Maternal exposure to pesticides and pregnancy complications in Mato Grosso

Exposição materna aos agrotóxicos e complicações gestacionais em Mato Grosso

Exposición materna a plaguicidas y complicaciones del embarazo en Mato Grosso

RESUMO

Objetivo: Analisar a exposição materna aos agrotóxicos e a ocorrência de desfechos gestacionais adversos no estado de Mato Grosso no período de 2011 a 2017. Método: Trata-se de um estudo quantitativo e ecológico, em 16 municípios do estado de Mato Grosso, onde foi realizada a divisão em dois grupos de comparação, sendo o 1° grupo (caso) constituído de 8 municípios de maior consumo de agrotóxicos e o 2° grupo (controle) constituído igualmente por 8 municípios com características sociodemográficas semelhantes, porém, com menor consumo de agrotóxicos. Posteriormente foi calculado os indicadores de desfechos gestacionais selecionados do Sistema de Informações de Nascidos Vivos (SINASC), tendo como variáveis resposta os indicadores: proporção de nascidos vivos com malformação congênita, proporção de nascidos vivos com prematuridade, proporção de baixo peso e proporção de muito baixo peso ao nascer. Resultados: Comparando às médias de consumo de agrotóxicos por habitante dos municípios caso em relação ao controle observa-se que o grupo dos municípios caso consume 6.078% (32.884.497,03 litros por habitante) a mais que o grupo dos municípios controle. As taxas dos casos tanto de baixo peso quanto de prematuridade se apresentaram superior em relação à taxa controle em todos os anos estudados, porém observou-se tendência estável nas proporções dos desfechos gestacionais para todas as morbidades. Conclusão: As tendências de taxas dos desfechos gestacionais adversos foram estáveis para todos os municípios estudados no período e houve uma maior ocorrência de taxas de nascidos vivos com baixo peso e com prematuridade nos municípios de maior utilização de agrotóxicos.

PALAVRAS-CHAVES: Anomalias Congênitas; Recém-Nascido de Baixo Peso; Recém-Nascido Prematuro; Pesticidas.

ABSTRACT

Objective: To analyze maternal exposure to pesticides and the occurrence of adverse gestational outcomes in the state of Mato Grosso between 2011 and 2017. Method: This is a quantitative, ecological study in 16 municipalities in the state of Mato Grosso, which was divided into two comparison groups, with the 1st group (case) consisting of 8 municipalities with the highest pesticide consumption and the 2nd group (control) also consisting of 8 municipalities with similar sociodemographic characteristics, but with lower pesticide consumption. Subsequently, selected gestational outcome indicators from the Live Birth Information System (SINASC) were calculated, with the following indicators as response variables: proportion of live births with congenital malformation, proportion of live births with prematurity, proportion of low birth weight and proportion of very low birth weight. Results: Comparing the average consumption of pesticides per inhabitant of the case municipalities in relation to the control, it can be seen that the group of case municipalities consumes 6,078% (32,884,497.03 liters per inhabitant) more than the group of control municipalities. The rates of both low birth weight and prematurity were higher than the control rate in all the years studied, but there was a stable trend in the proportions of gestational outcomes for all morbidities. Conclusion: The trends in rates of adverse gestational outcomes were stable for all the municipalities studied during the period and there was a higher occurrence of rates of low birth weight and prematurity in the municipalities with the highest pesticide use.

KEYWORDS: Congenital Anomalies; Low Birth Weight Newborn; Premature Newborn; Pesticides.

