Types of Environmental Pollutants and Women's Health
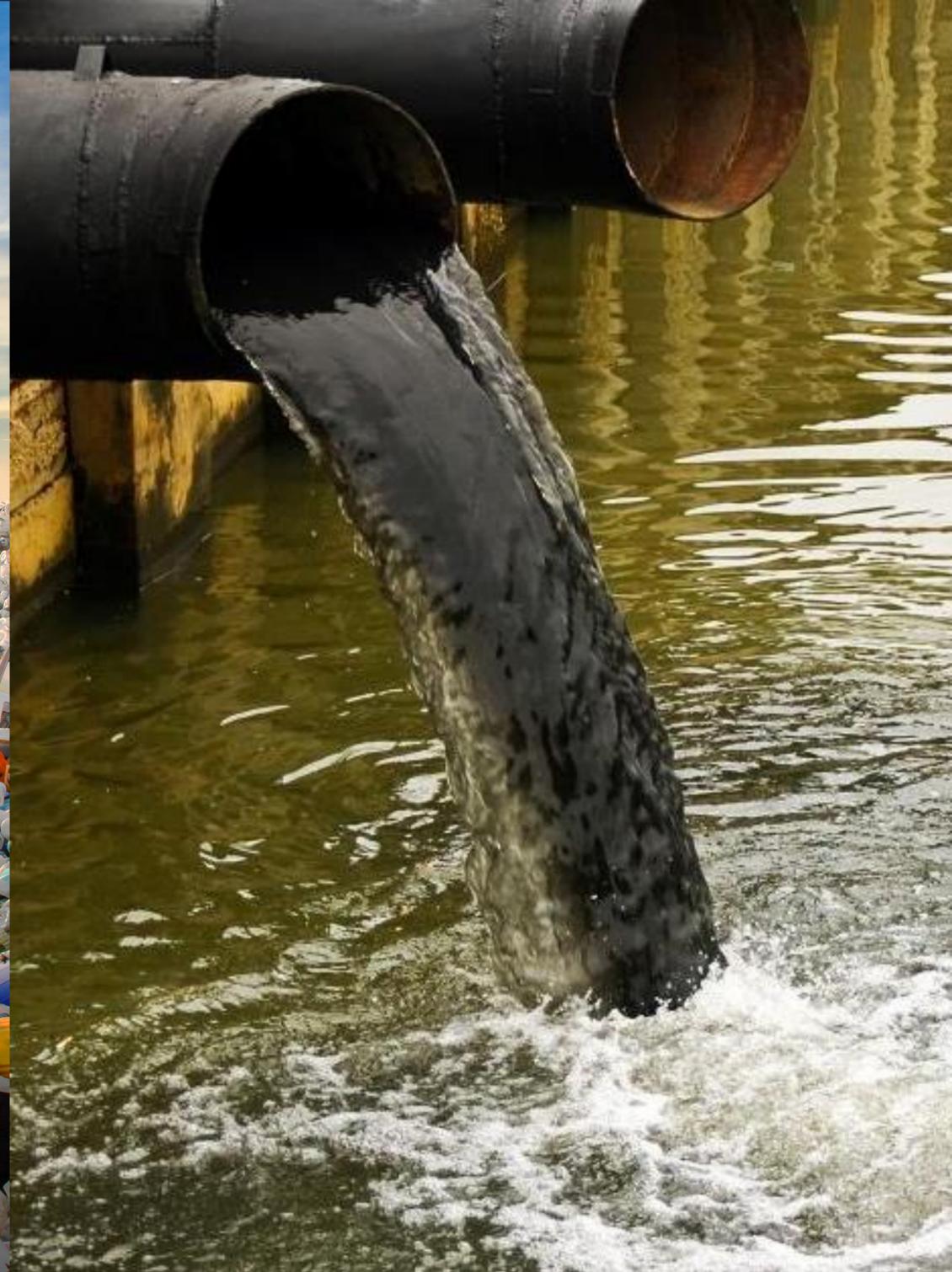
JUNE 2025

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Environmental Pollutants

Air Pollution

Plastic Waste

Water Pollution

Pollutants

Pollutant:
Air Pollution

Air Pollution: Primary Pollutants

- Particulate matter (PM_{10} and $PM_{2.5}$)
- Nitrogen oxides (NO_x)
- Sulfur dioxide (SO_2)
- Carbon monoxide (CO)
- Ozone (O_3)
- Volatile organic compounds (VOCs)
- Dioxins
- Polycyclic aromatic hydrocarbons (PAHs)
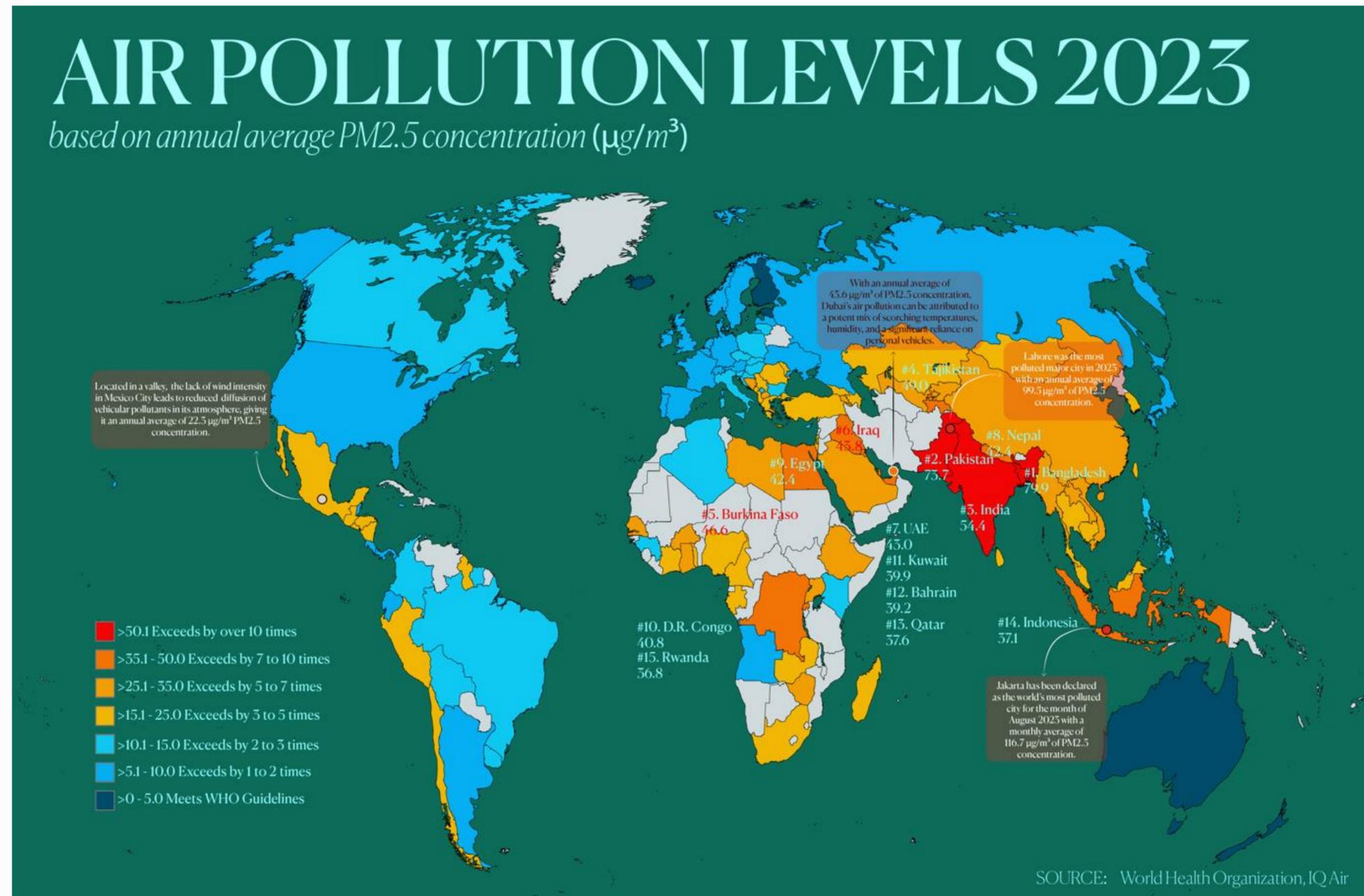- Heavy metals like lead

