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The impact of lifestyle factors on fertility: An analysis of effects on women and men. A review of the literature

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ABSTRACT

Fertility, defined as the ability to achieve a clinical pregnancy, is a crucial aspect of human reproduction. Infertility, on the other hand, is a complex condition affecting both men and women. This review examines the impact of key lifestyle factors, including body weight, diet, smoking, alcohol consumption, psychoactive substances, stress, mental health, sleep disturbances, and circadian rhythm, on the fertility of both sexes. Bad eating habits and excess body weight impair reproductive functions in both sexes. In women, they mainly contribute to ovulation disorders, and in men, to reduced semen quality. Smoking and excessive alcohol consumption are related to gamete DNA damage, oxidative stress, and hormonal imbalances. Psychological factors influence the hypothalamic-pituitary-gonadal axis, disrupting reproductive processes in both sexes. The review shows how lifestyle changes improve reproductive potential and the quality of life of people affected by infertility.

Keywords: Fertility, Lifestyle factors, Infertility, Hormonal balance, Reproductive health

1. INTRODUCTION

Fertility, defined as the ability to achieve a clinical pregnancy, is an essential component of human reproduction. Infertility, on the other hand, is a multifactorial condition affecting the male or female reproductive system, characterized by the inability to conceive after at least 12 months of regular, unprotected sexual activity, as described by the World Health Organization (WHO) (Zegers-Hochschild et al., 2017). Although infertility prevalence has been stable over time, the popularity of infertility treatment services has grown

significantly in recent years. Improved infertility awareness, increased access to care, and a growing number of physicians specializing in infertility treatment have all contributed to this trend.

According to WHO data from 1990 to 2021, approximately one in six adults worldwide has experienced fertility challenges at some point in their lives. The prevalence is estimated at 17.8% in high-income countries and 16.5% in lower-income regions. However, obtaining accurate data on infertility in the population is difficult due to different definitions of infertility. While the advancing age of women at conception remains the most significant factor negatively impacting fertility, increasing attention is being given to lifestyle factors that may also play a critical role (Vander and Wyns, 2018). Despite the growing recognition of lifestyle's impact on fertility, large-scale randomized clinical trials investigating behaviors such as smoking, body mass index (BMI), stress, alcohol consumption, and caffeine intake remain lacking.

Most available studies are observational, which introduces potential biases. For instance, studies have suggested that primary tubal infertility is more common among women with a history of multiple sexual partners, earlier sexual debut, and cigarette smoking. These factors are often interrelated; women with more sexual partners and earlier initiation of sexual activity are also more likely to smoke, complicating efforts to isolate smoking as an independent risk factor. Women who smoke cigarettes often consume alcohol and caffeine more frequently, which can make it challenging to determine whether reduced fertility is a result of smoking or associated with the intake of these substances. An additional complication in studying the impact of lifestyle factors on fertility is the lack of an objective biomarker that would allow for an accurate assessment of reproductive potential (Hornstein et al., 2022).

Infertility often causes significant emotional and psychological distress for couples, exacerbated by societal and familial pressures. Fortunately, many causes of infertility can now be addressed through advanced assisted reproductive technologies (ART). Addressing modifiable lifestyle factors is vital in enhancing reproductive health by supporting normal oocyte maturation and increasing the chances of successful conception (Ilacqua et al., 2018). This review aims to examine how specific lifestyle factors affect female fertility, with a focus on body weight (obesity and overweight), diet and nutrition, smoking, alcohol consumption, caffeine intake, the use of psychoactive substances and medications, stress, mental health, sleep, and circadian rhythm.

It seeks to explore how modifiable behaviors influence fertility and propose strategies to improve fertility outcomes and enhance the overall quality of life for women experiencing infertility. In addition to age, various lifestyle-related factors adversely influence female fertility. While many cases of infertility can be successfully treated using Assisted Reproductive Technologies (ART), normalizing these lifestyle factors could restore proper oocyte maturation and reduce reliance on such procedures. Therefore, the major lifestyle factors affecting infertility are outlined and discussed in detail below (Ilacqua et al., 2018).

