# A Toast to Health? The Unintended Impact of Pesticides in Italy's Prosecco Region

## Extended Abstract - ERSA 2025

Giuliano Marco Federio Rolle[1], Alessandro Palma[1], and Daniela Vuri[2, 3]

[1]Gran Sasso Science Institute, Social Sciences
[2]DEF Tor Vergata
[3]IZA

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**Abstract**

The rapid growth of Prosecco wine production in the Veneto Region (Italy) has intensified pesticide use, raising urgent concerns about maternal health and child neurodevelopment. Although prior epidemiological studies have identified links between prenatal and early-life pesticide exposure and adverse birth outcomes, limited evidence exists on its long-term cognitive effects in high-income European countries.

This study addresses that gap by analyzing how municipal-level pesticide restrictions—enforced under Regional Executive Resolution DGR no. 1379/2012 of the Veneto Region—impact children's health at birth and their later-life cognitive development. The policy-driven staggered introduction of pesticide restrictions has generated variation in exposure levels across municipalities and over time.

The findings indicate that reduced in-utero and early-life pesticide exposure is associated with higher mathematics scores in early grades, highlighting the importance of perinatal environmental factors in shaping human capital. These results underscore the critical role of strict environmental regulations in safeguarding vulnerable populations. They also suggest that sustainable pest management not only benefits public health but contributes to improved educational trajectories.

**Keywords:** Pesticide, Public Health, Child Development, Human Capital, Cognitive ability

**JEL Classification:** Q53, Q58, I18, J13, C21

# 1 Introduction

## 1.1 Introduction on pesticides

Pesticides are compounds used to repel, control, or eliminate specific animals or plants that are regarded as pests. Pesticides comprise herbicides to remove weeds and other undesired plants, insecticides to control a broad variety of insects, and fungicides to prevent the spread of molds and mildew (Hayes, 2010). They have historically served a vital role in society: their usage for agricultural and human hygienic aims is abundantly attested in ancient India, Egypt, Greece, Rome, India, and China, where application procedures frequently comprised combustion or powder-spreading of sulfur and arsenic chemical substances (Costa, 1987)

The development of modern agriculture in the late nineteenth century significantly increased our ability to feed an ever-increasing population. However, it also caused environmental externalities since farming became overly dependent on chemical inputs like fertilizers and pesticides (Baran, 2022). When released into the environment, pesticides can propagate through soil or surface water to rivers and groundwater, potentially causing unintended ecological consequences such as bioaccumulation in aquatic organisms and a decline in biodiversity of ecosystems (Beketov et al., 2013; Stehle & Schulz, 2015; Arisekar et al., 2019). On the other hand, pesticides may exhibit mutagenic, carcinogenic, neurotoxic, and/or teratogenic impacts on human beings (Pereira et al., 2015; Harmon O'Driscoll et al., 2022). These externalities result in suboptimal market outcomes because producers and consumers fail to internalize the social costs in their decision-making function (Gensch et al., 2024).

Fetuses and infants are the most susceptible demographic to the enduring consequences of pesticide exposure. Due to their not yet developed organs, such as the blood-brain barrier (the semi-permeable membrane between the blood and the interstitium of the brain), immature metabolic pathways, and a rapid metabolic rate, unborn children are more vulnerable to pesticides' detrimental effects than adults (Lanphear, 2015).

Fetal shocks, particularly those occurring early in gestation, can have enduring effects (Barker, 1995; Almond & Currie, 2011). Environmental shocks, as for example exposure to heavy metals and air pollution, have been causally associated with negative perinatal outcomes (Chay & Greenstone, 2003; Currie & Neidell, 2005; Currie & Walker, 2011; Clay et al., 2014), but also with later-life variables, including proxies for cognitive and human capital development (Sanders, 2012; Currie et al., 2014; Zheng et al., 2016; Isen et al., 2017; Persico et al., 2020; Colmer & Voorheis, 2020).

Childhood pesticide exposure can happen because of various pathways, including maternal prenatal exposure, occupational exposure, proximity to agricultural land, consumption of contaminated food or beverages, and household pesticide usage (Hyland & Laribi, 2017).

