

# “Does Air Pollution Play a Role in Infertility?: a Systematic Review” (2017), by Julie Carré, Nicolas Gatimel, Jessika Moreau, Jean Parinaud and Roger Léandri

In 2017, Julie Carré, Nicolas Gatimel, Jessika Moreau, Jean Parinaud, and Roger Léandri published “Does Air Pollution Play a Role in Infertility?: a Systematic Review,” hereafter “Does Air Pollution Play a Role,” in the journal *Environmental Health*. The authors completed a systematic literature review to investigate the effects of air pollutants on fertility in exposed populations. Since air quality has an impact on overall health as well as on reproductive function, the authors sought to increase the awareness of the importance of environmental protection issues among the general public and the authorities. The article “Does Air Pollution Play a Role” provided the foundation for further research on how air pollution can contribute to low reproductive capacity in areas with high exposure.

Air pollution has a serious toxicological impact on human health and the environment. Pollution can come from small units such as cigarettes to large volumes of emission such as from the motor engines of automobiles or industrial activities. Air pollution causes adverse health outcomes such as respiratory infections, inflammation, and cardiovascular dysfunction. It can also harm or disrupt a variety of bodily functions which are connected to reproductive ability. For example, air pollutants can act as endocrine disruptors, meaning they interfere with hormones that are crucial to reproductive function. Throughout “Does Air Pollution Play a Role,” the authors use the terms “fertility” and “infertility” to refer to the ability or inability to produce offspring.

At the time of publication, Carré, Gatimel, Moureau, Parinaud, and Léandri were all doctors in reproductive medicine at the Centre Hospitalier Universitaire de Toulouse, or Toulouse University Hospital, in Toulouse, France. All but Carré were also associated with a research group on human fertility at Paul Sabatier University, also located in Toulouse. They wrote the article to investigate the impact of air pollution on reproductive function. The authors note that there are many studies documenting the effect of pollutants on the human body in ways that could affect procreation, but at the time of publication, the actual effect on fertility was not well known.

The authors conducted a systematic review of the research involving exposure to environmental air pollutants and its effect on fertility. The authors selected relevant studies from January 2000 to February 2016 and used them to compile data involving air quality and infertility. Carré and colleagues grouped the data according to the type of pollutants, such as automobile exhaust pollutants, sulfur oxide, or nitrogen oxide, to draw specific conclusions about their impact on fertility and the molecular pathways involved.

The article consists of four sections. In the first section, Introduction, the authors reference other articles which demonstrate the negative effects of air pollutants on different aspects of the human body, including those relevant to reproduction. In the second section, Methods, they discuss how they found articles and chose which to include or exclude in their study. The third section, Results, consists of many smaller sections, discussing the effects of air pollutants on spontaneous and in vitro fertilization, male gametes in humans and animals, female gametes in humans and animals, and the mechanisms of how air pollutants can affect reproduction. Spontaneous fertility refers to conception which happens without external aid, whereas IVF is a method in which medical practitioners combine an egg and sperm outside the body, and then implant the fertilized egg in someone’s

uterus. Gametes are eggs or sperm, which combine to form a zygote that can develop into a fetus. In the fourth section, Conclusion, the authors state that the effect of air pollutants on reproduction is well-established but scientists and physicians still do not completely understand what causes it.

In the first section, Introduction, Carré and colleagues establish that air pollutants have repeatedly been shown to have a negative impact on human health. They list specific pollutants and discuss the health problems, such as cardiovascular disease and respiratory diseases like asthma, those pollutants can cause. They also discuss the mechanisms that may connect the pollutants to the observed health problems, such as oxidative stress, an imbalance of oxygen-containing molecules in the body. Oxidative stress can alter DNA, the material that makes up genes. DNA modification can affect the whole body, and particularly affect procreation by disrupting the production of hormones or degrading the DNA in gametes, which can prevent successful fertilization.

In the next section, Methods, the authors describe the criteria they used to find studies to include in their review. They state that they completed their analysis in compliance with Preferred Reporting Items for Systematic Reviews and Meta-Analyses, or PRISMA, standards. PRISMA is a widely used reporting method for systematic reviews and meta-analyses in scientific research. The researchers explain that they used the database PubMed and list the specific search terms they used. The authors state that they included all articles arising from that search except for articles on topics in reproduction other than fertility, such as ovarian cancer or precocious puberty, research on animals other than mammals, and any research on in vitro cultures. In vitro cultures are tissue or cell growths in an artificial medium. Research on in vitro cultures did not fit the authors' selection criteria because they did not reflect fertility outcomes observed within a mammal's body.