2. METHODOLOGY

This review systematically analyzed literature from the past 20 years (2003–2023) on the impact of lifestyle factors on fertility in men and women. The methodology included:

Database Search: PubMed, Scopus, Update, and Web of Science were searched using keywords such as "fertility", "infertility", "lifestyle factors", "diet", "smoking", "stress", and "circadian rhythm".

Inclusion Criteria: Studies on the link between lifestyle factors and fertility outcomes in humans, published in English, with quantifiable or qualitative fertility data.

Exclusion Criteria: Studies with weak methodologies, animal studies unrelated to human fertility, and research older than 20 years unless seminal.

3. RESULTS AND DISCUSSION

Diet and Body Weight: Impact on Fertility

Numerous studies have shown that excess body weight in women is associated with reduced fertility and a host of other adverse health outcomes. Maintaining a BMI between 18.5 and 25 kg/m² is linked to minimal health risks, making it a desirable target, regardless of fertility challenges (Silvestris et al., 2018). Improper calorie and protein intake caused by unbalanced diets can lead to underweight or overweight conditions, both of which negatively affect ovarian function and increase infertility risks. Nurses' Health Study II, which included 116,678 women, found a strong link between dietary habits and fertility. A diet rich in low-glycemic index foods was

associated with a reduced risk of ovulatory disorders. Changes in body weight, whether due to overweight, obesity, or severe underweight resulting from energy imbalances, significantly contribute to ovulatory dysfunction

Women with a BMI above 25 kg/m² or below 19 kg/m² experience longer times to conception. High BMI is also linked to lower pregnancy rates, higher gonadotropin requirements, increased miscarriage risks, and complications such as gestational diabetes, hypertension, and preterm births (Emokpae and Brown, 2021). Diets lacking balance—whether excessively high in carbohydrates, fats, or proteins or deficient in essential vitamins and micronutrients—can adversely affect ovulation, oocyte maturation, embryo quality, and implantation efficiency. Although evidence about diet's impact on fertility is growing, further studies are needed to create precise dietary recommendations for infertile women (Emokpae and Brown, 2021).

Obesity, Overweight, and Biological Mechanisms

The literature highlights two primary mechanisms linking obesity and infertility in women. The first involves anovulation caused by endocrine and metabolic disruptions, while the second pertains to reduced endometrial receptivity, which can impair embryo implantation. Excess adipose tissue increases the risk of oligoovulation, even in women who previously had regular menstrual cycles. The follicular and luteal phases of the menstrual cycle are disrupted due to weight gain, which leads to disruption of luteinizing hormone (LH) secretion by the pituitary gland, resulting in reduced LH pulse amplitude. Furthermore, higher body weight is associated with lower levels of follicle-stimulating hormone (FSH), which plays a critical role in ovarian function (Ennab and Atiomo, 2023).

Recent studies indicate that obese women exhibit reduced expression of gonadotropin-releasing hormone (GnRH) mRNA, which contributes to dysregulation of the hypothalamic-pituitary-gonadal axis. These changes demonstrate the link between obesity and fertility. They involve not only the hypothalamic-pituitary-ovarian (HPO) axis but also other neuroendocrine systems. Studies have shown that leptin receptors are present in the ovaries, where leptin negatively affects granulosa and thecal cell steroidogenesis, folliculogenesis, and oocyte maturation. In obesity, increased adipose tissue elevates leptin levels while decreasing adiponectin levels, impairing glucose and fatty acid metabolism and adversely affecting reproductive function. Elevated leptin levels in obesity also result in leptin resistance (Merhi et al., 2019).

Leptin resistance disrupts the hypothalamic-pituitary-gonadal (HPG) axis by suppressing the release of GnRH, which in turn reduces the production of FSH and LH—hormones critical for regulating the menstrual cycle and ovulation in women, as well as spermatogenesis in men. Increased levels of leptin have many adverse effects, such as a reduction of egg cell sensitivity to gonadotropins, which affects the impairment of ovarian function and ovulation. On the other hand, adiponectin plays a protective role in ovarian function. Adiponectin influences key genes involved in follicular development and ovarian reserve, such as kisspeptin and anti-Müllerian hormone (AMH), emphasizing its importance in female reproductive health (Merhi et al., 2019).

