themselves with improvement of their psychophysical wellbeing, increased productivity and decreased absenteeism (Mennini et al., 2018, Pereira et al., 2018; Cherniack, 2015). Nevertheless, the recourse to similar initiatives is still today limited in Europe. For more, in certain companies the only “compensation” for night and shift work is a salary economic increase, sometimes even not even recognized in current times of crisis (Giorgi et al., 2015a; Giorgi et al., 2017; Mucci et al., 2016c).

7. Conclusions

In recent years, multidisciplinary methodologies of the management of occupational health and safety in the workplace have spread to all European countries. In this sense, an effective and efficient management of shift work cannot be separated from the synergistic and strategic interaction of economic sciences, life sciences and ergonomics. The integration of these science in the organization of shift systems is a strong and emerging need for companies. Our proposed approach is applicable in any employment context, especially in big companies. A careful risk assessment focused on shift work and a subsequent adoption of truly effective measures can bring benefits in terms of reducing injury risk and increasing productivity, in addition to the health and safety protection of workers. Therefore, in the context of the *future of work*, the organization of shifts according to ergonomic criteria must be seen by the companies more as an opportunity than as a cost.

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