RESUMEN

Objetivo: Analizar la exposición materna a plaguicidas y la ocurrencia de resultados gestacionales adversos en el estado de Mato Grosso entre 2011 y 2017. Método: Se trata de un estudio cuantitativo, ecológico en 16 municipios del estado de Mato Grosso, donde el estudio se dividió en dos grupos de comparación, con el 1er grupo (caso) formado por 8 municipios con el mayor consumo de plaguicidas y el 2° grupo (control) también formado por 8 municipios con características sociodemográficas similares, pero con menor consumo de plaguicidas. Posteriormente, se calcularon indicadores de resultado gestacional seleccionados del Sistema de Información de Nacidos Vivos (SINASC), con los siguientes indicadores como variables respuesta: proporción de nacidos vivos con malformación congénita, proporción de nacidos vivos con prematuridad, proporción de nacidos con bajo peso y proporción de nacidos con muy bajo peso. Resultados: Comparando el consumo medio de plaguicidas por habitante de los municipios caso en relación al control, se observa que el grupo de municipios caso consume un 6,078% (32.884.497,03 litros por habitante) más que el grupo de municipios control. Las tasas tanto de bajo peso al nacer como de prematuridad fueron superiores a las del control en todos los años estudiados, pero hubo una tendencia estable en las proporciones de resultados gestacionales para todas las morbilidades. Conclusión: Las tendencias de las tasas de resultados gestacionales adversos se mantuvieron estables en todos los municipios estudiados durante el período y hubo una mayor incidencia de las tasas de bajo peso al nacer y prematuridad en los municipios con mayor uso de plaguicidas.

PALABRAS CLAVE: Anomalías congénitas; Recién nacido con bajo peso al nacer; Recién nacido prematuro; Plaguicidas.

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INTRODUCTION

Brazil began modernizing its agriculture in 1965, with the so-called Green Revolution, which made the country one of the largest food producers and largest consumer of pesticides in the world since 2008 (FIOCRUZ, 2018). In the state of Mato Grosso in 2009, the population was exposed to 34.1 liters of pesticides per inhabitant, compared to the national average, exposure being eight times greater (UEKER et al., 2016).

The indiscriminate use of chemical products can cause a strong environmental impact, contaminating water, air and soil (OLIVEIRA, 2012). Furthermore, several studies have identified contamination of workers and residents of plantation regions due to pesticide spraying carried out by tractors and agricultural planes, which in turn can cause health complications for humans (OLIVEIRA et al., 2014).

Human exposure to pesticides is associated with several health problems and adverse effects during the gestational period (WINDHAM; FENSTER, 2008). Among them, suicide, depression, cancer, heart problems (BURIGO, 2016), abortion, congenital malformation (CM) and low birth weight (LBW) newborns can be highlighted (MILDEMBERG; ONOFRE; RIBAS, 2017).

The birth weight of all newborns weighing less than or equal to 999 grams is considered extremely low birth weight, weighing less than or equal to 1,499 grams is called very low weight (VLBW) and weighing less than 2,500 grams is called underweight (WHO, 2014). The life expectancy of every child in the first years of life is impacted by the weight of the newborn (TOURINHO; REIS, 2012). Which, in turn, is influenced by multiple maternal factors, one of which is exposure to pesticides during pregnancy (DUTRA; FERREIRA, 2019).

In Brazil, in 2013, prematurity was considered the main cause of death in children under 5 years of age (WHO, 2015). Any

baby born alive (LB) before 37 weeks of gestation is considered premature (WHO, 2018). In this sense, Chrisman (2008) identified a higher incidence of low birth weight newborns and verified a link between premature birth and exposure to pesticides during pregnancy.

Congenital malformation or congenital anomaly is any structural, functional or metabolic deformity that occurs with the fetus in the intrauterine period, which can be identified both before and after birth (WHO, 2016). MCs generally have multiple causes, some factors are considered to influence the increase in teratogenicity and sensitivity of a large part of fetal systems during pregnancy, such as environmental exposure and pesticides (STILLERMAN et al., 2008). However, there are few studies in the state of Mato Grosso on this topic and methodology.

Therefore, the objective of this study was to analyze maternal exposure to pesticides and the occurrence of adverse pregnancy outcomes in the state of Mato Grosso from 2011 to 2017.

METHODS

This is a quantitative, ecological study, covering the period from 2011 to 2017, carried out in 16 municipalities in the State of Mato Grosso.

This study was divided into two stages, in the first stage the municipalities were divided into two comparison groups, where the 1st group (case) was made up of 8 municipalities with the highest consumption of pesticides in the state: Campo Novo do Parecis, Campo Verde, Diamantino, Lucas do Rio Verde, Nova Mutum, Primavera do Leste, Sapezal and Sorriso. The 2nd group (control) was also made up of 8 municipalities with similar sociodemographic characteristics, however, with lower consumption of pesticides: Alta Floresta, Aripuanã, Barra dos Garças, Cáceres, Guarantã do Norte, Juína, Mirassol D´Oeste and Pontes e Lacerda.