Hormonal imbalances are frequently observed in obese women, including alterations in sex hormone-binding globulin (SHBG), androgens, and estrogens. Women with central obesity tend to have lower SHBG levels compared to women of similar age and weight with more peripheral fat distribution. Central obesity is linked to elevated insulin levels, further suppressing SHBG synthesis. Low SHBG levels raise the proportion of free testosterone in women with polycystic ovary syndrome (PCOS), which, in turn, perpetuates a cycle of insulin resistance and hyperinsulinemia. This exacerbates hormonal imbalances and adds to the complexity of obesity-related infertility.

Diet and Nutritional Factors

The concept of an ideal diet for optimizing fertility remains undefined, and the specific effects of various nutritional factors on reproductive outcomes are not yet fully understood. A case-control study involving 485 women, conducted as part of the Seguimiento Universidad de Navarra (SUN) Project, found that couples who adhered to a well-balanced diet experienced improved reproductive outcome (Toledo et al., 2011). While some associations between periconceptional nutrition and fertility have been observed, the mechanisms through which nutritional status impacts implantation, embryo quality, perinatal health, and child development are still not completely elucidated (Anderson et al., 2010). The following sections explore the effects of key nutrients on female fertility.

Proteins

The next element of a fertility diet is protein. The role of protein consumption in reproductive processes is complex, and the extent to which the source or amount of protein intake affects ovulatory function or female fertility remains unclear. However, it is known that protein intake is linked to disruptions in steroidogenesis in women with PCOS, likely due to its ability to reduce hyperinsulinemia (Silvestris et al., 2019). Chavarro and colleagues suggested that consuming animal protein is associated with an increased risk of ovulatory infertility. In contrast, the intake of plant-based protein appears to enhance fertility in women over the age of 32. This difference may be attributed to the varying effects of plant and animal proteins on insulin and IGF-I secretion. Plant protein is associated with a lower insulin response than animal protein, which could influence reproductive outcomes (Skoracka et al., 2021).

Nevertheless, there is considerable evidence that dietary changes can improve fertility in cases where infertility is due to ovulation disorders. Several studies have explored the link between protein intake and ovulatory dysfunction. Two randomized trials compared low-protein diets (15% of energy intake) with high-protein diets (30% of energy intake). Both studies found no significant differences in ovulation rates or circulating androgen levels between the two groups (Stamets et al., 2004; Moran et al., 2003). A large-scale study involving 18,555 women examined the relationship between dietary protein sources and ovulatory disorder infertility. The findings indicated that the consumption of red meat and poultry (chicken/turkey) was associated with a higher risk of infertility related to ovulatory dysfunction.

Conversely, consuming processed meats and fish showed no significant association with an increased risk. Moreover, consuming plant foods rich in protein was associated with a reduced risk of ovulation disorders and, consequently, infertility (Chavarro et al., 2008). Protein has many favorable properties and is a valuable component of diets aimed at improving reproductive outcomes in the population. Furthermore, increasing protein intake can help regulate the balance of carbohydrates and insulin in the body, which is key in treating ovulatory infertility (Skoracka et al., 2021). Unfortunately, to fully understand the impact of protein in women's diets on their fertility, many more studies need to be conducted.

Carbohydrates

Both insulin sensitivity and glucose metabolism play critical roles in ovulation and female fertility. Among carbohydrates, the glycemic index and glycemic load are particularly significant factors. Eating foods with a high glycemic index has been linked to increased insulin resistance, dyslipidemia, and oxidative stress—factors that can adversely affect fertility and disrupt ovarian function (Fontana and Torre, 2016). A study by Chavarro et al., (2007a) involving a cohort of 17,544 women revealed a strong association between chronic carbohydrate intake and the prevalence of ovulatory disorders. In women with polycystic ovary syndrome (PCOS), restoring glucose homeostasis has been linked to improved ovulatory function and fertility. This suggests that certain ovulatory disorders may result from the effects of carbohydrate consumption on glucose metabolism (Mioni et al., 2004).

