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Microplastic and Nanoplastic Pollution in Pregnant Women: Contribution to Preterm Birth and Health Policy Implications

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Abstract: Microplastic and nanoplastic pollution has emerged as a major environmental and public health issue, particularly in developing countries such as Indonesia, where contamination levels are among the highest in the world. Recent findings from Ekspedisi Sungai Nusantara (2022) revealed microplastic concentrations of up to 636 particles per liter in East Java's rivers, indicating widespread exposure through water, air, and food sources. Indonesia also ranks third globally in plastic pollution, contributing approximately 3.4 million tons annually. This study employs a literature review and policy analysis approach to assess the impact of microplastic exposure on maternal and fetal health, with an emphasis on preterm birth risk and the adequacy of current regulatory frameworks. Evidence from human and animal studies indicates that microplastics can translocate across the placental barrier, inducing oxidative stress, inflammation, and endocrine disruption that may impair fetal development and increase the risk of preterm birth. Despite the implementation of the Regulation of the Minister of Health of the Republic of Indonesia No. 2 of 2025 concerning reproductive health, the absence of explicit environmental pollutant protection clauses highlights a critical policy gap. Strengthening intersectoral collaboration among the Ministry of Environment, the Ministry of Health, and the Ministry of Marine Affairs and Fisheries is essential to establish national safety thresholds, implement continuous monitoring, and integrate reproductive health protections into environmental policies. This study underscores the urgent need for comprehensive microplastic management strategies and maternal health safeguards to mitigate the growing risks associated with microplastic and nanoplastic exposure in Indonesia.

Keywords: Environmental policy; Maternal health; Microplastics; Nanoplastics; Placental exposure; Preterm birth

Introduction

Microplastic and nanoplastic pollution in Indonesia has become a growing concern, with data showing extremely high concentrations in many major rivers. According to the latest report from *Ekspedisi Sungai Nusantara* (2022), East Java recorded the highest concentration of microplastics in Indonesian rivers, reaching 636 particles per liter of water, followed by North Sumatra (520 particles/L) and West Sumatra (497 particles/L) (Figure 1A). The most common types of microplastics found were fibers (49.2%), filaments

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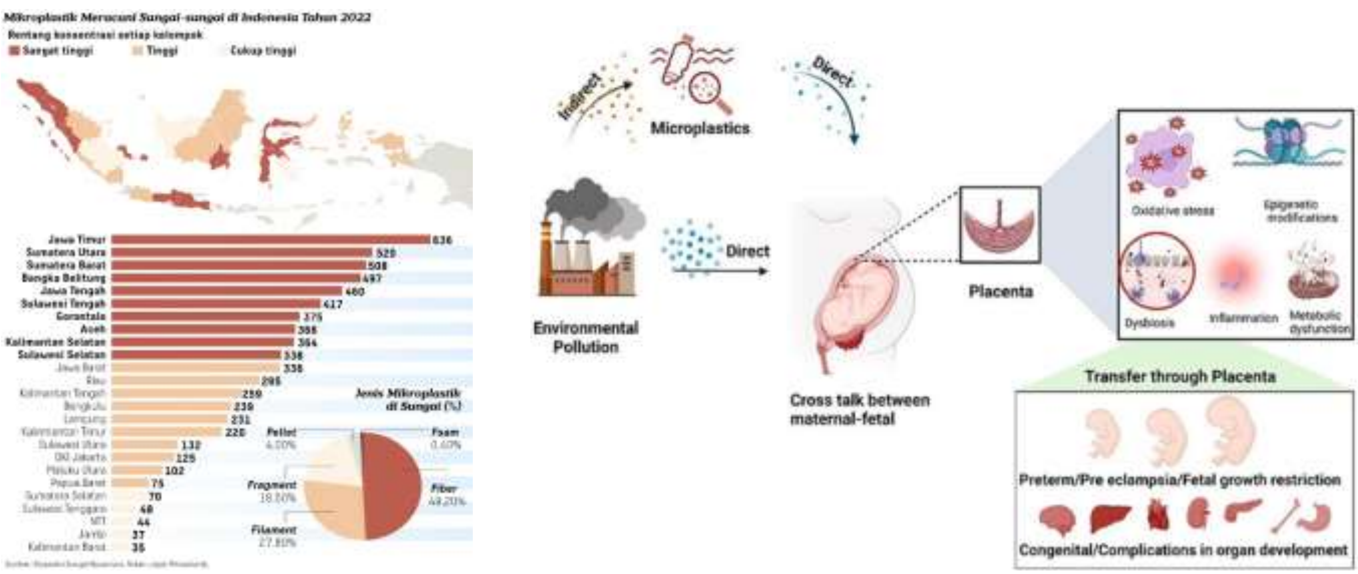
(27.8%), and fragments (18.6%). These findings indicate that rivers in densely populated and industrialized areas tend to have higher levels of microplastic pollution, which may pose significant risks to public health (IPEN, 2024; Sharma et al., 2024).

