

# Mitigation of Shift Rotation Effects on Workers' Health and Sleep Quality in Manufacturing Companies in Latvia

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*Abstract:* This study aims to analyze the impact of rotating and night shifts on workers' sleep quality and health. To conduct the study authors use data from foreign and Latvian studies on the effects of shift, night shift, and rotating shift work on workers' sleep and health; survey data from four manufacturing companies in Latvia and work absence data from one of the surveyed companies. The results of the study indicate that rotating shifts and night work affect the quality of sleep of employees. In turn, poor sleep quality in the long term can result in serious health consequences for the employees involved in shift and night work. Rotating shifts and night work can be a contributing factor to other work environment risks as well as non-work-related health problems. Rotating shifts and night shifts can also be associated with more frequent work absences. Public institutions, employers, and employees need to be involved to reduce the negative impact. To mitigate the negative effects, the authors recommend changes in legislation, health-promoting measures on the part of employers, and responsible action from employees regard to preventive measures.

*Keywords:* Health, Night shifts, Rotating shifts, Sleep quality

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## 1 Introduction

Rotating and night shifts are commonly used to organize work schedules in manufacturing and other types of companies. Usually, these shifts help to maximize the productivity of the work equipment and devices. There are also work processes that require continuous operation. Many workplaces, including medical institutions, emergency services, and fire and rescue services, need the presence of employees 24/7 due to vital needs. According to a study on working conditions and work risks in Latvia in 2017 and 2018, approximately one-fifth of Latvian employees admit that at least half of their working time they are exposed to shift work risk factors, while 8.3% of employees are exposed to night work risk factor at least half of working time [3]. Consequently, the risk factors of shift work and night work for health are important for a large part of employed people in Latvia. This study is relevant in the context of almost every country in the world since shift and night work are present in various fields of employment. Already back in 2003, Harriet Presser expressed the challenges caused by living in a 24/7 economy, in which the round-the-clock availability of products and services increases the demand for non-standard work schedules [10]. Nowadays this non-stop work demand has

increased, even more, thus the number of employees exposed to shift and night work-related risks has also increased. Employers and employees need to be aware of these risks to mitigate them and create sustainable nonstandard worktime workplaces.

The study will use data from previous studies on the effects of night work and rotating shift work on workers' sleep and health; survey data from four manufacturing companies, and data on the incapacity for work of one company for the years 2018, 2019, and 2020.

## 2 Circadian Rhythms and Health

Rotating and night shift work cannot be analyzed without looking at the theory of circadian rhythms. Circadian rhythms are also called "body's internal clock". It is a 24-hour cycle, a part of the body's "clock" that constantly provides the human body with all the necessary functions and processes [13]. Circadian rhythms are mostly affected by light and dark. They are controlled by a part of the brain called the suprachiasmatic nucleus, or SCN located in the hypothalamus [2]. SCN is built up from around 20 000 neurons and receives information about light and dark through the eyes [2]. This is the reason interiors have daylight lamps. They imitate

the light, which a person would receive through their eyes if they would be outside. If an employee works a night shift and the room has daylight lamps, his or her eyes "inform" the brain and the brain is "tricked" that it is daytime. That, of course, disrupts the employee's circadian rhythms. The sleep cycle is considered the most important health aspect controlled by circadian rhythms, but it is not the only one.

Circadian rhythms affect several important functions in the human body. By adjusting to a certain time of the day, the human body releases certain hormones at certain times. Depending on the time of day or night, a person's body temperature, blood pressure, cardiovascular endurance, and other body functions may also change [2]. Considering daily habits such as getting up, going to bed, and eating, which is adapted to work, shift, and night work can have a direct impact on circadian rhythms and, consequently, on the health of employees. Especially rotating shifts can have a significant effect, as constantly changing working hours do not allow the employee's body to adapt to the same time of getting up, sleeping and eating. As a result, it is much more difficult for the employee's body to secrete the necessary hormones and bodily fluids, e.g. digestive fluids, at appropriate times.

An irregular daily routine, in turn, can cause a variety of health problems. Abnormal circadian rhythms can lead to health problems such as obesity, diabetes, depression, bipolar disorder, seasonal affective disorder, and sleep problems such as insomnia [1].

### 3 Shift work and Health

According to the World Health Organization's latest definition of human health, health includes physical, mental, and social well-being and is not limited to only the absence of diseases [4]. Therefore, when studying the impact of shift work on human health, attention should also be paid to a person's mental, emotional, and social health.

