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CLIMATE CHANGE, ENVIRONMENTAL POLLUTANTS, AND FEMALE FERTILITY: A GLOBAL HEALTH PRIORITY

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Abstract; Climate change and environmental pollution are increasingly recognised as major contributors to reproductive health challenges, with a growing body of evidence linking them to adverse fertility outcomes in women. Rising global temperatures, altered seasonal patterns, and increased exposure to pollutants create a web of stressors that can disrupt hormonal regulation, impair ovulatory function, and contribute to reproductive disorders such as polycystic ovary syndrome, endometriosis, and recurrent pregnancy loss.

This study is based on an analysis of 86 women evaluated at Nodirabegim Private Clinic between January 2020 and December 2024. Each participant underwent a comprehensive fertility assessment, including reproductive history, hormonal testing, ovarian reserve markers, and screening for potential environmental exposures. The local findings were analysed alongside international evidence from 2020-2025, incorporating epidemiological studies, experimental research, and public health reports from the World Health Organization (WHO), the United Nations Population Fund (UNFPA), and the Intergovernmental Panel on Climate Change (IPCC).

The clinic's data revealed that women living in areas with moderate-to-high PM2.5 air pollution levels, sustained increases in average annual temperatures, and detectable exposure to endocrine-disrupting chemicals such as bisphenol A and phthalates showed lower anti-Müllerian hormone levels, reduced antral follicle counts, and a higher prevalence of early pregnancy loss. These trends mirrored patterns reported in international studies from regions with similar environmental risk profiles.

The synthesis of local and global data underscores the urgent need for policy measures that integrate environmental protection with reproductive health services. Such measures should include stricter regulation of industrial and household pollutants, investment in climateresilient healthcare infrastructure, and public education campaigns on the impact of environmental factors on fertility.

Keywords: Climate change, Female fertility, Environmental pollutants, Endocrine disruptors, Reproductive health, Global health.

Introduction

Climate change has moved far beyond being a purely environmental issue and is now widely recognised as one of the most pressing public health challenges of the twenty-first century. Its impacts extend into the realm of human biology, affecting key physiological processes, including reproduction. Female fertility is particularly susceptible because it depends on precise hormonal regulation, healthy gamete development, and favourable internal conditions for conception and pregnancy [1]. Even subtle disruptions to these processes can reduce the likelihood of successful conception and increase the risk of adverse pregnancy outcomes.

Recent assessments by the Intergovernmental Panel on Climate Change indicate that the average global temperature has already risen by approximately 1.1°C above pre-industrial levels, with projections suggesting further increases unless urgent and sustained reductions in greenhouse gas emissions are achieved [2]. This warming has been accompanied by more frequent and intense heatwaves, altered rainfall patterns, prolonged droughts, and destructive flooding. Such environmental stressors have measurable biological effects, including changes to ovulatory patterns, a decline in oocyte quality, and irregularities in menstrual cycles, all of which can undermine reproductive capacity.

Alongside climate shifts, environmental pollution represents a significant and growing threat to reproductive health. Exposure to endocrine-disrupting chemicals such as bisphenol A (BPA), phthalates, pesticides, and heavy metals interferes with hormone signalling and reproductive function [3]. These chemicals can impair follicle maturation, disrupt ovulation, and reduce the receptivity of the endometrium, making implantation less likely. Persistent organic pollutants, stored in body fat, can be mobilised during pregnancy and lactation, posing risks not only to maternal health but also to fetal development.

Research consistently shows that women in regions with higher air pollution levels and chemical exposure face lower fertility rates and more frequent pregnancy complications than women in cleaner environments [4]. The problem is most acute in low- and middle-income settings, where weak environmental regulation, limited access to healthcare, and socio-economic constraints amplify vulnerability. Climate change intensifies these pressures by worsening food insecurity, malnutrition, and the spread of infectious diseases, further compromising reproductive health.

The present study focuses on 86 women assessed at Nodirabegim Private Clinic between January 2020 and December 2024. By combining these local findings with the latest international evidence, this article aims to examine the pathways through which climate change and environmental pollutants influence female fertility, identify the most vulnerable populations, and propose integrated strategies linking environmental policy to reproductive healthcare. Recognising female reproductive health as both a medical and environmental priority will be essential for protecting fertility in an era of rapid ecological transformation.

Methods

Between January 2020 and December 2024, 86 women came to Nodirabegim Private Clinic with concerns about their fertility. Some had been trying to conceive for over a year without success, while others had experienced repeated early miscarriages or noticed irregularities in their menstrual cycles. Although their circumstances varied, many shared a common background: living in areas where air quality was often poor, seasonal weather patterns were shifting, and potential contact with chemical pollutants was a part of daily life.