According to data from Kompas.com (2024), Indonesia ranks third globally as one of the largest contributors to plastic pollution, after India and Nigeria. India leads the world with 10.2 million metric tons of plastic pollution per year, followed by Nigeria with 3.5 million tons, and Indonesia with 3.4 million tons annually (International Pollutants Elimination Network (IPEN, 2024). China ranks fourth with a contribution of 2.8 million tons per year. In addition, a study published in Environmental Science & Technology (2024) estimated that each person in Indonesia consumes approximately 15 grams of microplastics per month — equivalent to the size of a credit card. Indonesia is thus recorded as the country with the highest microplastic consumption in the world.

Microplastics enter the human body mainly through food consumption, inhalation, and skin absorption, originating from aquatic sources such as seafood and river water, single-use plastics, contaminated air and water, as well as personal care products containing microbeads. Previous studies have shown an association between microplastic exposure in pregnant women and an increased risk of preterm birth. A meta-analysis of several epidemiological studies revealed that microplastic exposure can increase the risk of preterm birth by 1.5 times among highly exposed pregnant women compared to unexposed populations (Wright & Kelly, 2017). Furthermore, other studies indicate that microplastics can cross the placental barrier, increasing the likelihood of direct fetal exposure (Figure 1b) (Inam, 2025; Jinesh & Aditi, 2025; Sharma et al., 2024). This raises serious concerns given the long-term health implications of preterm birth for affected children.

The purpose of this policy brief is to examine the health impacts of microplastic and nanoplastic pollution on pregnant women and to assess the effectiveness of existing policies in protecting this vulnerable group. One of the key regulations discussed is the Regulation of the Minister of Health of the Republic of Indonesia No. 2 of 2025 on the Implementation of Reproductive Health Efforts, which may play a role in mitigating health risks caused by such pollution (Kementerian Kesehatan, 2025). Based on the available data, the extremely high concentrations of microplastics in Indonesian rivers such as those recorded in East Java and several other provinces further exacerbate the country's environmental pollution crisis. The conclusion drawn from these findings underscores the urgent need for more effective and comprehensive policy measures to protect maternal health and prevent preterm births linked to microplastic pollution.



(a) (b)

Figure 1. (a) Microplastic pollution in Indonesian rivers (Kompas.com, 2024); (b) Effects of micro/nano plastics on maternal health (Jinesh & Aditi, 2025)

Method

This study employs a literature review and policy analysis approach to examine the impact of microplastic pollution on pregnant women in Indonesia. The primary data sources include scientific articles and reports from the Ekspedisi Sungai Nusantara on microplastic pollution, as well as the Regulation of the Minister of

Health No. 2 of 2025. Data on microplastic consumption and plastic pollution are used to strengthen the argument for the need for stricter policies to protect maternal health from this form of pollution.

Result and Discussion

Microplastic Pollution in Indonesia: Effect on Pregnant Women

Microplastic pollution in Indonesia has reached an alarmingly high level, both in water and in the air, directly impacting human health, including that of pregnant women. According to the latest data, Indonesia ranks third among the world's largest contributors to plastic pollution, with an annual contribution of 3.4 million tons of plastic waste. Furthermore, findings from the Ekspedisi Sungai Nusantara revealed that nearly all major rivers in Indonesia are contaminated with microplastics, with the highest concentration recorded in East Java (636 microplastic particles per liter). This contamination not only pollutes the environment but also poses a significant threat to human health, particularly through exposure among pregnant women.

