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Agrochemicals and negative effects on obstetric outcomes in Uruguay between 2010 and 2017

Jimena Heinzen [I]
Reinaldo Souza-Santos [II]
Frederico Peres [III]
Andréa Sobral [IV]

Abstract: Through an ecological design, we aimed to spatially analyse the correlation between residence in rural areas near crops that use agrochemicals with birth weight and gestational age. Inclusion criteria were pregnant women that lived in rural areas of the west coast of Uruguay, during 2010-2017. Outcome variables were low birth weight for gestational age and prematurity. Exposure was characterised through satellite images of land use and land cover and in-depth interviews. The population was 5735 pregnant women. Correlation analysis was performed using a Spearman matrix. Positive and significant correlations were obtained for both obstetric outcomes with irrigated and non-irrigated crops < 4-5 hectares, in both periods analysed. This work contributes to the characterisation of agrochemical use impact in the Uruguayan rural environment, particularly for vulnerable groups' health.

Keywords: Agrochemicals; Pregnancy; Geographic Information Systems; Premature Birth; Infant Low Birth Weight.

[I] *Faculty of Medicine, University of the Republic, Montevideo, Uruguay.*

[II] *Sergio Arouca National School of Public Health, The Oswaldo Cruz Foundation, Rio de Janeiro, Brazil.*

[III] *Sergio Arouca National School of Public Health, The Oswaldo Cruz Foundation, Rio de Janeiro, Brazil.*

[IV] *Sergio Arouca National School of Public Health, The Oswaldo Cruz Foundation, Rio de Janeiro, Brazil.*

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Introduction

The expansion of the agricultural frontier and proximity of agriculture to suburban areas has raised mounting concerns and research interest, leading to the mobilization of a range of actors from different fields and public denunciations. Concerns center on the potential impacts of the extensive use of pesticides on human health and the diversity of native flora and fauna[1-5]. Pesticides can affect human health directly, through contact with these substances, or indirectly, through the contamination of the environment and modifications to ecosystems[6-7]. Groups such as rural workers, children, and women of reproductive age are particularly vulnerable to exposure to pesticides[8-13].

Birthweight and gestational age at birth, both of which are decisive factors affecting newborn adaptation to extrauterine life[14-18], can be affected by exposure to certain groups of pesticides[9-12]. A total of 32,467 children were born in Uruguay in 2021 and the infant mortality rate was 6.3 per 1000 live births. While this rate is one of the lowest in Latin America, the development of public policies to end preventable deaths of newborns and children remains a priority[19-20]. The leading causes of death in the first year of life arise during the perinatal period, notably complications related to prematurity (46.1%)[19]. According to both national and international literature, birthweight is a key predictor of survival in the first year of life[16-18]. Previous studies in the Americas have shown that first year of life mortality rates are higher among children living in rural areas[16].

Between 2004 and 2007, 8.5% of newborns in Uruguay were born underweight, defined as less than 2500 g at birth[20]. This rate stood at 8.1% in 2017[20-22]. Chawanpaiboon et al. (2018) estimated that 12% of all births in Uruguay in 2014 were before 37 completed weeks of gestation[23].

The assessment of different types of exposure to pesticides (occupational, domestic, residential proximity to agriculture, ingestion, etc.) across different settings and time periods requires a multideterminant approach that takes into account the complexity of this process, including the heightened vulnerability of certain groups[6-11,13,24]. Community-based studies in Uruguay highlight the dominant logic underpinning industrial agriculture and limited awareness among some groups regarding the health and environmental risks of pesticides[13]. According to Breilh[8], the daily exposure to pesticides driven by agribusiness is not casual, but rather an *imposition* by a model of intensive agriculture that relies on the use of huge amounts of pesticides. Thus, while pesticide toxicity can be acute or chronic, the underlying issue is the *imposition* of an agroexport model *"that is permanent, stable, [and] promoted by the state and multinational agribusiness companies"*[13].

