

Histologic Assessment of Polyvinyl Chloride on the Uterus of Adult Wistar Rats

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ABSTRACT

Backgrounds: Polyvinyl chloride (PVC), has emerged as a significant environmental concern with potential impacts on reproductive health. The uterus, a critical organ for female fertility and embryo development, may be vulnerable to microplastic exposure. This study investigated the histological effects of orally administered PVC microplastics on the uterus of adult Wistar rats.

Methods: Fifteen adult female Wistar rats (150-200g) were randomly divided into five groups: A: control group, B: negative control group receiving cyclohexanone at 0.1 mg/kg, and C, D and E: Test groups receiving PVC at 0.1, 0.2, and 0.3 mg/kg. Animals were euthanized after 21 days of administration. Uterine tissues were harvested, fixed immediately in 10% formal saline and processed under a histological procedure.

Results: Histological examination revealed distorted uterine architecture across all PVC-treated groups.

Conclusion: Findings from the current study, showed that PVC-MPs impacted the histoarchitecture of the uterus and prolong and daily exposure can initiate fertility issue in the future, thereby preventing pregnancy in its totality.

KEYWORDS: Histologic, Polyvinyl chloride, Uterus, Wistar rats

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INTRODUCTION

Polyvinylchloride microplastics (PVC-MPs) is a synthetic polymer with the chemical formula $(C_2H_3Cl)_n$, known for its high resistance to chemicals, corrosion, water, and weather conditions¹. PVC is the third most widely produced synthetic polymer globally, with approximately 40 million tons produced annually². PVC is valued for its strength, durability, lightweight nature, and versatility, making it widely used in applications such as food packaging, plastic films, containers, water pipes, and medical supplies³. However, PVC use are associated with environmental and health concerns, including the release of volatile organic compounds², leaching of phthalates and other plasticisers⁴, emission of carcinogenic vinyl chloride monomers⁵, and accumulation of PVC additives³.

In 2015, the United Nations acknowledged microplastic pollution as a critical environmental and ecological issue⁶. These pollutants are detected in various environments worldwide, including land, rivers, soil, and air⁷. Humans are

vulnerable to microplastics directly through drinking water, sea salt, and air, and indirectly via feeding⁸. The disposal and growing use of plastics are driven by their reliance on major sectors such as agriculture, engineering, and cosmetics, which generate major amounts of waste daily⁹. Previous and recent research has demonstrated that microplastic pollutants can disrupt normal reproductive system functioning. Studies have shown that MPs can cause various detrimental effects in both males and females, with an obvious influence on the female reproductive system, ultimately leading to reduced fertility¹⁰. In males, polystyrene MPs can initiate testicular inflammation, decrease viable epididymal sperm count, increase sperm deformities, impair sperm motility, and compromise DNA integrity.^{11,12} In female mice, polystyrene microplastics have been found to induce pyroptosis and apoptosis of ovarian granulosa cells, resulting in larger

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ovaries with fewer follicles, reducing the number of embryos produced, lowering pregnancy rates, altering sex hormone levels, and causing oxidative stress.^{13,14} MPs intake can adversely affect the uterus, a crucial organ in the female reproductive system. Some studies have shown that MPs presences in the uterus can lead to pathological changes, including a thinner endometrium, reduced uterine glands, and decreased endometrial adhesion.^{7,15}

While there are growing concerns about the impact of plastics and microplastics on the reproductive system, the effects on the uterus remain poorly understood. The rising rate of infertility in females, caused by MPs intake^{16,17}, emphasises the need of detailing the effects of PVC consumption on fertility, especially on the uterus, which is crucial for reproduction and embryo development. Therefore, this study aimed to investigate the histological assessment of PVC microplastics on the uterus of adult Wistar rats.

METHODS

Ethical Consideration

Ethical clearance was obtained from the Research and Ethics Committee in the Faculty of Basic Medical Sciences of Delta State University before the commencement of this research. All experimental procedures were conducted in accordance with institutional guidelines for animal care and use.

Experimental Design

Fifteen female Wistar rats weighing 150 to 200g were obtained from the animal unit of the College of Health Sciences, Delta State University, Nigeria. They were acclimatised for a week and were kept under standard laboratory conditions. The animal models were randomly divided into 5 groups:

Group A (Control): Two rats receiving standard feed and water only.

Group B (Negative Control): Two rats receiving cyclohexanone 0.1mg/kg.