Exposure to microplastics occurs through various pathways, such as the consumption of seafood contaminated with microplastics, inhalation of microplastic-laden air, and drinking contaminated water. A study published in Environmental Science & Technology (2024) estimated that each person in Indonesia consumes approximately 15 grams of microplastics per month, equivalent to the size of a credit card. As microplastics continue to accumulate in the body, the potential health risks—especially for pregnant women—are expected to increase.

Epidemiological studies have shown that exposure to microplastics may elevate the risk of preterm birth. A meta-analysis revealed that pregnant women exposed to high levels of microplastics had a 1.5-fold increased risk of preterm delivery compared to those unexposed (Wright & Kelly, 2017). This finding is closely related to the fact that microplastics contain more than 14,000 hazardous chemicals, including Endocrine Disrupting Compounds (EDCs), which can interfere with hormonal balance and fetal development. Further research has indicated that microplastics can cross the placental barrier, potentially leading to direct exposure of the developing fetus (Ragusa et al., 2020).

Recent studies have provided growing evidence that microplastics and nanoplastics can accumulate in placental tissue, trigger inflammation, oxidative stress, and hormonal disruption, which may impair placental function and increase the risk of adverse pregnancy outcomes such as preterm birth and fetal growth restriction (Kusbijantoro et al., 2022; X. Li et al., 2024). Another study showed that microplastic exposure during pregnancy resulted in a decrease in the fetoplacental weight ratio, indicating poor nutrient transfer and fetal growth restriction. Microplastic-exposed fetuses also had shorter umbilical cords, a feature seen in both animal models and human cases of IUGR and fetal distress (Zurub et al., 2023). A summary of the key studies that have investigated the effects of micro- and nanoplastics in pregnancy is presented in Table 1: Micro/Nano Plastics in Pregnancy, highlighting both human and animal research that demonstrates biological plausibility and mechanistic pathways underlying these health effects.

Table 1. Micro/Nano Plastics in Pregnancy

Author, year	Study type	Sample /exposure duration	Key Findings
(Ragusa et al., 2020)	Human observational / detection	Placentas from term deliveries; particles 5–10 µm detected	First direct detection of microplastics in human placenta (maternal & fetal sides); raises concern for fetal exposure.
(Ragusa et al., 2022)	Human histology / microscopy	Term placentas; cellular localization reported	Microplastic fragments found inside placental cells; ultrastructural organelle alterations (mitochondria, ER) hypothesized.
(Halfar et al., 2023)	Human placenta study (preterm cases)	Small series examining placentas from preterm births	Presence of MNPs and additives in placentas of preterm births; suggests association between placental MPs and preterm delivery.
(Jochum et al., 2025)	Human analytical quantification (Py-GC/MS)	Term (n=87) vs preterm (n=71) placentae	Quantified multiple polymers; higher MNP loads observed in preterm placentae vs term — association reported (not causal).
(Medley et al., 2023)	Systematic review on placental translocation	Review of 11 studies	9/11 studies found evidence that plastic particles can translocate across the placenta — placental transfer is plausible.

Author, year	Study type	Sample /exposure duration	Key Findings
(Zhao & You, 2024)	Global exposure modelling / dietary intake	Population estimates (1990–2018)	Estimated Indonesian monthly intake ≈15 g microplastics per person; supports high exposure environment. (relevance: high population exposure increases maternal exposure)
(Fournier et al., 2020)	Animal (rodent) inhalation / translocation	Acute pulmonary exposure to nanopolystyrene during pregnancy	Nanopolystyrene translocated to placenta and fetal tissues after maternal inhalation — demonstrates maternal→fetal transfer route.
(Yu et al., 2024)	Animal (mouse) oral exposure across gestation	Chronic gestational exposure (drinking water / oral)	Maternal exposure caused fetal growth restriction, altered umbilical/placental blood flow, shorter umbilical cords, and later postnatal neurodevelopmental changes in offspring.
(Dibbon et al., 2024)	Animal (mouse) — placental hemodynamics	Gestational exposure throughout pregnancy	Placental dysfunction and altered fetal hemodynamics after maternal exposure to micro- and nanoplastics; fetal growth effects noted.
(Sharma et al., 2024)	Narrative/systematic reviews	Multiple studies included	Synthesis: MNPs can induce inflammation, oxidative stress, endocrine disruption, metabolic disturbance — all mechanisms linked to adverse pregnancy outcomes (including preterm birth).
(Zurub et al., 2023)	Narrative reviews	Gestational exposure throughout pregnancy	Microplastic exposed during pregnancy result the fetoplacental weight ratio drops, indicating poor nutrient transfer and fetal growth restriction.