Of all the health problems, the most analyzed diseases related to shift and night work are cardiovascular diseases. Several studies on shift work have shown a link between shift work and an increased risk of cardiovascular diseases [14]. Employees who work night and rotating shifts are more likely to have higher blood pressure [14]. Both cardiovascular disease and high blood pressure are most commonly diagnosed in people who have been working shift work for 10 years or more [14]. Cardiovascular diseases are one of the most common causes of death in Latvia - a total of more

than 144 thousand people or fifty-five percent of all deaths in Latvia in the last nine years have been caused by cardiovascular diseases [11]. Employees' lifestyle choices, daily habits, eating habits, and other factors also play an important role. However, rotating shifts and night work can be contributing factors to the development of cardiovascular diseases. Latvian Professor of Occupational Health Maija Eglīte also points out that despite the unclear reasons, epidemiological studies conducted around the world indicate that rotating shifts and night shifts can be associated with an increased risk of circulatory system diseases [6].

Another important health factor for employees, which is influenced by rotating shifts and night work, is the health of the gastrointestinal tract. Employees who work according to shift work schedules, especially rotating shifts, cannot get used to a certain meal rhythm. The circadian rhythm of eating, as well as the rhythm of sleep and waking up, is one of the most important circadian rhythms for the human body.

The human body, accustomed to a certain meal schedule, is already automatically preparing to ingest and process the food in the digestive tract. Following a regular meal schedule daily, the conditional reflex develops in the digestive tract, and the secretion in the digestive tract increases at certain times of the day, causing appetite [15]. The secreted fluids help the digestive tract to digest the food and absorb the nutrients [15]. Irregular meals due to rotating shifts or night work do not allow the human body to adapt to a certain rhythm of food intake and digestion, which in the long run can lead to various gastrointestinal problems, such as functional digestive disorders. These, in turn, can lead to more serious gastrointestinal tract diseases.

There is also a connection between rotating shifts and night work and an increased risk of various oncological diseases. In 2019, the International Agency for Research on Cancer published the results of a study confirming that night work can significantly increase the risk of oncological diseases and announced that night work is carcinogenic [19]. Previous research indicates that the longer people work rotating shift work or night work, the higher their risk of developing colorectal cancer, prostate, and breast cancer [14]. Fifteen years of working in rotating shifts are associated with an increased risk of colorectal cancer, thirty years of working in rotating shifts are associated with an increased risk of breast cancer, and forty years of working in rotating shifts are associated with an increased risk of prostate cancer [14]. Since these health problems occur over a longer period,

rotating shifts or night work are unlikely to be identified as a root cause of oncological disease development, but can be a contributing factor. The risk of oncological diseases must be taken into account, considering the trends of oncological diseases in Latvia. Twenty percent of all deaths in Latvia between 2010 and 2018 were due to oncological tumors [11]. Studies show that adequate vitamin D levels are associated with a reduced risk of developing oncological tumors and diseases [17]. However, reduced levels of vitamin D in the body are also a fairly common problem for rotating shifts and night shifts.

A study of vitamin D levels of employees in various professions found that up to eighty percent of rotating shift workers have reduced vitamin D levels, less than or equal to 20 ng / mL [12]. In Latvia, the evaluation of vitamin D in the largest laboratories is very similar, and in all evaluations the value  $\leq 30$  ng/ mL is in the category 'insufficient'. Vitamin D level is considered to be "deficient" if the vitamin D content is below 10 ng / mL.

Low levels of vitamin D in the body can lead to several diseases. Immune system problems, bone pain, osteoporosis, muscle problems, dental problems (such as periodontitis or tooth loss), liver and kidney diseases, and other diseases can occur [8]. In addition, vitamin D deficiency can also cause symptoms of weakness and depression [16]. Vitamin D deficiency is a very common problem worldwide. Studies show that up to fifty percent of the world's population may have reduced levels of vitamin D in the body [8]. When analyzing the role of vitamin D for rotating and night shift workers, it is important to consider that vitamin D is a relevant factor in the prevention of oncological diseases, which in turn is very important for workers in rotating shifts and night work [8]. The risk of developing colorectal, prostate, and breast cancer is associated with reduced levels of vitamin D in the body. These three types of oncological diseases are associated with an increased risk for rotating shift and night shift workers. Authors conclude that due to the possibly decreased level of vitamin D rotating and night shift workers are exposed to a double risk. Employees who work rotating and night shifts for more than fifteen years are at a higher risk of developing oncological diseases, but at the same time, there is a higher risk of vitamin D deficiency, which reduces the chances of resisting the development of oncological diseases.

