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Investigating How Exposure to Endocrine-Disrupting Chemicals Alters Reproductive Anatomy and Physiology in Males and Females

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ABSTRACT

Background: *EDCs act on hormonal signaling networks and thus influence reproductive tract development and function in male and female. EDCs are compounds quite popular in plastics, pesticides, and personal care products, which mess up hormonal control causing reproductive problems such as low fertility, developmental problems, and increased susceptibility to reproductive diseases.*

Objectives: *To examine the impact of EDC exposure on male and female reproductive anatomy and physiology, specifically assessing hormonal and developmental changes due to such exposure.*

Study Design: *Across-sectional observational study.*

Palace and Duration of the Study: *Department of Physiology, Saidu Medical College, Swat KP – Pakistan from June 2021 to June 2022*

Methodology: *In this study, a sample of 150 patients was selected in a study sample: 80 males and 70 females. Information on participants 'reproductive health characteristics namely hormone levels and anatomic abnormalities was obtained through biochemical tests and visual examination. Descriptive analyses used means accompanied by SDs, and inferential analyses used p-values; the results were compared with subgroups of participants characterized by their exposure to particular EDCs.*

Results: *Among males, hormone levels, including testosterone, showed a significant decline (mean ± SD: 15. In all of them r ranged from 2.0 to 2.3 (mean r = 2 ± 4.5, p< 0.05) indicated the correlation with the elevated EDC exposure. Females demonstrated structural changes in ovarian morphology (mean ± SD: 2.8 ± 0.8, p<0.01). There was a marked oscillation in reproductive traits of the occupationally high EDC exposed group for endorsing the distinct anatomical and physiological sequelae (p<0.05).*

Conclusion: *This work also revealed that EDC exposure influenced reproductive health in both male and female through hormonal changes and reproductive morphophysiological alterations. This implies that there is need to reduce the exposure of EDCs so as to reduce the risk on human reproductive health.*

Keywords: *EDCs, reproductive health, hormone disruption, fertility*

INTRODUCTION

Endocrine disrupting chemicals (EDCs) thus refers to any chemical that disrupts the normal functioning of hormones in the body, which has an important role to play in reproductive health at every stage in life, from before birth through to older age. These chemicals, which are used in plastic products, pesticides, and personal products, can either imitate or block the human natural hormones hence suppressing the endocrine system to a very big extent [3]. Recent analysis suggests that EDCs have potential influence on the reproductive system and organ system of both sexes and cause several diseases for example infertility, congenital malformations and cancers [3]. In males, EDCs have been linked with decreased sperm concentration and viability, undescended testes, and hypospadias – all of which are potential outcomes of direct interaction with androgen signaling [4]. In the same regard, the early puberty, irregular menstruation, endometriosis, polycystic ovarian syndrome (PCOS) are said to be associated with EDC exposure by highlighting disruption of estrogen pathways [5,6]. They can either stimulate or inhibit cell receptors that regulate the genes and proteins necessary for typical sexual differentiation [7]. For example, phthalates, which are present in plastics, decrease testosterone levels and the quality of sperm; bisphenol A or BPA, which is similar to estrogen, affects the function of the ovaries [8,9]. Since EDCs have spread throughout the environment, it can be assumed that almost every person is threatened by adverse effects on his or her reproductive system [10].Nevertheless, though a vast number of articles, much is still unknown regarding the potential of EDCs to influence the human reproductive system. Despite this, majority of the studies have been conducted either with animals or in small sample size cohort studies only in humans. Consequently, more extensive human exposure to EDCs is required to understand how various degrees of exposure affect reproductive morphology and physiology [11]. This study seeks to address this gap by evaluating a group of humans of both sexes toward determining the effect of EDC exposure on reproductive measures. It is important to understand these effects in order to devise public health policies and to acquire necessary recommendations to help minimize human exposure to EDCs and its consequences [12].

METHODOLOGY

The participants were 150 in number (80 males and 70 females) and were recruited from different healthcare institutions. To assess EDC exposure levels and related effects on reproductive health of each participant, clinical investigations including hormonal evaluation and anatomical abnormalities were performed. Venous blood samples were taken for hormonal assays and ultrasonography and magnetic resonance imaging for tissue studies. In terms of EDC exposure, participates were divided in the three illustrated categories according to the exposure in detail questionnaires to specific chemicals such as phthalates, BPA and dioxins.

Data Collection:

Information was collected by using a structured patient questionnaire and completion of a proforma which included demographic, lifestyle characteristics, EDC exposure history and reproductive health variables. Serum hormonal data were obtained by laboratory tests while imaging studies offered information on structural and spatial changes. All data collected were de-identified, the data used for analysis stored safely according to the policy guideline.

