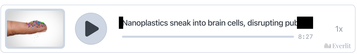
Nanoplastics sneak into brain cells, disrupting puberty and fertility hormones, new study finds

Pamela Ferdinand | February 14, 2026



Tiny pieces of plastic, widely found in food, water, and air, can harm the development and function of specialized brain cells that regulate reproduction, new research reports.

These cells, called gonadotropin-releasing hormone (GnRH) neurons, act like main switches for puberty and fertility. During early development, they must travel to the right place in the brain and then release hormones in a precise rhythm throughout life.

However, in a study recently published in the journal *Small*, researchers found that polystyrene nanoplastics — fragments thousands of times smaller than a grain of sand — were able to slip into these cells through an unusual "side door." Once inside, the particles reduced hormone levels, slowed cell movement, and altered genes required for reproductive health. The particles also accumulated in the GnRH neurons, increasing the potential for long-term effects, the authors say.

The findings add to growing concerns that common environmental contaminants, including plastic particles and their additives, may be toxic to reproductive health in females and males. The results point to plastic pollution as a plausible environmental contributor to disorders such as GnRH deficiency, which is associated with conditions such as delayed puberty and infertility that cannot be fully explained by genetics alone.

"These results suggest that [polystyrene nanoplastics] disrupt key physiological functions of GnRH neurons and may act as novel endocrine disruptors, contributing to the pathogenesis of reproductive disorders," the researchers wrote.

Nanoplastic intruders interrupt hormone signaling

GnRH neurons play a central role in puberty and fertility, signaling the pituitary gland to activate the ovaries or testes. Even small disruptions can delay puberty, disrupt menstrual cycles, reduce sperm production or impair fertility, the study notes. When such disruptions occur during early development, the effects can be permanent, increasing disease risk later in life, and may affect future offspring by impacting parental health.

Key findings of the study, based on a cell line derived from mice often used to study GnRH neurons, include:

- **Plastic nanoparticles slipped past cellular defenses**. Tiny polystyrene plastic particles, commonly used in food packaging, disposable cups, and foam containers, entered both developing and mature GnRH neurons through an unusual cellular pathway, bypassing the cell's usual regulated entry mechanisms.
- **Polystyrene nanoplastics directly disrupted hormone production**. Particles lowered activity of the gene that produces GnRH and reduced hormone release by mature neurons. This aligns with earlier animal studies showing that nanoparticles can cross the blood–brain barrier and reduce GnRH release in the brain, the authors note. "Given the central role of GnRH in orchestrating puberty and fertility, even modest reductions in its synthesis may have substantial physiological consequences," they write.
- **Nanoparticles affected early GnRH neuron development and triggered stress.** Exposure to the plastic caused a gradual increase in reactive oxygen species (ROS), a common marker of cellular stress. The stress did not kill the cells but reduced their ability to move, suggesting subtle but potentially harmful effects rather than outright toxicity.
- **Size mattered**. Disruptions to cell movement depended strongly on particle size more than concentration. Very small particles (50 nanometers) entered cells but did not impair movement. Larger particles (albeit only 500 nanometers) caused the strongest effects, slowing or blocking migration in immature neurons. These cells became more rigid and overly attached to their surroundings, or "sticky," making them less able to move to where they needed to go.
- **Gene changes matched known reproductive disorders**. Analysis revealed widespread changes in hundreds of genes involved in neuron movement, attachment, brain development, and reproductive hormone regulation. Many of these changes overlapped with genetic patterns linked to delayed puberty and other reproductive conditions in humans, the authors say.

Heightening overall health concerns about plastic pollution

To conduct the study, the researchers used laboratory models of GnRH neurons representing different life stages. One model reflected mature neurons that actively produce reproductive hormones. The other represented immature neurons that must migrate during early development to establish reproductive hormone signaling.

Scientists exposed both cell types to two sizes of polystyrene nanoplastics at doses that did not kill the cells. Fluorescent green dye tracking showed that the particles entered neurons within hours and continued to accumulate. Imaging showed that plastic particles began to enter cells within 2 hours, increasing steadily over time and reaching the highest levels at 24 hours.

To assess potential real-world relevance, researchers compared their findings with genetic data from patients with delayed puberty and gonadotropin deficiency. They identified rare variants in one gene (NPAS2) in two males with severe pubertal delay. Another gene linked to puberty timing and hypogonadism also overlapped with the cellular data.

Microplastics and nanoplastics, which enter the body through ingestion, inhalation or skin contact, have been detected in human placenta, brain tissue, semen, ovaries, follicular fluid, and breast milk. Animal studies have also linked exposure to disrupted hormone signaling and reduced fertility, with research published this month showing 50-nanometer plastic nanoparticles can enter cow eggs and interfere with early reproductive development.

The researchers caution that the latest study does not prove nanoplastics cause infertility in humans. The work was conducted in laboratory cells, and human exposure levels vary widely.

In addition, plastic particles may exert toxic effects not only through direct cellular interactions but by acting as carriers for endocrine-disrupting chemicals, amplifying their biological impact. Such interactions may disrupt hormonal signaling and impair how the body makes sperm and eggs, a process known as gametogenesis, potentially contributing to declining fertility worldwide.

While polystyrene is commonly used in research studies, humans are exposed to various MNP, such as polyethylene and PVC, in different sizes and shapes, notes another study on plastic pollution in human reproduction, due to be published next month [March 2026]. It concludes that addressing the challenge of plastic pollution and protecting reproductive health must remain a "global priority."

The researchers of this current study concur: "Beyond direct effects on GnRH neurons, our findings contribute to broader concerns regarding [polystyrene nanoplastics] as pervasive environmental contaminants."

Further research is needed "to assess the broader health risks associated with NP exposure and to guide strategies aimed at mitigating their impact," they wrote. "A deeper understanding of how PS-NPs modulate reproductive pathways may ultimately improve the diagnosis and treatment of idiopathic infertility linked to environmental exposures."

Reference

Amoruso F, Paganoni AJ, Saraceni A, et al. Nanoplastics Impair GnRH Neuron Migration and Neuroendocrine Function: Emerging Players in the Pathogenesis of Reproductive Disorders. *Small*. Published online February 6, 2026. doi:10.1002/smll.202506171

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