An array of strategies have been used to characterize exposure from residential proximity to agriculture. While ecological studies conducted in other countries have suggested that exposure to pesticides has a negative effect on prematurity, fetal growth and congenital malformations[11,26-29], the characterization of this type of exposure in Uruguay has come up against obstacles, including the lack of georeferenced records of pesticide application[13,25].

Analyses of specific substances have shown as association between the widely used herbicide glyphosate and prematurity[30]. Although there is insufficient information to

classify the other active ingredients used in dryland farming, the mechanisms of action of these chemicals suggest adverse reproductive and hormonal effects[10-12]. In a study of umbilical cord blood of full-term infants, Wickerham et al. found that birthweight was inversely associated with the number of pesticides detected in the blood. These results support the suggestion that exposure to mixtures of pesticides may have a greater effect than individual compounds alone[31].

Methods used to assess community exposure to pesticides include estimating seasonal changes in the concentration of pesticides in surface water, quantifying crop area in a particular region and analyzing records of the use and/or sale of pesticides[11,26-29,31-32]. Ecological studies can help assess exposure from residential proximity to agriculture in cases where it is not possible to conduct a biomarker study or to account for possible memory bias regarding exposure[24]. In this sense, spatial analysis is a useful tool for characterizing exposure to pesticides when data on application of pesticides by crop field or area are not available[25,33-34].

The aim of this study was to assess the relationship between exposure from residential proximity to pesticide-intensive agriculture on Uruguay's west coast and obstetric outcomes in women during the period 2010-2017. Spatial analysis was used to help characterize exposure from residential proximity to agriculture among a scarcely studied group in the southern cone, addressing an important public health concern.

Methods

We conducted a descriptive and analytic observational study using an ecological design.

The study area was rural areas in the departments of Paysandú, Río Negro and Soriano on the west coast of Uruguay (Figure 1). Due to the soil characteristics, the main type of agriculture on Uruguay's west coast is dryland farming, meaning that intensive farming has become increasingly widespread in the region since the beginning of the twenty-first century[13,35]. The west coast is therefore considered a sensitive area for exposure to pesticides, resulting in denunciations and claims by affected communities[5,13].

For the purposes of this study, rural areas were defined as the entire territory of the departments of Paysandú, Río Negro and Soriano except department capitals. This delimitation encompasses the region's strictly rural population (< 5000 inhabitants) and inhabitants of the region's agro-cities[36].

The inclusion criterion was locations where pregnant women were residing, resulting in 51 locations during the period 2010-2017 and a population of 5,735 pregnant women.

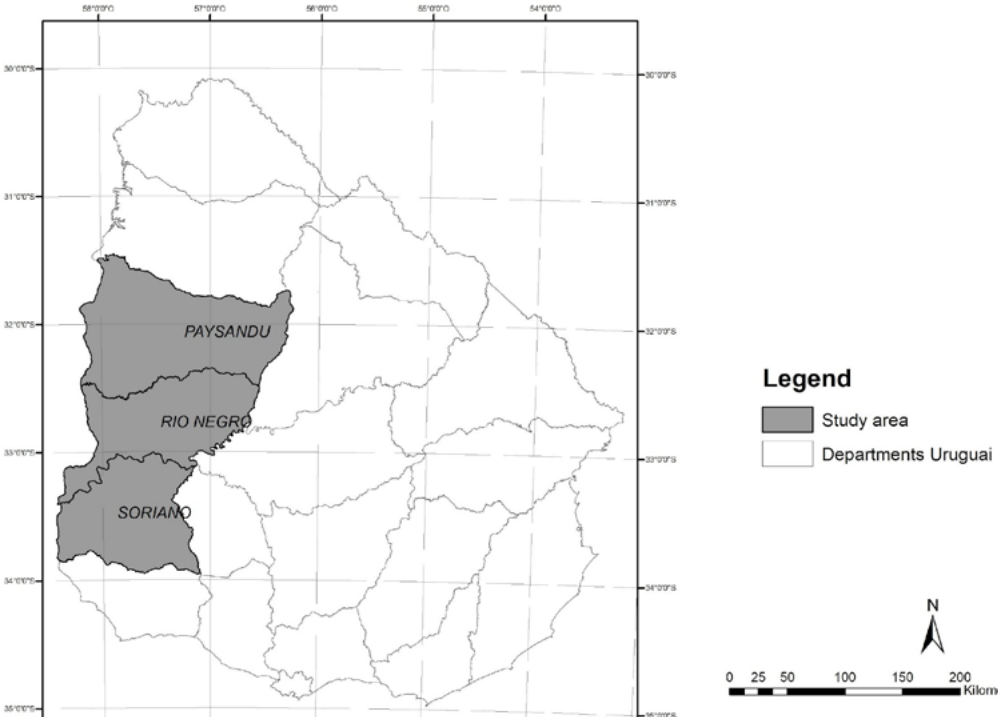
The data sources were unnamed data from the Ministry of Health's Perinatal Information System (SIP)[1] and the Ministry of Housing, Territorial Planning and Environ-

