

MICROPLASTICS AND NANOPLASTICS IN CARDIOVASCULAR DISEASE

Dr Saloni Jain, Assistant, Samarkand state medical university, Uzbekistan

Qureshi Mohd Aqdas Mohd Akram , Medical Student, Samarkand state medical university, Uzbekistan

Md Shahreyar , Medical Student, Samarkand state medical university, Uzbekistan

Muskan parween , Medical Student, Samarkand state medical university, Uzbekistan

Abstract

Plastic has become so deeply woven into modern life that it is now found in the food we eat, the water we drink, and even the air we breathe. As these materials fragment into microplastics and nanoplastics, particles small enough to cross into the human body, a pressing question has emerged: what are they doing to our hearts and blood vessels? This article explores the growing evidence linking micro- and nanoplastic exposure to cardiovascular disease. It traces how these particles enter the bloodstream, the routes by which they reach the heart, and the biological mechanisms — oxidative stress, chronic inflammation, lipid dysfunction, and endothelial injury — through which they may promote atherosclerosis, hypertension, and thrombosis. Landmark human studies, including the recent detection of plastic particles within human atheromas and their association with cardiovascular events, are reviewed alongside animal and laboratory findings. The article also considers the formidable challenges scientists face in measuring exposure and establishing causality, and outlines steps individuals and societies can take to reduce contact with these invisible pollutants. While much remains unknown, the evidence gathered so far urges us to take this emerging risk seriously before it becomes another irreversible public health burden.

Keywords: microplastics, nanoplastics, cardiovascular disease, atherosclerosis, endothelial dysfunction, environmental pollution, heart health

1. Introduction

Every year, humanity produces more than 400 million tonnes of plastic, a figure that continues to climb. Much of it is used briefly and then discarded, but plastic does not truly go away — it breaks down. Sunlight, waves, and mechanical wear shatter plastic

bottles, bags, and packaging into ever-smaller fragments. Pieces smaller than five millimetres are called microplastics; those below one micrometre are nanoplastics, so tiny that they cannot be seen under an ordinary microscope. Scientists once assumed these particles simply passed through the environment. We now know they are passing through us.

The implications for the cardiovascular system are only beginning to be understood. Cardiovascular disease remains the leading cause of death worldwide, responsible for nearly 18 million deaths each year. Its classic risk factors — smoking, high blood pressure, diabetes, high cholesterol, and physical inactivity — are well established. Yet cardiologists have long noted that heart attacks and strokes sometimes strike people with few of these conventional risks. Could an invisible, ubiquitous pollutant be part of the explanation? Emerging research suggests the answer may be yes. This article examines the journey of microplastics and nanoplastics from the environment into the human heart, the mechanisms by which they may damage blood vessels, the evidence linking them to cardiovascular events, and what can be done to reduce the risk.



Figure 1. Microplastic fragments viewed under magnification — a colourful but invisible pollutant that has spread through every corner of the environment. (Image: Woolcock Institute of Medical Research)

2. Where Do Microplastics Come From, and How Do They Reach Us?

Microplastics enter our lives through two broad pathways. Primary microplastics are manufactured small — think of the microbeads once common in cosmetics or the plastic pellets (nurdles) used as industrial raw material. Secondary microplastics form when larger items degrade: a plastic bag left in the sun, synthetic clothing shed in the washing machine, or car tyres wearing down on the road. Synthetic textiles alone can

release hundreds of thousands of fibres per wash, while tyre abrasion is now considered one of the largest sources of microplastics entering the environment.

From there, the particles travel. Rivers carry them to the sea, where they contaminate seafood; they settle into soil and enter crops and livestock; they float in indoor and outdoor air and settle on our food. Bottled water, table salt, tea bags, and even the dust in our homes have all been shown to contain them. The average person may ingest tens of thousands of microplastic particles every year, and inhale many more. What happens next is where the story becomes medically important: some of these particles are small enough to be absorbed through the gut and lungs, and from there they can enter the circulation.

Table 1. Common sources of microplastic and nanoplastic exposure

Source	Example	Route into the body
Food and beverages	Bottled water, seafood, salt, packaged food	Ingestion
Air (indoor and outdoor)	Household dust, synthetic fibre shedding, tyre wear particles	Inhalation
Personal care products	Microbeads in scrubs, toothpaste (being phased out)	Skin contact / ingestion
Textiles	Synthetic clothing and furnishings releasing fibres	Inhalation and ingestion
Occupational exposure	Plastic production, recycling, textile industries	Inhalation and skin contact

3. From Bloodstream to Heart: What the Evidence Shows

For years, the idea that plastic particles circulated in human blood belonged to the realm of speculation. That changed in 2022, when researchers in the Netherlands announced they had detected microplastics in the blood of healthy adults — the first direct proof that these particles can and do enter the human circulation. Since then, microplastics have been reported in the lungs, liver, kidneys, placenta, and even the brain, with

concentrations rising over time in post-mortem tissue studies. Each new detection narrows the gap between environmental exposure and human health.

