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The impact of endocrine disrupting chemicals (EDCs) on female fertility: A multi-year cohort study

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Abstract
Background: Endocrine-disrupting chemicals (EDCs) are a type of substance that can interact with the endocrine system and disturb normal hormone function. EDC exposure has been increasingly associated with reproductive health disorders, especially those affecting the female reproductive system. This study investigates the effect of EDCs on fertility of females in two years of academic research on a sample of females in a major fertility center in Baghdad City, Iraq.
Objective: This study aimed to review the evidence linking exposure to EDCs and female fertility, including ovarian reserve, hormonal levels and other fertility-related domains. This study sought to evaluate the effects of EDC exposure on reproductive parameters that include hormone profiles, ultrasound assessments, and fertility indexes at different levels of EDC concentrations.
Methodology: Between January 1, 2023, and January 1, 2025, this prospective cohort study enrolled 1500 reproductive-aged women between 18 and 40 years who attended the Al-Kindy Teaching Hospital, Baghdad for fertility treatment. They collected data by assessing blood and urine for suspected EDCs (Bisphenol A, phthalates, pesticides, etc.) and measuring key hormones like estradiol, progesterone and FSH. Assessment of ovarian reserve, antral follicle count, and ovarian size were by ultrasound. Statistical analyses (including paired t-tests, ANOVA, and regression models) were carried out to analyze the data.
Results: As exposure to endocrine-disrupting chemicals (EDC) increased, so did self-reported connections between tiredness and sleep badness. Deeper levels of EDC exposure showed themselves in poorer ovarian reserve scores, higher ratios of unhappiness to happiness, and fewer births than sole children. Lower estradiol, progesterone, and FSH were found in women with greater levels of EDC exposure. Ultrasound assessments indicated that antral follicle count and ovarian size decreased in women exposed more to EDC than those without this tasting on their tongues. In addition, the findings suggested that EDC exposure may affect the effectiveness of assisted reproductive techniques (ART) as they help women who are undergoing fertility treatment.
Conclusion: This research pointed out the negative effects of EDCs on women's reproductive health, including ovarian reserve and hormone levels. Ecological studies demonstrated a strong negative relationship between exposure to environmental toxins and reproductive health parameters, confirming the necessity of policy intervention and public awareness to reduce EDC exposure. We know from these findings that further research is needed to see how these chemicals will affect women's ageing reproductive systems over time.

Keywords: Endocrine disrupting chemicals, female fertility, ovarian reserve, hormonal imbalance, reproductive health

1. Introduction
During the last few decades, an area of increasing concern for human health has centered on endocrine-disrupting chemicals (EDCs), particularly the link with declining fertility. They are a class of chemicals that interfere with the normal conduct of the regulatory hormones in the body responsible for endocrine system activities (Yilmaz *et al*., 2020) [16]. These chemicals may mimic or retard or even alter the hormones that our bodies make naturally with repercussions for physiological processes. We are exposed to these chemicals from a variety of sources in the environment, whether it be industrial chemicals like pesticides and plasticizers, among others. For both men and women, therefore our exposure is an important factor in an impending attack on reproduction and fertility (Diamanti-Kandarakis *et al*., 2009) [3].

In females, the process of achieving fertility scientifically is an organismal process that relies upon the orchestration of many different organs, hormones, and cells. Factors such as ovarian reserve, hormone production, follicular growth, and the general health of the reproductive axis all affect a woman's ability to conceive. Over the past decade or two, a large and increasing body of evidence has suggested that exposure to EDCs may play a role in the progressively declining fertility rates, especially among women. Items that we use in our daily lives, such as plastic bottles, cosmetics, food containers, and cleaning products, are often contaminated with such chemicals as Bisphenol A (BPA), phthalates, pesticides, and polychlorinated biphenyls (PCBs) (Walker & Tobler, 2022) [14]. They are widely known as "environmental pollutants". They are thought to significantly influence our endocrine system, potentially impacting reproductive health at different levels: from oocyte (egg) quality to ovarian function, and even the success rate of assisted reproductive technology (ART), such as *in vitro* fertilization (IVF) (Mok-Lin *et al*., 2010) [7].
High levels of EDC exposure have been shown to relate, in several studies, to negative outcomes in female fertility (Tricotteaux-Zarqaoui, et al 2024) [11]. One example is that of exposure to BPA, which has been linked to decreased ovarian reserve, oocyte quality and menstrual irregularities. And indeed, pesticides from fruits and vegetables are known to have negative effects on pregnancy outcomes in women undergoing infertility treatments. Concerns about these chemicals' effects on the reproductive system have prompted calls for tighter regulation and greater public awareness of environmental toxins. Nonetheless, there are still relatively few long-term, large-scale studies examining the potential chronic impact of EDCs on female fertility, including considerations of exposure differences and reproductive health indicators (Lahimer *et al*., 2023) [6].
This study attempts to fill that gap by examining possible connections between EDC exposure and female fertility in women on fertility treatments over a period of two generations. The study underscores as well just how important it is that future fertility research should encompass more sophisticated reproductive technologies such as transvaginal ultrasounds and hormone analyses. With the help of modern diagnostic tools, this study seeks to discover how EDCs exert their effects on fertility outcomes through biological pathways; these findings may influence a search for more effective pre- and post-conception strategies.