1 - The dataset was obtained by making an information access request to the Ministry of Health. Related indicators and metadata for other periods can be found at sis://uins.msp.gub.uy/..

ment's land cover classification for 2011 and 2015[2].

We performed a univariate analysis of all variables from the database using frequencies to describe qualitative variables and summary measures for the quantitative variables. The analyses were performed using R Commander (version 3.5.1; R Core Team 2018)[37].

Figure 1. Map of the departments included in the study.



Source: the authors, 2024.

The outcome variables were small for gestational age and prematurity, estimated using the tools and calculators developed by the INTERGROWTH-21st Consortium, which estimate sex-specific birth weight for gestational age[3]. Low weight was defined as birthweight below the 3rd percentile for gestational age and sex[38]. Gestational age at birth was calculated in weeks based on the date of the last menstrual period when reliable, or early ultrasound estimation (before 24 weeks). The date used was that recorded by the technician attending the delivery.

A number of methods were used to define exposure from residential proximity to pesticide-intensive agriculture. ArcGIS 10 was used to analyze satellite images from 2011 and 2015 of land use and land cover. To identify the pesticides used in dryland farming, especially soybean cultivation, we used secondary sources, drawing on previous studies

2 - https://sit.mvot.gub.uy/sit/.

3 - The calculators can be found at https://intergrowth21.tghn.org/intergrowth-21st-applications/

in the country and interviews with specialists on the topic[5,13,39]. Our methodological approach was based on the methodology proposed by González et al. to identify the types of pesticides used on soybean plantations[25,33], adapted to the national context and considering the limited resources available due to the health crisis caused by the pandemic.

Land use and land cover are interrelated yet different concepts. The term *land use* precedes cover as it refers to the effects of human action on a physical space, which subsequently determines *cover*. Land cover consists of the biophysical characteristics of the land surface, which includes percentage coverage of water courses and types of vegetation, etc. Since only one satellite image per year was used, it was not possible to identify crop rotations or changes over the year and therefore for the purposes of this study the terms land use and land cover are used interchangeably[40]. The use of only one single image per year also meant it was not possible to draw inferences by pregnancy trimester.

The study locations were used as centroids of 2-km buffer areas, with tests being carried out using different radii to define the appropriate area of the buffer within which land use and land cover were analyzed.

The use of 2-km buffers accounts for aerial dispersion of pesticides, which is particularly prevalent when there are large areas of agriculture close to residential areas[4,25]. The analysis estimated the percentages of different types of land use and land cover (surface water, irrigated crops, dryland crops, native forest, forestation, etc.), enabling the identification of the main types of crops surrounding the study locations[40].

Using theoretical sampling, in-depth online semi-structured interviews were conducted with four professors at the University of the Republic who are renowned researchers in the area[39]. The interviews were recorded with the prior consent of the interviewees. We performed a content analysis to assess the consistency and regularity of notions and ideas expressed in the interviews, resulting in the definition of core categories[40].

