Nuclear Power Generation and Health Outcomes: Evidence from U.S. Commercial Nuclear Plants

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Abstract

Nuclear power is experiencing a resurgence, yet the health impacts remain poorly understood. This paper estimates the effects of commercial nuclear power plant openings in the United States on infant mortality and birth rates utilizing data from 1948-1988. Since the timing of plant openings is staggered, we estimate effects utilizing the methodology from Callaway and Sant'Anna (2021). Though our primary set of control counties consists of locations where nuclear plant projects were canceled, we document robustness to a range of alternative control groups. Our findings indicate that nuclear power plants did not have a statistically significant impact on infant mortality or birth rates. This constitutes one of the first causal estimates of the impacts of normal nuclear plant operations on health outcomes across the United States.

JEL Codes: I18, L94, Q40, Q53

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1 Introduction

Nuclear power remains a central component of global strategies to decarbonize electricity production and meet climate targets (Lee et al., 2023). Despite this, concerns persist about the potential health risks from radiation exposure associated with nuclear power generation. Licensed facilities in the United States routinely release extremely small amounts of radiation during normal operations, which are tightly regulated and monitored by the Nuclear Regulatory Commission (NRC) to ensure doses remain well below established safety limits. Decades of monitoring and epidemiological research—including the seminal National Cancer Institute (NCI) study *Cancer in Populations Living Near Nuclear Facilities* (Jablon, Hrubec and Boice, 1991)—have found no systematic evidence that proximity to nuclear facilities increases cancer mortality.

Nonetheless, public concern has endured, in part fueled by high-profile nuclear accidents such as Three Mile Island, Chernobyl, and Fukushima. These accidents have heightened perceptions of risk even when routine operational exposures remain extremely low. These perceptions have influenced public debates, policy decisions, and contributed to the slow growth or even phase-out of nuclear power in some countries (Jarvis, Deschenes and Jha, 2022).

In response to ongoing concerns, the NRC commissioned the National Academy of Sciences (NAS) in 2010 to reexamine the issue using modern data and methods. The NAS ultimately concluded that, given the small expected effect sizes, data limitations, and long latency periods of most cancers, such a study was unlikely to produce meaningful results within a reasonable timeframe or cost. As a result, the NRC continues to rely on the NCI findings when implementing licensing and radiation-protection regulations for nuclear power. Importantly, since the early case studies of radiation exposure in the 1970s, researchers have argued that short-run indicators—such as infant mortality and birth outcomes—may offer a more sensitive lens for detecting potential effects of low-level radiation exposure (DeGroot, 1972; Landau, 1972; Sternglass, 1972; Tompkins, Hamilton and Hoffman, 1972).

This paper estimates the effects of commercial nuclear power plant operations in the United States on infant mortality and births using data from 1948-1988. We focus on infant health outcomes because they are more plausibly exogenous to the introduction of

nuclear power plants than all-age mortality. Namely, given the short exposure window around birth, infant health outcomes are less likely to reflect long-term selective migration or health accumulation effects that we cannot observe in our data. Our primary outcomes of interest are infant mortality and birth rates. Infant birth and mortality data are from the ICPSR Natality and Mortality dataset (Bailey et al., 2016).

Since the timing of nuclear power plant openings is staggered, we estimate event studies specifications utilizing the methodology from Callaway and Sant'Anna (2021). A county home to a nuclear power plant is considered treated in any year on or after the plant's first grid connection year. To construct the control group, we compiled a list of canceled nuclear plant projects from multiple publicly available sources, including *Nuclear Plant Cancellations: Causes, Costs, and Consequences* (DOE, 1983).[1] However, the results remain similar across a range of alternative control groups, such as considering "Ring 1" counties adjacent to treated counties or "Ring 2" counties adjacent to "Ring 1" counties.

The paper has two main findings. First, nuclear power generation did not have an adverse impact on infant mortality rates. Our 95% confidence intervals always include zero. The bounds of these intervals for our preferred specification rule out any adverse effect larger than 7.5%. Event study estimates indicate that average infant mortality rates moved in parallel across treated and control counties in the years prior to the nuclear power plant opening—evidence in favor of the parallel trends assumption necessary to interpret these estimates as causal.[2]

Second, nuclear power generation did not have an adverse impact on birth rates. As with infant mortality rates, the estimated effect of nuclear plant openings on birth rates is not statistically significant and the pre-treatment event study estimates provide evidence in support of the parallel trends assumption. The lower bound of our estimated 95% confidence interval suggests that we can rule out adverse effects on birth rates larger than 5.1%.

Our findings are subject to a number of important caveats. First, we cannot rule

[1]Utility companies retain the discretion to cancel nuclear generation projects at any stage. The primary reasons for these cancellations were economic motives and stricter regulations due to the Three Mile Island accident (DOE, 1983).

[2]The parallel trends assumption dictates that infant mortality rates in treated counties would have continued to move in parallel to those in control counties in the absence of nuclear power plant openings.

out potential chronic effects of nuclear power generation, as our data do not track individual health outcomes over time. Several studies have examined chronic impacts of sustained low-dose radiation exposure, particularly in the context of nuclear accidents such as Chernobyl or Fukushima (Almond, Edlund and Palme, 2009; Black et al., 2019). Second, we do not consider the health implications of catastrophic nuclear accidents, which differ qualitatively from routine plant operations. Third, our analysis is restricted to commercial plant sites and does not examine offsite nuclear waste storage facilities, which may impose distinct environmental and health risks. Finally, we do not address the health consequences of atmospheric atomic weapons testing, which has been linked to increased cancer risks and mortality over time (Simon et al., 2010).

Our study contributes to a long-standing literature on the health impacts of nuclear power generation. One of the earliest systematic investigations into this topic was conducted by Morris H. DeGroot for the *Sixth Berkeley Symposium on Mathematical Statistics and Probability*. He concluded: *"... in view of the smallness of the effects and the simplicity of the model. Namely, the studies are inconclusive. They neither establish nor disprove the existence of an effect. They do, however, lead to the inescapable recommendation that more comprehensive and detailed studies of these questions are urgently needed."* (DeGroot, 1972). To our knowledge, there are no studies that show a causal relationship between nuclear power generation and infant health. Jablon, Hrubec and Boice (1991) did not find higher rates of cancer near nuclear power plants. While relatively comprehensive, the study is limited by its correlational design and narrow focus on cancer. Case studies in both the U.S. and the U.K. found no significant increase in cancer or infant mortality near nuclear power plants, with the possible exception of childhood leukemia (Enstrom, 1983; Forman et al., 1987). In contrast, other studies have estimated that proximity to nuclear plants negatively affects various health outcomes (Ghirga, 2010; Hatch et al., 1991; Mangano, 2008; Mangano et al., 2002).[3] To our knowledge, we provide the first causal estimates documenting the lack of relationship between nuclear power generation and infant health.

[3]Additionally, an epidemiological study by the National Academy of Sciences highlighted the challenges in conducting epidemiologic studies of cancer risks in populations near NRC-licensed nuclear facilities (National Research Council and Division on Earth and Life Studies and Radiation Studies Board and Committee on the Analysis of Cancer Risks in Populations near Nuclear Facilities: Phase I, 2012).

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