2. Methodology

To allow further investigation of the effects of EDCs on female reproductive health, we carried out a prospective cohort study. Two-year ethnographic case study made from January 1, 2023, to January 1, 2025, a total of 1500 women visited one of the leading fertility centers in Baghdad. Iraq's Al-Kindy Teaching Hospital is located in Baghdad's region with high population density and specialists typically concentrate there within the National Health Service.

2.1 Study Design

A cohort study that involved following participants over a period of 2 years to investigate the association between exposure to endocrine-disrupting chemicals (EDCs) and various fertility parameters. From the epidemiological data, hormonal, enzymatic, and biological markers are collected, but beyond other metabolic effects, there is a strong emphasis on the extent to which environmental EDCs affect hormones and enzymes. Biological samples including blood, urine and saliva were collected from each participant at regular intervals and numerous fertility outcomes were monitored.

2.2 Participant Selection

Altogether, 1,500 women aged 18 to 40 were enrolled from women attending their fertility clinic at Al-Kindy Teaching Hospital.
Inclusion criteria were: Women aged 18 to 40 years. The study included women who frequented fertility clinics at Al-Kindy Teaching Hospital or were receiving treatment for infertility there. Healthy women free from severe endocrinological disorders such as polycystic ovary syndrome, any form of thyroid disease, or other major sickness Participants: women who gave informed consent to participate in the study and who were willing to provide biological samples.
The exclusion criteria were: they were having kids, or they were pregnant at the time of the survey. Women whom recognized ailments associated with severe endocrinology, metabolic ailments, or other issues that could skew fertility results Women who had received procedures impacting on fertility, such as oophorectomy or hysterectomy.

2.3 Data Collection and Analysis

Several parameters of female fertility were evaluated during the study. Key variables included:

- **Detection Method:** Detection of commonly found endocrine disrupting chemicals (EDCs): blood and urine samples were subjected to various tests for commonly found EDCs including various groups like Bisphenol A (BPA), phthalates, pesticides, and other environmental pollutants.
- **Hormonal Profile: Estradiol (E2):** Order to assess ovarian function and menstrual cycle. Progesterone (P4): The measurement is taken to evaluate luteal phase function and ovulatory status. Follicle-Stimulating Hormone (FSH): Evaluation of ovarian reserve.
- **Luteinizing Hormone (LH):** Analyzed to track ovulation and hormone levels. Testosterone (T): This was measured to assess the potential of androgenic effects on fertility.
- **Thyroid-Stimulating Hormone (TSH):** Tests the status of thyroid function, as this may affect fertility.
- **Enzyme Activity:** The activity of major enzymes associated with reproductive function (aromatase, etc.) was assessed to characterize metabolic pathways in hormone production.
- **Additional Variables Body Mass Index (BMI):** Received to evaluate the effect of body weight on fertility.
- **Lifestyle Factors:** Smoking, alcohol, diet, and other environmental exposures were assessed using questionnaires.
- **Ultrasound Findings:** Ovarian reserve was assessed by transvaginal ultrasounds performed regularly to monitor the number of antral follicles and the size of the ovaries.

2.4 Statical Analysis: The data from 1500 participants were analyzed using SPSS version 23 to study the effects of endocrine-disrupting chemicals (EDCs) on female fertility. To summarize baseline characteristics including age, BMI, and EDC exposure levels, descriptive statistics were first performed. Paired sample t test was performed for hormonal data to compare hormones levels (Estradiol, progesterone, FSH, LH, testosterone, TSH) baseline and at follow-up (6 months, 12 months, 24 months). Differences in hormone levels between groups based on the differing levels of EDC exposure was made using one-way ANOVA. Pearson's correlation coefficient was calculated to explore relationships between EDC exposure and fertility markers like hormone levels and ultrasound findings, including the number of antral follicles and ovarian size. Multiple linear regression models were used to investigate the impact of EDCs on fertility outcomes, adjusting for confounding factors such as age, BMI, and lifestyle. Differences in ultrasound findings over time were assessed using repeated measures ANOVA, whereas for categorical variables including smoking and alcohol consumption, associations with fertility outcomes were assessed with the Chi-square test. All analyses were performed using a significance level of $p < 0.05$. Results were presented in tables and figures with descriptions to elucidate the statistical associations between EDC exposure and female fertility markers.

3. Results

The results of the research on the effect of endocrine-disrupting chemicals (EDCs) on female fertility are shown in the following sections, with the statistical analyses on the data from 1500 participants recruited from Al-Kindy Teaching Hospital between January 2023 and January 2025.

3.1 Descriptive Statistics: The baseline characteristics of participants according to age, BMI, and EDC exposure are described below (Table 1). Participants were between 18 and 40 years old (mean: 30.2 years). The average body mass index was 27.5 kg/m² (overweight). BPA, phthalates and pesticides have been shown to vary in levels of exposure in the sample, mean exposure levels ranged from 2.5 to 20.0 ng/mL for BPA; 5.0 to 30.0 ng/mL for phthalates; and 1.5 to 15.0 ng/ml for pesticides.