Microplastics can enter the human body through three mechanisms: ingestion, inhalation, and skin contact. Ingestion means microplastic particles enter the digestive tract, where they can be found when consuming foods containing microplastics. The second method is inhalation, which is the process of inhaling microplastics. In fact, some inhaled microplastics originate from indoor environments. The third method is dermal contact, where microplastics can enter the body using personal care products or medications. Microplastics can enter the bloodstream through endocytosis and paracellular diffusion. Microplastics undergo endocytosis by M cells in Peyer's patches, then are transported through the epithelium to the subepithelium, where they meet dendritic cells that transport them to the lymphatic system, ultimately ending up in the bloodstream. Meanwhile, through paracellular diffusion, microplastics can enter through loose junctions between cells in the intestinal lumen, then are transported by dendritic cells to the lymphatic system, and subsequently to the bloodstream (Fan & Ha, 2025).

Once in the bloodstream, microplastics can travel to various organs, including the placenta in pregnant women. After passing through the placenta, microplastics can reach the fetus and amniotic fluid. A 2023 study by Halfar et al. (2023) found that microplastics were found in the placenta and amniotic fluid of premature babies. Another study by Liu et al. (2022) even found microplastics in the placenta, meconium, infant feces, breast milk, and infant formula samples. Microplastics can trigger preterm labor through mechanisms that are still hypothetical. The first hypothesis is that microplastics can activate an inflammatory cascade. One inflammasome that can be activated by microplastics is NLRP3 (Alijagic et al., 2023). NLRP3 has been shown to cause the release of Il-1B, which is required in the intra-amniotic inflammatory cascade, thus causing preterm labor. NRLP3 also triggers fetal membrane activation, uterine contractions, and cervical dilation (Motomura et al., 2022). Another pathway involves the activation of ROS, which leads to the production of prostaglandins, which play a role in the labor process. Another pathway involves the activation of ROS, which leads to the production of prostaglandins that play a role in the labor process. Another pathway involves inducing endocrine changes in hormones that play a role during pregnancy and triggering placental dysfunction, which reduces nutrient flow to the fetus (Anifowoshe et al., 2025).

Distribution and Concentration of Microplastics in Indonesia

Plastic waste has become a major global concern because of the increasing production and improper disposal of plastics into the environment. Only about 9% of plastic waste is recycled, whereas the majority ends up in landfills (50%) or is directly released into the environment (22%) (Naderi Kalali et al., 2023). Once discarded, plastic waste undergoes natural degradation processes—such as oxidation, temperature changes, UV exposure, and mechanical forces—breaking down into smaller particles known as microplastics (MPs), which range in size from 1 μm to 5 mm (Isfarin et al., 2024).

Indonesia shows a widespread distribution of microplastics across various environmental matrices — rivers, estuaries, coastal areas, marine sediments, mangroves, and offshore waters — with concentration hotspots primarily located in urban coastal zones and river estuaries as well as in tourism and fisheries regions. Studies on MP distribution in Indonesia have predominantly concentrated on areas that are easily accessible to researchers, such as Java Island, leading to limited or even no available data from certain regions, including Papua Island.

Indonesia is considered one of the major contributors of plastic waste to the ocean, leading to extensive microplastic contamination in marine environments. Oceanic areas near East Java and Jakarta exhibited the highest concentrations of MPs (>2000 n/L), surpassing those recorded in other regions (<500 n/L). This trend may be associated with the greater research activity on marine MPs (approximately 20–25 publications) reported from these provinces. Conversely, although fewer studies have been conducted, marine sediments around Java Island, Sumatra, and Maluku still showed elevated MP concentrations (>2000 n/kg) (Isfarin et al., 2024).