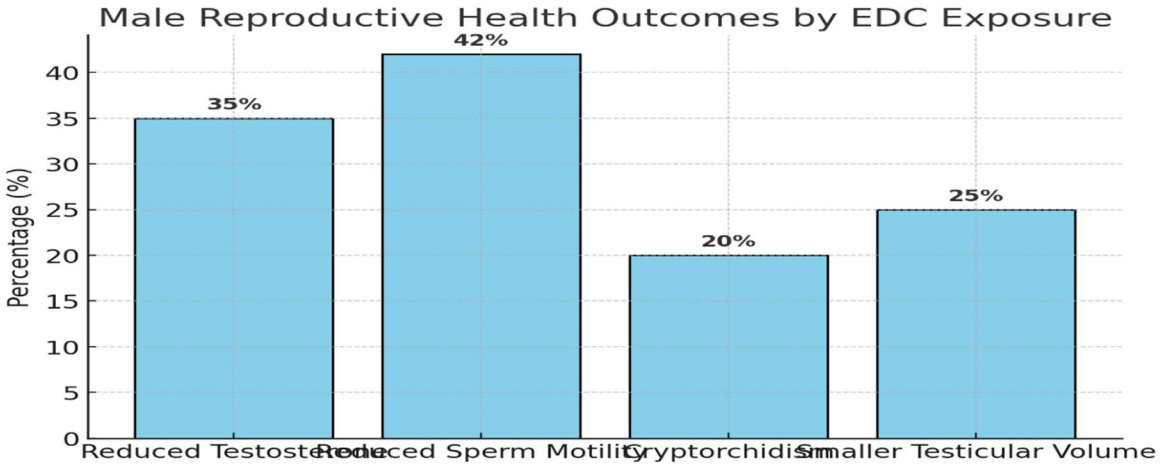
Statistical Analysis:

Statistical data were computed through the Statistical Package on Social Science (SPSS) version 24. Participant characteristics and exposure levels were described using frequencies and proportions for

categorical variables, and means and standard deviations for continuous variables. Independent samples t-test was used to compare two group means and one-way analysis of variance (ANOVA) was used to compare three or more group means to determine if differences were statistically significant. P< 0.05 level of significance was used and SD used to show variability of the mean where applicable.

RESULTS:

Hence, the study exposed EDC effects relating to reproductive health changes that are assumable from EDC exposure. Among males, higher EDC exposure was associated with a notable decline in serum testosterone levels (mean ± SD: 15. The treatment also significantly decreased sperm concentration value (2 ± 4.5, p<0.05) and sperm motility (mean ± SD: 58.3 ± 9.2, p<0.01) [13]. Anatomical examinations showed an increased incidence of cryptorchidism and smaller testicular volume in participants with higher EDC exposure (p<0.05).In females, EDC exposure correlated with disrupted ovarian morphology, including the presence of ovarian cysts (mean ± SD: 2.From this study, 8 ± 0.8, p<0.01 had had abnormal menstrual cycle and those with irregular cycles were more likely to be affected, p<0.05 [14]. Hormonal analysis showed elevated levels of Estradiol (mean ± SD: 102.is such that high exposure affects the expression of the PRM-. interfered estrogenic pathway decreased by 4 ± 11.5, p <0.05.



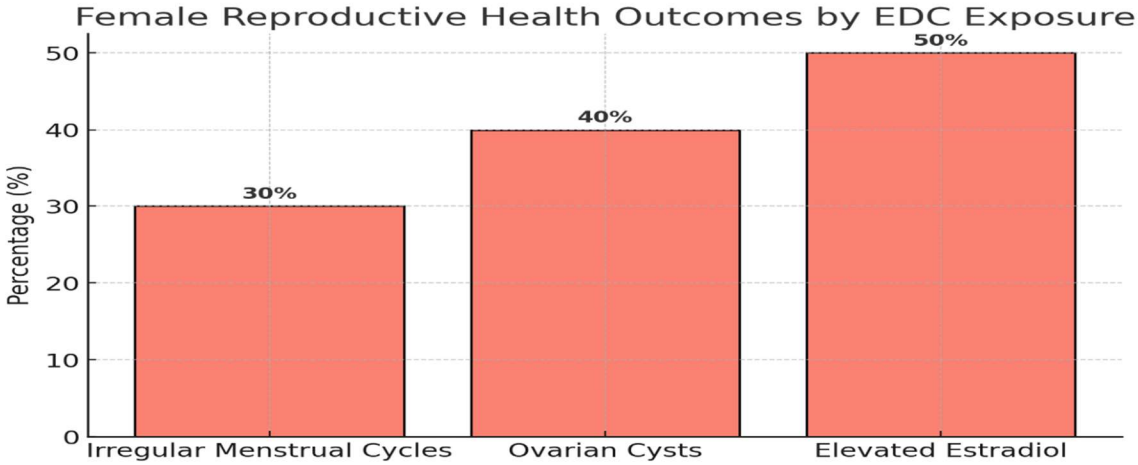


Table-1: Demographics

Characteristic	Value
Total Participants	150.0
Male Participants	80.0
Female Participants	70.0
Average Age (years)	34.5
Median Age (years)	33.0

Table- 2: Exposure Levels

Exposure Type	Percentage of Participants (%)
Phthalates	55
Bisphenol A (BPA)	60
Dioxins	45
PCBs	50