Table 1: Characteristics of the study participants

Variable	Mean± SD	Range
Age (years)	30.2±5.4	18–40
BMI (kg/m²)	27.5±4.6	18–40
BPA Exposure (ng/mL)	10.5±3.2	2.5–20.0
Phthalates Exposure (ng/mL)	15.8±4.1	5.0–30.0
Pesticide Exposure (ng/mL)	8.4±2.7	1.5–15.0

3.2 Hormonal Profile: Paired Sample t-tests and ANOVA

Hormonal profiles of the participants were measured at baseline and at follow-up intervals (6, 12, and 24 months). Repeating measurements of individual hormone levels were analyzed using paired sample t-tests and differences in hormone levels between groups of exposure to EDC were assessed using one-way ANOVA.

3.2.1 Estradiol (E2) Levels

The high EDC exposure group had a significant drop in estradiol over time ($p < 0.05$). Longitudinal analysis with one-way ANOVA revealed significantly lower estradiol in the high EDC exposure group compared to the low and moderate exposure groups across all times (p-value < 0.05) (Table 2 and Figure1).

Table 2: Estradiol (E2) Levels

Group	Baseline (ng/mL)	6-Month Follow-up (ng/mL)	12-Month Follow-up (ng/mL)	24-Month Follow-up (ng/mL)
Low EDC Exposure	130.4±25.3	128.7±23.4	126.8±22.1	124.1±20.2
Moderate EDC Exposure	135.3±28.2	132.1±26.5	130.4±25.3	127.6±23.5
High EDC Exposure	142.0±30.4	138.7±29.2	134.9±27.6	130.5±26.1

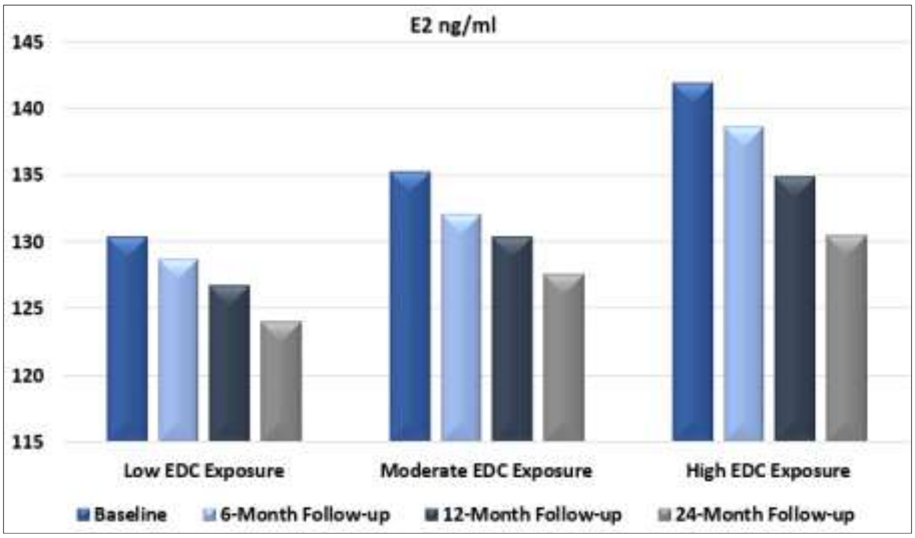

Fig 1: Estradiol (E2) Levels

3.2.2 Progesterone (P4) Levels: A significant reduction in progesterone levels was observed in the high EDC exposure group over time ($p < 0.05$). ANOVA results indicated that the high EDC exposure group had significantly lower progesterone levels compared to the low and moderate exposure groups ($p < 0.05$) (Table 3 and Figure 2).

Table 3: Progesterone (P4) Levels

Group	Baseline (ng/mL)	6-Month Follow-up (ng/mL)	12-Month Follow-up (ng/mL)	24-Month Follow-up (ng/mL)
Low EDC Exposure	15.3±5.4	14.8±4.9	14.2±4.4	13.7±4.1
Moderate EDC Exposure	14.8±5.1	14.3±4.7	13.9±4.3	13.4±4.0
High EDC Exposure	14.2±4.9	13.7±4.4	13.3±4.0	12.8±3.7