Finally, we computed a Spearman's correlation matrix using R Commander (version 3.5.1; R Core Team 2018)[37] to investigate the dependence between different types of land use and land cover and the outcome variables. As mentioned above, the data from the SIP covered the period 2010-2017. Since satellite images from 2011 and 2015 were used, the following four-year periods were adopted: 2010-2013 and 2014-2017.

The study was conducted in accordance with the ethical, legal and regulatory norms and standards for research involving human subjects set out in national legislation (Law 18335) and the Declaration of Helsinki. The study protocol was approved by the Pereira Rossell Hospital Center's research ethics committee in July 2020.

Results

Of the 5735 pregnant women in the study sample, 484 (8.44%) resided in Paysandú, 2418 (42.19%) in Río Negro and 2828 (49.25%) in Soriano. Twenty-five of the

4 - In Uruguay, the minimum distance from residential areas for the aerial application of pesticides to crops is 500 meters (Res. MGAP Mayo 2004).

51 locations/agro-cities were located in Paysandú, 10 in Río Negro and 16 in Soriano.

In 32 of the 51 locations, in more than 50% of cases antenatal care was received in the location of residence or other locations and/or agro-cities in the study area. Practically all the deliveries were institutional births in secondary- or tertiary-level care facilities, as provided by national legislation.

Antenatal, labor and childbirth care was provided by public care providers in 43.43% of cases and private care providers in 56.56% of cases, with 41.26% of cases receiving care in private services in the interior of the country and 15.30% in private services in the capital Montevideo.

Table 1 shows the sociodemographic characteristics and medical history of the women included in the study.

Table 1 – Sociodemographic characteristics and medical history of pregnant women living in rural areas in Paysandú, Río Negro and Soriano (Uruguay), 2010-2017.

Sociodemographic characteristics					
	Mean	**Median**	**Standard deviation**		
Age in years	**25.58**	**25**	**6.53**		
	No education	Completed primary school	Completed secondary school	Completed higher education	Data not available
Level of education	0.88%	21.23%	67.04%	0.88%	9.97%
Medical history					
	Yes	**No**	**Data not available**		
Diabetes Mellitus	2.65%	96.7%	0.65%		
High blood pressure	2.49%	96.8%	0.71%		
Pre-eclampsia	3.73%	95.58%	0.69%		
Eclampsia	0.28%	99%	0.72%		

Source: the authors, based on data from the SIP, 2023.

The findings show that the prevalence of underlying health problems prior to the current pregnancy was low, and in general terms, the data were practically complete. Just under 2% of the pregnancies (1.86%) were multiple and 97.73% were singleton. Major and minor birth defects were found in 0.52% and 0.40% of cases, respectively (data not

presented).

Table 2 presents the relative frequencies of complications during the current pregnancy. These problems have been shown to be risk factors for both low birthweight and prematurity[16,41-42]. However, less than 8% of the women in the sample presented gestational hypertension (high blood pressure, pre-eclampsia and/or eclampsia) during the current pregnancy. Prevalence of intrauterine growth restriction (IUGR) was 2.23%.

The rate of active maternal smoking decreased over the course of the trimesters, while passive smoking remained relatively stable throughout pregnancy (data not presented).

Overall prevalence of small for gestational age throughout the study period was 12.36%; 80.70% of the newborns were normal weight and 6.87% were high weight, while 16.67% of the births were preterm, the overwhelming majority of which were moderate preterm babies (born between 32 and 37 weeks of pregnancy).

Table 2. Relative frequencies of complications during the current pregnancy in women living in rural areas in Paysandú, Río Negro and Soriano (Uruguay), 2010-2017.

Complications during the current pregnancy					
	Type 1 diabetes	**Type 2 diabetes**	**Gestational diabetes**	**No**	**Data not available**
Diabetes Mellitus	0.19%	0.23%	13.48%	80.71%	5.39%
	Yes		No	Data not available	
High blood pressure	4.74%		89.71%	5.54%	
Pre-eclampsia	2.79%		91.77%	5.44%	
Eclampsia	0.14%		94.37%	5.49%	
IUGR	2.23%		92.22%	5.54%	
Premature rupture of membranes	15.06%		79.53%	5.40%	
Anemia	12.1%		82.37%	5.44%	

Source: the authors, based on data from the SIP, 2023.

