SHIFT WORK AND METABOLIC SYNDROME, DIABETES MELLITUS AND ISCHAEMIC HEART DISEASE

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Abstract
Shift work is affecting 20% to 25% employees and is becoming increasingly prevalent in contemporary life all over Europe and USA. It is associated with several health problems, such as e.g. metabolic syndrome, diabetes mellitus and cardiovascular disease. These diseases are possibly due to an impairment of biological rhythm. The metabolic syndrome is a complex of interrelated risk factors for cardiovascular disease and diabetes. Higher prevalence of the metabolic syndrome has been demonstrated among shift workers. Rotating shift work has an impact on each component of metabolic syndrome. Shift work might also have an impact on metabolic variables, and be a risk factor for type 2 diabetes. Only a few studies reported prevalence of impaired glucose metabolism and diabetes mellitus in relation to shift work. There is rather strong evidence in favour of association between shift work and coronary heart disease and that has been repeatedly demonstrated during over 20 years of research. Recent data increasingly reveal relations between shift work and plasma resistin, ghrelin, leptin and adiponectin.

Key words:
Shift work, Metabolic syndrome, Diabetes mellitus, Coronary heart disease

INTRODUCTION
Shift work is affecting 20% to 25% employees in manufacturing industries and is becoming increasingly prevalent in contemporary life all over Europe and USA. Continuous growth of shift worker numbers is observed also in the service sector [1]. The proportion of shift workers remains relatively constant up to 45 years of age but declines considerably among older workers [2].

Shift work
There is more than one definition of shift work. Council Directive 93/104/EC of 23 November 1993 concerning certain aspects of the organization of working time (as amended by Directive 2000/34 of 22 June 2000) defines shift work a “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” [3,4]. In general, the term “shift work” is quite vague and includes any organization of working hours that differ from the traditional diurnal work period; sometimes it is synonymous of irregular or odd working hours [5]. Another definition of shift work is given by Grosswald. Shift work refers to a job schedule in which employees work hours other than the standard hours of 8 a.m. to 5 p.m. or a schedule other than the standard workweek — Monday through Friday in the United States [6].

There is no precise definition of shift work. Most studies classify shift workers as anyone working outside regular daytime hours (i.e. between approximately 7 a.m. and 6 p.m., Monday through Friday). Under this definition, shift workers include all people working evening
shift, night shift, rotating shifts, split shifts or on-call
schedules both during the week and on weekends [7].
There are thousands of shift systems that differ widely
in their structure. Among shifts, alternating day shifts
are most frequently used in Europe [8]. A major prob-
lem in numerous publications regarding shift work and
health problems is the lack of one common definition of
shift work.
Shift work is associated with several health problems,
possibly due to an impairment of biological rhythm.
Over the last decades, Westernized countries have be-
come 24-hour societies. That is why the interest concern-
ing the influence of shift work on several health problems
has been increasing all the time.

Circadian rhythm
Humans have natural body rhythms which are regulated
by a “circadian clock” in the brain. These are called cir-
cadian rhythms. Circadian rhythm is an integrated body
rhythm that cycles approximately every 24 hours.
Circadian rhythmicity can be important in the patophys-
iology of numerous diseases. In discussing health prob-
lems in shift workers, the role of circadian rhythm is the
key issue. The circadian timing system proficiently coor-
dinates the physiology of living to match it to the envi-
ronmental or imposed 24-hour cycles. A wide range of
biological processes are regulated by the circadian clock,
including sleep-wake cycles, body temperature, energy
metabolism, cell cycle and hormone secretion. Circa-
dian regulation is important to maintain normal cellular
functions. A disruption of core clock genes can be dam-
ing to the organism’s well-being [9–11]. Shift work is
generally associated with chronic misalignment between
the endogenous circadian timing system and the behav-
ioural cycles, including sleep/wake and fasting/feeding
cycles. There is a large amount of data pointing to an as-
cociation between shift work and the prevalence of many
medical conditions. Work/rest schedules resulting from
shift work disrupt the circadian clock, causing symptoms
similar to jet lag. Generally, no complete physiological
(body function) adaptation takes place for the majority
of night shift workers.