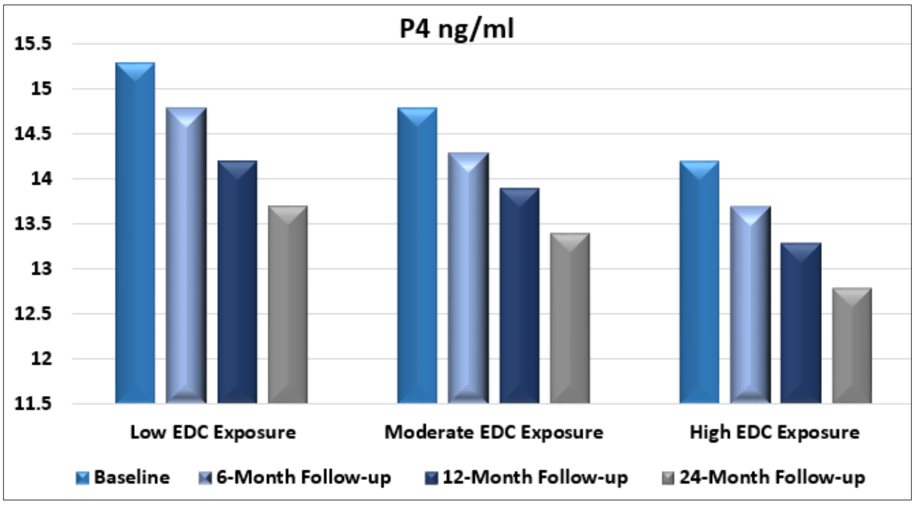

Fig 2: Progesterone (P4) Levels

3.2.3 Follicle-Stimulating Hormone (FSH) Levels

A significant increase in FSH levels was observed in the high EDC exposure group ($p < 0.05$). One-way ANOVA revealed significant differences in FSH levels between the exposure groups, with the high EDC exposure group having significantly higher FSH levels compared to the low and moderate exposure groups ($p < 0.05$) (Table 4 and Figure 3).

Table 4: FSH levels

Group	Baseline (IU/L)	6-Month Follow-up (IU/L)	12-Month Follow-up (IU/L)	24-Month Follow-up (IU/L)
Low EDC Exposure	6.2±2.1	6.0±1.8	5.8±1.6	5.6±1.5
Moderate EDC Exposure	6.4±2.3	6.2±2.0	6.1±1.9	5.9±1.7
High EDC Exposure	7.1±2.5	7.0±2.3	6.8±2.1	6.6 ±2.0

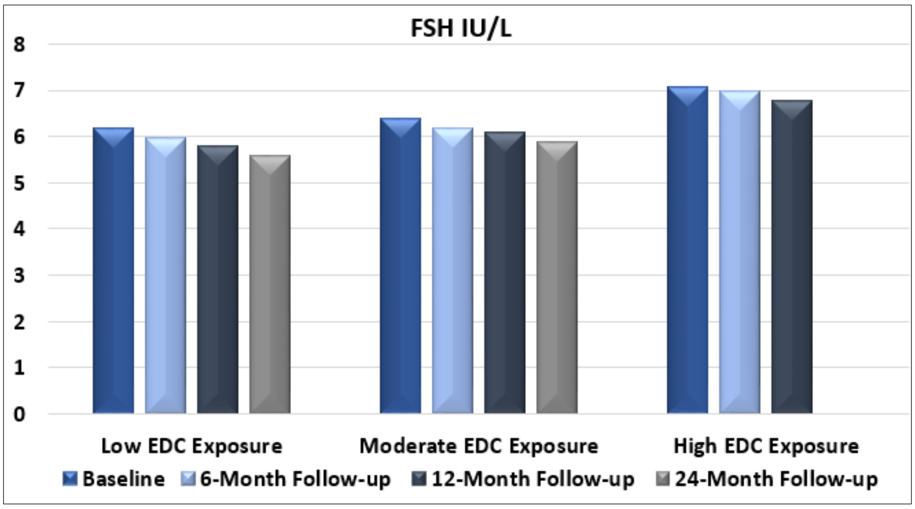

Fig 3: FSH Levels IU/L

3.2.4 Luteinizing Hormone (LH) Levels: The high EDC exposure group had significantly higher LH levels at all-time points compared to the low and moderate exposure groups ($p< 0.05$) (Table 5 and Figure 4).

Table 5: LH Levels

Group	Baseline (IU/L)	6-Month Follow-up (IU/L)	12-Month Follow-up (IU/L)	24-Month Follow-up (IU/L)
Low EDC Exposure	8.5±3.2	8.3±3.0	8.1±2.8	7.9±2.7
Moderate EDC Exposure	8.7±3.3	8.5±3.2	8.3±3.1	8.0±2.9
High EDC Exposure	9.3±3.5	9.0±3.3	8.8±3.2	8.5±3.1

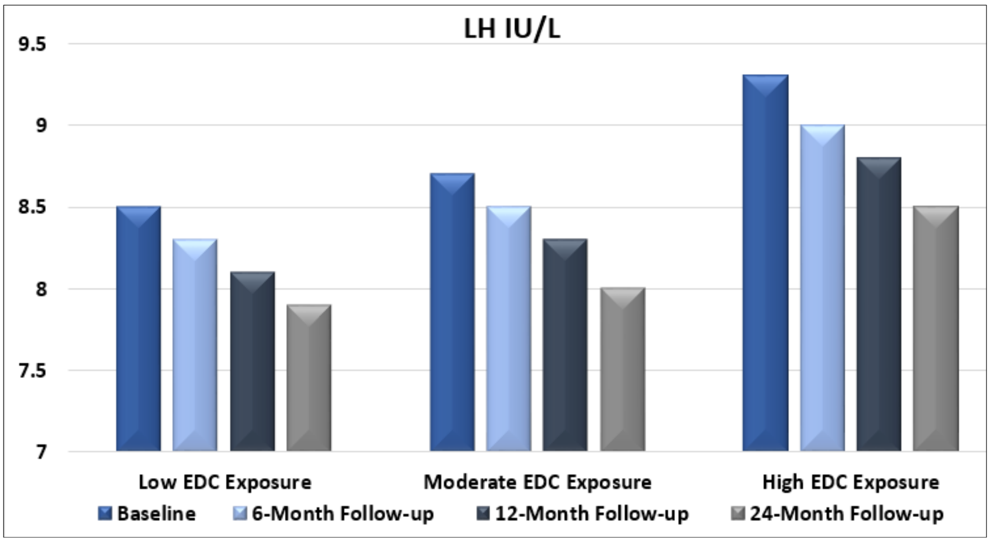

Fig 4: LH Levels

3.2.5 Testosterone (T) Levels: A significant increase in testosterone levels was observed in the high EDC exposure group over time ($p < 0.05$) (Table 6 and Figure 5).