For the selection and inclusion of municipalities in their respective groups, the method of Pignati, Oliveira and Silva (2014) was first used, where the consumption of pesticides in liters per inhabitant is estimated considering the total area of planted area in each municipality and how much pesticides are used per hectare, according to the type of crop, as well as the resident population of these municipalities according to the year studied. It is important to highlight that for the selection of the 8 municipalities in the control group, we sought to ensure matching with the corresponding municipalities according to population size and some of the main sociodemographic characteristics, such as sanitation conditions and average monthly income, using a ratio of 1 :1 (control municipality for each case municipality).

In the second stage, indicators of gestational outcomes selected from the Live Birth Information System (SINASC - Sistema de Informações de Nascidos Vivos) were calculated, namely congenital malformation, low birth weight, very low birth weight and prematurity, accessed through the DATASUS homepage.

The following indicators were evaluated as response variables: proportion of live births with CM, proportion of live births with prematurity, proportion of low birth weight and proportion of very low birth weight. These indicators were calculated considering the selected outcomes as numerators and the denominators, the total number of live births according to the year of occurrence.

The proportions were calculated using the following formulas:

$$\frac{\text{CM Rate} \times 100}{\text{Total live births}}$$

$$\frac{\text{Prematurity rate} \times 100}{\text{Total live births}}$$

$$\frac{\text{LBW Rate} \times 100}{\text{Total live births}}$$

$$\frac{\text{VLBW Rate} \times 100}{\text{Total live births}}$$

Subsequently, these indicators were compared between the municipalities of Groups 1 and 2 using rate ratios and the average rates of the study municipalities and the average rates of the case municipalities were estimated. The population statistics of the studied municipalities were filtered by the Brazilian Institute of Geography and Statistics (IBGE - *Instituto Brasileiro de Geografia e Estatística*) (IBGE, 2010).

The proportions of live births were calculated according to the study outcome, followed by a trend analysis of the proportions (1st phase) using simple linear regression models. The analysis of the scatter diagrams of the proportions of adverse pregnancy outcomes demonstrated that the assumption of a linear evolution could be assumed for all analyses, a fact that justified the use of linear models, with these models then being adjusted for each time series. The statistical modeling considered each proportion of the outcomes under study as a dependent variable and the chronological time (from 2011 to 2017), where it was decided to center this variable by subtracting the midpoint of each value in the series (X – 2014). In this way, autocorrelation between the terms of the regression equation was avoided. The estimated models can be written as: $Y = \beta 0 + \beta 1 (X - 2014)$, where Y corresponded to the proportions of adverse pregnancy outcomes, β0, average annual coefficients, β1, linear effect coefficients and X, years of birth. The trend was considered significant when the model obtained $p < 0.05$. As a measure of model precision, the coefficient of determination was used (R2) (KLEINBAUM; KUPPER; MULLER, 1988; MORETTIN; TOLOI, 1986).

Then, contingency tables were constructed where the Proportion Ratios of adverse pregnancy outcomes in the municipalities of Group 1 were calculated, whose estimated use of pesticides was high, divided by the proportions of group 2 (control), the latter referring to those who did not use pesticides intensively, as shown in Table 1. The proportion ratios and 95% Confidence Interval (95%CI) were estimated using the Mantel–Haenszel method. For all analyses, the significance level adopted was p-value < 0.05. For all analyses, the Statistical Package for the Social Science (SPSS) software, version 18.0 for Windows, was used.

As this is a study carried out with secondary data, in the public domain, where per-

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sonal data from the records, extracted from DATASUS, are not provided, according to Resolution 510/2016, this study did not require submission to a research ethics committee (CEP - *comitê de ética em pesquisa*).

RESULTS

It can be seen that of the case municipalities (group 1), those with the highest consumption of pesticides per inhabitant were Campo Novo do Parecis, Primavera do Leste and Sapezal, while the control municipalities (group 2) were Barra do Garças, Alta Floresta and Cáceres. If compared to the average consumption of pesticides per inhabitant of the case municipalities in relation to the control, it is observed that group 1 consumes 6,078% (32,884,497.03 liters per inhabitant) more than group 2 (Table 1).