Higher dietary glycemic loads correlate with elevated fasting glucose levels, hyperinsulinemia, and insulin resistance. These conditions subsequently lead to increased secretion of free insulin-like growth factor I (IGF-I) and androgens, contributing to endocrine imbalances and impairments in oocyte maturation (Chavarro et al., 2009). Another large cohort study involving 18,555 women without a history of infertility found that higher carbohydrate consumption—particularly at the expense of naturally occurring fats and in diets with a high glycemic index—was associated with an increased risk of ovulatory infertility (Chavarro et al., 2009).

These findings have been corroborated by additional studies showing that higher consumption of high-glycemic-index foods and carbohydrates, particularly when paired with low fiber intake, consistently reduced the likelihood of conception. Elevated consumption of simple sugars, a common component of these diets, was also linked to lower pregnancy rates (Willis et al., 2020). The primary source of added sugars in these studies was carbonated beverages. Furthermore, Machtinger et al. observed that the consumption of sweetened carbonated beverages—regardless of caffeine content—was associated with reduced success rates in assisted reproductive technologies (ART). Their findings also indicated a link between carbonated beverage intake and increased levels of free estradiol (Willis et al., 2020).

Lipids

The role of dietary fats in female reproductive processes is an area of growing scientific interest. It is hypothesized that the intake of fatty acids and cholesterol may influence fertility and pregnancy outcomes, potentially through the production of prostaglandins and steroid hormones. Unfortunately, however, we have limited data on the relationship between fat consumption, androgen levels in the

body, and ovulation (Silvestris et al., 2018). Fats are an essential dietary component that significantly impacts fertility. Hohos and Skaznik-Wikiel, (2017) suggested that a high-fat diet could influence reproductive functions, including menstrual cycle length, levels of reproductive hormones such as luteinizing hormone (LH), and embryo quality during assisted reproductive technology (ART) cycles.

Notably, the quality of dietary fats appears to play a more critical role than their quantity. For example, a study by Chavarro et al., (2007b) involving 18,555 women planning pregnancies or already pregnant found that increasing transfat (TFA) intake by just 2% significantly raised the risk of ovulatory infertility. In contrast, Mumford et al., (2016), in the BioCycle Study, found no association between TFA or saturated fat (SFA) consumption and the risk of anovulation. Despite these mixed findings, TFAs are widely associated with pro-inflammatory effects and insulin resistance, conditions that increase the likelihood of type 2 diabetes and metabolic disorders like polycystic ovary syndrome (PCOS), both of which can impair fertility (Mumford et al., 2016).

The harmful effects of TFAs are thought to result from their role in suppressing the expression of peroxisome proliferator-activated receptor γ (PPAR-γ). Furthermore, TFA consumption has been linked to a higher incidence of endometriosis (Missmer et al., 2010). Conversely, omega-3 fatty acids (ω-3) are believed to enhance fertility through their anti-inflammatory properties and involvement in steroid hormone production (Li et al., 2014). Research indicates that omega-3 intake from fish or supplements may improve oocyte development, reduce the risk of anovulation, and enhance embryo quality, although findings are not entirely consistent (Mumford et al., 2016; Li et al., 2014; Hammiche et al., 2011).

Supplementing with omega-3 has shown potential benefits for women with PCOS, including improved insulin sensitivity and lipid profiles, which may help extend reproductive lifespan (Yang et al., 2018; Al-Safi et al., 2016). Additionally, regular fish consumption, a primary source of omega-3, has been linked to increased live birth rates following ART and enhanced sexual activity, promoting fertility. Monounsaturated fatty acids (MUFAs) are also believed to positively impact fertility, which is attributed mainly to their anti-inflammatory properties and interactions with PPAR-γ, which may support conception. However, the role of dairy fats in fertility remains ambiguous.

According to some studies, high-fat dairy products contribute to increased fertility, while low-fat dairy products may contribute to ovulatory disorders in women. Research suggests that this is likely due to differences in the content of fat-soluble vitamins and the amount of estrogen in these dairy products (Skoracka et al., 2021). Based on current evidence, a dietary pattern rich in MUFAs and polyunsaturated fatty acids (PUFAs), particularly omega-3, while minimizing the intake of TFAs and SFAs, is recommended for women seeking to improve fertility. Further research is required to clarify the impact of dairy-derived fats on reproductive health.