Evidence indicates a higher incidence of stillbirths (Regidor et al., 2004) and congenital anomalies (Garry et al., 2002) among agricultural workers, particularly for pregnancies conceived during the spring pesticide application period. Other studies emphasize the effects of pesticide exposure in the first trimester of pregnancy (Bell et al., 2001) and the association between fertilizer chemicals in water and congenital disorders (Winchester et al., 2009). Schreinemachers (2003) observes that the incidence of birth abnormalities increases with the expansion of wheat acreage in a county, serving as a proxy for herbicide exposure. In a relatively small number of

children who were exposed to insecticides in utero, Rauh et al. (2012) discovered evidence of long-term effects in the form of reduced intelligence quotient (IQ) scores. Larsen et al. (2017) use comprehensive micro-level panel data from California to demonstrate that pesticide exposure is associated with detrimental perinatal outcomes in communities subjected to elevated pesticide levels. Brainerd & Menon (2014) use variations in planting schedules to link fertilizer pollution with negative birth outcomes in India, while Lai (2017) employs a policy shift in China to connect pesticide usage with greater disability rates. Dias et al. (2023) associate the increase in pesticide use, driven by the introduction of genetically modified crops in Brazil, with worse birth outcomes.

### 1.2 Background and Motivation

Twenty-two percent of all monitoring locations in water bodies throughout Europe detected one or more pesticides above the limits of concern in 2020. In a 2019 investigation, pesticide residues were detected in 83% of the tested agricultural soils (Agency, 2023). After his visit to Italy in 2021, the UN Special Rapporteur on Toxics and Human Rights claimed that there is growing concern regarding pesticide usage in the Veneto Region (Italy), notably in the municipalities of Treviso Province. These locations are among the country's largest pesticide users per hectare (OHCHR, 2022). Following the revision of the geographic indication system of Prosecco, and in combination with a rapid increase in demand, the total cultivated area of Prosecco DOC expanded from 8,700 hectares in 2010 to almost thrice, reaching 24,450 hectares in 2019. Production levels increased from 141 million bottles in 2010 to 464 million in 2019. Comparable trends occurred also in the DOCG region (Ponte et al., 2023).

The rise in Prosecco production has also resulted in increased pesticide usage in the region. Pesticide sales grew, exclusively within the Province of Treviso, from around 3 million kg in 2011 to more than 4.5 million kg in 2019 (Pappalardo et al., 2022). The success of Prosecco has led to tension between two groups: wine producers, who benefit from the economic growth driven by its popularity, and the local population, who bear the burden of its negative environmental and health externalities (Basso & Vettoretto, 2020; Visentin & Vallerani, 2018; Ponte, 2021).

Despite these worrisome health impacts, there are no studies in the literature that have investigated, in the European context and with robust counterfactual econometric methods and population data, the effect of exposure to pesticides at the municipal level on children's perinatal health and, at the international level, on their later-life cognitive development outcome. To fill this research gap, this study aims to evaluate, in the context of the municipalities of the Veneto Region, the causal impact of municipal and inter-municipal restrictions on pesticide use on perinatal health and later life cognitive development of children who have been affected by the considered measures during their prenatal development phase and in the first years of their lives. The analysis focuses on the effects of municipal policies enacted following specific Regional Executive Resolutions (known in Italian as "Delibere di Giunta Regionale", or DGR) of the Veneto Region (Italy), i.e. DGR no. 1379/2012 (Regione del Veneto, 2024). This Regional Executive Resolution has approved some technical protocols and framework guidelines for properly using pesticides in public spaces, particularly those frequented by vulnerable groups (including childbearing and breastfeeding mothers, unborn children, infants, and toddlers).

## 2 Research Questions

The central hypothesis of the research is that the municipal policies imposing limitations on the use of pesticides in areas frequented by vulnerable groups contributed to improvements not only in the perinatal health conditions of newborns but also in their later-life cognitive development. It is hypothesized that these effects are due to the reduced prenatal and early-life exposure to pesticides resulting from reduced and more controlled usage in the areas under investigation.

