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Review Article

Microplastics in pregnancy: placental transfer, maternal exposure and adverse pregnancy outcomes: a literature review

Ishita Mehra*, Pooja Goel, Aditya Vikram

Department of Obstetrics and Gynaecology, Amrita Hospital, Faridabad, Haryana, India

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*Correspondence:

Ishita Mehra,

E-mail: drishita08198@gmail.com

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ABSTRACT

Microplastics (MPs) are widespread environmental contaminants detected in human tissues, including the placenta, raising concerns regarding maternal exposure and fetal health. The objective is to review evidence on microplastic presence in pregnancy-related tissues, toxicity mechanisms, and maternal–fetal outcomes. Literature from PubMed, Scopus, Embase, and Google Scholar was reviewed. MPs have been detected in placenta and reproductive tissues. Experimental evidence suggests that microplastics may induce oxidative stress, inflammatory responses and placental injury associated with fetal growth restriction and placental dysfunction. Further prospective studies with standardized methods are required to establish clinical significance.

Keywords: Microplastics, Pregnancy, Reproductive health

INTRODUCTION

Plastic production has increased dramatically over the past few decades, resulting in extensive accumulation of plastic waste in the environment. Continuous degradation of plastic materials generates microplastics (MPs), which are now widely detected in water, food products, seafood, household dust and air. As a result, human exposure to MPs is almost unavoidable and occurs mainly through ingestion, inhalation, and dermal contact. Early research highlighted concerns regarding their potential biological effects, including oxidative stress, inflammation, and cellular damage caused by particle accumulation and associated chemical additives.¹ Subsequent studies demonstrated widespread human exposure through dietary sources and identified multiple environmental pathways contributing to microplastic exposure.^{2,3}

Pregnancy is considered a vulnerable period because environmental pollutants may influence placental function and fetal development. The placenta acts as a critical

interface between maternal and fetal circulation, and exposure to contaminants capable of reaching this barrier may have implications for pregnancy outcomes.

The identification of microplastics in human placental tissue has significantly changed the understanding of prenatal exposure and has stimulated research into their possible effects on maternal and fetal health. This review aims to summarise current evidence regarding the presence of microplastics in reproductive tissues, possible mechanisms of toxicity, reported pregnancy outcomes, and the major gaps that require further investigation. The objective is to systematically review the current evidence on the presence of microplastics in pregnancy-related tissues, their potential mechanisms of toxicity, and their association with maternal and fetal outcomes.

METHODS

A systematic search of PubMed, Scopus, and Google Scholar was conducted for studies published between

January 2017 and June 2025. Original research articles, systematic reviews, and meta-analyses investigating microplastics in pregnancy or female reproductive tissues were included. Data on study characteristics, methods of microplastic detection, biological mechanisms, and reported pregnancy outcomes were extracted and narratively synthesised.

Inclusion criteria

Combinations of either of the key words “microplastics” with any of the following: “pregnancy”, “placenta”, “umbilical cord”, “pregnancy-related tissues”, “female reproductive organs”, “infant mortality”, “post-neonatal mortality”, “post-neonatal mortality”, “birth weight”, “birth-weight”, “intrauterine growth retardation”, “IUGR”, “premature birth”, “prematurity”, “fetal growth”, and “foetal growth.” The reference lists of identified papers for additional publications.

Exclusion criteria

Abstracts of conference presentations since they did not contain sufficient information.

RESULTS

Twelve key studies published between 2017 and 2025 were included in the review, as summarised in Table 1. Collectively, the evidence demonstrated the presence of microplastics in pregnancy-related tissues and female reproductive organs indicating potential adverse biological effects associated with oxidative stress, inflammation, endocrine disruption, and placental injury. The discovery of microplastics in human placenta by Ragusa et al. in 2021 found pigmented microplastic particles in different regions of placental tissue, including the maternal side, fetal side, and chorio-amniotic membranes.⁴

Braun et al detected microplastics in both placental tissue and neonatal meconium, suggesting that particles may cross the placental barrier and reach the fetus.⁵ The detection of microplastics in human blood by Leslie et al provided evidence that these particles can circulate within the body and potentially accumulate in different tissues.⁶

Liu et al further demonstrated microplastic contamination in pregnancy-related and early-life samples, including placenta, meconium, breast milk, infant feces, and infant formula, highlighting continuous exposure from pregnancy through infancy.⁷

Recent systematic reviews have found microplastics in various female reproductive organs, including placenta, amniotic fluid, ovaries, uterus, and follicular fluid. These suggest that microplastics may cross biological barriers

and accumulate in tissues involved in reproduction and fetal development.^{8,9}

Several mechanisms have been proposed to explain the potential harmful effects of microplastics during pregnancy. Oxidative stress appears to be one of the most consistently pathways. Microplastic exposure increases reactive oxygen species production, resulting in cellular injury, mitochondrial dysfunction, and impaired tissue function.^{1,10}

Inflammation is another important mechanism. Microplastics can stimulate inflammatory responses and cytokine release, which may interfere with implantation, placental development, and maternal immune adaptation during pregnancy.^{9,10} They also contribute to endocrine disruption.