Air Pollution: Factors to Pollution

- PM levels vary across regions due to many factors
  - industrial activity
  - traffic density
  - natural events
- Urban areas with heavy traffic and industrial emissions often experience higher PM concentrations
- For instance, the Harvard Six Cities study highlighted differences in mortality rates corresponding to varying pollution levels among U.S. cities

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Air Pollution: Air Quality Map

- World Health Organization has an [interactive map](#) for air quality around the world.

- Here's an example from 2023

- This is specific to particulate matter ($PM_{2.5}$) since it has been extensively studied due to its ability to penetrate deep into the lungs and even enter the bloodstream (Adamkiewicz et al., 2020)

AIR POLLUTION LEVELS 2023
based on annual average PM2.5 concentration (µg/m³)

- >50.1 Exceeds by over 10 times
- >35.1 - 50.0 Exceeds by 7 to 10 times
- >25.1 - 35.0 Exceeds by 5 to 7 times
- >15.1 - 25.0 Exceeds by 3 to 5 times
- >10.1 - 15.0 Exceeds by 2 to 3 times
- >5.1 - 10.0 Exceeds by 1 to 2 times
- >0 - 5.0 Meets WHO Guidelines

SOURCE: World Health Organization, IQ Air

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Air Pollution: Outdoor Sources

Anthropogenic Sources

- Fossil fuels
  - Burning coal, oil, and natural gas for electricity, heat, and transportation

- Industrial Processes and Manufacturing
  - Factories emit various pollutants depending on the industry and processes involved

- Agricultural Activities
  - Practices such as burning of agricultural waste and use of fertilizers (Manisalidis et al., 2020)

Natural Sources

- Wildfires
  - Natural or human-induced fires

- Dust Storms
  - Wind-driven events lift large quantities of dust particles into the air

- Volcanic Eruptions
  - Emit sulfur dioxide, carbon dioxide, and ash particles (Cromar et al., 2024)

Air Pollution: Indoor Sources

Combustion for Heating and Cooking

- Use of solid fuels like wood, coal, or crop residues in households leads to the release of particulate matter, CO, and other harmful substances. Household combustion from stoves and heating, particularly in low-income regions that rely on biomass and coal. (Maung et al., 2022)

Household Products

- Cleaning agents, pesticides, and personal care products often contain VOCs that can evaporate into indoor air.

HOUSEHOLD AIR POLLUTION

Over 3.2 million people a year die prematurely from household air pollution (2019). Household air pollution is mostly created by using kerosene and solid fuels such as wood with polluting stoves, open fires and lamps.

Women and children are the most at risk.

23% from stroke

32% from ischaemic heart disease

19% from chronic obstructive pulmonary disease (COPD)

6% from lung cancer

21% are due to lower respiratory infections

CLEAN AIR FOR HEALTH   #AirPollution   World Health Organization

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Air Pollution: Wildfires and Birth Outcomes

- A study published in *Environmental Research* found that each additional day of exposure to wildfire smoke during pregnancy was associated with an increased risk of preterm birth. Exposure later in pregnancy had stronger associations with preterm birth risk (Heft-Neal et al., 2022).

- A prospective birth cohort study published in *The Science of the Total Environment* suggested that exposure to $PM_{2.5}$ increased the risk of adverse treatment outcomes in the ART population, particularly in women undergoing fresh embryo transfer cycles (Foo et al., 2024).

- Research published in *Human Reproduction* found that higher levels of particulate matter ($PM_{2.5}$ and PM_{10}) prior to oocyte retrieval were associated with lower live birth rates, regardless of conditions at the time of embryo transfer (Leathersich et al., 2025).