The average proportions of pregnancy outcome indicators in the case and control municipalities for the years 2011 to 2017 are shown in table 2. The case rates of both LBW and prematurity were higher in relation to the control rate in all years studied . Regarding VLBW and CM rates, it was found that in some years the control rates were higher than the case ra-

Table 1- Description of selected municipalities by population and pesticide consumption per inhabitant, Mato Grosso, 2010

Group 1 (Case)	Population	Consumption of pesticides/inhabitants	Group 2 (Control)	Population	Consumption of pesticides/inhabitants
Campo Novo do Parecis	35.360	44.598.865,71	Alta Floresta	51.782	750.915,83
Campo Verde	44.041	28.580.505,48	Aripuanã	22.354	91.680,80
Diamantino	22.041	27.801.677,49	Barra do Garças	61.012	1.218.723,68
Lucas do Rio Verde	65.534	26.026.017,25	Cáceres	94.376	663.468,24
Nova Mutum	45.378	25.616.478,89	Guarantã do Norte	35.816	168.821,15
Primavera do Leste	62.019	40.619.087,13	Juína	40.997	570.084,30
Sapezal	25.881	39.319.339,16	Mirassol D´Oeste	27.739	411.494,25
Sorriso	90.313	34.842.330,09	Pontes e Lacerda	45.436	453.136,72
Total	-	267.404.301,20	Total	-	4.328.324,97

Source: IBGE, prepared by the Author, 2021

Table 2 – Average proportions of congenital malformations, low birth weight, very low birth weight and prematurity according to the Live Birth Information System (Sinasc) in the case and control municipalities, Mato Grosso, 2011 to 2017

Year	CM Proportion Case	CM Proportion Control	LBW Proportion Case	LBW Proportion Control	VLBW Proportion Case	VLBW Proportion Control	Premature Proportion Case	Premature Proportion Control
2011	8,31	8,70	7,52	6,44	0,98	0,88	13,12	10,77
2012	6,61	6,20	6,66	6,08	1,13	0,83	13,71	10,29
2013	6,10	6,30	7,69	6,18	1,16	0,72	14,05	10,74
2014	5,47	3,10	7,38	6,94	1,01	0,73	13,28	11,61
2015	7,80	14,6	7,29	6,83	0,82	0,90	11,40	11,21
2016	5,34	14,0	7,75	6,79	1,07	0,81	12,40	10,61
2017	6,10	2,50	6,78	6,54	0,93	0,96	12,08	9,66

Source: Live Birth Information System (Sinasc) Prepared by the author, 2021

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tes. However, in 2012 and 2014 the case rates for all gestational outcomes analyzed were higher than the control rates.

Figure 1 presents the graphical analyzes of trends in proportions of gestational outcomes studied between 2011 and 2017. In figure A, It appears that although the rate of live births with congenital anomalies remains higher than the cases in 2015 and 2016, the trend remained stable. The same occurred in figure B, where the rates of live births with LBW in cases were also higher than the rates in controls in all years, and the trend of both proportions was also stable. Figure C shows a stability in the rates of live births with VLBW, also with a stable trend, however the rates in the case municipalities remained lower than the rates in the control municipalities in the years 2015 and 2017. In figure D, the same stability of rates of live births with prematurity is observed, even though they are higher among the case group in relation to the control municipalities.