Smoking

Both men and women experience adverse effects on fertility as a consequence of smoking, which impairs reproductive function through a range of biological mechanisms. The principal culprits responsible for this phenomenon are the toxins present in cigarette smoke, including nicotine, cotinine, carbon monoxide, and heavy metals such as cadmium and lead. Additionally, free radicals that induce oxidative stress play a pivotal role (De-Angelis et al., 2017). The findings demonstrate that the impact of smoking on semen quality is markedly more pronounced in individuals who smoke heavily (more than 20 cigarettes per day) and in those who smoke moderately (10 to 20 cigarettes per day) compared to those who smoke lightly (1 to 10 cigarettes per day) (Sharma et al., 2016).

In women, the presence of nicotine and various substances found in cigarette smoke accelerates the process of degeneration of ovarian follicles, known as atresia, resulting in a decrease in ovarian reserve. Consequently, this can lead to the onset of menopause several years earlier (Sun et al., 2012). It can be stated that nicotine harms the hypothalamic-pituitary-ovarian axis, which in turn results in irregularities in the menstrual cycle and ovulation. The consumption of nicotine has been demonstrated to disrupt the hypothalamic-pituitary-ovarian axis, which can result in irregularities in the menstrual cycle and ovulation. This disruption results in reduced production of estrogen and progesterone, which are vital for the process of ovulation and the preparation of the endometrium (Bashiri et al., 2018).

In addition, toxins present in cigarettes damage DNA in oocytes, which reduces their quality and the likelihood of successful fertilization. The presence of free radicals causes oxidative stress, which has a detrimental effect on oocyte mitochondria, which are crucial for their optimal functionality (Cnattingius, 2004). Impaired blood flow to the uterus and reduced expression of proteins necessary for implantation may lead to these effects. Smoking also negatively affects men's reproductive health. Smoking leads to a decrease in the sperm count in the ejaculate, diminished sperm motility, and an elevated proportion of sperm with aberrant morphology.

The results of the studies indicate that the total sperm motility in smokers is 24.27±31.32%, which is significantly lower than the rates observed in non-smokers, who exhibited values of 31.32% and 37.86±14.00%, respectively (0.0001) (Amor et al., 2022). This discrepancy is associated with oxidative stress and the presence of toxins, which have been demonstrated to damage cell membranes and increase sperm DNA fragmentation. Such damage markedly diminishes the probability of successful fertilization of the egg and elevates the risk of miscarriage, even when fertilization Zhang et al., (2013), Al-Turki, (2015) occurs.

Furthermore, the functionality of Leydig and Sertoli cells in the testes, which are responsible for testosterone production and sperm maturation, can be adversely affected by nicotine and other harmful substances (Dai et al., 2015). The impact of smoking extends beyond natural fertilization, negatively affecting the success of assisted reproductive methods such as in vitro fertilization or intrauterine insemination. A reduction in the risk of failure of assisted reproduction methods of 4% is associated with each year that a man quits smoking Vanegas et al., (2017), as long-term smoking can permanently reduce reproductive capacity. This should be one of the most important arguments for giving up this habit for those planning to have children.

Alcohol

The evidence base regarding the impact of alcohol consumption on female fertility is somewhat inconsistent, with only a limited number of studies having specifically examined fertility outcomes in individuals with a history of alcohol abuse. The consumption of alcohol, particularly in excess, has been demonstrated to have a detrimental impact on fertility, primarily through the disruption of endocrine function and the infliction of damage to gametes (Pecora et al., 2023). In women, alcohol consumption has been demonstrated to disrupt the hormonal balance, which in turn affects the menstrual cycle and ovulation.

It has been shown that excessive alcohol consumption is associated with a reduced likelihood of live birth in cases of assisted reproductive procedures, thereby increasing the risk of miscarriage (De-Angelis et al., 2020; Gormack et al., 2015). In men, alcohol consumption has been demonstrated to result in a reduction in testosterone levels, an increase in estrogen production, and, in some cases, the onset of erectile dysfunction. To illustrate, a meta-analysis comprising 15 different cross-sectional studies demonstrated that regular alcohol consumption markedly influences semen parameters (Amor et al., 2022).