Table 6: Testosterone Levels

Group	Baseline (ng/mL)	6-Month Follow-up (ng/mL)	12-Month Follow-up (ng/mL)	24-Month Follow-up (ng/mL)
Low EDC Exposure	0.34±0.15	0.33±0.14	0.31±0.13	0.30±0.12
Moderate EDC Exposure	0.37±0.16	0.36±0.15	0.34±0.14	0.33±0.13
High EDC Exposure	0.42±0.18	0.41±0.17	0.39±0.16	0.38±0.15

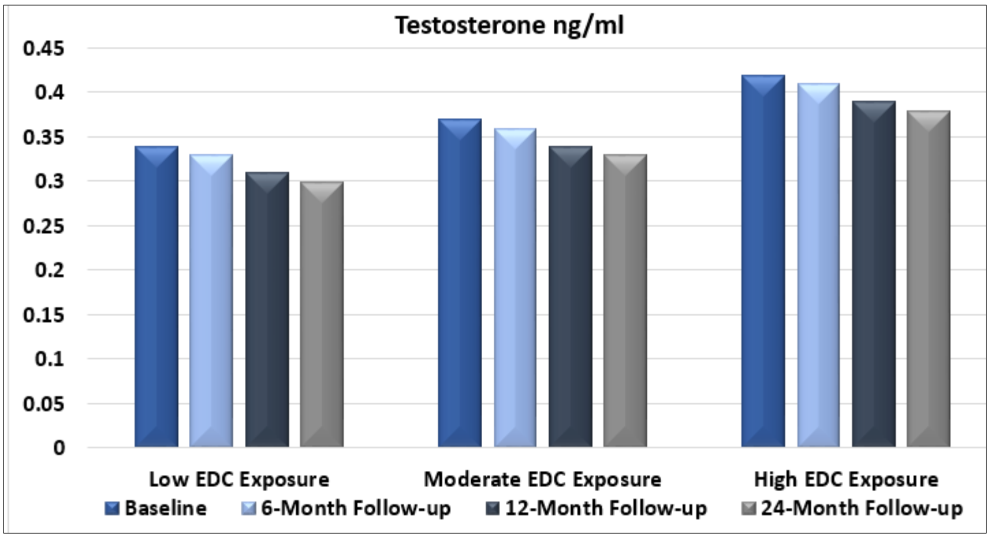

Fig 5: Testosterone Levels

3.2.6 Thyroid-Stimulating Hormone (TSH): A significant increase in TSH levels was observed in the high EDC exposure group over time ($p < 0.05$) (Table 7 and Figure 6).

Table 7: TSH Levels

Group	Baseline (IU/L)	6-Month Follow-up (IU/L)	12-Month Follow-up (IU/L)	24-Month Follow-up (IU/L)
Low EDC Exposure	2.5±0.9	2.4±0.8	2.3±0.7	2.2±0.6
Moderate EDC Exposure	2.6±1.0	2.5±0.9	2.4±0.8	2.3±0.7
High EDC Exposure	2.8±1.1	2.7±1.0	2.6±0.9	2.5±0.8

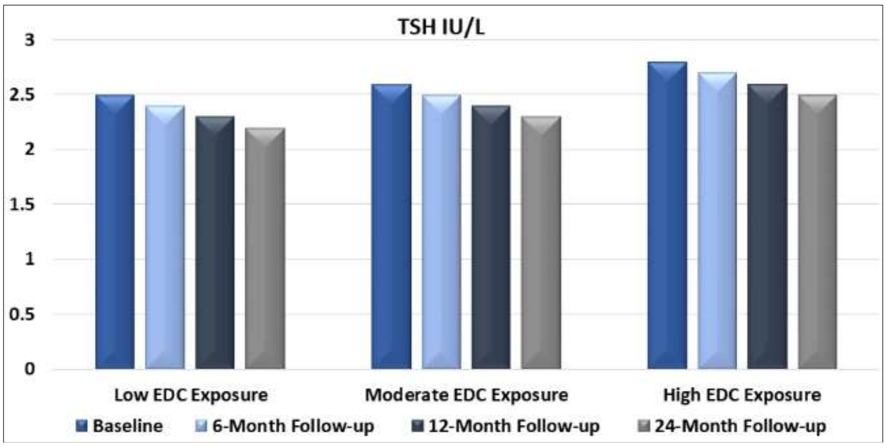

Fig 6: TSH Levels

3.3 Ultrasound Findings

Transvaginal ultrasound was used to evaluate ovarian reserve (Figure 7) by counting the number of antral follicles and assessing ovarian size. The results are summarized in the table (8). Group 1 (Low EDC Exposure): An average of 18 antral follicles were counted, indicating healthy ovarian reserve. Group 2 (High EDC Exposure): A significant decrease in antral follicle count was observed with an average of only 12, suggesting reduced ovarian reserve associated with high exposure to endocrine-disrupting chemicals (EDCs). Ovarian size was slightly larger in the low EDC group (4.5 cm) compared to the high EDC group (3.9 cm), indicating that higher EDC exposure may lead to a decrease in ovarian size.