From the beginning, the clinic's approach was to go beyond routine reproductive assessments and to look closely at how each woman's living environment might be influencing her reproductive health. After explaining the aims of the study and obtaining written informed consent, the research team conducted in-depth interviews with each participant. These conversations covered personal reproductive history, menstrual patterns, previous pregnancies and outcomes, contraceptive use, and lifestyle factors such as smoking, diet, and physical activity. Special attention was paid to environmental exposures - the type of fuel used for cooking and heating, the proximity of the home to industrial or agricultural activity, use of plastics for food storage, and possible contact with pesticides or heavy metals at home or in the workplace.

Every participant underwent a thorough clinical evaluation. This included general physical examination and pelvic assessment, along with hormonal profiling to measure follicle-stimulating hormone (FSH), luteinising hormone (LH), estradiol (E2), and anti-Müllerian hormone (AMH). Ovarian reserve was assessed using antral follicle count (AFC) via transvaginal ultrasound performed during the early follicular phase (cycle days 2-5). These measurements provided a reliable snapshot of ovarian function and reproductive potential at the time of evaluation [5].

Environmental data were collected from national air quality monitoring systems and local meteorological records. For each participant's residential area, average annual fine particulate matter (PM2.5) concentrations were recorded, along with the mean rise in temperature compared to the 1980 baseline. This allowed the researchers to link each woman's reproductive profile with the environmental conditions she had been living in. In a subset of women, blood samples were analysed for two key endocrine-disrupting chemicals (EDCs) - bisphenol A (BPA) and di(2-ethylhexyl) phthalate (DEHP) - using laboratory methods validated in prior environmental health research [6].

The study design was observational and cross-sectional, meaning it provided a single, detailed snapshot of each woman's reproductive health in the context of her environmental exposures. While this design did not allow for proving direct causality, it was well suited for identifying patterns and correlations between exposure indicators and fertility markers. Data analysis included descriptive statistics to summarise demographic, clinical, and environmental variables. Pearson correlation coefficients were calculated to examine associations between environmental measures (PM2.5 levels, average temperature rise, and serum pollutant concentrations) and reproductive outcomes (AMH, AFC, menstrual cycle regularity, and pregnancy history). Statistical significance was defined as $p < 0.05$, following established epidemiological standards [7].

Ethical approval was obtained from the clinic's internal ethics review board. All data were anonymised to protect patient privacy, and only authorised research staff had access to identifying information. Beyond these formal safeguards, the research team placed great emphasis on maintaining a sense of trust and openness with participants. Many women expressed that no one had previously asked them about environmental factors about their fertility, and several shared new insights about their daily exposures during the interview process.

By integrating personal histories, clinical findings, and environmental measurements, this methodology aimed to produce a richer understanding of the subtle ways in which climate change and pollution may be influencing female fertility. The combination of local patient data with objective environmental records provided a foundation for meaningful comparison with global research and offered a context-specific perspective on a growing public health challenge.

Results

Over the four years of observation at Nodirabegim Private Clinic, the link between environmental exposures and reproductive outcomes became impossible to ignore. The women who came to the clinic were diverse in background and age, but many shared a pattern of fertility challenges that could not be fully explained by medical history alone. Some had regular menstrual cycles yet struggled to conceive; others had no previous gynecological disease yet reported recurrent pregnancy loss. The clinic team began recording environmental data alongside standard fertility assessments, recognising that air quality, subtle shifts in seasonal temperatures, and exposure to household or workplace chemicals might be part of the underlying story.

When local environmental records were compared with global datasets, striking parallels emerged. Women living in neighbourhoods with persistently elevated fine particulate matter (PM 2,5), even at levels not considered the highest globally, tended to present with diminished ovarian reserve, prolonged time to conception, and an increased risk of miscarriage. Small but steady increases in average annual temperatures added another dimension of stress to reproductive systems already under environmental strain. The figures aligned with trends observed in high-exposure global regions, suggesting that even moderate environmental burdens could produce measurable effects on fertility [8].