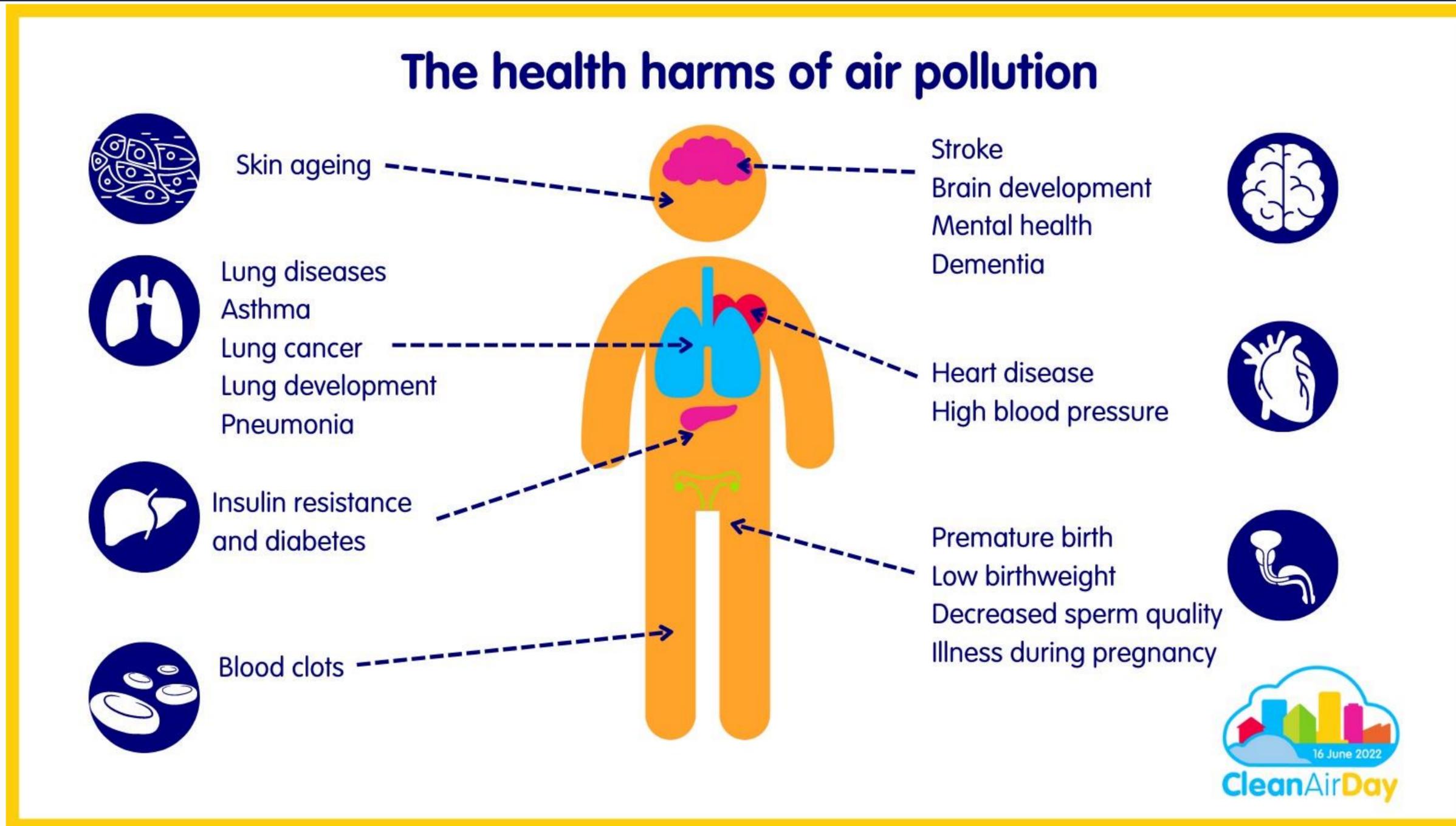# Air Pollution: Health Effects

Respiratory System

- Short-term exposures → asthma, bronchitis, pneumonia, etc. (Cromar et al., 2024)
- Chronic long-term exposures → reductions in lung function and increased risk for chronic obstructive pulmonary disease (COPD) and lung cancer (Maung et al., 2022)

Cardiovascular System

- Cardiovascular effects include heightened risk of hypertension, stroke, myocardial infarction, and atherosclerosis due to systemic inflammation and oxidative stress (Xiao et al., 2025).
- Exposure to air pollution during pregnancy and early life has been associated with adverse neurodevelopmental outcomes, including cognitive deficits and behavioral disorders in children (Kusters et al., 2025)
- Long-term exposure to air pollution has been linked to an increased risk of diseases such as Alzheimer's and Parkinson's (Thompson et al., 2023)

Air Pollution: Health Effects

The health harms of air pollution

Skin ageing

Lung diseases
Asthma
Lung cancer
Lung development
Pneumonia

Insulin resistance
and diabetes

Blood clots

Stroke
Brain development
Mental health
Dementia

Heart disease
High blood pressure

Premature birth
Low birthweight
Decreased sperm quality
Illness during pregnancy

CleanAirDay
16 June 2022

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Air Pollution: Health Effects

Metabolic and Immune System Effects

- Studies also report associations with type 2 diabetes, systemic inflammation, and altered immune responses, particularly in high-exposure environments (Huo et al., 2025).

Other Health Effects

- Certain air pollutants, including benzene, formaldehyde, and particulate matter, are known carcinogens and have been linked to increased cancer risk.

Vulnerable Populations

- Children, the elderly, pregnant individuals, and those with preexisting health conditions are particularly vulnerable to the effects of air pollution. Socioeconomic and environmental justice factors also play a significant role in differential exposures and health outcomes (Huang et al., 2025).

Air Pollution: Women's Health

Air pollution, particularly exposure to fine particulate matter ($PM_{2.5}$), has unique and significant implications for women's health, due to physiological differences, hormonal influences, and exposure patterns shaped by social roles.

Air Pollution: Reproductive and Perinatal Health

Menstrual and Fertility Effects

- $PM_{2.5}$ exposure has been associated with irregular menstrual cycles, reduced ovarian reserve, and decreased fertility. (Huang et al., 2025).

Pregnancy Outcomes

- Numerous studies have linked $PM_{2.5}$ and PM_{10} exposure during pregnancy to preterm birth, low birth weight, intrauterine growth restriction (IUGR), and stillbirth (Song et al., 2023).

A 2021 systematic review found that higher maternal exposure to $PM_{2.5}$ was consistently associated with a lower birth weight, increasing the risk for long-term metabolic and developmental disorders in offspring (Brumberg & Karr, 2021).

# Air Pollution: Reproductive and Perinatal Health

Placental Function

- PM can translocate into the bloodstream and reach the placenta. Evidence shows altered placental morphology and gene expression profiles in individuals exposed to high levels of PM during gestation, potentially affecting fetal development.

Polycystic Ovary Syndrome (PCOS)

- Environmental exposures, including endocrine-disrupting chemicals and air pollutants like PM, may contribute to the development and progression of polycystic ovary syndrome (PCOS) (Peebles & Mahalingaiah, 2024).

Higher Exposure to Chemicals Resulted in 2–5X Higher Probability of Breast Cancer
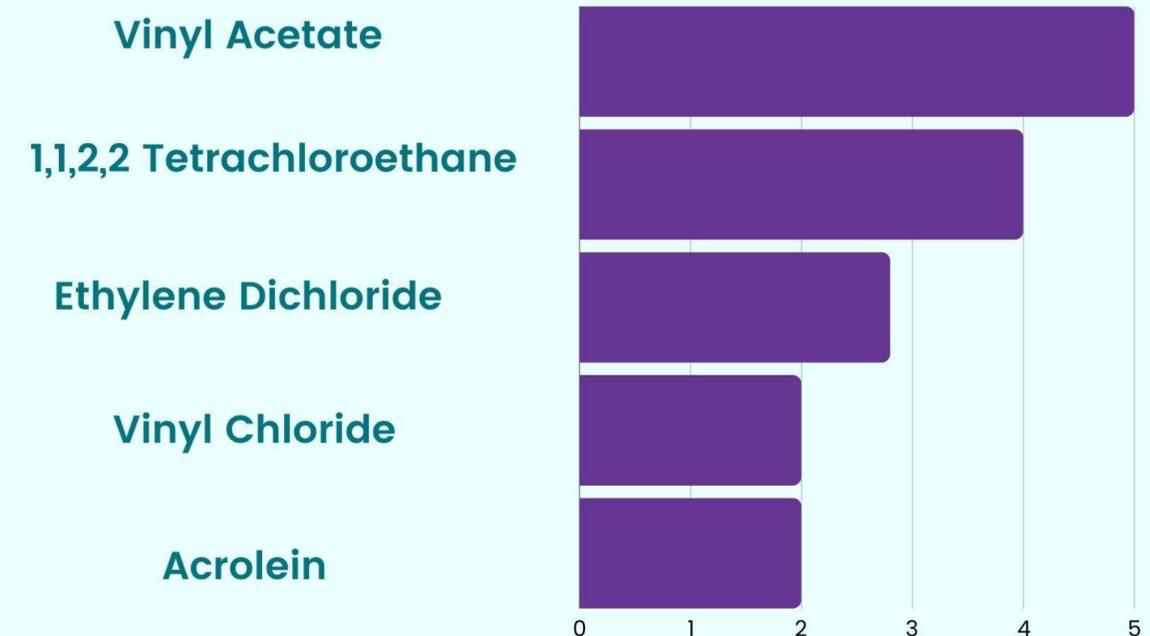
Air Pollution: Pregnancy-Specific Vulnerability

- Air pollution affects pregnancy outcomes with mechanisms like immune dysregulation and epigenetic changes that may increase risks of complications such as preterm birth and preeclampsia (Aguilera et al., 2023).