The most common types of land cover in Paysandú in 2011 were natural grassland, dryland agriculture on farms with an area of over 4-5 hectares and forestation. Natural pasture (which may be regarded as extensive livestock farming) coexisted both with dryland agriculture and forestation. Dryland agriculture and forestation tended to be mutually exclusive, with few locations showing high proportions of both types of land cover. The most common type of farming in Río Negro was dryland crops, except in the north of the department (Algorta, Grecco), where forestation was predominant. Finally,

the most common type of land cover in practically all locations in Soriano was dryland agriculture on farms with an area of over 4-5 hectares (Figure 2).

The interviewees pointed out that the proportion of land set aside for soybean cultivation has decreased since 2015 due to a fall in global grain prices (interviews 1,2 and 3). However, similar trends to those in 2011 were observed in both Paysandú and Río Negro, with an increase in the proportion of dryland crops in some locations. While in Soriano dryland agriculture on farms with an area of over 4-5 hectares remained the most common type of land use, there was a slight decrease in percentage cover in some locations, which may be explained by the interviewees' comments mentioned above (Figure 2).

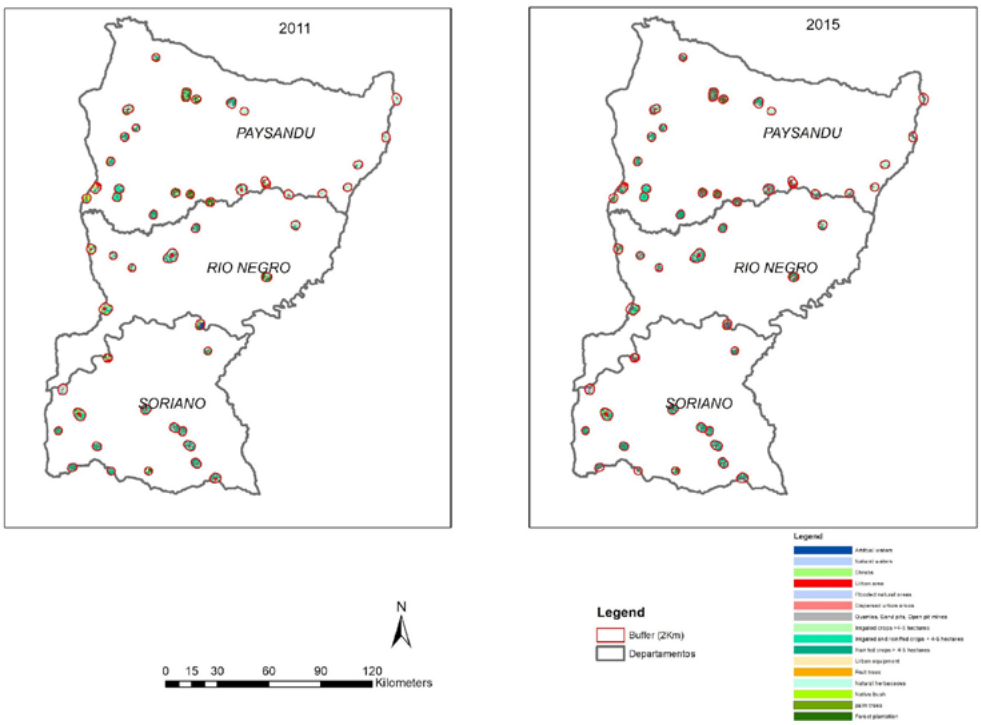


Figure 2. Land use and land cover in 2-km buffers in 2011 and 2015.

Source: the authors, 2024. Based on MVOTMA satellite images.