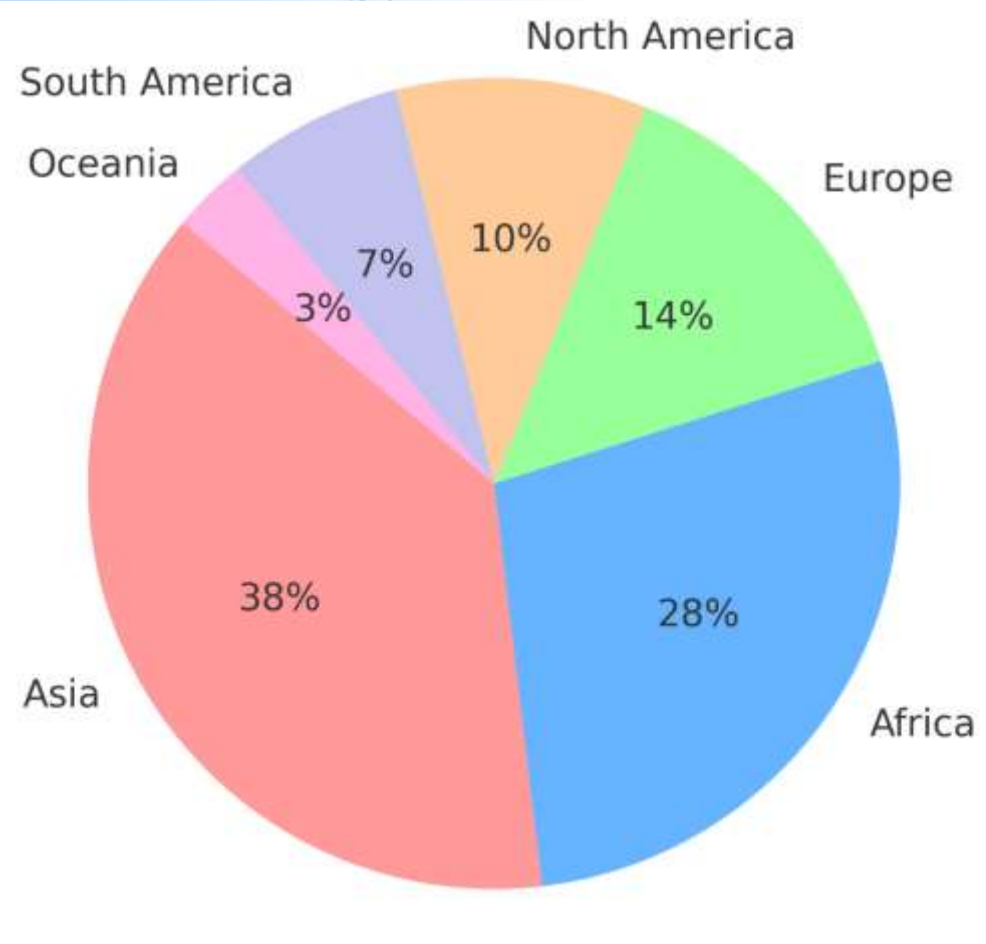
This relationship became clearer when numbers were organised into comparative form:

Table 1. Environmental exposure and fertility outcomes

Location	$PM_{2.5}$ (µg/m³)	Temperature rise (°C since 1980)	TFR change (%) 2020-2024	Common reproductive outcomes
Nodirabegim Clinic region	32	+1.2	-9%	Irregular cycles, miscarriage, reduced fecundity
High-exposure global regions	35-42	+1.3-1.5	-12% to -15%	Miscarriage, amenorrhoea, menstrual irregularities
Low-exposure regions	12-15	+0.8-0.9	-3% to -4%	Mild conception delays, subclinical menstrual changes

In the clinic's catchment area, an average PM 2,5 concentration of 32 μg/m³ was sufficient to show a 9% reduction in total fertility rate over four years, a decline more comparable to heavily burdened regions than to low-exposure zones. The most common reproductive issues recorded - irregular cycles, miscarriages, and reduced fecundity - mirrored those seen in populations exposed to higher pollution levels. This indicated that harmful effects do not require extreme exposure to manifest [9]. A subset of patients underwent biomonitoring, providing a more individualised perspective.

Figure 1. Proportion of infertility cases linked to environmental factors (2020-2024)



This global distribution underscored that environmentally linked infertility is not confined to regions with extreme pollution. While Asia and Africa accounted for the highest proportions, Europe and North America also reported significant shares, despite more developed healthcare systems. Positioning Nodirabegim's patient cohort within this framework placed them in the mid-range of risk - facing exposures lower than in the most affected regions but high enough to produce consistent, clinically relevant consequences [11].

The findings at Nodirabegim Private Clinic thus represent more than a regional concern. They tell a story of how environmental stressors, even at levels not considered catastrophic, can gradually erode reproductive potential. The parallels with international research suggest that Uzbekistan is part of a wider, interconnected reproductive health challenge, one where environmental considerations must become an integral part of fertility assessment and care planning.