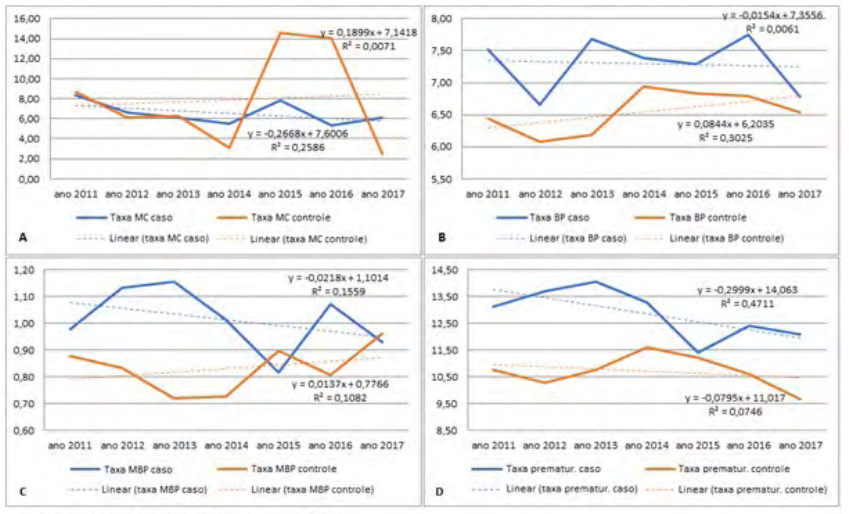
The proportion of live births with gestational outcomes studied in the case and control municipalities between 2011 and 2017 are described in table 3. It was observed that the rate of low birth weight live births was 1.05 times higher in the case municipalities compared to controls, with these differences being statistically significant (p=0.019). In the same sense, the rate of live births with prematurity was also higher in the case municipalities and with statistical significance (RT=1.06; p=0.001). Regarding the proportions of live births with very low birth weight and with CM, both did not show statistical significance (p=0.059 and p=0.113 respectively).

DISCUSSION

The results obtained from the analyzes carried out with municipalities with intense agricultural production and use of pesticides in comparison with municipalities with less agricultural activity presented, in all analyses, stable trends, although the rates of live births with LBW and prematurity were higher in the case municipalities, in all years studied.

Corroborating the findings of the pre-

Figure 1- Demonstração gráfica de tendência de proporção de alguns desfechos gestacionais em municípios de Mato Grosso, com alto (caso) e baixo (controle) consumo de agrotóxicos de 2011 a 2017



(A) Proporção de Nascidos Vivos com Malformação Congênita
(B) Proporção de Nascidos Vivos com Baixo peso
(C) Proporção de Nascidos Vivos com Muito Baixo Peso
(D) Proporção de Nascidos Vivos com Prematuridade

Figura 1 - Demonstração gráfica de tendência de proporção de alguns desfechos gestacionais em municípios de Mato Grosso, com alto (caso) e baixo (controle) consumo de agrotóxicos de 2011 a 2017
Fonte: Autor, 2021

Fonte: Autor 2021

Table 3 – Proportion ratios of live births with congenital malformations, low birth weight, very low birth weight and prematurity in the case and control municipalities, Mato Grosso, 2011 to 2017

Indicators	Rate (%)	Fee ratio (CI 95%)	p-value
Proportion of LBs x malformation			
Control Municipalities	0,68	1,00	0,113
Case Municipalities	0,61	0,91 (0,77-1,06)	
Low weight x LB ratio			
Control Municipalities	6,60	1,00	0,019
Case Municipalities	6,95	1,05 (1,01-1,73)	
Very low weight x LB ratio			
Control Municipalities	0,90	1,00	0,059
Case Municipalities	0,10	1,10 (0,97-1,26)	
Proportion of LB x prematurity			
Control Municipalities	11,72	1,00	0,001
Case Municipalities	11,07	1,06 (1,02-1,10)	

Source: Live Birth Information System (Sinasc), prepared by the Author, 2021

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sent study in relation to low birth weight live births, research carried out in Brazilian states by Guimarães et al. (2014) identified a statistical association between low birth weight and exposure to pesticides during pregnancy. In this sense, another case-control study carried out in Spain identified that genitourinary CMs, spontaneous abortion and low birth weight increase with environmental exposure to pesticides (GONZÁLEZ et al., 2017).

Regarding prematurity, a study carried out in the southern region of Brazil, from 1996 to 2000, investigated possible adverse events during and after pregnancy, such as duration of pregnancy, birth weight and Apgar score. As a result, they identified cases of prematurity in male (0.5%) and female (3.8%) babies, that is, births with a gestational period of less than 37 weeks (CREMONESE et al., 2012). In this sense, Guimarães et al. (2014) obtained similar results, where they identified a statistically significant association between prematurity and exposure to pesticides during pregnancy.

One of the findings of this study was the borderline association for MBP at birth, due to its small number of occurrences. Despite this, research carried out in Nova Friburgo, in the interior of Rio de Janeiro, from 2004 to 2006 with 6714 live births, identified that women living in rural areas have a greater risk of giving birth to newborns with extremely low weight, low Apgar score and a CM compared to women living in urban areas (CHRISMAN et al., 2016).

