

## Shift Work and Diabetes: A Cause for Concern

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### Editorial

An estimated 15-20% of adults in US and Europe work outside the traditional daytime schedule [1,2]. For these workers, the reasons for choosing shift work are varied and pragmatic. These include personal choice, nature or availability of job, financial obligations, school duties and other family or childcare responsibilities [2,3]. However they could be susceptible to higher rates of chronic diseases, including diabetes [4].

In an increasingly globalized 24/7 society, shift work has become essential to keep many systems running in an urbanized and industrialized environment. Non-traditional daytime work necessitates a disruption of the body's circadian timing system (CTS; circadian=rhythm with 24h periodicity) and an inability to cope with social and biological challenges leading to poor health conditions including abnormalities of glucose metabolism [5,6]. In these workers, poor adaptation and transformations in lifestyle which ultimately leads to poor diet, inadequate exercise, smoking habits, disordered sleep, family and psychosocial stress are important mechanisms for disease development [7,8].

In the US, the rate of diabetes is said to be about 9.3%, and rising [9,10]. Many reports suggest an elevated risk of type 2 diabetes (T2DM) for individuals who work varying shifts [11-13]. Regardless of the metabolic links connecting shift work circadian disorganization to glucose intolerance, for shift workers the risk of diabetes continues to increase many years after cessation of shift duties [12]. In a recent meta-analysis, Gan et al. [14] conclude that shift work is significantly associated with diabetes. This diabetogenic effect was shown to be more severe men when compared with women. In addition, workers on a rotating shift had a greater risk for diabetes than those on night, mixed, evening or unspecific shifts.

Repeated disruptions to circadian rhythm regulation of body systems in shift work ensure that synchronization and re-entrainment of the endogenous rhythms is rarely achieved even for permanent night shift workers. The suprachiasmatic nucleus (SCN, the master oscillator or circadian clock), which orchestrates the circadian timing system that are linked to retinal light exposure in the 24 h natural environment, and through chemical signaling synchronizes control over neuroimmunoendocrine systems, including the hypothalamic-pituitary-adrenal (HPA) axis [15,16]. These outputs are important for modulating several physiological and behavioral functions such as mood, stress response, glucose metabolisms, hunger drive and other endocrine and bodily functions. Among rotating shift workers, the speed of rotation as well as the direction of shift (either forward or backward rotation), speed of return to baseline daytime work (for

discontinuous rotating shifts) and length of recovery from rotating shifts appear to be crucial for circadian re-entrainment [17,18].

Results of epidemiological studies determine that shift workers are disproportionately obese, a known risk factor for T2DM, when compared to daytime workers [19,20]. The SCN maintains rhythmic control of energy metabolism through the hypothalamus by direct neurohumoral connections to some of the organs involved in eating and energy expenditure pancreas including liver, adipose tissues, and gut tissues, and skeletal muscles [21-23]. Repeated shift work exposes the individual to chronic loss of pulsatile cortisol secretion, increased sensitivity of the adrenal cortex to ACTH through SCN-mediated activation of the autonomic nervous system, higher cortisol sensitivity at night, lipolysis with resultant gluconeogenesis, glycogenolysis, lipolysis, insulin resistance, dyslipidemia, and truncal obesity. The lower leptin levels observed in these individuals eliminates the inhibitory action on hunger, while promoting appetite and lower energy expenditures [24]. Consistent with this background, shift workers may express higher consumption rates of fast foods, indulgence in high-fat breakfast meals, or resort to smoking and drinking alcohol [25-27]. The regular intake of fast foods with rapidly absorbable sugar by shift workers, partly explains the greater risk of diabetes in this group [28,29]. Furthermore, due to a circadian misalignment, shift work is associated with reduced total energy expenditure after dinner, boosting energy stores and long-term increase in BMI [30].

Given the expanding prevalence of diabetes, it is possible to control the development of diabetes among shift workers. From a public health perspective, it is appropriate to prepare public and private workforce on the risks of shift work with regards to T2DM and metabolic syndrome (MetS). The International Labor Organization (ILO) Night Work Convention 1990a highlights the need for pre-assignment evaluation of possible night shift workers, as well as training, and re-training of these workers [31]. Workers who already have diabetes or pre-diabetic conditions may not be suitable for shift work or night schedules because this could aggravate an abnormal metabolic index. It is noteworthy that these effects were more strongly observed in shift workers <50 years, suggesting that those >50 years could have already demonstrated a healthy selection to non-shift work [13,32]. Also, many of the studies have been restricted to singular job types, and do not account for unrecognized diabetes [33]. Shift work might benefit from regular supervision and maintenance of healthy work environment that include the availability of beneficial food choices in close perimeter. Healthy work culture, which promotes non-smoking, regular physical exercise, relaxation techniques, constrains fast food vending services and limits rapidly rotating shift is advocated. Regular wellness checks and counseling for shift workers will aid early detection, and management of diabetes and its complications among shift workers [34].

By triggering the circadian-related stress response, or worsening the poor behavioral habits seen in insulin resistance and weight gain, shift workers maintain a link with diabetes. Detecting and initiating the management of diabetes among shift workers is pivotal, which will help to lower the burden of disease, achieving one of the objectives of the Healthy people 2020, and maintain an efficient workforce.

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