Meanwhile, in riverine environments, MP concentrations were lower than in marine areas, and the highest MP concentrations were found in West Kalimantan, West Java, Riau, and Aceh. The variation in MP distribution in rivers is evident, as it is directly influenced by human activities (Jin et al., 2023). In addition, MP migration in rivers is greatly affected by various factors, such as river flow, which determines whether the migrated MPs eventually end up in the ocean or are trapped along the way (Cai et al., 2021).

Nevertheless, terrestrial MPs can be transported by rainfall, contributing to the presence of MPs in aquatic environments (Li et al., 2022). The accumulation of MPs in soil may deteriorate soil quality by altering key physicochemical properties, such as pH and porosity. Moreover, these pollutants can be taken up by plants, allowing MPs to enter the terrestrial food chain (Yang et al., 2021). High MP concentrations on Indonesian land were recorded in East Java, West Java, and West Kalimantan (Isfarin et al., 2024).

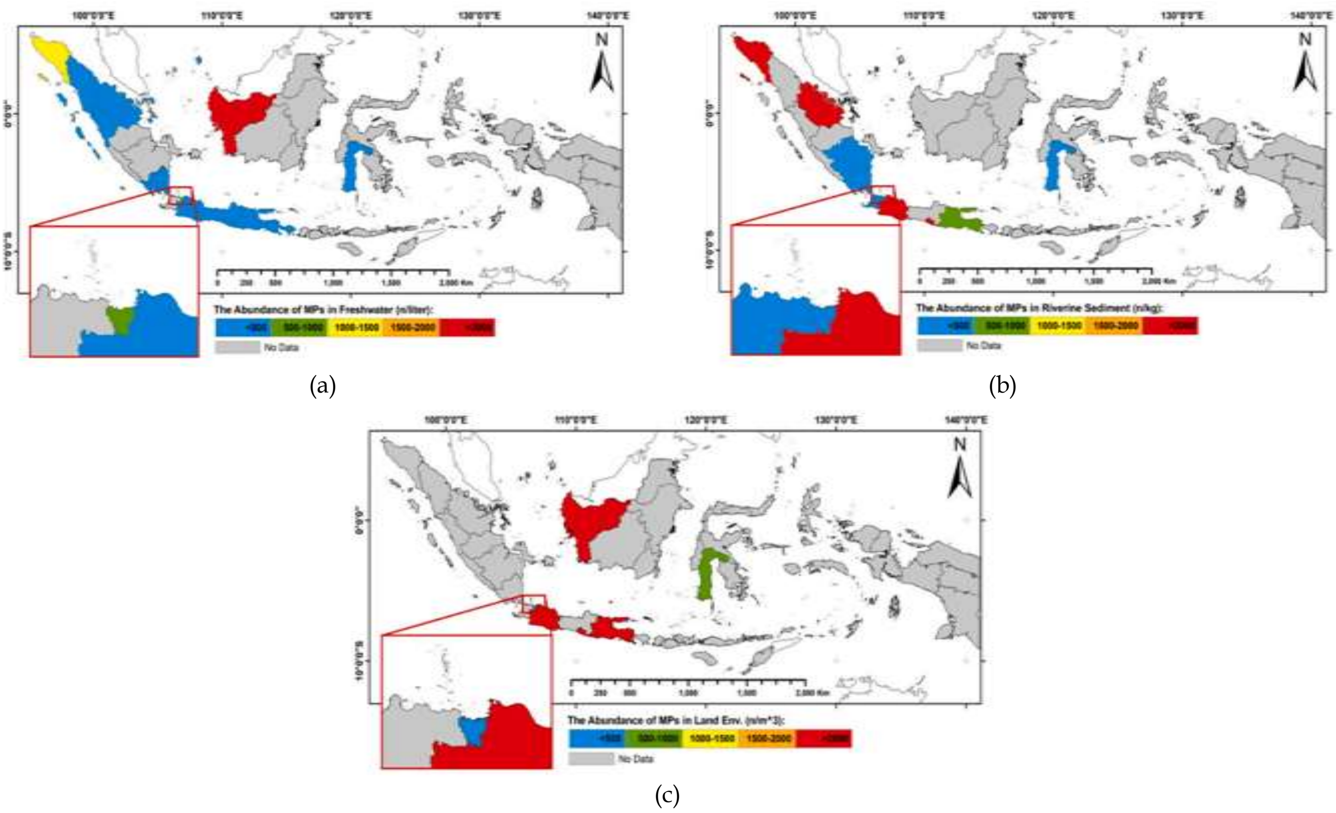


Figure 2. (a) The abudance MPs in freshwater; (b) The abudance MPs in LRiverine Sediment; (c) The abudance MPs in Land Environment (Isfarin et al., 2024)

