Shift work is a significant biological and social stressor. Thousands of scientific publications in the past 5 decades leave no doubt as to the association between shift work and negative health and work outcomes. A search in database PubMed confirms that the scientific literature on this subject is enormous.

The lives of shift workers turn around their work schedule. They are frequently, even if only partially, excluded from social contacts and the community. Chronic fatigue and excessive sleepiness are frequently reported by such workers. These conditions are due to the difficulty to recover from the physical and mental effort at work, insufficient amount and quality of daytime sleep, or reduction of nighttime sleep for starting work too early in the morning.

The effects of shift work initially manifest as biological rhythms perturbations, shorter sleep duration, sleep disorders, and difficulty to reconcile professional activities and social and family life. There are countless publications in the literature on chronic-degenerative diseases related with shift work and night shift work. Some reviews published\(^1\)\(^-\)\(^3\) and many other authors have performed large epidemiological studies and systematic reviews on this subject.

Longer exposure is associated with higher risk for development and aggravation of several chronic-degenerative diseases. Individual differences and the working conditions, including shift work schedules, are relevant mediators of the effects on health, professional performance and occurrence (or not) of work-related accidents and diseases.

Effects are influenced by the physical and mental workload, and the availability or not and duration of breaks within and between the working hours\(^4\). Due to the reduced duration of sleep, progressive sleepiness develops along a night at work, and workers often fall involuntarily asleep. This situation might be worsened by increasing sleep deficit after many nights at work\(^5\). The risk of work accidents associated to sleepiness increases together with the number of consecutive nights at work, the working hours length, and lack of or insufficient breaks. The larger the number of nights at work, probably the higher the cumulative sleep deficit.

A systematic review\(^6\) compared 8-, 12-hour and longer shifts, showed that long working hours, shift work and night shift work increase the risk of accidents. A recent review with meta-analysis performed\(^7\) compared several studies, found that the risk of work accidents is higher in the case of too short (less than 30 minutes) or insufficient breaks, long working hours of more than 11 daily hours, and more than 3 consecutive night shifts.

LONG WORKING HOURS: THE CASE OF MINING

Shift work with long working hours (more than 8 h/day) is frequent in some production sectors in Europe, United States, Canada, Australia and Brazil, among other countries. More in particular, this arrangement was implemented in mining operations, which occur far away from urban areas. The working hours are often longer than 8 hours/day, not seldom of 12 hours/day, and workers lodge close to ore extraction/refining and transport areas. A compressed working week, with long daily working hours, might be favorable to workers who need to travel a long distance between home and work.

However, there are controversies among experts on the adoption of longer shifts. While they are attractive for enabling a larger number of days off in each cycle, as the working week is compressed, strict control of environmental and occupational stressors is needed to avoid excessive exposure to harmful agents present in the work environment. In the case of mining, workers are exposed to simultaneous hazards of different nature. Fletcher (2010)\(^8\) commented on the multiple stressors associated with fatigue present in mining operations: workload, thermal discomfort, sleep problems, and living conditions.
A significant issue concerns the occupational exposure limits (OELs): they do not discriminate between day and night shifts. However, as a function of the changes in biological rhythms, and more particularly in the mechanisms of detoxification following occupational exposure, night workers are more vulnerable to chemical, physical and biological agents. This problem is made even worse by long working hours, as is the case in the mining industry.

The metabolism of toxic substances is less efficient in association with night compared to daytime work, which aggravates the effects of occupational exposure. A recent publication\(^9\) points out gaps in industrial hygiene practice and biological monitoring, and the proper way to set occupational tolerance limits for night workers and the ones with long working hours\(^9\).

According to these authors:

“Because of slow and usually incomplete circadian time structure adjustment by rotating and permanent nightshift workers, occupational chemical and other contaminant encounters occur during a different circadian stage than for dayshift workers. Thus, the intended protection of some threshold limit values when working the nightshift compared to dayshift might be insufficient, especially in high-risk settings.”\(^9\).

This is a complex scenario, for which the combined effects of multiple occupational exposures is unknown, and there are no criteria for protection of OELs specific for shift and daytime workers.

**POSSIBLE INTERVENTIONS**

Several publications reported possible interventions to reduce the negative effects of shift work. A recent review of this subject\(^10\) describes several measures to be implemented or reinforced by organizations and workers. Some of such measures are:

- Short naps to minimize excessive sleepiness;
- Meals low in fats and sugars and rich in fresh vegetables and fruit and wholegrains are among the main dietary recommendations, especially for evening meals;
- Exposure to intense light at night to reduce sleepiness might result in changes in the circadian rhythms. However, the latter should be carefully assessed, because its efficacy depends on several factors, such as light intensity, shift work schedule and use of light exposure protection after the working hours, among others;
- Lifestyle changes, such as regular physical activity and avoidance of tobacco and alcohol, among others;
- Shift work schedule is the main factor associated with sleep perturbations, excessive sleepiness, biological disorders and the effects of sleep.

Changes in the work schedule involving all the interested parties (shift workers and supervisors) showed that reorganization of shift work has positive effects. Particularly in the case of mining companies which establish daily 12-hour or longer shifts, the schedule should include the minimum possible number of consecutive night shifts and several breaks within the working hours in addition to the meal breaks. Proper facilities should be made available from to rest during breaks, or to take a nap at times of strongest sleepiness (early hours, some times in the day). Also monitoring the workers’ health via periodic examination is relevant, especially in regard to sleep and excessive sleepiness, cardiovascular and metabolic aspects.

Equity in the workplace also involves ensuring healthy working conditions to all the workers (daytime and shift workers). However, this goal is not systematically accomplish in the case of shift workers. Therefore, new trends, such as prolonged shifts, should be evaluated carefully, and the necessary precautions should be implemented. In the mining industry, which comprises large companies, good management policies for human resources should include special protections to the health of the individuals who precisely enable their continuous 24/7 operation.

**REFERENCES**