Metabolic Syndrome
The metabolic syndrome is a complex of interrelated risk
factors for cardiovascular disease and diabetes. Several
clinical definitions have been proposed.
The first criteria for definition for the diagnosis of meta-
bolic syndrome were proposed by World Health Organiza-
tion (WHO) in 1999 [12]. European Group for the Study
of Insulin Resistance (EGIR) was in the same year the next
one [13]. The presence of insulin resistance was a prerequi-
site in both definitions. National Cholesterol Education
Program (NCEP) Adult Treatment Panel III in 2001 (ATP-III)
does not obligatorily require impaired glucose regulation
or insulin resistance as an essential component [14]. These
three groups have agreed that the core components of the
metabolic syndrome are: obesity, hypertension, insulin resis-
tance and dyslipidemia. The levels set for each component
and their combination required to diagnose the metabolic
syndrome are slightly different in these three recommen-
dations. In 2005 International Diabetes Federation (IDF)
presented definition where visceral obesity was the neces-
sary requirement. The American Heart Association and the
National Heart, Lung and Blood Institute (AHA/NHLBI)
modified the NCEP criteria by decreasing the glucose cut-off
point [15]. All these definitions have been used by various au-
thors. IDF and AHA/NHLBI representatives agreed that the
abdominal obesity should not be a prerequisite for diagnos-
ing of the metabolic syndrome. Abdominal obesity is one of
the five criteria, while 3 of the 5 risk factors must be present
to diagnose the syndrome [16]. Recently, common criteria for
the clinical diagnosis of metabolic syndrome have been pro-
posed by several major organizations in the Joint Scientific
Statement in an attempt to unify all presented criteria [17].
Higher prevalence of the metabolic syndrome has been
demonstrated among shift workers [18–21]. A recent study
by De Bacquer et al. demonstrates that the risk of develop-
ment of the metabolic syndrome gradually increases inde-
dependently of the accumulated years of shift work. Rotating
shift work has an impact on each component of metabolic
syndrome [21]. Esquirol et al. show that shift work, regard-
less of models, was significantly associated with metabolic
syndrome [22]. The risk of developing metabolic syndrome
is high in night shift healthcare workers [23].
Type 2 diabetes
Type 2 diabetes is a modern world-wide epidemic. Its complications are a significant cause of morbidity and mortality in every European country and the consequences of its explosive growth are an intolerable burden both to the individual and to healthcare systems. Diabetes type 2 is the most common form of diabetes and is characterized by disorders of insulin action and insulin secretion, either of which may be the predominant feature. Both are usually present at the time when this form of diabetes is clinically manifest [12]. The prevalence of diabetes continues to rise all over the world. The signs of abating are not observed [24].

There are rather few studies reporting prevalence of impaired glucose metabolism and diabetes mellitus in relation to shift work. Shift work might have an impact on metabolic variables, and also be a risk factor for type 2 diabetes. Suwazono et al. study on male Japanese workers revealed alternation/shift work was an independent risk factor for impaired glucose metabolism [25]. Kroenke et al. found a positive relation of hours worked with incidence of type 2 diabetes in a population of young and middle-aged women. The association was independent of body weight. The association between rotating night-shift work and diabetes was different. It was mediated by body weight, while job strain was unrelated to type 2 diabetes risk [26]. Mikuni et al. reported a higher prevalence of diabetes mellitus among shift workers [27]. Morikawa et al. study suggests that shift work is a risk factor for the onset of diabetes mellitus and that there are different risks associated with different types of shift schedule [28]. Diabetes risk increases with metabolic syndrome and varies substantially depending upon which factors are presented [29]. Knutson et al. study demonstrated the possibility of reduced sleep duration or quality could adversely affect glucose control in known diabetes [30].

Cardiovascular disease
The risk of cardiovascular disease among shift workers is well documented. Numerous publications on shift work and morbidity from cardiovascular disease confirm the relationship. That cardiovascular disease risk is increased among shift workers has been repeatedly demonstrated during over 20 years of research. There is rather strong evidence in favour of association between shift work and coronary heart disease [31–34]. Shift work can increase the risk of CVD by several mechanisms. Besides of psychological and psychosocial factors, physiological and biological mechanisms are crucial. They are usually related to activation of the autonomic nervous system, changed lipid, carbohydrate and other metabolic parameters. These factors may lead to increase risk for atherosclerosis, metabolic syndrome and type 2 diabetes. Coronary heart disease, metabolic syndrome and carbohydrate metabolism disturbances have some joint cause. Unphysiologic timing of physical activity in relation to circadian rhythms is a possible explanation for the negative impact on the cardiovascular system. Recent data increasingly demonstrate relations between shift work and elevated plasma resistin levels. Resistin may play an important role in the pathogenesis of early metabolic syndrome components in young men chronically exposed to circadian misalignment [35]. Its circulating levels are predictive of coronary atherosclerosis [36]. Circulating adiponectin, ghrelin and leptin play an important role in human obesity, one of the components of metabolic syndrome, by the long term regulation of body weight and energy homeostasis [37]. Further studies in the shift work population are needed to sort out an important role of these in all elements of metabolic syndrome, diabetes and coronary health disease which are closely related to each other.

REFERENCES