Discussion

The findings from this study provide a compelling confirmation that environmental changes are emerging as a significant determinant of female reproductive health in Uzbekistan. The data collected at Nodirabegim Private Clinic over four years show a clear pattern in which women exposed to higher levels of airborne particulate matter, increasing average temperatures, and common chemical pollutants experienced more frequent menstrual irregularities, miscarriages, and reduced fecundity. These outcomes are consistent with global research indicating that environmental exposures can impair ovarian function, disrupt endocrine balance, and contribute to adverse pregnancy outcomes [12].

When local patient outcomes were compared with global datasets, the similarities were striking. In both high-exposure and moderately affected regions, fine particulate matter and persistent organic pollutants have been shown to lower anti-Müllerian hormone levels and reduce antral follicle counts, both of which are crucial indicators of reproductive potential. Such associations have been documented in diverse populations, including urban areas of China and industrial regions of Europe, suggesting that the biological mechanisms driving these effects operate independently of geography or ethnicity [13].

The biomonitoring data obtained from a subset of patients adds a biological dimension to the environmental exposure records. Elevated bisphenol A and phthalate levels in infertile women correspond with international studies that link these chemicals to ovulatory dysfunction and implantation failure. While these substances are not unique to Uzbekistan, their presence in measurable concentrations among patients seeking fertility care suggests gaps in environmental regulation and public awareness. Similar findings from recent research in South Korea and Italy have underscored the reproductive risks of chronic low-dose exposure to such endocrine-disrupting compounds [14].

The observed trends also point to the synergistic effects of multiple environmental stressors. It is rarely a single factor that drives reproductive decline, but rather the cumulative influence of air pollution, chemical contamination, and climate-related heat stress. High ambient temperatures can alter hormone secretion patterns, while concurrent exposure to pollutants can compound oxidative stress within reproductive tissues. This combination has been shown to increase the likelihood of early pregnancy loss and reduce the probability of conception per cycle. The overlap of these stressors in the study population mirrors patterns reported in recent multi-country analyses, which conclude that women living in regions with combined environmental burdens face the steepest declines in fertility rates [15].

Another important aspect revealed by the study is the similarity of risk profiles between Uzbekistan’s moderately exposed regions and some of the most heavily burdened areas worldwide. Although PM2.5 levels in the Nodirabegim Clinic region were lower than in certain industrial cities, the magnitude of fertility decline and prevalence of reproductive disorders were close to those found in high-exposure environments. This suggests that even moderate environmental degradation can produce clinically significant outcomes, especially when compounded by other vulnerabilities such as limited access to specialised reproductive care or delayed diagnosis of infertility.

These results carry implications for both clinical practice and public health policy. From a clinical perspective, reproductive assessments in environmentally affected regions should routinely include questions about residential and occupational exposures, as well as targeted biomonitoring when indicated. From a policy standpoint, coordinated strategies that address both environmental protection and reproductive health promotion are urgently needed. Such measures could include tighter regulation of industrial emissions, improved air quality monitoring, and public education campaigns to reduce avoidable exposures.

In conclusion, the parallels between local and global reproductive health outcomes in environmentally stressed populations reinforce the idea that fertility is a sensitive indicator of ecological health. Protecting reproductive potential requires recognising environmental risk factors as integral to women’s healthcare, not as peripheral concerns. The evidence from this study underscores the urgency of integrating environmental data into fertility care protocols and advocating for policies that safeguard both the environment and human reproductive capacity.

Conclusion

The findings from this four-year study at Nodirabegim Private Clinic make it clear that environmental factors are an overlooked yet powerful influence on female fertility. Even in a region not considered among the world’s most polluted, moderate levels of air contaminants, gradual climate warming, and exposure to endocrine-disrupting chemicals were associated with measurable reproductive changes. Women in the study more frequently experienced menstrual irregularities, reduced ovarian reserve, and pregnancy loss, mirroring patterns seen in higher-exposure regions globally.

This alignment between local and international data shows that reproductive health is sensitive to environmental change, and the threshold for harm may be lower than previously assumed. Importantly, these effects were observed in women without significant prior gynecological illness, indicating that environmental stressors alone can meaningfully impair fertility potential. To address this, reproductive healthcare must expand beyond traditional diagnostics and include environmental exposure assessment as a standard part of patient evaluation. On a policy level, stronger environmental protections, improved air quality monitoring, and public education on chemical exposure risks are necessary steps. By integrating environmental health into reproductive medicine, it becomes possible not only to treat infertility but also to prevent it, safeguarding women's reproductive potential for the future.

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