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REVIEW

Impact of pesticides on reproductive health: insights from animal and *in vitro* models in both sexes

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This paper forms part of a special collection on the theme of sex effects in endocrine health and disease. The editors for this collection were Sakeneh Zraika, Flavia Bloise and Ruth Andrew.

Abstract

Over the years, environmental exposure to pesticides has significantly increased. Several new pesticides are being developed and approved for use, although their full impact on health and the environment remains unclear. Pesticides interfere with the endocrine system by acting on hormonal pathways, including hormone-receptor interactions and hormonal metabolism. Concomitant with the increasing use of endocrine-disrupting chemical molecules, reduced fertility and reproductive alterations in men and women have attracted increasing attention in recent years. Given the potential of pesticides to impact the reproductive system significantly, we conducted a narrative review of relevant animal studies, including those conducted on humans, and *in vitro* models exploring changes in the male and female reproductive systems associated with exposure to various pesticide classes, such as organochlorines, organophosphates, pyrethroids, carbamates, and neonicotinoids. Key dysfunctions reported primarily in different experimental models include alterations in the hypothalamic–pituitary–gonadal axis, morphological changes in the ovaries and testes, increased numbers of atretic follicles, and reduced sperm motility. Although research in this area has increased, important gaps remain, including inconsistencies in findings, lack of long-term human exposure studies, and limited understanding of the synergistic effects of pesticide formulations. It is crucial to emphasize the impact of pesticide exposure on fertility and encourage further research to elucidate the pathophysiological, morphological, and molecular mechanisms involved, as well as the effects of exposure to mixtures of these pesticides, mimicking the human exposome.

Keywords: endocrine disruptors; pesticides; reproductive dysfunctions; programming reproductive system

Introduction

Endocrine disrupting chemicals (EDCs) are substances that interfere with the mechanism of hormonal action. Direct or indirect exposure to these compounds can have significant effects on the reproductive system of both sexes, altering the physiology and morphology of the gonads and reproductive tract (Pan *et al.* 2023).

The female and male reproductive systems are regulated by a complex system of hormonal interactions called the hypothalamic–pituitary–gonadal (HPG) axis. This system is responsible for coordinating fundamental processes such as the production of gametes, the development of secondary sexual characteristics, and the maintenance of fertility (Xie *et al.* 2022).

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