Rotating shifts and night work affects not only the physical health of employees but also their psychological, emotional, and social well-being. In

2012 and 2014, a large-scale study was conducted in South Korea. The authors collected data from more than eighty-two thousand employees and found that rotating shifts both directly and indirectly affect the development of depressive symptoms caused by poor sleep quality and decreased vitamin D levels [9]. Thus, the disrupted circadian rhythms and the decreased level of vitamin D affect not only affects the physical, but also the mental health of employees. A study of Romanian workers indicates an increased likelihood of early-shift workers experiencing panic attacks, high blood pressure, and chronic drowsiness [18]. Research also points to the impact of shift work on employees' social and psychological well-being. It is more difficult for employees in rotating shifts to ensure a proper work-life balance. Rotating workers may have difficulty interacting socially with people working standard work hours, and this may contribute to the development of depression [5].

If we use the World Health Organization's definition of health as a basis for assessing human health, then, in light of all the above studies, rotating shift and night work has the potential to harm all aspects of human health, including physical health, mental health, and social life. Rotating shifts and night work increase the risk of several diseases, especially cardiovascular diseases and various oncological diseases. It also can lead to lower levels of vitamin D in the human body, which can cause multiple health issues. Low vitamin D levels, combined with poor sleep quality and disrupted circadian rhythms can cause depressive symptoms, thus negatively impacting the mental and social well-being of shift and night workers.

## 4 Methods

One of the main tools of the study is a survey of employees from production companies A, B, C, and D on their health, work absences, and quality of sleep during the last year. The respondents completed the questionnaire in January and February 2021. The survey was available in three languages - Latvian, English, and Russian. Participation was voluntary. One hundred and ten respondents from all four companies participated in the survey. The authors used The World Health Organization's Workplace Health Survey to develop the Health and Sleep Questionnaire.

Questions on health included:

- respondents' physical health self-assessment on a scale from very poor to excellent;

- respondents' mental health self-assessment on a scale from very poor to excellent;
- how many days during the last year the respondents have been absent from work (counting all the days of absence, except for absences due to the child's illness);
- the reason for absences from work (general illness, chronic health problems, injuries outside of work, occupational disease, accident at work, or other) [7].

Questions on sleep quality included answers to these statements on a scale from always to never:

- felt too tired to carry out daily activities;
- felt drowsy during the day;
- I needed two or more hours to fall asleep;
- when I got up in the middle of the night, I could not fall asleep again for at least one hour;
- I got up faster than I planned and could no longer fall asleep (Health at Work Survey, 2010).

To assess the quality of sleep, respondents had to answer the question of whether they think they have sleep problems (yes; no; I do not know) [7].

Respondents were required to provide the following demographic information:

- name of their workplace (for the study the names of the companies were encrypted with the names A, B, C, and D);
- gender;
- marital status;
- working time (shift), which mostly characterizes their everyday work;
- length of work experience in the specified working time.

The authors also used the statistics of work absences for company C in 2018, 2019, and 2020, except for absences related to pregnancy, caring for a sick child, or accidents at work. Work absences were analyzed by comparing absences in night shifts and rotating shifts and absences of employees who work standard working hours (day shifts).

## 5 Results

The results of the survey indicate that rotating shifts and night work may be associated with lower sleep quality. There is a correlation between the type of working time and employees' responses about their

sleep quality. The relationship is not very pronounced, but there is a slightly lower quality of sleep among rotating and night shift workers.

In comparison to all shifts, nights shift workers more often were not able to fall asleep for more than one hour if they had accidentally woken up in the middle of the night. Almost one-fifth of respondents who work the night shift had this experience often or very often.

Respondents who work day shifts were less likely to experience trouble falling asleep. Morning/evening, rotating and night shift employees were more likely to have this problem always, very often, or often.

There is no direct connection between the self-assessment of physical health and the type of working time. Night shift workers mostly rate their physical condition as good (55%) or average (27%). Day shift workers mostly rate their physical health as good (48%), average (21%), or very good (19%). The largest part of respondents who rated their physical health as poor (10%) work in day shifts, but it is probably related to other life problems, as day shift respondents were not absent from work more than other shift respondents, and in general they rate their physical health as good (55%). The majority of morning/evening shift respondents rate their physical health as good (44%), average (31%), or very good (19%). Respondents who work two or three rotating shifts rate their physical health as good (42%), average (29%), or very good (13%).