These findings indicate that the distribution of MPs on the ocean, river, and land is closely linked to the sources and pathways of plastic pollution. Generally, MPs originate from the breakdown of plastic waste and are subsequently dispersed to other regions through both natural processes and human activities, creating an interconnected network of MP distribution across the environment. Since human activities serve as the primary source of MPs, densely populated areas tend to exhibit higher MP concentrations (Isfarin et al., 2024). Moreover, recent studies have identified the presence of airborne MPs that can be transported extensively through the atmosphere and inhaled by humans, although their potential toxic effects remain under investigation (Wang et al., 2021). In Indonesia, continuous high rainfall throughout the year enhances the transport of MPs from major sources—such as landfills and illegal dumping sites—toward the ocean via river systems. Consequently, these pollutants can accumulate in various natural resources and commodities that serve as pathways for human exposure (Isfarin et al., 2024).

Humans can be exposed to microplastics through various pathways, including ingestion, inhalation, and dermal absorption. Among these routes, ingestion is considered the dominant pathway of microplastic exposure. Pregnant women might be exposed to MPs from many sources. The occurrence of MPs in several potential sources worldwide has been reported in a review. First is seafood consumption; as stated previously, MP exposure in humans may occur through the food chain, such as fish and other seafood (Elizalde-Velázquez & Gómez-Oliván, 2021).

Pregnant women can be exposed to microplastics through various sources. The presence of MPs has been reported in several potential environmental and dietary sources worldwide. One of the main pathways is through the consumption of seafood, as MPs can enter the human body via the food chain, particularly from fish and other marine products (Elizalde-Velázquez & Gómez-Oliván, 2021).

Microplastic exposure in pregnant women has been documented in several studies, in which polyethylene terephthalate (PET), polyamide/nylon, polyethylene chlorinated (PEC), high-density polyethylene (HDPE), and ethylene propylene (EP) were present, and polyamide was the most frequently detected polymer in the feces of pregnant women (Hasanah et al., 2024). Furthermore, in placental tissue, polyethylene (PE) was the most frequently identified polymer, followed by polyurethane (PU), polyamide (PA), polyethylene vinyl acetate (PEVA), polypropylene (PP), polystyrene (PS), polyester (PES), polysulfone (PSU), and polyvinyl methyl ether (PVME). Umbilical cord tissue had a similar polymer distribution when compared with the placental group, with small changes in their frequencies. Of the 119 MPs found in umbilical cords, the most frequent polymers remained PE, PA, PEVA, PP, PU, PES, and PP with PE mixtures (Oliveira et al., 2025).

High concentrations of PE in the placenta and umbilical cord have also been reported in other studies (Amereh et al., 2022; Braun et al., 2021; Ragusa et al., 2022). MPs are commonly found in items that are commonly used by humans, including pregnant women. The high concentrations of polyethylene (PE)—a polymer extensively employed in packaging materials, plastic bags, and films—highlight the urgent necessity for tighter regulations on its use, improved waste management practices, and the advancement of sustainable substitutes. In addition to PE, polyamide (PA), polyethylene vinyl acetate (PEVA), and polyurethane (PU) were also commonly identified in both organs. Polyamide (PA) is mainly utilized in textile manufacturing and industrial membrane filters (Lara et al., 2021), polyethylene vinyl acetate (PEVA) is frequently present in laundry-related products and textiles (Rolsky & Kelkar, 2021), and polyurethane is broadly used in foams, adhesives, and various textile applications.