Spearman's matrix for 2011 showed positive correlations ($p < 0.05$) between both outcome variables and the following types of land use: urban areas, natural flooded areas, irrigated and dryland crop fields < 4-5 hectares and urban facilities (Table 3). It is important to highlight that the exposure variable (proximity to dryland crops) showed a medium positive correlation with the outcomes.

It is interesting to note that pesticide-intensive irrigated and dryland crops on farms with an area of < 4-5 hectares showed a medium positive correlation with both outcomes, with very significant p-values (<0.001).

In 2015, urban areas and irrigated and dryland crops < 4-5 hectares showed a medium positive correlation with both outcomes, with significant p-values.

Table 3. Correlation between land use and obstetric outcomes in 2-km-buffers in rural areas in Paysandú, Soriano and Río Negro, 2011 and 2015.

Type of land use/cover	2011				2015			
	Preterm		Small for GA	P-value	Preterm	P-value	Small for GA	P-value
Artificial watercourses	-0.1858		-0.0753	0.6032	0.0959	0.5120	0.1372	0.3471
Natural watercourses	0.1721		0.2897	**0.0413**	0.1858	0.2012	0.2879	0.0448
Shrubland	0.0259		0.0774	0.5929	0.0798	0.5857	0.0988	0.4996
Urban areas	0.5186		0.5980	**<.0001**	0.5053	**0.0003**	0.2512	0.0002
Bare areas	-0.1450		-0.1497	0.2993	- 0.1885	0.1945	0.0216	0.8828
Natural flooded areas	0.3450		0.3413	**0.0153**	0.2102	0.1472	0.2136	0.1405
Dispersed urban areas	0.0965		0.1357	0.3474	- 0.2883	**0.0445**	- 0.1486	0.3081
Quarries, sand mines, open-pit mines	0.0984		0.1342	0.3527	0.0733	0.6166	0.0919	0.5302
Dryland crops > 4-5 ha	-0.0029		-0.0020	0.9891	0.0788	0.9438	0.0103	0.5906
Irrigated crops > 4-5 ha	Data not available	--	Data not available	--	- 0.1885	0.1945	- 0.1405	0.3357
Irrigated and dryland crops < 4-5 ha	0.4858		0.5084	**0.0002**	0.3481	**0.0059**	0.3880	**0.0142**
Urban facilities	0.2978		0.3301	**0.0192**	0.1556	0.2858	0.1489	0.3072
Forestation	0.0633		0.0546	0.7067	- 0.0833	0.5695	- 0.0749	0.6090
Fruit	0.0381		0.0306	0.8329	0.1158	0.4283	0.0514	0.7260
Natural grassland	-0.1857		-0.2547	0.0743	- 0.2094	0.1487	- 0.2757	0.0552
Native forest	0.2141		0.2203	0.1243	0.1266	0.3862	0.2456	0.0889
Palm plantations	0.0633		0.0546	0.1212	Data not available	--	Data not available	--

Source: the authors.

Discussion

Our findings show that the prevalence of small for gestational age and prematurity in the study locations was higher than that reported for the departments and at the national level[20-22]. The prevalence of chronic conditions among the sample was not high (Table 1). The rate of gestational hypertension was within the expected levels based on international standards for these conditions[42-43]. It is important to highlight that present study did not control for possible confounding factors. A multi-level analysis or the use of directed acyclic graphs would have helped remove the effects of possible confounding variables.

Although variations in land use percentages were observed between the years analyzed in this study (2011 and 2015), the same types of use remained predominant in each location[35,45-46]. The present study focused on dryland agriculture, particularly soybean cultivation. However, the land use that showed a correlation with small for gestational age and prematurity was irrigated and dryland crops < 4-5 hectares.

This raises a question about the characteristics of the production processes encompassed by this category. The fact that they are small areas (<4-5 hectares) located on the outskirts of urban areas or the urban-rural interface suggests that they are family run endeavors in which women take part in the work and therefore experience greater exposure. Likewise, the presence of irrigated crops may suggest the presence of horticultural crops, which are common in areas on the edge of the locations, and use other pesticides than those analyzed by this study that should be included in future analyses. On the other hand, the fact that large percentages of dryland agriculture on farms with an area of over 4-5 hectares were not observed may be explained by the buffer zone radius adopted in this study, as this type of agriculture is not generally found close to residential areas. This decision was taken to enhance the resolution of the satellite images but may have affected the extent of the data analyzed.