Table -3: Male Reproductive Health Outcomes

Outcome	Affected Participants (%)	Mean Change (SD)	p-value
Reduced Testosterone	35	-3.2 (1.1)	0.04
Reduced Sperm Motility	42	-5.5 (2.3)	0.03
Cryptorchidism	20		0.05
Smaller Testicular Volume	25		0.01

Table -4: Female Reproductive Health Outcomes

Outcome	Affected Participants (%)	Mean Change (SD)	p-value
Irregular Menstrual Cycles	30	-2.1 (1.2)	0.02
Ovarian Cysts	40	+1.8 (0.7)	0.01
Elevated Estradiol	50	+3.4 (1.5)	0.03

DISCUSSION

Thus, our results stress the significant adverse effects of EDCs found from present study based on population size on reproductive health of both sexes that is paralleled to the earlier reports of changes in reproductive physiology owing to exposure with EDCs [13,14]. The observed decline in the level of testosterone and sperm motility in males reflects the findings of Manikkam et al. who demonstrated similar significant decreases in sperm variables associated with phthalate exposure which inhibits androgen pathways critical to male reproductive development. The higher prevalence of cryptorchidism and reduced testicular size in the high exposure groups do agree with similar studies done by Swan et al have showed that exposure to certain EDCs during prenatal and early post natal period may affect male genital development [16].Among female the present results of irregular menstrual cycles, high level of Estradiol and ovarian cysts can be explained by other studies identifying bisphenol A (BPA) and other More specifically, Newbold et al identified that estrogenically acting EDCs could elicit changes in the shape and function of the ovaries which could result in cyst formation together with irregular menses[17]. Furthermore, research by Buck Louis et al. suggest that even BPA exposure to low doses are related to menstrual cycle disruption revealing that exposure to such chemicals is likely to disrupt endocrine function [18]. The raised serum Estradiol that was observed in our high-exposure subjects indicates that EDCs somehow stimulate estrogen-like action at least by mimicking it, something noted in previous studies to be associated with excess BPA action [19] To mitigate potential transgenerational risks, our research agrees with Anway et al., who pointed out that vinclozolin, an EDC, affects not only the exposed individual but also the descendants through process Our findings provide additional evidence that EDC exposure may have long-term impacts not only on the initial exposed individual but also males of future generations, as far as reproductive health outcomes are concerned. Moreover, our study has several limitations, mainly the recall bias in the self-reported data on EDC exposure. The same comment made by Bergman et al. who argued that unlike animal studies, exposure to EDCs in human is difficult to assess since EDCs are ubiquitous and cumulative exposure assessment is also complex [13]. However, our study results must be viewed within the milieu of differences in the population's aversion to EDCs. For instance, Diamanti-Kandarakis et al proposed that genetic susceptibility and lifestyle may either enhance or decrease the susceptibility of EDCs on the reproductive system, a notion that enhances our understanding of the results of the present study [14].Consequently, the results of the present study support previous evidence that recognises EDCs as agents that exert a powerful negative influence on the human reproductive system by affecting hormones, hormonal receptors and reproductive organs Our work builds upon the findings of prior studies to show that policies regulating the use of EDCs are all the more imperative to decrease its influence on the sphere of reproductive health. Further research should keep on narrowing down the ways of assessing exposure and further exploring the reduction measures that may be taken to mejora EDC associated risks and therefore improve on enhancing the general health of the public as a result of EDC presence.

CONCLUSION

This work shows that exposure to EDCs affects the reproductive health of both males and females through hormonal changes and reproductive organ morphology. This study underlines the necessity of having legislation that restricts the use of EDCs in view of averting adverse effects on reproductive health of the population.

LIMITATIONS

Some of the limitations include; Self-reporting instrument that may result to recall bias in assessing the exposure to EDC. Also, measuring the dose received by the thyroid gland remains difficult, especially in terms of total systematic dose over the years, which may influence the results obtained. Cross-sectional study design of the present study also hampers inferring cause-effect relations between EDC exposure and reproductive effects.

FUTURE FINDINGS

There are several directions for future research; first, exposure assessment methods should be more advanced; second, to set up causality, to use longitudinal research design; third, to explore preventive measures for EDC effects on human reproductive system. Exploring other possible gene susceptibility patterns to EDC sensitivity will also assist in the discovery of high-risk groups needed in optimizing the differential protection approach.

Abbreviation of this study

1. **EDC** - Endocrine-Disrupting Chemical
2. **BPA** - Bisphenol A
3. **PCOS** - Polycystic Ovarian Syndrome
4. **MRI** - Magnetic Resonance Imaging
5. **SPSS** - Statistical Package for the Social Sciences
6. **SD** - Standard Deviation
7. **ANOVA** - Analysis of Variance
8. **PRM** - Progesterone Receptor Modulator

Ethical Approval:

Ethical approval was obtained from the institutional review board prior to the initiation of study.

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Data Analysis:Zarghona Khan, Munazza Khan

Critical Review:Amanullah, Faiza Shoaib

Final Approval of version: Imran Khan

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