The cardiovascular evidence took a decisive turn in 2024, when a study published in the New England Journal of Medicine reported that microplastics and nanoplastics had been found within atherosclerotic plaques — the fatty deposits that clog arteries — in patients undergoing surgery. Strikingly, patients whose plaques contained plastic particles experienced more heart attacks, strokes, or death over the following years than those without. Although the study could not prove that the particles caused the events, the association was strong enough to send shockwaves through the cardiology community. Animal studies have added biological plausibility: in mice and rats, engineered plastic particles have been shown to promote plaque formation, raise blood pressure, trigger abnormal heart rhythms, and impair the function of blood vessels.

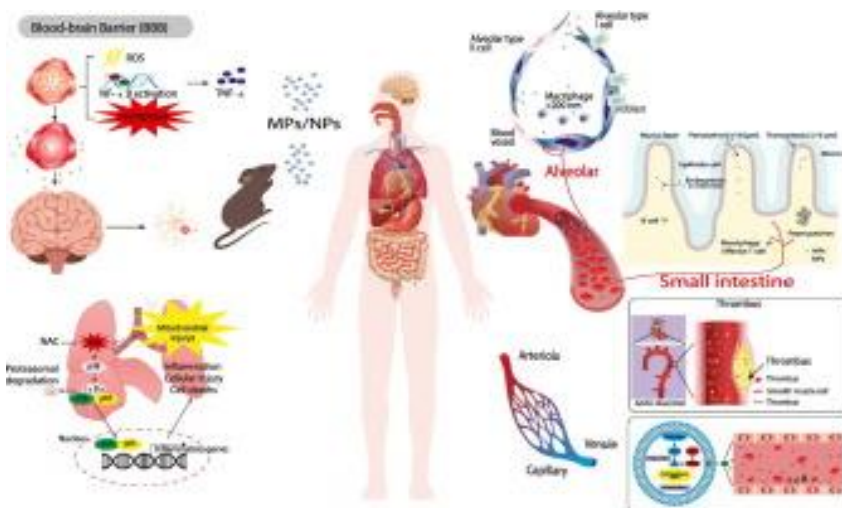


Figure 2. Micro- and nanoplastics can enter the body through the lungs and gut, cross biological barriers, and reach the cardiovascular system, where they may drive inflammation and vascular injury. (Illustration based on a Science of The Total Environment review, 2024)

4. How Tiny Particles Can Harm the Heart: Proposed Mechanisms

How could something so small injure an organ as robust as the heart? The answer lies in the biology of the blood vessel wall. The inner lining of our arteries, called the endothelium, is a thin, delicate barrier that regulates blood flow, clotting, and inflammation. Laboratory studies show that microplastics can attach to and cross this barrier, generating oxidative stress — an imbalance of damaging molecules that injures cells. The immune system responds by sending inflammatory cells to the site, and chronic low-grade inflammation is a well-known driver of atherosclerosis, the slow

build-up of plaques that narrows arteries and can rupture to cause heart attacks and strokes.

Other proposed mechanisms add to the concern. Some plastics carry chemical additives — plasticizers, flame retardants, heavy metals — that can leach out and disrupt hormones and lipid metabolism. Nanoplastics are small enough to penetrate cell membranes, enter the mitochondria that power our cells, and interfere with energy production. Particles in the bloodstream may also activate platelets and the clotting cascade, tilting the balance toward thrombosis. In the heart muscle itself, animal experiments have linked plastic exposure to altered calcium handling and abnormal rhythms. Individually, each effect may be small; together, over years of continuous exposure, they may quietly erode cardiovascular health.

Table 2. Proposed mechanisms linking microplastics to cardiovascular damage

Mechanism	Description	Cardiovascular consequence
Oxidative stress	Particles generate reactive oxygen species that injure endothelial cells	Endothelial dysfunction, early atherosclerosis
Chronic inflammation	Immune activation at particle deposition sites	Plaque formation and destabilisation
Chemical toxicity	Leaching of additives (phthalates, bisphenols, flame retardants)	Hormone and lipid metabolism disruption
Mitochondrial injury	Nanoplastics disrupt cellular energy production	Heart muscle and vascular cell damage
Pro-thrombotic effects	Platelet activation and clotting cascade stimulation	Increased risk of heart attack and stroke
Autonomic disruption	Airborne particles may alter nervous system control of the heart	Blood pressure changes, arrhythmias

5. How Big Is the Risk? Interpreting the Evidence Honestly

It is important to hold this evidence with care. Most studies so far are observational or preclinical; they show association and biological plausibility, not proven causation. Microplastics come in countless shapes, sizes, and chemical compositions, and standardised methods to measure human exposure are still being developed — different laboratories can report very different concentrations from similar samples. Doses used in animal experiments are also often far higher than typical human exposures, though some researchers argue that real-world doses may be higher than we think, and that chronic low-dose exposure over decades has never been properly studied.

Even with these caveats, the pattern of evidence follows a familiar path. Decades ago, the health effects of tobacco smoke and air pollution were similarly debated before the cumulative evidence became undeniable. Today, few scientists doubt that inhaled particulate air pollution worsens cardiovascular disease, and microplastics may represent a new and poorly measured fraction of that burden. Prudent public health practice suggests acting on reasonable suspicion rather than waiting for perfect certainty.