As mentioned in the introduction, previous studies using a range of research designs have obtained varying results. The most similar study to ours is that conducted by Xiang et al. in Colorado, in the United States[27]. The authors used remote sensing and geographic information system technologies to determine crop types within 300- and 500-m buffers around the mothers' homes, observing significant associations between low birthweight and all study crops in the 300-m buffer. When the study crops were considered separately, low birthweight was associated with sugar beet and corn production in the 300- and 500-m buffer[27]. Other studies have associated different government records of pesticide use by region with obstetric outcomes. Larsen found different degrees of positive association between regions with a high consumption of pesticides and prematurity, low birthweight and birth defects[26], while Cremonese et al. and Mendonça Guimarães et al. did not observe significant associations. Boccolini et al. found positive associations between pesticide sales in rural areas and low birthweight, revealing a positive gradient effect[26-29,47]. A study in Argentina revealed that maternal place of residence was associated with low birthweight, showing that the likelihood of low birthweight was twice as high among mothers from regions with intensive pesticide use[11]. Our findings are therefore consistent with those of other ecological studies, reaffirming the need for more in-depth research into this matter

using other research designs. It is interesting to consider the proposal put forward by Ling et al., who combined California's Pesticide Use Reports (PUR) with the analysis of land use using remote sensing. The authors found an association between maternal address at birth and prematurity and low birthweight for some specific pesticides and by pregnancy trimester[48]. While one of the limitations of the study was that it was assumed that birth addresses reflected the location of mothers over the entire pregnancy, the authors found a weak but increased association with prematurity but no association with low birthweight[48].

Ecological studies have the ability to cover large geographic areas and produce a significant number of observations, permitting comparison across different regions and time periods. One of their weaknesses is that they are limited in their ability to characterize the types of pesticides actually used on particular crops and seasonal and regional variations[46-49].

This study presents at least two innovations that can contribute to health surveillance and the formulation of health promotion policy. First, the findings show that using the standards proposed by the INTERGROWTH-21st Consortium enables a more accurate classification of the risk growth impairment among infants and therefore helps prevent complications related to prematurity and low weight, both of which are intrinsically linked to infant mortality. Second, the study shows that spatial analysis tools are very useful for investigating, monitoring and evaluating health problems as they provide insights into distribution, possible patterns and areas of greater intensity, as well as social, economic and cultural aspects that are difficult to explore at individual level[40, 50-52,54]. One of the strengths of this study is that it was possible characterize and quantify land use and land cover in the study areas, enabling an analysis of the correlation between these areas and the outcome variables[54]. One of the limitations of this study is the lack of national data to compare the results obtained.

Pregnant women living in the study locations coexist with agriculture and therefore package technology (transgenic seeds, direct sowing, fertilizers, machinery etc.). In dryland farming, where soy is just one of a range of paradigmatic crops, the use of pesticides is inherent to production[5,13]. Damage to health can therefore not be taken as a mere probability, but rather an ongoing certainty resulting from an imposition[8,13]. Exposure to pesticides is part of the everyday lives of rural communities living in proximity to agricultural fields. Health surveillance and promotion policies therefore need to identify, monitor, and prevent this problem at local level[5,13].

Conclusions

The results of this study highlight the need for further in-depth research into the impacts of agriculture on fetal development. This study analyzed residential proximity to agriculture using satellite images of land use and land cover as a proxy for exposure to pesticides but did not characterize the substances used in the types of crops that showed a correlation with the outcomes. One direction for future research is the role women play in the different production processes they are exposed to, focusing on the development of care policies to address associated risks. Previous studies have observed greater likelihood

of damage to health among women who carry out tasks involving exposure to pesticides or when their partners carry out these tasks[51-52].