Caffeine

Although the results of the studies are inconsistent, caffeine consumption in the recommended amounts does not appear to affect fertility (Skoracka et al., 2021). Some studies show that high caffeine intake (over 400 mg per day) may increase the risk of pregnancy problems and miscarriage. The mechanism may include caffeine's effect on blood flow to the uterus and ovaries, which may interfere with embryo implantation. At the same time, it should be noted that caffeine is not only in coffee but also in tea, soft drinks, cocoa, and some medications (Gaskins et al., 2018).

Drugs and Medicines

The use of drugs such as cannabis or cocaine has also been shown to harm fertility (Mueller et al., 1990). They can reduce the number and quality of sperm in men and interfere with ovulation in women. Some drugs, especially those used chronically (e.g., opioids, some antidepressants, or hormonal drugs), can also disrupt the hypothalamic-pituitary-gonadal axis, which also affects reproductive function. The impact of intoxicating substances on fertility depends on the dose taken, the duration of exposure to the substance, as well as the health condition of the individual using them. There is substantial evidence indicating the negative impact of intoxicating substances on reproductive health. Preventive measures in this area can bring many positive effects in terms of fertility.

Stress and Mental Health

Both stress and mental health play a significant role in regulating the reproductive process and in the effectiveness of infertility treatments. There is evidence to suggest that chronic stress disrupts hormonal balance by activating the hypothalamic-pituitary-adrenal (HPA) axis. This can result in several adverse effects, including ovulation disorders, reduced sperm quality, and the prevention of embryo implantation. To summarize, women experiencing infertility tend to exhibit significantly poorer mental health than those who are fertile (Lakatos et al., 2017).

Biological mechanisms (HPA axis)

The hypothalamic-pituitary-adrenal (HPA) axis is a biological mechanism that is pivotal in regulating the body's response to stress. Stress activates this mechanism, which is responsible for releasing hormones that prepare the body to cope with stressful situations—the activation of HPA results in elevated cortisol levels, the primary stress hormone. Elevated cortisol levels have been observed to inhibit gonadotropin (GnRH) secretion, which in turn has been shown to result in decreased secretion of luteinizing hormone (LH) and follicle-stimulating hormone (FSH).

In women, this can result in irregular menstrual cycles and difficulties with ovulation, while in men, it can lead to a reduction in testosterone production and impaired spermatogenesis (Tsoi et al., 2015). Furthermore, studies have indicated that inflammatory mediators may also play a role in this process, with evidence suggesting that they can negatively impact the quality of germ cells and embryo implantation in the uterus when subjected to chronic stress conditions (Palomba et al., 2018; Kondoh et al., 2009).

The role of psychological support in infertility treatment

Psychological support is an essential factor in improving the outcomes of infertility treatment, particularly in the context of assisted reproductive technology (ART). Individuals undergoing psychotherapy, particularly those participating in mindfulness-based stress reduction (MBSR) programs, indicate experiencing reduced anxiety and depression along with a better quality of life (Patel et al., 2020; Psaros et al., 2015). Research has demonstrated that implementing psychological intervention techniques to manage stress can enhance the effectiveness of in vitro fertilization (IVF) treatments, resulting in improved outcomes, including a higher yield of oocytes.

Implantation rates and overall success are influenced by multiple factors. Psychological support for individuals struggling with chronic stress is crucial. It helps stabilize mood, which lowers cortisol levels in the body and indirectly improves reproductive health. In summary, stress and mental health problems are significant risk factors for fertility, negatively affecting hormonal regulation and reproductive capacity in both men and women. The sooner stress problems are recognized, the sooner it will be possible to include psychological support, which is essential in the treatment of infertility, as well as in improving the lives of patients.

Sleep and Circadian Rhythm

Sleep plays a pivotal role in maintaining diurnal rhythm and hormonal function synchronization. Sleep disorders, including insomnia, delayed sleep phase syndrome, and sleep apnea syndrome, have been demonstrated to impact the hypothalamic-pituitary-gonadal (HPG) axis. Disruption to the quality and duration of sleep can result in desynchronization of the HPG axis, which may manifest as irregular menstrual cycles in women and reduced testosterone levels in men. In women, for example, sleep disturbances have been linked to reduced levels of luteinizing hormone (LH) and follicle-stimulating hormone (FSH), which can interfere with ovulation and fertility (Hall et al., 2005). Furthermore, women who slept regularly exhibited estradiol levels that were 60% lower than those observed in women who slept irregularly (Merklinger-Gruchala et al., 2008).