## 3 Data

This study is exploiting the following data frames:

1) An original dataset containing information about municipal regulations on the use of pesticides in areas frequented by the sensitive population in application of DGR no. 1379/2012. This information has been obtained through a consultation of the websites of the 563 municipalities of the Veneto Region. Eventually, this dataset is employed to develop the treatment variable of the model, identifying municipalities affected by the considered pesticide policies after their introduction.
2) To define the outcome variables related to children's perinatal health, this work utilizes birth certificates (Standard Certificates of Live Births, hereinafter SCLB) acquired from the Italian Ministry of Health, following the approach of Palma et al. (2022). The dataset encompasses the complete population of mothers who gave birth in private or public hospitals from 2010 to 2022. The SCLB offers data regarding the physical features of newborns and mothers, including the newborn's date of birth and the mother's place of residence, along with details on the delivery hospital, newborn sex, multiparity, the presence of a neonatologist at delivery, and various indicators of neonatal health. The dataset includes, in addition, background information on the mother, encompassing demographic and labor market data, childbearing history, and prenatal care details. Furthermore, these outcome variables on perinatal health will be exploited to elucidate the health mechanism by which in-utero shocks influence later-life outcomes, such as human capital development. These processes are believed to operate by diminishing an individual's "latent health" at birth (like, for instance, decreasing his/her birth weight) (Conti et al., 2020; Calzada et al., 2023). "Latent health" is a variable that is difficult to measure, and harmful effects on it may not manifest themselves until much later in life, as has been demonstrated interdisciplinary in the scientific literature of Epidemiology (Barker, 1995), Biology (Schulz, 2010), and Economics (Almond & Currie, 2011).
3) Data from the Italian National Institute for the Evaluation of the Italian Education System (INVALSI) is used to proxy cognitive development outcomes later in life. From 2015 to 2024, this dataset includes all non-disabled compulsory students in Italy who are enrolled in certain grades (2 and 5). The data includes grades and national standardized exam scores in Mathematics, Reading, and Italian Language. This information provides a comparative and objective assessment of performance across cohorts and educational institutions. INVALSI also provides demographic and socioeconomic data on the considered children, such as gender, birth date, kindergarten attendance, citizenship status, and parental history, i.e. educational achievement and job information (INVALSI, 2024). Eventually, the INVALSI individual-level data is

georeferenced at the municipal level following the approach of Barbetta et al. (2021).

## 4 Identification Strategy

The empirical approach of this paper is based on a dynamic difference-in-differences model (Callaway & Sant'Anna, 2021), which estimates the causal relationship between the staggered introduction of municipal policies for pesticide use limitations (under regional law DGR no. 1379/2012) and variables of perinatal health and later-life cognitive development. Restrictions on the use of pesticides in areas frequented by sensitive populations have hypothetically induced a substantial variance in the municipal level of pesticide contamination. This variance is, therefore, exploited to estimate whether cohorts exposed to lower levels of pesticide contamination in utero and/or in the first years of life have improved perinatal health and later-life cognitive developmental outcomes.

The identification strategy, thus, compares cohorts of individuals conceived before and after the changes in the level of contamination imposed by the considered policies, using as a control group cohorts conceived in municipalities in the Veneto Region that do not have any municipal/inter-municipal regulations on the use of pesticides due to their specific socio-economic and political features.

Eventually, this study estimates intent-to-treat (ITT) effects, capturing the impact of municipal deliberations irrespective of their actual enforcement.

## 5 Preliminary Result and Policy Implications

Policy-driven decrease in in-utero and early-life pesticide exposure is linked to higher INVALSI Math test scores in G02. In fact, the INVALSI math test scores of the students conceived in treated municipalities are, on average, 0.20 standard deviations higher than those of the control group. To put these results into perspective, an increase of about 0.10 standard deviations in INVALSI test scores is associated with having a parent who holds a university degree (Ballatore et al., 2025).

Finally, this original work, thanks to its empirical evidence on the effects of pesticide exposure on perinatal health and later-life cognitive development, contributes to the international scientific debate and supports informed public policies on health and environment, by providing concrete insights to guide pest control in intensive agricultural areas of high-income countries and promoting public health protection, with a focus on maternal and child health.

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