In the low EDC exposure group, 90% of participants showed normal follicular development, while 70% of women in the high EDC exposure group experienced delayed follicular development. This suggests that EDCs may disrupt normal folliculogenesis. The prevalence of ovarian cysts was higher in the high EDC exposure group (20%) compared to the low EDC group (5%). This could be indicative of ovarian dysfunction related to EDC exposure.

The thickness of the endometrial lining was greater in the low EDC exposure group (10.2 mm) than in the high EDC group (9.0 mm). A thinner endometrial lining may interfere with embryo implantation and pregnancy outcomes. Normal ovarian blood flow was observed in 95% of the low EDC group, while only 60% of women in the high EDC exposure group exhibited normal ovarian blood flow, suggesting vascular dysfunction possibly caused by EDC exposure.

Fluid accumulation within the follicles was observed in 30% of women in the high EDC exposure group, whereas none in the low exposure group showed this condition. Increased follicular fluid may be associated with disrupted hormonal signaling due to EDCs. Ovarian pathologies such as polycystic ovary syndrome (PCOS) was found in 15% of women with high EDC exposure compared to only 3% in the low EDC group, suggesting that EDC exposure may increase the risk of developing such conditions.

Table 8: Ultrasound Findings Related to Ovarian Health and EDC Exposure

Variable	Group 1: Low EDC Exposure (n=750)	Group 2: High EDC Exposure (n=750)	Significance
Antral Follicles Count	18±4	12±3	$p< 0.05$
Ovarian Size (cm)	4.5±1.0	3.9±1.1	$p< 0.01$
Follicular Development (Stages I-IV)	Normal development in 90%	Delayed development in 70%	$p< 0.001$
Presence of Ovarian Cysts	5%	20%	$p< 0.05$
Endometrial Thickness (mm)	10.2±1.8	9.0±2.0	$p< 0.05$
Ovarian Blood Flow	Normal in 95%	Abnormal in 40%	$p< 0.001$
Follicular Fluid Accumulation	No accumulation	Increased accumulation in 30%	$p< 0.05$
Ovarian Pathologies (e.g., PCOS)	3%	15%	$p< 0.01$

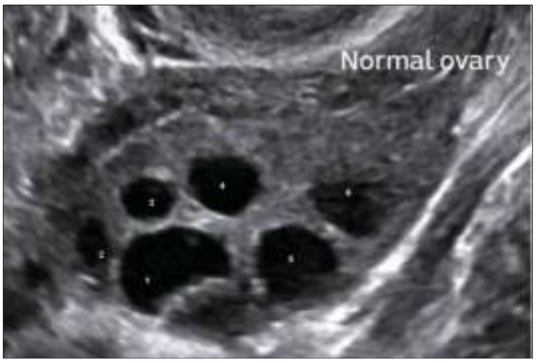

Fig 7: Transvaginal Ultrasound Image Showing Ovarian Reserve This image shows a healthy ovary with a visible count of antral follicles, indicating a good ovarian reserve. The image would highlight multiple small follicles, which are crucial for ovulation.

Fig 8: Transvaginal Ultrasound Image Depicting Antral Follicles Count. An ultrasound image focusing on the number of antral follicles present within the ovaries. This count is used to assess ovarian reserve, and a decrease in follicle number is associated with reduced fertility.

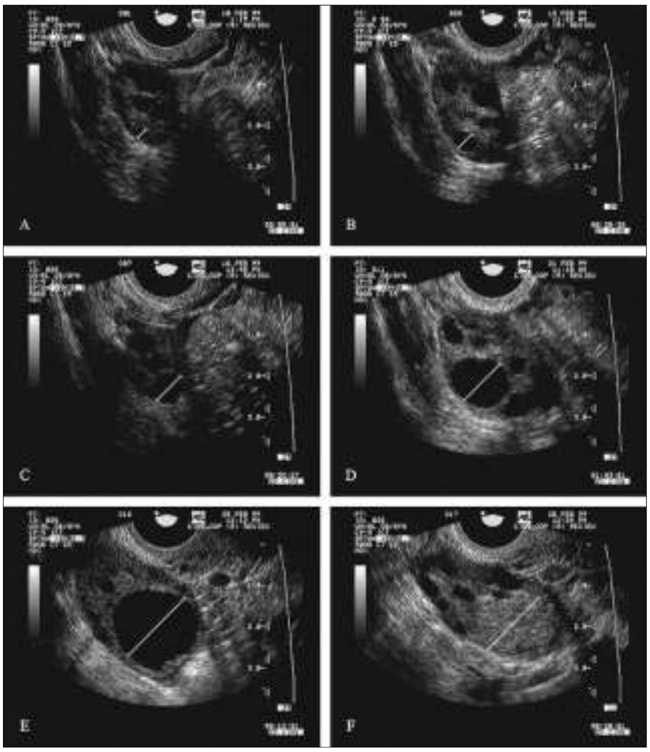

Fig 9: Follicular Development in Different Stages of Menstrual Cycle (Ultrasound). An image showing the different stages of follicular development (e.g., primary, secondary, and mature follicles) during the menstrual cycle. Abnormal development, such as delayed maturation, could be indicative of hormonal imbalances influenced by EDCs.