- Pregnant individuals experience increased minute ventilation, leading to greater inhalation of pollutants.

- Increased systemic inflammation and oxidative stress during pregnancy may amplify the adverse effects of air pollution.

Air Pollution: Endocrine and Metabolic Health

Hormonal Disruption

- Certain air pollutants, including PAHs and heavy metals in PM, act as endocrine-disrupting chemicals (EDCs), interfering with estrogen and progesterone signaling (Seli & Taylor, 2023).

Type 2 Diabetes and Metabolic Syndrome

- Emerging evidence links long-term PM exposure to insulin resistance and systemic inflammation, which disproportionately affect women due to hormonal influences on glucose metabolism (Huo et al., 2025).

Air Pollution: What you can do

- Get an air purifier to remove pollutants

- Open windows daily for better ventilation

- Vacuum with a HEPA filter to reduce dust and allergens.

- Avoid products with synthetic fragrances (use unscented or naturally scented options)

- Use beeswax candles instead of paraffin (which releases toxins)

- Keep houseplants (like snake plants, peace lilies) to naturally filter air
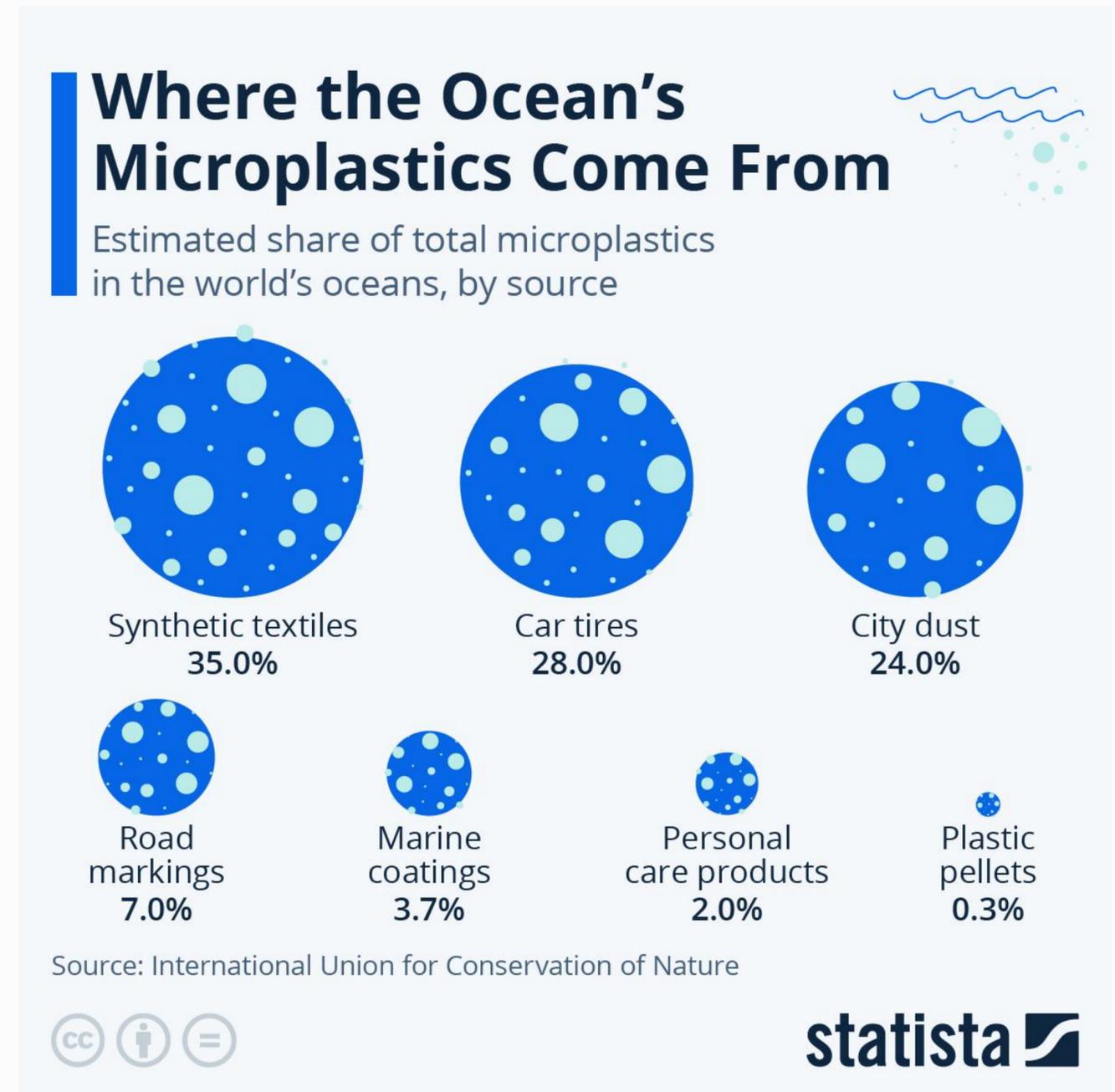
Pollutant:
Plastic Waste

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Plastic Waste: What is it?

- Plastic waste refers to discarded plastic materials that persist in the environment due to their resistance to biodegradation (Qin et al., 2024).

- Over time, larger plastic items degrade into microplastics (particles <5 mm) and nanoplastics (<1 μm), which can infiltrate ecosystems and human food chains.

- These particles have been detected in various human tissues, including the placenta and bloodstream, raising concerns about potential health impacts (Dzierżyński et al., 2024).

- A 2017 landmark study estimated that over 8.3 billion metric tons of plastics have been produced globally, with 79% accumulating in landfills or the natural environment (Geyer et al., 2017).

Plastic Waste: Primary Pollutants

- Polyethylene (PE)

- Polypropylene (PP)

- Polystyrene (PS)

- Polyvinyl chloride (PVC)

- Polyethylene terephthalate (PET)

Where the Ocean's Microplastics Come From

Estimated share of total microplastics in the world's oceans, by source

Synthetic textiles
35.0%

Car tires
28.0%

City dust
24.0%

Road markings
7.0%

Marine coatings
3.7%

Personal care products
2.0%

Plastic pellets
0.3%

Source: International Union for Conservation of Nature

statista

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Plastic Waste: Sources

Consumer Products and Packaging

- Packaging accounts for nearly 40% of total plastic use.