CMs did not show a statistically significant association, possibly because these women live in municipalities with intensive agricultural production, but far from these spraying regions. Corroborating this idea, a study carried out in 2008, in Lavras, Minas Gerais, sought to estimate the horizontal distance reached by a sprayed droplet of a given size, at different heights and wind speeds. Thus, he identified that a drop launched from 0.8 m high, 40 μm, with a wind of 5 ms-1 can travel 38.3 m, these being the conditions that took it the greatest distance (DA CUNHA, 2008).

Despite this, associations with MCs are verified in the literature in several studies. One of them is this study developed in the state of Paraná, from 2008 to 2015, which sought to analyze the prevalence rate of live births with MC in relation to social indicators, economic, health and environmental factors. Thus, the MC rate showed statistical significance with pregnant women exposed to pesticides (FREIRE et al., 2020).

Still in this sense, a study carried out in hospitals in the city of Cuiabá (MT) in 2011, investigated the association between exposure to pesticides and the occurrence of CM, the research used the following criteria: the mother having been exposed to pesticides three months before and after fertilization and also paternal exposure for one year before fertilization. In conclusion, paternal exposure to pesticides, correlated with low maternal education, may corroborate the occurrence of CM (UEKER et al., 2016).

Oliveira et al. (2014), when analyzing the association of exposure to pesticides during pregnancy with the presence of CM, in eight municipalities in Mato Grosso, considered all live births with CM within the period from 2000 to 2009 as cases and live births with CM as controls. more than thirty-seven weeks of gestation and without any CM. The aforementioned study concluded that maternal exposure to pesticides in the post-fertilization period (first trimester of pregnancy) and in the total gestational period were associated with a greater occurrence of CM cases.

Dutra and Ferreira (2019) analyzed the presence of CM in Brazilian states with greater use of pesticides in the period from 2000 to 2016, namely, Mato Grosso, São Paulo, Paraná and Rio Grande do Sul. The rates found were higher in microregions with a higher rate of pesticide consumption (from 0.50% to 0.94%) and the CM rate ratios were between 2.3 and 10.68 times higher in these states compared to those with lower pesticide use.

It was observed that the gestational outcomes studied affect mothers living close to cultivated areas, presenting a stable trend in all outcomes. However, even so, low birth weight and prematurity showed higher proportions over the time studied.

This study encountered some limitations during its development, such as the difficulty of obtaining real information on pesticide consumption in municipalities in the state of Mato Grosso, which is why these data were estimated using the methodology of Pignati, Oliveira and Silva (2014). Ideally, the sales records of agricultural houses and prescriptions from agronomists in the state are obtained by the Agricultural Defense Institute (INDEA - Instituto de Defesa Agropecuário), which no longer makes this data available. Another difficulty is in relation to the level of exposure of the population, as it is not possible to determine exactly the distance between the population and the crops where pesticide applications occurred. However, the findings of this study make great contributions to understanding the risks to maternal and child health that are linked to exposure to pesticides.

CONCLUSION

As tendências de taxas dos desfechos gestacionais adversos foram estáveis para todos os municípios estudados no período. Houve uma maior ocorrência de taxas de nascidos vivos com baixo peso e com prematuridade nos municípios de maior utilização de agrotóxicos. Por isso, é de suma importância melhorar o controle de aplicação de agrotóxicos e facilitar o acesso às informações com a divulgação dos dados de consumo de pesticidas por parte dos órgãos governamentais. Permitindo assim, instruir e alerta a população quanto aos riscos à saúde ligados a exposição a produtos agrícolas.

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REFERENCES

1.Fundação Oswaldo Cruz. Agrotóxicos e Saúde. Coleção Saúde, Ambiente e Sustentabilidade. Série Fiocruz – Documentos Institucionais. Rio de Janeiro: Fiocruz; 2018.

2.Ueker ME, Silva VM, Moi GP, Pignati WA, Mattos IE, Ageo MCS. Parenteral exposure to pesticides and occurence of congenital malformations: hospital-based case–control study. BMC Pediatr 16, 125 (2016). https://doi.org/10.1186/s12887-016-0667-x

3.Oliveira NP. Malformações congênitas e o uso de agrotóxicos em municípios de Mato Grosso, período de 2000 a 2009. (Dissertacao de Mestrado). Cuiaba: Universidade Federal de Mato Grosso, 2012. 99 p.