The third section, Results, is broken into nine smaller sections. Those sections summarize the information the authors found in their analysis on the impact of air pollution on spontaneous and laboratory fertilization, the effects on gametes, and four suggested mechanisms of air pollutants to affect fertility. The four suggested mechanisms were hormonal changes due to an endocrine disruptor action, oxidative stress induction, cell DNA alteration, or epigenetic modifications. In the first two subsections, Carré and colleagues discuss several studies which investigated the connection between exposure to air pollution and spontaneous fertility and IVF. In their analysis, the authors found that there is evidence for a negative effect of air pollution on spontaneous fertility, from studies on both mice and humans, but that there is not strong enough evidence to suggest any single pollutant is responsible. The authors also analyzed studies on the effect of air pollution on IVF outcomes, and found a weak connection. That means that they found that air pollution may affect IVF, but there was not strong evidence to say it absolutely does, or does so strongly. In the case of both spontaneous fertility and IVF studies, they state that the evidence may not be robust because the studies are overwhelmingly retrospective, meaning the researchers had limited control over variables and therefore it would be difficult to identify isolated effects.

The authors then include two sections on the effect of air pollutants on male and female gametes, in humans and animals. The authors state that studies on animals reveal that several air pollutants have demonstrated harmful effects on sperm quality. Carré and colleagues describe studies in which rodents were exposed to exhaust from motor vehicles and showed a decrease in daily production of motile sperm cells and an increase in abnormally shaped sperm cells. Less motile or abnormally shaped sperm are less likely to fertilize an egg. Rodents also had more sperm DNA breakage when exposed to ambient air pollution. Human men showed similar results, as in a study which compared sperm parameters among men who had high chance of exposure to vehicle exhaust from their workplace at toll plazas to unexposed men working in an office in the same company. The men exposed to exhaust had decreased sperm count and sperm mobility, and increased abnormal sperm shape. Regarding female gametes, the authors described the results of two studies on mice and three on human women. Both studies on mice indicated decreased numbers of follicles following exposure to automobile pollution. Follicles contain immature eggs, or oocytes, and are associated with reproductive capacity, or how many eggs remain in someone's body. The authors then reference studies that have observed the length of menstrual cycles in Chinese women who worked in petrochemical industries and experienced exposure to organic solvents. Those studies indicated an increase in menstrual cycle abnormalities, such as very long or very short menstrual cycles, following long-term exposure to common industrial solvents, which are liquids common in

industrial settings. A third study on female police officers in Rome showed no difference in menstrual cycles due to increased exposure to traffic pollution, but that levels of estradiol, a hormone involved in the menstrual cycle, was lower during certain phases, and could impact fertility.

The authors conclude the results section by discussing evidence for four possible mechanisms for the action of air pollutants on fertility: hormonal changes due to endocrine disruptor action, oxidative stress induction, cell DNA alteration, and epigenetic modifications. Endocrine disruptors are chemicals which disrupt endocrine function, meaning they interfere with hormones. Hormones like estrogen are important to fertility, and disruptions in the production or action of those hormones can disrupt the production of gametes and the regulation of the reproductive system. Oxidative stress induction refers to an imbalance of oxygen-containing molecules in the body and can impair the production and function of gametes. Cell DNA alteration and epigenetic modifications both refer to changes in an organism's DNA, which can interrupt or change gene expression, causing problems in different parts of the reproductive system. In the final section, Conclusion, the authors summarize their results, and state that although it is well established that pollutants can affect fertility, the mechanisms are still poorly understood.

The physiological mechanisms that hinder fertility are not well understood, and Carré and colleagues' article provided a systematic review of the available research on the effect of different pollutants on fertility outcomes. As of August 2021, the article has been cited over 160 times, primarily in other studies on the impact of pollutants on different aspects of reproduction and reproductive health.

## Sources

1. Carré, Julie, Nicolas Gatimel, Jessika Moreau, Jean Parinaud, and Roger Léandri. "Does Air Pollution Play a Role in Infertility?: A Systematic Review." *Environmental Health : A Global Access Science Source* 16 (2017): 1-16. <https://www.ncbi.nlm.nih.gov/pmc/articles/PMC5534122/> (Accessed October 28, 2020).
2. Sierra-Vargas, Martha Patricia, and Luis M Teran. "Air Pollution: Impact and Prevention." *Respirology* 17 (2012): 1031-8. <https://www.ncbi.nlm.nih.gov/pmc/articles/PMC3532603/> (Accessed October 28, 2020).