- Despite recycling programs, less than 10% of global plastic is successfully recycled.

- Majority of plastic waste comes from single-use items such as packaging materials, bottles, and bags (Geyer et al., 2017)
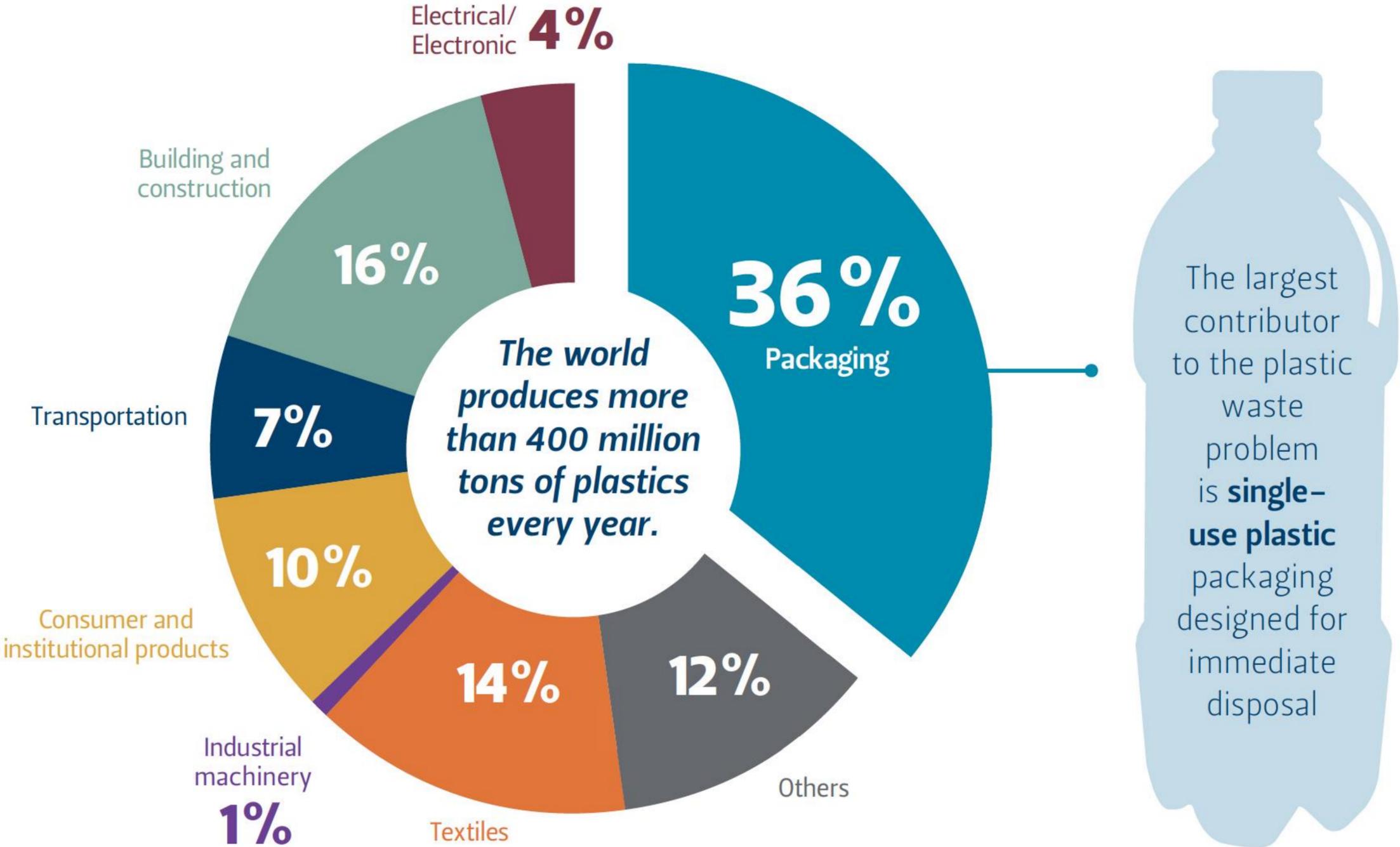
Textiles and Synthetic Fibers

- Synthetic garments made of polyester, nylon, and acrylic release microfibers during washing. Each laundry cycle can release hundreds of thousands of fibers into wastewater systems, which are often not removed during treatment processes (Landrigan et al., 2023).

Industrial and Medical Waste

- Manufacturing processes and improper disposal of medical plastics (e.g., PPE, test kits) can contribute to environmental contamination and exposure in waste-handling communities (Zuri et al., 2023).

Plastic Waste: Sources

Electrical/Electronic **4%**

Building and construction **16%**

Transportation **7%**

Consumer and institutional products **10%**

Industrial machinery **1%**

Textiles **14%**

Others **12%**

36% Packaging

The world produces more than 400 million tons of plastics every year.

The largest contributor to the plastic waste problem is **single–use plastic** packaging designed for immediate disposal

Degraded Microplastics

- Over time, larger plastic debris fragment into microplastics and nano plastics due to UV radiation (sunlight), mechanical abrasion (waves), and microbial action. These fragments are often ingested by plankton, fish, and humans, forming a toxic food chain loop (Inam, 2025).

- New sources of plastic pollution include tire wear particles, atmospheric fallout, and synthetic cosmetics.

- A recent review found that microplastic contamination is often underreported in indoor environments where humans spend over 90% of their time (Landrigan et al., 2023).

Phthalates and Bisphenol A (BPA)

- Phthalates and BPA are common additives in plastics that can leach into food and beverages. They bind to estrogen receptors, altering hormonal signaling by mimicking estrogen (Schug et al., 2011).

- This disrupts menstrual cycles, follicular development, and ovulation, and may elevate the risk of endometriosis and uterine fibroids (Darbre, 2020).

Pregnancy Outcomes

- Prenatal exposure to EDCs like phthalates and BPA is linked to shorter gestation, preterm birth, and impaired fetal neurodevelopment (Inam, 2025)

National Geographic

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Ingestion and Inhalation

- Humans are exposed to microplastics through drinking water, seafood, table salt, and even air.
- Microplastics have been found in human placentas, lungs, and blood.
- People ingest up to 5 grams of microplastics per week, equivalent to the weight of a credit card.
- Inhalation of airborne microplastics is a growing concern, especially indoors, where synthetic fabrics and dust contribute to respiratory exposure (Dzierżyński et al., 2024).