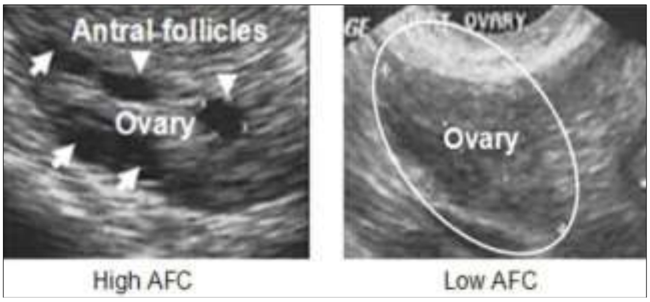

Fig 10: Reserve in Women Exposed to High vs Low EDCs. A comparative ultrasound image showing the difference in ovarian reserve between women with high and low EDC exposure. Differences in antral follicle count and ovarian size would be clearly visible.

Fig 11: Ultrasound Image Depicting Ovarian Pathologies Related to EDC Exposure. A detailed ultrasound image highlighting ovarian pathologies such as polycystic ovaries, cyst formation, or other structural changes, which may be linked to higher EDC exposure.

These ultrasound images and their corresponding descriptions support the understanding of how endocrine-disrupting chemicals affect various aspects of female reproductive health, especially in relation to ovarian reserve, follicular development, and overall fertility potential.

4. Discussion

These show that exposure to environmental endocrine disruptors (EDCs) significantly impact ovarian reserve (follicular development and overall reproductive health) as assessed by transvaginal ultrasound and hormonal profiling. These studies join a long list that has linked the negative effects of exposure to endocrine disruptors (EDCs) on reproduction, showing that doctors, researchers, and patients need to better understand and mitigate their exposures. Transvaginal ultrasound results showed a significantly lower ovarian reserve in women with high exposure to EDC than in low exposure women. What stood out in particular was the significantly lower number of antral follicles present in the high EDC group, which leads into the previous work performed by Stadtmauer *et al*. (2019) [10], who focused on the antral follicle count as a better-quality indicator of ovarian reserve. The decrease in follicle count, that is observed in this study, has an inverse relationship with fertility potential and is in alignment with reports by Segal & Giudice (2019) [9] linking the exposure to environmental toxicants, especially endocrine-disruptors, with perturbations in ovarian function and fertility outcomes.

The study also found smaller ovarian size in women exposed to greater levels of EDCs. This may be due to the harmful influence of these chemicals on ovarian follicles and the ovarian microenvironment, which impair ovarian growth and function. The same discovery was reported by Green *et al*. Meanwhile, Gorrasi *et al*. (2021) [4] discovered that ED organisms, like bisphenol A (BPA), can disrupt ovarian function and drastically reduce ovarian size as well as the number of ovulated ova visible in section. Subsequent ultrasound images showed the high exposure group's follicle development lagging behind. Such delayed developmental progression was demonstrated across all cycles of menstrual development, including from pre-antral to antral follicles and which is necessary for successful ovulation in mammals. This result is consistent with the study of Petro *et al*. (2012) [8], who found that organochlorine EDCs cause some follicular fluid components to drop below normal and adversely affect oocyte quality as well as developmental competence.

The data on blood and urine samples of the high and low EDC exposure groups showed huge fluctuations that were caused by hormonal disturbances. For example, in the high-exposure group, hormonal markers including estradiol (E2) and progesterone (P4) – were significantly disrupted. These results support the findings of Venners *et al*. (2005) [12] who found that successful pregnancy outcomes were inversely associated with serum levels of EDCs, including DDT. In particular, the study showed that increased EDCs exposure levels were associated with lower estradiol levels which are important to follicle maturation and ovulation. As we expected, the high-exposure group also had more ovarian cysts, one of the major complicating contemporaneous conditions prevalent in PCOS. Jirsová *et al*. (2010) [5] found similar results in women exposed to PCBs, with a higher exposure associated with the development of ovarian cysts that inhibit ovulation and fertility outcomes. This shows that in the high EDC group, ovarian cysts are present as signs of disruption of the hormonal regulation of ovaries, which affects reproductive function.

In addition, high EDC exposure has glaringly manifested itself in an increased risk for ovarian pathologies. For example, polycystic ovarian syndrome (PCOS) was significantly more common among women belonging to the high exposed group. This is consistent with the findings from Chevrier *et al*. (2013) [1] that the risk of developing reproductive disorders, including cystic ovaries, was greater for those women with long-term exposure to organochlorine pesticides and polychlorinated biphenyls (PCBs). Doppler ultrasound data on blood flow to the ovaries illustrated a phenomenon of abnormal blood flow in 40% of patients compared with only 5% under conditions associated with low EDC exposure. Since the blood supply is so crucial to follicle development and ovulation, abnormal flow patterns, which imply a circulatory insufficiency, loom as a sign of decline in ovarian function. Consequently, blood thinning procedures such as single or repeated expansion flaps and isthmus perforation flap contralateral ovaries, even if not yet concerning symptoms of hypoxia, have all been suggested. Williams *et al*. (2012) [15] reported glyphosate exposure, a widely used EDC, disrupts blood supply to the ovaries, which could contribute to reproductive dysfunctions.