Health Implications for Pregnant Women and Fetus

Emerging evidence indicates that microplastics (MPs) and nanoplastics (NPs) pose real risks to maternal and fetal health. In human placenta samples, for example, Ragusa et al. (2020) detected 12 microplastic fragments (5–10 µm in size) across 4 of 6 examined placentas, finding particles on both fetal and maternal sides and in the chorioamniotic membranes (Ragusa et al., 2020; Zhao & You, 2024). In a broader survey, temporal trends in placental microplastic accumulation showed detection rates rising from 60% in 2006 to 100% in 2021, with average particles per 50 g of tissue increasing from 4.1 ± 1.3 in 2006 to 15.5 ± 3.0 in 2021. More recently, a study of 12 term pregnancies using laser direct infrared (LDIR) spectroscopy reported median microplastic abundances in multiple compartments: umbilical cord: 10.397 particles/g; maternal blood: 8.176 particles/g; fetal membrane: 6.561 particles/g; amniotic fluid: 4.795 particles/g; placenta: 4.675 particles/g; umbilical vein: 2.726 particles/g — and over 90 % of particles sized 20–100 µm . In human amniotic fluid (AF) samples (n = 40), MPs were detected in 32 samples, with average abundance 2.01 ± 4.19 particles/g, and MPs levels showed a statistically significant negative association with gestational age (β = –0.44, 95% CI –0.83 to –0.05). In addition to human tissue detection, exposure modeling estimates that Indonesians ingest approximately 15 grams of microplastics per month—the highest per-capita rate among 109 countries studied globally (Zhu et al., 2024).

Mechanistically, these plastics and their chemical additives may cross from maternal blood into the placenta and further into fetal compartments, provoking inflammation, oxidative stress, endoplasmic reticulum stress, apoptosis, and interfering with placental endocrine and nutrient transport pathways. These perturbations can impair placental function, reduce fetal growth, and in animal models have been associated with preterm birth, intrauterine growth restriction, and altered neurodevelopment. Collectively, the convergence of quantitative detection in maternal–fetal compartments, exposure estimates, and mechanistic plausibility underscores a pressing concern: micro- and nanoplastic pollution is not only an environmental issue, but also a potential maternal-fetal health threat, especially in high-exposure settings (Bai et al., 2024; Fournier et al., 2020; Medley et al., 2023).

Policy Analysis: Evaluating Regulation No. 02/2025

Overall, these results demonstrate the urgent need to address microplastic pollution in Indonesia, particularly to protect vulnerable groups such as pregnant women. Although regulations such as the Regulation of the Minister of Health of the Republic of Indonesia No. 2 of 2025 on the Implementation of Reproductive Health Efforts have been implemented to regulate healthcare services for pregnant women, these policies need to be strengthened with more specific measures to address the impact of environmental pollution on maternal and child health (Kementerian Kesehatan, 2025). Therefore, strengthening environmental regulations and raising awareness about the increasingly widespread impacts of microplastic pollution, which can affect the quality of life of the community, especially pregnant women, is crucial.

Based on the findings regarding high exposure levels and the potential risks of microplastics for pregnant women in Indonesia, a series of comprehensive and integrated policy recommendations are proposed. For the Government of Indonesia, specifically the Ministry of Environment and Forest, the Ministry of Health, and the Ministry of Marine Affairs and Fisheries, urgent strategic actions include establishing safety limits for microplastics in drinking water, fishery products, and industrial wastewater through the development of standard thresholds reinforced by stricter regulations (Adji, 2024; Choi et al., 2025). The implementation of routine monitoring for microplastic contamination in rivers, source water, and in commonly consumed fish commodities, such as tilapia and catfish, is also imperative. To ensure effective coordination, the establishment of a national Microplastic Control Agency is highly recommended to harmonize policies, conduct inspections, and propose more rigorous regulations. Furthermore, in-depth investigations through toxicological testing and evidence-based studies on the impact of microplastics on the health of pregnant women and infants need to be promptly initiated (Gao et al., 2023; Wang et al., 2025).