There is also no direct link between self-assessment of mental health and the type of respondents' working time. Night shift respondents rate their mental health as good (55%), very good (18%), or average (18%). Day shift respondents also rate their mental health as good (55%) or average (35%). Respondents who work morning/evening shifts rate their mental health as average (50%) or good (38%). Rotating shift respondents rate their mental health as good (39%), average (26%), or very good (19%). A very small proportion of respondents rate their mental health as poor or very poor. As there is no direct correlation between the type of working time and self-assessment of mental health, other factors may influence the low assessments, such as respondents' personal lives or the Covid-19 pandemic.

There is a correlation between good sleep quality and better physical health self-assessment. Those respondents who rated their sleep quality lower also rated their physical health lower. Respondents who said they thought they had some sleep problems rated their physical health as moderate (39%), good (30%), or poor (17%). On the

other hand, those respondents who do not consider that they have sleep problems also rated their physical health higher - 55% as good, 22% as very good, and only 16% as average. These responses suggest that sleep quality has an impact on physical health.

Although respondents who work rotating or night shifts assessed their health as equally good or even better than respondents in day shifts, statistics about work absences from company C indicate that employees in night shifts and rotating shifts are much more likely to be absent from work due to health issues. Over three years, night shift and rotating shift employees were absent from work more often than day shift employees.

## 6 Conclusions

Several previous studies indicate that rotating shifts and night work have a long-term negative impact on the health of employees. Although the causes have not been identified, the possible causes include the impact of working hours on circadian rhythms and sleep quality, and in the long run, disrupted circadian rhythms and poor sleep can lead to various health problems. Consequently, rotating and night shift work can increase the risk of cardiovascular diseases, and the risk of developing oncological diseases, as well as adversely affecting the digestive system and other functions of the human body. A very common problem for rotating and night shift workers is vitamin D deficiency, which further affects both physical and mental health. Due to reduced vitamin D levels and the specifics of the working hours, rotating shifts and night work influence not only the physical health of employees but also their mental and social well-being. It is much more difficult for rotating and night shift employees to spend time with their families and plan their leisure time with people who work standard day shifts.

The results of the survey confirm that rotating and night shifts can affect employees' sleep quality, which in turn can affect their physical health. Respondents who work rotating night shifts rated their sleep quality lower than those who work day shifts. Those employees who rated their sleep quality as poor were more likely to rate their state of physical health as poor. Although employees of all shifts assessed their physical and mental health quite similarly, the work absence data from company C indicates that employees in night shifts and rotating shifts were more likely to be absent from work than employees working day shifts. Therefore, this study indicates that rotating shifts and night shifts can

harm the quality of sleep and the health of employees.

## 7 Suggestions

To assess the impact of rotating shifts the authors recommend revising the list of psycho-emotional risk factors regards to compulsory health examinations in Latvia. At the moment this list includes only night shift work as a risk factor. Authors believe that rotating shift work should also be listed as a psycho-emotional factor harmful to health. Foreign studies and this study indicate that rotating shift work poses health risks even if it is organized during normal daily working hours, so the risk factor "Rotating shift work" should be included in the mandatory health check for all employees who work in rotating shifts more than 50% of their work time in one year. As shift workers and night workers are at higher risk of vitamin D deficiency, blood tests for vitamin D levels should also be included in the tests required for the health checks of shift work and night work. Shift and night work and vitamin D deficiency increase the risk of oncological diseases, so employees are exposed to a double risk. Therefore it is very important to find out whether employees have sufficient levels of vitamin D and act accordingly.

Timely preventive measures are key to maintaining good health and reducing the risk of various illnesses, and this should be a focus for both employees and employers. Health insurance as a part of the workplace bonus for the employees is very important for ensuring quality health care. Several health tests that are performed to discover breast, prostate, colorectal, and other oncological diseases on time are free of charge in Latvia. Employers can run information campaigns to encourage employees to carry out these health checks. Particular attention should be paid to workers who have more than fifteen-year experience working in rotating or night shifts, as these workers are at a particularly high risk of oncological diseases. Employers can motivate employees to turn to a healthy lifestyle through a variety of activities, providing fruit and, for example, extra holidays for non-smokers. As far as possible, employers can plan shift work so that at least some of the employees who want to work a constant shift (for example, only in morning shifts or only in evening shifts) can do so. It is, of course, very important for employees to do their utmost to reduce the negative on their sleep and health. It is important to observe sleep hygiene - allow seven to eight hours of sleep a day, ventilate the room before going to bed, and do not

use a computer and telephone at least one hour before going to sleep. Unhealthy daily habits can intensify the negative effects of rotating and shift work, so a healthy lifestyle is especially essential for rotating and night shift workers.

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