

IMPACT OF SHIFT WORK ON WOMEN'S REPRODUCTIVE FUNCTION – A REVIEW OF THE LITERATURE

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ABSTRACT

Infertility is becoming more of a growing health problem every year. It affects women at a slightly higher rate than men of childbearing age. Shift work, including night work, is undertaken by a relatively large proportion of the population.

Sleep is essential for the proper functioning of the human body. There is a growing body of scientific evidence supporting the fact that both partial sleep deficiency and total sleep deprivation are associated with reproductive dysfunction in women. This can cause difficulties in conceiving a child. It seems that an attempt to eliminate this problem could be made by hiring more workers, which would translate into less strain on individual workers. The purpose of this study was to present the current state of knowledge on the impact of shift work on women's reproductive functions. To this end, internet databases were reviewed, using the words: female infertility, sex steroid hormones, circadian rhythm, night shift work.

Key words: female infertility, sex steroid hormones, circadian rhythm, night shift work.

INTRODUCTION

Shift work involves the performance of job duties, according to a fixed work schedule, which provides for a change in the time of performance of work by individuals, after a certain number of hours, days, and weeks. A characteristic feature of shift work is the changing of employees in the same positions. The following models of shift work can be distinguished: discontinuous system (work in 2 shifts with a break at night and at the end of the week), semi-continuous system (work in 3 shifts with a break at the end of the week), and continuous work (work lasts 24 hours on all days of the week) [1]. In the European Union, in 2015, about 19% of all workers declared night shift work at least once a month [2].

Health care units, including hospitals, employ the largest number of shift workers compared to any other professional industry. Night shift work can have a significant negative impact on many aspects of the daily lives of the workers who perform it, affecting, among other things, mental, physical, and psychosocial health, thereby contributing to decreased productivity and exhaustion. Nurses on night medical duty, for example, have a higher risk of breast cancer, colorectal

cancer, and diabetes. They are more prone to immune system dysfunction, and are more likely to suffer from obesity. Shift work also increases the risk of pregnancy planning failures and promotes disruptions in relationships between spouses and their children [3].

Infertility is defined as a state of inability to become pregnant, despite regular sexual intercourse, with an average frequency of 3-4 times a week, persisting for more than 12 months, without the use of any protective measures [4]. Infertility is estimated to affect nearly 15% of couples worldwide. However, female infertility accounts for about 35% of all cases, 20% of cases involve both men and women, 30% involve problems on the part of men, while 15% of infertility cases remain undetermined [5, 6].

Female infertility is defined as infertility caused mainly by female factors, which include ovulation disorders, reduced ovarian reserve, anatomical abnormalities, endocrine and/or genetic disorders, and co-morbid chronic diseases [7].

REVIEW METHODS

The purpose of the present study was to conduct a systematic literature review to assess the impact

of sleep parameters, including sleep duration and quality, on women's reproductive function. To do this, we used scientific publications both review and original articles published in PubMed, Google Scholar, the available literature, as well as other commonly available sources by typing the search terms: female infertility, sex steroid hormones, circadian rhythm, night shift work. The total number of records was 414,464 items. We have included 50 works in the review, most of which are from 2013-2023. The subject matter of the works was the main criterion for selection based on which we made our choice. Excluded from the database of available articles were those whose topics that differed significantly from those we covered and those published before 2010, with the exception of one published in 2007.

DESCRIPTION OF A STATE OF KNOWLEDGE

Factors that may affect reproductive function

It is possible to distinguish a relatively large group of mechanisms that interact with each other to affect fertility. Not all of them show a direct effect. An example of an indirect factor may be the fact that shift workers have a higher risk of family conflicts, spending less time with their families, which significantly translates into the frequency of sexual relations [8]. Shift work also translates into a disjointed daily schedule, which can make it difficult to maintain a healthy diet and physical activity that prevents the onset of obesity. Night shifts contribute to the consumption of highly processed, nutrient-poor foods [9]. Cigarette smoking is associated with increased time to conception and increases the risk of pregnancy loss. In 2013, in the UK, smoking affected 23% of women undertaking shift work compared to 15% of women working regular hours [10]. Sleep quality has been shown to affect glucose metabolism, contributing to the development of insulin resistance and type 2 diabetes. Proper glucose levels are essential for implantation and subsequent normal embryo development [11].

There are a number of modifiable factors that affect women's reproductive function. Among them are the type of diet, and consequently body weight and body mass index (BMI), but also stress, socioeconomic status, smoking, alcohol, and caffeine abuse [12]. An appropriate lifestyle, including proper caloric intake and the use of a diet that is varied in terms of vitamins, proteins, carbohydrates, and minerals, appears to be particularly important with regard to infertility caused by endometriosis and ovulatory disorders [13-16]. Because of the possible modification of the aforementioned factors, they represent an important pathway in terms of improving infertility treatment. Another factor that can contribute to the development of infertility is lack of sleep. The entire process is controlled by

homeostatic regulation, which is responsible for circadian regulation [17]. It is possible to observe a growing body of evidence for a link between sleep disorders and an increased risk of mental illness, or metabolic disorders such as depression, diabetes, obesity, but also endocrine disorders whose production depends on the time of day [18, 19]. In women, circadian regulation of sleep also depends on the phase of the menstrual cycle [10, 20]. From the sources cited, it can be concluded that shift work has a negative impact on fertility in women; however, it should be remembered that the impact in each woman may be different, and not necessarily harmful.