Table 2. Policy Recommendations to Mitigate Microplastic Exposure Risks in Pregnant Women in Indonesia

Level / Institution	Key Policy Actions / Recommendations	Objective / Expected Output
National Level (Ministry of Environment and Forestry; Ministry of Health; Ministry of Marine Affairs and Fisheries)	- Establish national safety limits for microplastic levels in drinking water, fishery products, and industrial wastewater. - Develop standardized microplastic threshold regulations. - Conduct routine monitoring of microplastic contamination in rivers, source water, and major fish species (e.g., tilapia, catfish). - Create a National Microplastic Control Agency to coordinate inter-ministerial policies, inspections, and enforcement.	- Prevent excessive microplastic exposure through water and food sources. - Improve national monitoring and data transparency. - Strengthen institutional coordination in environmental health regulation.
Legislative Level (Commission IV – House of Representatives / DPR RI)	- Support and ratify new legislation that sets maximum permissible limits for microplastic and nanoplastic content in water and consumer goods. - Accelerate deliberation and adoption of national microplastic standards. - Integrate microplastic control targets into the National Environmental and Public Health Action Plan.	- Provide a strong legal foundation for pollution control. - Ensure accountability and harmonization of national policies. - Protect vulnerable populations, including pregnant women and infants.
Regional Level (Local Governments and Local Water Companies – PDAM)	- Implement routine water quality monitoring focused on microplastic content. - Enforce stricter water sanitation standards aligned with national thresholds.	- Guarantee clean and safe water for communities. - Detect and respond to microplastic contamination early.

Level / Institution	Key Policy Actions / Recommendations	Objective / Expected Output
	- Develop local early warning systems for microplastic pollution in water supplies. - Strengthen public awareness campaigns on safe water consumption.	- Enhance local capacity for environmental health protection.
Health and Reproductive Sector (Ministry of Health; Healthcare Providers)	- Amend Minister of Health Regulation No. 2/2025 to include a specific clause on "Protection of Reproductive Health from Environmental Pollutants", addressing microplastic and nanoplastic exposure. - Develop and disseminate clinical guidelines for healthcare professionals regarding microplastic exposure screening and counseling for pregnant women. - Establish sentinel surveillance systems to track microplastic-related maternal health outcomes. - Fund toxicological and epidemiological research to generate local evidence on microplastic exposure impacts.	- Integrate environmental risk mitigation into reproductive health policy. - Increase early detection and prevention capacity among healthcare workers. - Strengthen evidence-based policymaking and clinical

In the legislative realm, Commission IV of the House of Representatives of the Republic of Indonesia (DPR RI) is encouraged to actively support the ratification of various policies aimed at reducing microplastic pollution, including regulations that set limits on microplastic content in consumer products and water. Expediting the deliberation of national microplastic standards that can be implemented to protect the public, particularly vulnerable groups such as pregnant women, is another crucial step.

At the regional level, Local Water Companies (PDAM) and Local Governments have a vital role in ensuring the safety of water distributed to the public. Therefore, routine monitoring of microplastic contamination and compliance with stricter water cleanliness standards concerning this parameter are absolutely necessary.

Specifically within the context of reproductive health, amending Indonesian Minister of Health Regulation No. 2 of 2025 to include a dedicated clause on "Protection of Reproductive Health from Environmental Pollutants," which explicitly addresses the risks posed by microplastic and nanoplastic exposure, is a strategic move. In line with this, the development and dissemination of standardized clinical guidelines for screening and counseling related to microplastic-associated health risks, targeted specifically at healthcare professionals providing care for pregnant women, would significantly enhance early detection and prevention capacity at the primary care level.

Conclusion

Microplastic and nanoplastic pollution represents an emerging threat to maternal and fetal health in Indonesia, where exposure levels are among the highest globally. The evidence linking microplastic exposure to oxidative stress, placental dysfunction, and preterm birth underscores the urgent need for regulatory intervention. Strengthening environmental and reproductive health policies—through clear safety limits, systematic monitoring, and the integration of pollution-related health protection into national regulations—is essential to safeguard pregnant women and future generations. A coordinated national response involving environmental, health, and legislative sectors is crucial to mitigate the far-reaching impacts of microplastic pollution on public health.

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Author Contributions

Conceptualization, A.S.A. and A.D.; methodology, A.S.A. and G.E.W.; validation, A.S.A., V.M.V., and S.H.; formal analysis, A.D., F.A., and G.E.W.; investigation, A.S.A., F.A., and V.M.V.; resources, A.D.; data curation, G.E.W.; writing—original draft preparation, A.S.A. and V.M.V.; writing—review and editing, A.D., F.A., and S.H.; visualization, V.M.V.; supervision, S.H.; project administration, A.S.A.; funding acquisition, S.H.

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Conflicts of Interest
The authors declare no conflict of interest.

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