It has been demonstrated that insufficient sleep in men can result in a reduction in testosterone levels in the blood. A decrease in this hormone is of particular importance in spermatogenesis, as it results in a decline in sperm quality and quantity (Axelsson et al., 2005). Shift work, particularly at night, is one of the factors that disrupt the diurnal rhythm. Changes in sleep patterns result in a disturbance of the secretion of melatonin, a hormone that regulates sleep cycles and supports reproductive function. Exposure to light at night should be avoided because exposure to light after dark disrupts the diurnal clock and inhibits the nocturnal increase in melatonin levels, which protects eggs from oxidative stress (Lateef and Akintubosun, 2020). Exposure to light at night reduces melatonin levels. This impacts the quality of a woman's ova (Tamura et al., 2008).

Research has demonstrated that women who work shifts are more prone to menstrual cycle disorders and an increased risk of miscarriage. The growing understanding of melatonin's capacity to mitigate ovarian oxidative stress has prompted research into the potential of exogenous melatonin as a protective measure during in vitro fertilization (IVF) (Reiter et al., 2014). Significant risk factors for reproductive health include both shift work and sleep disorders. Factors that can affect reproductive health include both sleep disorders and shift work. Behavioral therapy is essential to improve sleep quality in people prone to circadian rhythm disorders. Table 1 illustrates the critical lifestyle factors influencing fertility and their biological and physiological impacts on men and women.

Table 1 Key Lifestyle Factors and Their Effects on Fertility

Life Style Factor	Effects on Women	Effects on Men
Diet and Body Weight	Ovulatory dysfunction, reduced oocyte quality, implantation issues, gestational complications	Decreased sperm quality and motility, hormonal imbalances
Smoking	Reduced ovarian reserve, DNA damage in oocytes, irregular menstrual cycles, earlier menopause	Reduced sperm count, motility, increased DNA fragmentation, Leydig cell dysfunction
Alcohol Consumption	Hormonal imbalances, disrupted ovulation, increased miscarriage risk	Reduced testosterone levels, increased estrogen, decreased semen quality
Caffeine	Potential risks with high intake (>400 mg/day)	Minimal direct effects noted, inconsistent evidence
Psychoactive Substances	Disrupted ovulation, hypothalamic-pituitary-gonadal axis disruption	Reduced sperm quality, lower testosterone levels
Stress and Mental Health	Hypothalamic-pituitary-adrenal axis activation, ovulatory disorders, reduced implantation rates	Reduced testosterone, impaired spermatogenesis
Sleep and Circadian Rhythm	Hormonal desynchronization, menstrual irregularities, decreased estradiol levels	Reduced testosterone levels, poor sperm quality

4. CONCLUSIONS

The analysis of numerous studies and scientific articles unanimously shows that lifestyle factors correlate with fertility in both men and women. Excess body weight combined with unhealthy eating habits affects ovulation disorders in women and weakens sperm function in men. Smoking and alcohol consumption cause gamete damage and various hormonal disturbances. This leads to a decreased ovarian reserve in women and poorer semen quality in men. Meanwhile, chronic stress interferes with the functioning of the hypothalamic-pituitary-gonadal axis, resulting in menstrual irregularities in women and reduced testosterone levels and spermatogenesis in men.

Circadian rhythm disruptions, including sleep disorders and shift work, negatively affect fertility in both women and men by disturbing hormonal balance and reproductive processes. Lifestyle changes in each of the aspects mentioned above significantly reduce infertility rates in both sexes. Our review highlights that much research still needs to be conducted, mainly randomized clinical trials, to gain an even better understanding of the impact of lifestyle on fertility.

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Informed consent

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Conflict of interest

The authors declare that there is no conflict of interests.

Data and materials availability

All data sets collected during this study are available upon reasonable request from the corresponding author.

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