Inflammation and Oxidative Stress

- Studies suggest microplastics can induce oxidative stress, inflammation, and cytotoxicity in human cells. They can penetrate cellular membranes, triggering immune responses.
- In vitro studies show increased reactive oxygen species (ROS) and mitochondrial dysfunction following exposure (Darbre, 2020).
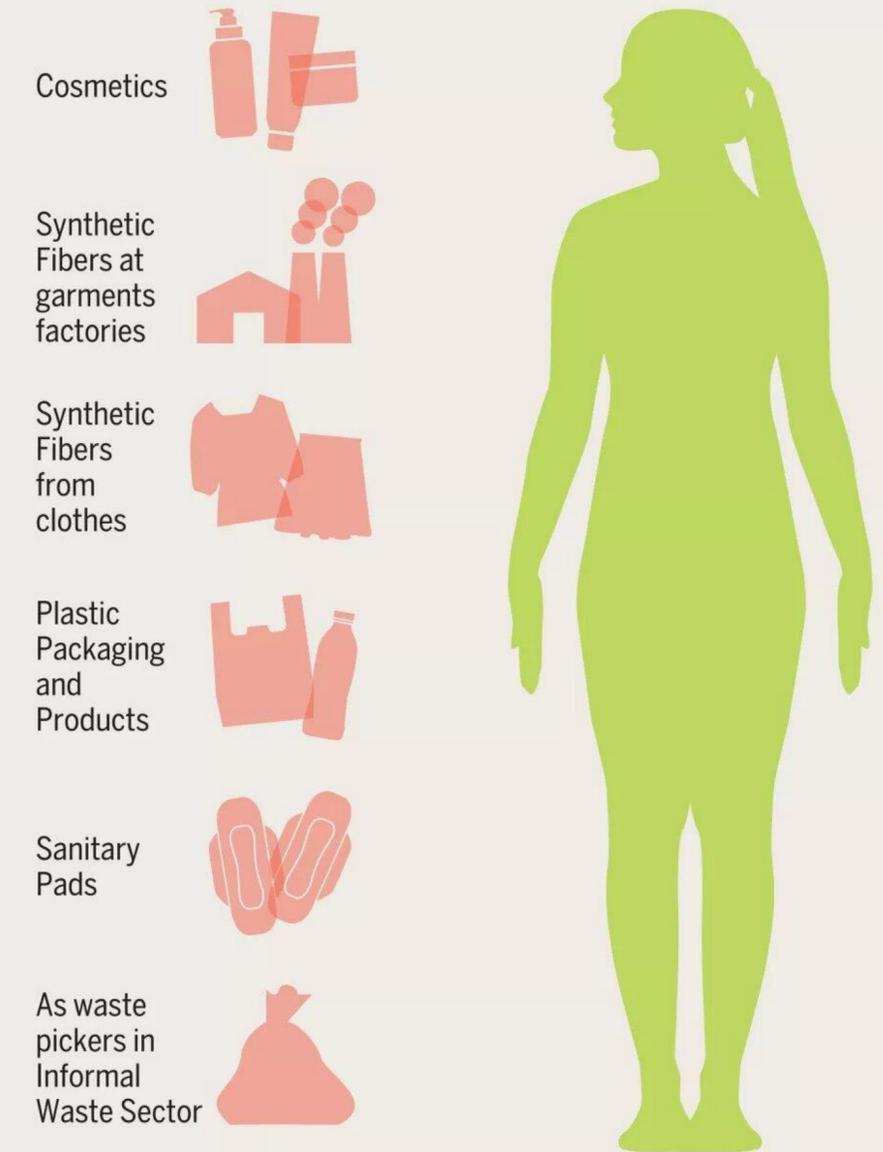
Plastic Waste: Women's Reproductive Health

- Emerging data confirms microplastics' ability to accumulate in the endometrial lining, where they interfere with implantation and menstrual regularity. (Qin et al., 2024).

- Prenatal exposure to these substances is linked to preterm birth, lower birth weight, and potential neurodevelopmental delay in offspring (Zuri et al., 2023).

WOMEN'S PLASTIC EXPOSURE
Women in Asia come into contact with plastic everyday, both at home and at work

Cosmetics

Synthetic Fibers at garments factories

Synthetic Fibers from clothes

Plastic Packaging and Products

Sanitary Pads

As waste pickers in Informal Waste Sector

PLASTIC ATLAS 2021/SHEKHAR

- Women, children, and individuals in low-income communities are disproportionately affected by plastic waste exposure.

- Workers in informal waste sectors, particularly in South Asia and Sub-Saharan Africa, face unhealthy exposure to toxic fumes and particulates during open-air burning of plastics without adequate protection. This exposure correlates with increased miscarriage rates and chronic bronchitis symptoms.

- Coastal indigenous communities reliant on fishing and marine resources suffer both ecological degradation and a reduction in traditional food resources due to marine plastic accumulation. Additionally, incineration of plastic waste in marginalized areas exposes residents to hazardous pollutants.(Kumar et al., 2022).

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Plastic Waste: What you can do

- Use reusable water bottles instead of one-use plastic bottled ones

- Avoid fast fashion made of synthetic fibers

- Store food in glass or silicone containers instead of plastic

- Avoid plastic containers for hot food and drinks

- Minimize packaged and processed foods

- Switch to bar soap and shampoo bars/reuse packaging

- Use natural fiber clothing (cotton, wool, linen)

- Use cloth grocery bags instead of plastic bags

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Pollutant:
Water Pollution

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Water Pollution: What is it?

- Water pollution refers to the contamination of water bodies by substances that are harmful to living organisms, ecosystems, and human health.

- These pollutants may include chemicals, heavy metals, pathogens, plastics, and nutrient-rich runoff. (Landrigan et al., 2020).

- The consequences are far-reaching, affecting drinking water safety, food security, ecosystem balance, and human health.(Levin et al., 2023).

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Water Pollution: Primary Pollutants