When it is not possible to obtain data on biological markers of relevant compounds due to technical, logistic, cost, and/or ethical issues, indirect methods of measuring exposure become even more valuable. Toxicological risk assessment to characterize the potential health risks of exposure is one of the strategies proposed in different surveillance models in the field of environmental epidemiology[24,53]. As mentioned above, multiple studies have used government records of the use and application of pesticides to help characterize exposure. However, this data is not available in Uruguay.

The spatial analysis methods used by this study (the creation of buffers, satellite imaging, etc.) can therefore make an important contribution to the characterization of exposure to pesticides in the absence of official records. Despite their limitations, ecological studies provide a valid tool for monitoring maternal and infant health and setting the environmental epidemiology research agenda to furnish inputs to help shape public health policy.

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Jimena Heinzen Cesio

heinzen@higiene.edu.uy

ORCiD: https://orcid.org/0000-0003-4052-3044

Reinaldo Souza-Santos

reinaldo.santos@fiocruz.br

ORCiD: https://orcid.org/0000-0003-2387-6999

Frederico Peres

frederico.peresdacosta@gmail.com

ORCID: https://orcid.org/0000-0003-2715-6622

Andréa Sobral

andrea.sobral@fiocruz.br

ORCID: https://orcid.org/0000-0003-0552-771X

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AMBIENTE & SOCIEDADE 25 anos 25 años 25 years

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Agroquímicos e efeitos negativos sobre os resultados obstétricos no Uruguai entre 2010 e 2017

Jimena Heinzen
Reinaldo Souza-Santos
Frederico Peres
Andréa Sobral

Resumo: Por meio de um desenho ecológico, buscou analisar espacialmente a correlação entre a residência em áreas rurais próximas a plantações que usam agroquímicos com o peso ao nascer e a idade gestacional de filhos de mulheres grávidas na área rural da costa oeste do Uruguai, durante 2010-2017. As variáveis de resultado foram baixo peso ao nascer para a idade gestacional e prematuridade. A exposição foi caracterizada por meio de imagens de satélite de uso e cobertura da solo e entrevistas em profundidade. A população foi de 5.735 mulheres grávidas. A análise de correlação foi realizada usando uma matriz de Spearman. Foram obtidas correlações positivas e significativas para ambos os desfechos obstétricos com culturas irrigadas e de sequeiro < 4-5 hectares, nos dois períodos temporais analisados. Este trabalho contribui no sentido de caracterizar o impacto do uso de agroquímicos na zona rural do Uruguai, especialmente na saúde de grupos vulneráveis.

Palavras-chave: Agroquímicos; Gravidez; Sistemas de Informação Geográfica; Nascimento Prematuro; Recém-Nascido de Baixo Peso.

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Artigo Original

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Agroquímicos y efectos negativos en resultados obstétricos de Uruguay entre 2010 y 2017

Jimena Heinzen
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Resumen: A través de un diseño ecológico se buscó analizar espacialmente la correlación entre residencia en zonas rurales cercanas a cultivos que utilizan agroquímicos con peso al nacer y edad gestacional de hijos/as de mujeres embarazadas del área rural del litoral oeste de Uruguay, durante 2010-2017. Las variables de desenlace fueron bajo peso para la edad gestacional y prematuridad. La exposición se caracterizó a través de imágenes satelitales de uso y cobertura de suelos y entrevistas en profundidad. La población fue de 5735 mujeres gestantes. Se realizó un análisis de correlación a través de una matriz de Spearman. Se obtuvieron correlaciones positivas y significativas para ambos resultados obstétricos con la tipología cultivos regados y de secano < a 4-5 hectáreas, en los dos cuatrieños analizados. Este trabajo aporta en la caracterización del impacto del uso de agroquímicos en el medio rural uruguayo, en particular para la salud de grupos vulnerables.

Palabras-clave: Agroquímicos; embarazo; sistemas de información geográfica; nacimiento prematuro; recién nacido de bajo peso.

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