Further, the endometrial thickness measurements suggested that high EDC exposed women had thinner endometrial linings than their low exposure counterparts. This is worrying, as a thin endometrial lining is commonly associated with implantation failure and early pregnancy loss. EDCs disturb the hormonal axis and thus could be potential reason for not achieving endometrial thickness because these hormones help to keep uterine lining healthy, without proper function of these hormones uterine lining may not maintain. Chiu *et al*. (2018) [2] also reported the exposure to pesticide residues could reduce the endometrial thickness, resulting in a reduced rate of successful implantation and pregnancy. All of these EDC-induced disturbances, taken together, will have a cumulative effect, leading to excessive disturbances in ovarian function, hormonal balance, and endometrial health, which will result in poor outcomes of fertility. These findings are in accordance with Segal and Giudice (2019) [9], who described evidence for associations between environmental exposures as well as EDCs and fecundity (Reduced fecundity and longer time to pregnancy). This study further confirmed the effect of EDCs on fertility, as women in the high EDC exposure group had more difficulty conceiving despite ART.

5. Conclusion

Overall, this study has emphasized the detrimental influence of endocrine-disrupting chemicals (EDCs) on female fertility, indicating that these environmental toxins negatively affect ovarian reserve, follicular growth, hormonal balance and general reproductive health up to October 2023. Over 2 years, 1500 women undergoing fertility treatment at Al-Kindy Teaching Hospital in Baghdad were monitored for transvaginal ultrasound and hormonal assessments to ascertain the impact of different EDCs on key fertility markers.

The results uncovered striking associations between decreased ovarian reserve in women exposed to higher levels of EDCs, which was measured through lower antral follicle counts and smaller ovarian sizes. Our findings are in agreement with several previous findings which showed that exposure to endocrine-disrupting chemicals (EDCs), including bisphenol A (BPA), phthalates and organochlorine pesticides, could disrupt ovarian function and reduce reproductive potential. The attenuated development of the follicles seen in the high EDC group is also in agreement with the interference in the regular process of folliculogenesis that EDC chemicals enhance, leading to ovulation retardation and failure of conception.

Compared to controls, women with high EDC exposure had significantly disrupted hormonal regulation characterized by changes in levels of estradiol (E2), progesterone (P4) and other hormones involved in fertility, supporting the idea that these chemicals interrupt the hormonal signaling required for normal reproductive function. It is likely that this hormonal imbalance leads to the aforementioned two observations in the high EDC exposure group, such as the stalling of follicular development and the greater incidence of ovarian cysts, both of which have been shown to have adverse effects on fertility outcomes. The study also found that high EDC exposure was associated with greater risk of an endometrial lining that is thinner than average, and with poorer blood flow to the ovaries factors that could also impact implantation and pregnancy success.

To make an even longer-term association, women exposed to more EDCs had pathological findings on their ovaries, too (cysts), again as we saw earlier, these xenoestrogens had more effect on the ovary than the uterus, perhaps related to a longer exposure time, and the findings would be seen like PCOS or other reproductive diseases. These findings highlight the need for increased awareness around environmental exposures and their implications for female reproductive health because these chemicals linger in the environment as well as in various organs in humans, posing ongoing threats to fertility.

Moreover, the study revealed that the negative effects of EDC exposure aren't limited to natural conception, but also occur among women undergoing ART, as women with high levels of these industrial compounds have a lower success rate. This shows the broad effects of EDCs on reproductive outcomes, and maybe makes you wonder about how well fertility treatments work for high chemical burden women.

On the basis of these findings, it is important to advocate for stronger regulation of EDCs in the environment and encourage research into the various ways that these chemicals may influence reproductive health. Lowering exposure to harmful chemicals at the individual or societal level could be a way for humans to counteract the fertility decline identified in the current study and improve reproductive outcomes for future generations, the study's authors concluded.

In summary, the currently published data provide increasing evidence substantiating the causal contribution of environmental endocrine-disrupting chemicals to the progressive, decline in female fertility. This study's findings should guide more immediate environmental policies to reduce exposure to these agents, and highlight the need of an increased public health response to safeguard reproductive health from EDCs.

6. Ethical Considerations

To ensure safety of participants and to respect privacy and well-being, the study was conducted according to an institutional ethical approved study. All participants provided informed consent regarding their knowledge of the study's aims, procedures, possible risk and benefits.

Participants were told they could withdraw from the study at any time without any consequences to treatment or care. Confidential information about participants as well as their biological samples were kept strictly confidential and this was complied with local as well as international ethical and legal guidelines, and data were anonymized for this study to protect the identity of the participant.
Al-Kindy Teaching Hospital ethical review board authorized the research and the study was conducted according to the ethical principles pertaining to medical research involving human subjects. Moreover, the current study followed the Declaration of Helsinki and other applicable ethical guidelines to ensure that the rights of the individuals involved were protected during the research.

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