- Nitrates
- Phosphates
- Lead
- Mercury
- Arsenic
- Pesticides
- Microplastics
- Biological contaminants
  - Escherichia coli
  - Other fecal coliforms
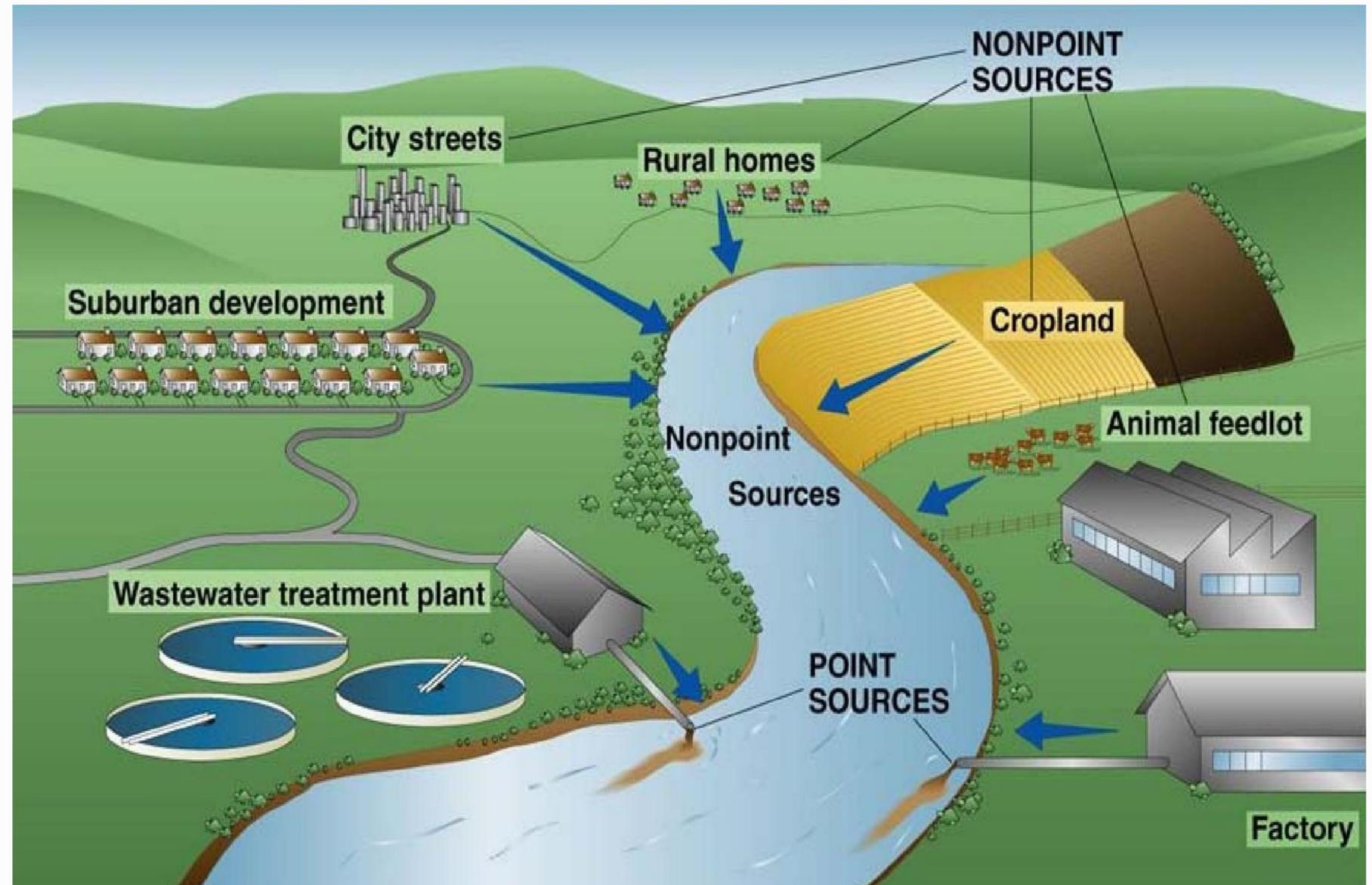
Water Pollution: Sources – point sources

Industrial Discharges

- Factories and industrial plants release pollutants such as heavy metals (lead, mercury, cadmium), solvents, and hydrocarbons directly into nearby water bodies (Landrigan et al., 2020).

Sewage and Wastewater

- Domestic and municipal wastewater carries nutrients (nitrogen and phosphorus), pathogens, pharmaceuticals, and microplastics into aquatic systems (Levin et al., 2023)(Rangel-Buitrago et al., 2024)

Oil Spills

- Accidental or illegal discharges of petroleum products contaminate surface waters and have long-lasting ecological effects (Landrigan et al., 2020)(Barron et al., 2020).

Agricultural Runoff

- Fertilizers and pesticides used in farming wash into rivers and lakes, contributing to nutrient pollution, eutrophication, and harmful algal blooms.
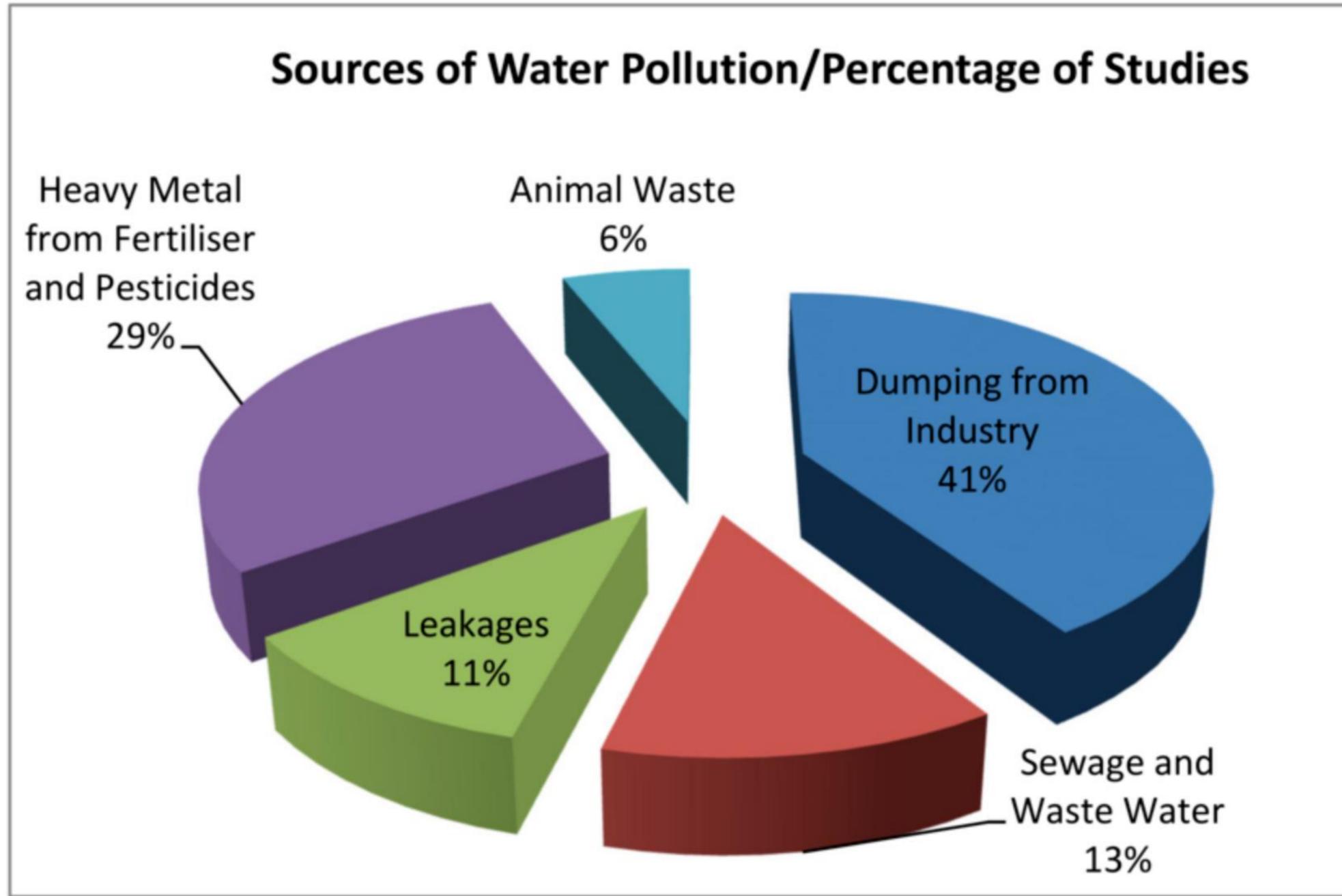
Urban Runoff

- Rainwater collects pollutants like motor oil, trash, and road salts from impervious surfaces and channels them into stormwater systems (Müller et al., 2020).