Plastic-associated chemicals, including bisphenols and phthalates, can interfere with hormonal pathways involved in implantation, placental development, fetal growth, and reproductive function.¹⁰ Placental injury due to microplastic exposure may alter placental structure, vascular development, nutrient transport, and barrier integrity, potentially affecting fetal growth.^{8,10}

The study titled Impact of Microplastics on Pregnancy and Fetal Development suggested possible associations between microplastic exposure and placental dysfunction, fetal growth restriction, altered gestational age, and low birth weight highlighting strong association between microplastic exposure and pregnancy outcomes.⁸

Animal research has provided stronger evidence, demonstrating reduced fetal weight, impaired embryonic development, placental inflammation, and structural abnormalities following microplastic exposure.^{8,10} Human evidence, although emerging, remains limited. Research has increasingly extended beyond pregnancy outcomes to examine the effects of microplastics on the female reproductive system.

The 2025 systematic review on microplastics in female reproductive and pregnancy organs reported the presence of MPs in placenta, ovaries, uterus, follicular fluid, amniotic fluid, and cord blood.⁹

Another review focusing on reproductive health mechanisms reported that microplastic exposure may impair ovarian function, affect oocyte quality, alter follicular development, and reduce fertility through oxidative stress, inflammation, endocrine disruption, and mitochondrial injury.¹⁰ These studies raise important concerns regarding potential effects on human fertility and reproductive health.

Table 1: Summary of literature evidence on microplastics and maternal–fetal health (2017–2025).

S. no.	Author (Year) and population/sample	Objective	Key findings
1.	Wright SL & Kelly FJ (2017) Environmental studies	Review health effects of microplastics	Linked MPs with oxidative stress, inflammation, and cellular injury.
2.	Cox KD et al (2019) Dietary exposure studies	Estimate human MP exposure	Showed widespread exposure through food and beverages.
3.	Prata JC et al (2020) Environmental exposure studies	Identify exposure pathways	Reported food, water, air, and dust as major sources.
4.	Ragusa A et al (2021) 6 human placentas	Detect MPs in placenta	First evidence of MPs in placenta; found on maternal and fetal sides.
5.	Braun T et al (2021) Placenta and neonatal meconium	Assess prenatal exposure	MPs detected in placenta and meconium, suggesting fetal exposure.
6.	Leslie HA et al (2022) Human blood samples	Detect circulating MPs	Identified PET, polyethylene, and polystyrene particles in blood.
7.	Liu S et al (2023) Placenta, meconium, breast milk, infant samples	Assess maternal and neonatal exposure	MPs detected in maternal and infant samples.
8.	Impact of Microplastics on Pregnancy and Fetal Development (2024) 12 studies, 234 participants	Assess pregnancy effects	Associated MPs with placental dysfunction, FGR, and low birth weight.
9.	Impact of Microplastics on Female Reproductive Health (2025) Human and animal studies	Review toxicity mechanisms	Reported oxidative stress, inflammation, endocrine disruption, and placental injury.
10.	Microplastics in Female Reproductive and Pregnancy Organs (2025) Human reproductive tissues	Assess MP distribution	MPs detected in placenta, ovaries, uterus, follicular fluid, and amniotic fluid.
11.	Effects of Exposure to Microplastics on Female Reproductive Health and Pregnancy Outcomes (2025) Human and animal studies	Evaluate reproductive effects	Suggested increased risk of placental dysfunction, IUGR, and adverse outcomes.
12.	Health Risks of Prenatal and Early-Life Microplastics Exposure (2025) Human and animal evidence	Assess prenatal and early-life effects	Suggested effects on immune, neurological, metabolic, and reproductive development.

DISCUSSION

The emerging evidence represents an important area of environmental reproductive health research and demonstrates escalation of research and interest in this field over last few years as shown in figure 1.