The effect of inadequate sleep on germ cell function

Germ cell function is precisely regulated by the hypothalamic-pituitary-gonadal axis and by 2 populations of hypothalamic neurons: kisspeptin and gonadoliberin [21, 22]. The kisspeptin neurons, located in the anterior ventral periaqueductal area, are involved in increasing the amount of luteinising hormone produced, while the kisspeptins, located in the hypothalamus, provide information to the hypothalamic-pituitary-gonadal axis, contributing to the release of secreted gonadoliberin. This hormone is released in a pulsatile manner by the hypothalamus, affecting the anterior lobe of the pituitary gland, regulating the secretion of folliculotropic and luteinising hormone into the bloodstream. In women, both of these hormones are responsible for the production of steroid hormones (oestrogen) by ovarian follicles [23].

Studies clearly indicate that lack of sleep affects the human endocrine system, which plays a significant role in the process of reproduction. This can be clearly observed in the female body, in which the ability to ovulate – and thus fertilise – is subject to regular changes in the menstrual cycle. Disturbances of the diurnal rhythm, caused, among other things, by shift work, affect reproductive capacity by deregulating the production of sex steroid hormones, gonadotropins and prolactin, which can contribute to infertility [24-26]. During the follicular phase, FSH, LH, oestrogen, progesterone, and sex hormone-binding globulin exhibit circadian rhythms. This is in contrast to the luteal phase, in which only folliculotropic hormone and sex hormone-binding globulin show such rhythmicity [27]. Equally important hormones appear to be androgens, whose secretion shows a diurnal oscillation with the morning peak of their production. In women, luteinising hormone regulates androgen production in the ovaries. Metabolic syndrome and obesity in patients with polycystic ovary syndrome are commonly associated with impaired reproductive function, disrupted menstrual cycles, and impaired gonadotropin production and secretion [28]. Glucocorticoids are

produced by the adrenal glands, and their regulation shows a diurnal pattern of release, reaching peak concentrations in the morning [29]. As is well known, night work is often associated with increased exposure of the worker to stress. The stressful situation results in increased glucocorticoid release, which can impair immune and reproductive system function [30-32]. Glucocorticoids affect the hypothalamic-pituitary-adrenal axis, influencing the inhibition of gonadoliberein release, while affecting the synthesis and release of gonadotropins [33]. They may indirectly contribute to ovarian dysfunction, both by inhibiting kisspeptin neurons and stimulating gonadotropin inhibitory hormone secretion [34]. In the pituitary gland, meanwhile, they inhibit folliculotropic and luteinising hormone synthesis and release, while in the ovaries they inhibit steroid hormone production and/or gametogenesis and induce apoptosis [23]. Melatonin is a neurohormone produced by the pineal gland, whose secretion is regulated by the dark-light cycle and the seasonal cycle [35]. Human melatonin receptors have been localised in various cells in the body, including the granulosa cells of ovarian follicles and in spermatozoa [36, 37]. Melatonin, whose function is to enable sleep, interacts with gonadotropins to potentiate the secretion of luteinising hormone. It is essential for the onset of ovulation. Consequently, night work, which contributes to the disruption of melatonin secretion, will also disrupt ovulation cyclicality, or contribute to the premature extinction of ovarian function [38-40]. Melatonin levels have been shown to be lower in women with idiopathic infertility, compared to healthy women. In women with increased exposure to stress who are melatonin deficient, the change in circadian rhythm significantly affects fertility and foetal development, increasing the risk of miscarriage, premature birth, and low birth weight of the child [41]. It is also known that blue light emitted from the screens of electrical appliances inhibits melatonin production [42]. At the same time, melatonin is important in the development of the foetal nervous and endocrine systems [43].

A correlation was noted between an increased risk of irregular menstrual cycles if the average sleep duration was less than 5 hours, compared with sleep duration greater than 8 hours, among 801 adolescent girls and 4445 women [44]. Poor sleep quality was also associated with an increased incidence of menstrual cycle problems, such as longer periods, or increased feelings of premenstrual syndrome among the 1006 patients studied [45, 46]. In a study of 71,077 nurses, women who had experienced more than 20 months of rotating shift work were more likely to experience irregular menstrual cycles [10]. In an experiment conducted by Stocker *et al.* it was shown that women undertaking shift work were about 15% more likely to experience irregular menstrual cycles,

compared to women working standard hours [47]. At the same time, disrupted diurnal rhythms associated with night shift work are associated with the production of increased amounts of the stress hormone cortisol and increased activity of catecholamines, and thus contribute to immune dysfunction. Impaired immune surveillance and excess free radicals increase the risk of endometriosis, which can also cause female infertility [48-50].

CONCLUSIONS

In the 21st century, infertility, along with cancer and cardiovascular disease, is one of the most important health problems. Shift work, and consequently disrupted circadian rhythms and lifestyle disorders (diet, smoking), can be significant causes of human infertility, contributing to it by reducing the amount of sex hormones produced, failing to implant the embryo in the uterine wall, and increasing the risk of miscarriages and premature births. Chronic sleep deprivation also contributes to the development of chronic diseases. Shift workers find it more difficult to take care of family relationships and the home hearth, which can result in difficulties in trying to have a child. They are more exposed to stressful situations, which will affect their immune systems. A thorough understanding of the above-described mechanisms, followed by spreading education on the impact of shift work on women's reproductive functions, can help reduce the percentage of women suffering from an inability to conceive a child. Facilities that are required to perform shift work should consider hiring additional employees to relieve the burden on those already employed. This will result in an even distribution of job duties, resulting in a lower workload and fewer hours of night work per employee, which will result in a lower risk of disorders caused by night shift work.

It is also worth mentioning that there is no conclusive scientific evidence that, with certainty, confirms the negative impact of shift work on women's reproductive functions. Most of them point to possible, potentially harmful effects of sleep deprivation on germ cell function. However, it is not said that these will occur in every woman subjected to shift work. For this reason, we believe it may be necessary to study the topic in more depth and try to determine which women are particularly vulnerable to the harmful effects of shift work.

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