6. Protecting the Heart: Individual and Societal Responses

No one can eliminate microplastic exposure entirely; the particles are too widespread. But exposure can be reduced. At the individual level, choosing glass or stainless steel over plastic bottles and food containers, avoiding heating food in plastic, filtering drinking water, ventilating indoor spaces, damp-dusting rather than dry-dusting, and choosing natural fibres over synthetics where practical can all lower intake. These steps are modest, but they mirror the logic of established preventive cardiology: many small risk reductions add up.

At the societal level, the solutions are bigger. Reducing single-use plastic production, designing plastics that degrade safely, improving recycling, capturing tyre and textile fibres at their source, and funding research into the health effects of nanoplastics are all active areas of policy and science. Regulators are beginning to respond: microbeads have been banned in personal care products in many countries, and the World Health Organization has called for urgent research into the human health impacts of microplastics in drinking water. The heart, it turns out, has yet another reason to hope for a less plastic world.

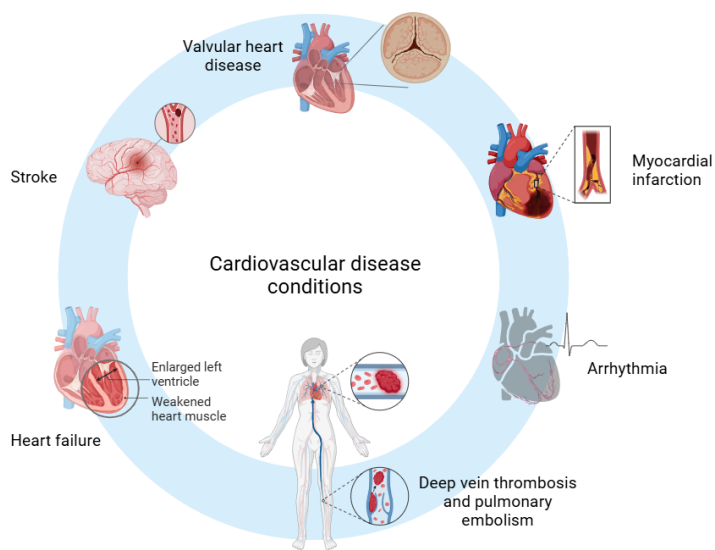


Figure 3. The spectrum of cardiovascular conditions — from atherosclerosis and heart attack to stroke and heart failure — that chronic microplastic exposure may help trigger or worsen. (Illustration: BioRender)

7. Future Directions

The research agenda ahead is clear. Scientists need harmonised methods to detect and quantify nanoplastics in human tissues, large long-term cohort studies that track exposure alongside cardiovascular outcomes, and toxicology work that uses environmentally realistic doses. Clinicians, meanwhile, may one day add exposure history to their cardiovascular risk assessments, just as smoking and pollution exposure are considered today. For now, the humblest summary of the science is also the most sobering: plastic designed for minutes of use may linger in our arteries for years.

8. Conclusion

A generation ago, microplastics were a curiosity of ocean science. Today, they are a subject of cardiology journals. The evidence that these particles enter the human bloodstream, lodge within arterial plaques, and are associated with heart attacks and strokes is young but rapidly strengthening. Many questions remain unanswered, yet the direction of discovery is consistent: the heart appears to be on the front line of humanity's plastic experiment. Reducing plastic pollution is often framed as an environmental cause. It may also, in the end, be a matter of the heart.

References

- Leslie HA, van Velzen MJM, Brandsma SH, Vethaak AD, Garcia-Vallejo JJ, Lamoree MH. Discovery and quantification of plastic particle pollution in human blood. *Environment International*. 2022;163:107199.
- Marfella R, Prattichizzo F, Sardu C, et al. Microplastics and nanoplastics in atheromas and cardiovascular events. *New England Journal of Medicine*. 2024;390:900-910.
- Ragusa A, Svelato A, Santacroce C, et al. Plasticenta: First evidence of microplastics in human placenta. *Environment International*. 2021;146:106274.
- Campen P, Nihart A, Garcia M, et al. Bioaccumulation of microplastics in decedent human brains. *Nature Medicine*. 2025;31:111-118.
- Cox KD, Covernton GA, Davies HL, Dower JF, Juanes F, Dudas SE. Human consumption of microplastics. *Environmental Science & Technology*. 2019;53(12):7068-7074.
- Prüst M, Meijer J, Westerink RHS. The plastic brain: neurotoxicity of micro- and nanoplastics. *Particle and Fibre Toxicology*. 2020;17:24.
- Wright SL, Kelly FJ. Plastic and human health: a micro issue? *Environmental Science & Technology*. 2017;51(12):6634-6647.
- World Health Organization. *Microplastics in Drinking-water*. Geneva: WHO; 2019.
- Galloway TS. Micro- and nanoplastics and human health. In: Bergmann M, Gutow L, Klages M, eds. *Marine Anthropogenic Litter*. Cham: Springer; 2015:343-366.
- Vethaak AD, Legler J. Microplastics and human health. *Science*. 2021;371(6530):672-674.