The detection of microplastics in human placenta provides strong evidence that environmental plastic pollution can reach the maternal–fetal interface.⁴ The possible mechanisms through which MPs may affect pregnancy include oxidative stress, inflammation, endocrine disturbance, and placental dysfunction.^{9,10}

Fewer studies directly examined pregnancy and fetal outcomes, including low birth weight, preterm birth, fetal growth restriction, and changes in placental function.

Overall, the findings suggest that research to date has mainly focused on establishing exposure and understanding possible biological effects, whereas

evidence directly linking microplastic exposure with specific pregnancy outcomes is still limited.

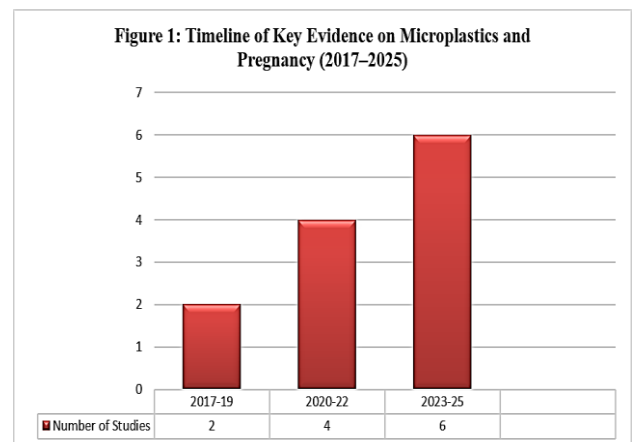


Figure 1: Increasing trend of publications evaluating microplastics exposure and pregnancy outcomes from 2017–2025.

The relationship between exposure level and biological effect, critical exposure periods during pregnancy, and long-term consequences for offspring development requires further investigation. Additionally, there is currently insufficient evidence regarding effective strategies to reduce maternal exposure and whether such interventions improve pregnancy outcomes. Establishing uniform methods for microplastic sampling and quantification will be essential for future research. Most human studies are observational, involve small populations, and use different methods for measuring exposure. Therefore, while current evidence raises significant concerns, it is premature to establish microplastics as a confirmed cause of adverse pregnancy outcomes.

Although microplastics have been detected in human placenta and reproductive tissues, several important questions remain unanswered. Figure 2 shows how the evidence was distributed across the different areas covered by the included studies on microplastics and pregnancy. Most studies focused on detecting microplastics in pregnancy-related tissues and biological samples, while others explored how these particles may affect the body through mechanisms such as oxidative stress, inflammation, endocrine disruption, and placental damage.

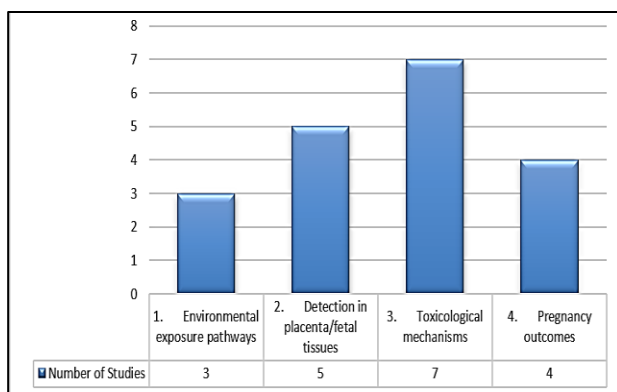


Figure 2: Distribution of evidence domains among included studies on microplastics and pregnancy.

Future well-designed prospective studies are required to clarify exposure thresholds, identify vulnerable periods during pregnancy, and determine the true clinical significance of microplastic exposure. Contamination during sample collection and laboratory processing remains a significant concern because microplastics are present throughout the environment and most available human studies include small sample sizes and cross-sectional designs, limiting the ability to determine cause-and-effect relationships. Finally, long-term effects of prenatal microplastic exposure on maternal health and childhood development remain largely unknown. Future studies should focus on standardised detection protocols and large prospective cohorts with long-term follow-up.

CONCLUSION

Microplastics are increasingly recognised as emerging environmental contaminants with potential implications for reproductive health. Experimental studies indicate that exposure may lead to oxidative stress, inflammation, endocrine disruption, mitochondrial dysfunction, and impaired placental function. Although observational studies suggest possible associations with fetal growth restriction, low birth weight, preterm birth, and placental dysfunction, current human evidence is insufficient to establish a causal relationship. Although existing findings provide biological plausibility, stronger human evidence is required to establish causation and guide clinical recommendations. Until further evidence becomes available, reducing avoidable plastic exposure during pregnancy may be considered a reasonable precautionary approach.

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