Atmospheric Deposition

- Pollutants such as mercury and nitrogen compounds can enter water bodies from the atmosphere through precipitation.

Water Pollution: Sources

Sources of Water Pollution/Percentage of Studies

- Heavy Metal from Fertiliser and Pesticides 29%
- Animal Waste 6%
- Dumping from Industry 41%
- Sewage and Waste Water 13%
- Leakages 11%

Water Pollution: Health Effects

Microbial Contaminants

- Waterborne Diseases: Contaminated water can spread diseases such as cholera, dysentery, typhoid fever, and hepatitis A.

- Antibiotic Resistance: Wastewater containing antibiotic residues and resistant bacteria contributes to the global spread of antimicrobial resistance (Li et al., 2022).

Chemical Contaminants

- Heavy Metals: Chronic exposure to lead, arsenic, or mercury in drinking water is associated with neurological damage, developmental delays, kidney disease, and cancer (Järup, 2003)

- Pesticides and Industrial Pollutants: Long-term ingestion of contaminated water may lead to endocrine disruption, reproductive harm, and increased cancer risk.

Water Pollution: Endocrine Disruption and Fertility

PFAS Exposure

Per- and polyfluoroalkyl substances (PFAS), commonly found in contaminated water sources, have been associated with endocrine disruption, leading to fertility issues and adverse pregnancy outcomes.
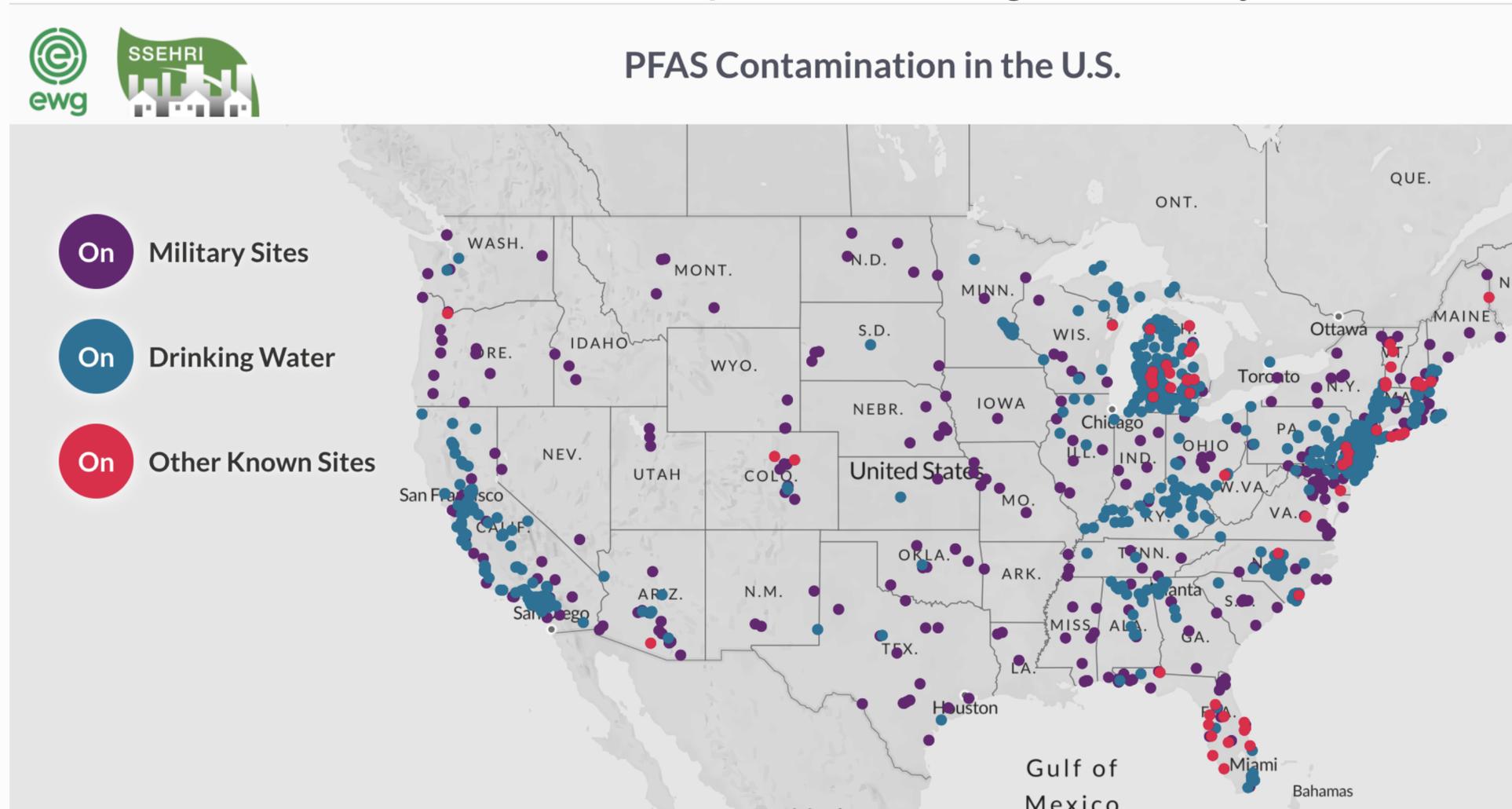
Interactive map for PFAS Contamination in Water Sources
https://www.ewg.org/interactive-maps/pfas_contamination/map/

Prenatal Exposure to Contaminants

- Studies have found that prenatal exposure to contaminants like tetrachloroethylene (PCE) in drinking water is associated with delayed time-to-pregnancy and increased risks of placental abruption, stillbirths stemming from placental dysfunction, and certain birth defects (Aschengrau et al., 2020).

Hypertensive Disorders in Pregnancy

- Exposure to contaminants such as cadmium, lead, trihalomethanes, and hexavalent chromium in drinking water has been linked to increased risk of hypertensive disorders during pregnancy(Padula et al., 2021).

Birth Defects and Miscarriages

- Research indicates that women consuming water contaminated with solvents have higher rates of spontaneous abortions and congenital malformations (Deane et al., 1992).

Water Pollution: What you can do

- Use a water filter to reduce contaminants

- Avoid bottled water as a primary source

- Switch to natural or eco-friendly cleaning and personal care products

- Avoid flushing medications or chemicals down the drain

- Avoid synthetic fertilizers and pesticides

- Fix leaky faucets (conserves water and lowers bills)

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Thank you!

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