Group C (Test Group 1): Two rats receiving 0.1 mg/kg of PVC

Group D (Test Group 2): Two rats receiving 0.2 mg/kg of PVC

Group E (Test Group 3): Two rats receiving 0.3 mg/kg of PVC

Sample Collection and Histological Processing

After 21st day of administration, animals were euthanized by cervical dislocation to prevent the possible effects of anaesthetic agents on collected samples. The uterus from each animal was immediately harvested through a midline abdominal incision, dissected carefully to remove surrounding tissues, and immediately fixed in 10% neutral buffered formalin for further histologic analysis.¹⁸

Photomicrography

Prepared slides were viewed and tissue images were captured using digital microscope "CARL ZEISS (Primo Star)" of about 8.3 mega pixel camera connected to computer. Obtained micrographs were interpreted to know the cytologic and histologic outcomes of PVC-MPs on the ovaries.^{19,20}

RESULTS

Effect of PVC on the Histoarchitecture on the Uterus of Adult Wistar rats Assessed Using Hematoxylin and Eosin Staining Patterns

The figure below, displayed sections of the uterus lined by simple columnar epithelium, possessing both the endometrium and myometrium. The endometrial lining is made up of ciliated epithelial cells that are supported by a cellular endometrial stroma, which is also lined by the same epithelial cells. The myometrium consists of well-organized bundles of smooth muscle. Specifically to the test groups, noticeably seen are occasionally displayed mild degenerative changes, which are characterized with some level of endometrial hyperplasia and features of endometritis

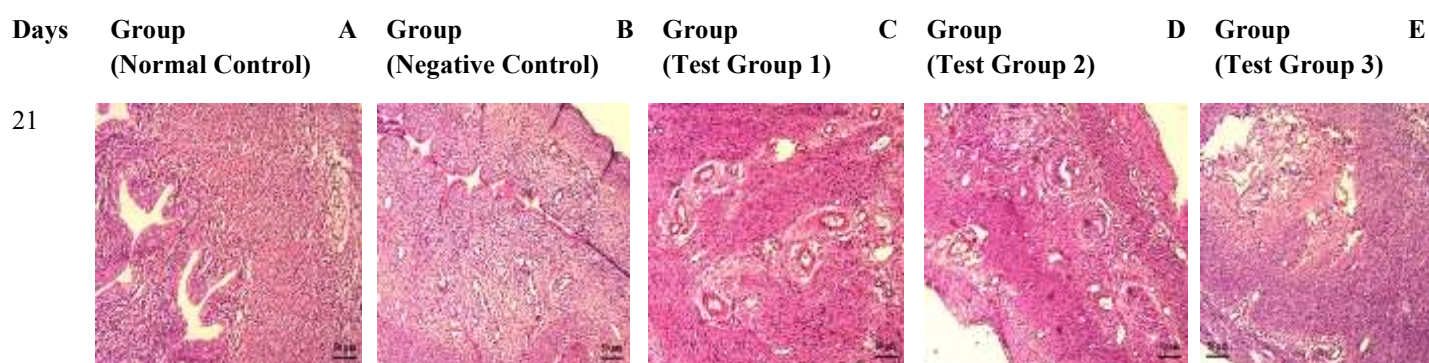


Figure 1. Histologic effects on the uterus of experimental animals exposed to graded doses of PVC-MPs for 21 days. H & E (x100)

DISCUSSION

The administration of PVC-MPs orally for 21 days displayed remarkable alteration to the microstructure of the uterine

tissue. This might be linked with the toxicological property associated with PVC exposure to the uterus. Report from the current study is similar with report conducted by²¹, were an

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observed distortion of the histo-morphology of the uterus was observed. This was associated with distortion in the nuclear property and cellular composition of the uterus. Additionally, findings from this study was also seen to be synonymous with findings of ¹⁶ where polystyrene microplastics was seen to initiate histologic distortion to the uterus which was characterized by degenerative features associated with unhealthy endometrial gland, oedema in epithelial cell. Similarly, ²², in their study buttressed the health risk effect of microplastics deposit in the uterus of mouse, were reduced fertility and abnormal sex ratio in mouse offspring was observed. Hence the current study therefore depicts the deleterious outcomes of PVC-MPs on the histology of uterus. Furthermore, similar study conducted by ⁷, also display a similar report as that in the current study, stating the distorting effect of bioaccumulation of polystyrene microplastics, characterized by increased reactive oxygen species (ROS) in oocytes. The outcome of MPs by-products also display similar histologic response on the uterus as in current study, which are in accordance with study conducted by ²³ were noticeable histologic alteration in the uterus after prolonged vulnerability to MPs based products (like; bisphenol -A) were seen. This is also in agreement with a study conducted by ²⁴, where bisphenol-A was observed to distort the histomorphology of adult rat uterus, specifically, the size of stromal cells was seen to be increased and interstitial spaces were displayed between stromal cells and were observed to be expanded. Thence, its imperative to say that PVC-MPs is deleterious to the uterus of adult Wistar rats, which in turn can initiate fertility related conditions.

CONCLUSION

Findings from the current study, showed that PVC-MPs impacted the histoarchitecture of the uterus and prolong and daily exposure can initiate fertility issue in the future, thereby preventing pregnancy in its totality.

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