4.Oliveira NP, Moi GP, Atanaka-Santos M, Silva AMC, Pignati WA. Malformações congênitas em municípios de grande utilização de agrotóxicos em Mato Grosso, Brasil. Ciência & Saúde Coletiva. 2014; 19(10): 4123-4130.

5.Windham G, Fenster L. Environmental contaminants and pregnancy outcomes. Fertility and Sterility – Journals. 2008; 89(2): 111- 116.

6.Burigo A. Impacto dos Agrotóxicos na alimentação, saúde e meio ambiente. Furnas: COPPE - UERJ, 2016.

7.Mildemberg RAR, Onofre PG, Ribas JLC. Teratogenia e Agrotóxico. Revista Saúde e Desenvolvimento. 2017; 11(9).

8.Organização Mundial da Saúde. Metas globais de nutrição 2025: resumo da política sobre excesso de peso na infância. Genebra, OMS. 2014. Acesso em: 10 jan. 2021.

9.Tourinho AB, Reis LBSMR. Peso ao nascer: uma abordagem nutricional. Revista ESCS. 2012; 23(1), 1-11. Disponível em: https://bvsms.saude.gov.br/bvs/periodicos/revista_ESCS_v23_n1_a02_peso_ao_nascer.pdf. Acesso em: 23 ago. 2020.

10.Dutra LS, Ferreira AP. Tendência de malformações congênitas e utilização de agrotóxicos em commodities: um estudo ecológico. Saúde Debate; 2019; 43(121), 390-405. doi:10.1590/0103-1104201912108. Disponível em: https://www.scielosp.org/article/sdeb/2019.v43n121/390-405/pt/. Acesso em: 13 ago. 2020.

11.Organização Mundial da Saúde. Brazil: WHO statistical profile. Geneva: WHO. 2015. Disponível em: https://www.who.int/gho/countries/bra.pdf. Acesso em: 30 abr. 2021.

12.Organização Mundial da Saúde. Preterm birth. Geneva: WHO. 2018. . Disponível em: https://www.who.int/news-room/fact-sheets/detail/preterm-birth. Acesso em: 30 abr. 2021.

13.Chrisman JR. Avaliação da contaminação por agrotóxicos em mulheres grávidas residentes no município de Nova Friburgo, Rio de Janeiro. Dissertação (Mestrado em Saúde Pública e Meio Ambiente) – Escola Nacional de Saúde Pública Sérgio Arouca, Fundação Oswaldo Cruz, Rio de Janeiro, 2008.

14.Organização Mundial da Saúde. Congenital anomalies. 2016. Disponível em: https://www.who.int/en/news-room/fact-sheets/detail/congenital-anomalies. Acesso em: 9 Jan. 2021.

15.Stillerman KP, et al. Environmental exposures and adverse pregnancy outcomes: a review of the science. Reprod Sci. 2008: 15(7), 631-650. DOI: 10.1177/1933719108322436. Acesso em: 26 fev. 2021.

16.Pignati WA, Oliveira NP, Silva AMC. Vigilância aos agrotóxicos: quantificação do uso e previsão de impactos na saúde-trabalho-ambiente para os municípios brasileiros. Ciência & Saúde Coletiva. 2014; 19(12), 4669-4678. Disponível em: http://www.scielo.br/pdf/csc/v19n12/1413-8123-csc-19-12-04669.pdf. Acesso em: 25 jun. 2020.

17.Instituto Brasileiro de Geografia e Estatística. Indicadores de Desenvolvimento Sustentável: Brasil. 2010. Rio de Janeiro: IBGE, 2010. Acesso em 22 de novembro de 2020.

18.Kleinbaum DG, Kupper LL, Müller KE. Applied Regression Analysis and other Multivariable Methods. Belmont, CA: PWS-KENT Publishing Company, 1988.

19.Morettini PA, Toloi CM. Séries Temporais. Coleção Métodos Quantitativos. São Paulo: Atual Editora, 1986.

20.Guimarães RM. et al. O impacto do consumo de agrotóxicos na prevalência de desfechos perinatais no Brasil. Boletín de Malariología y Salud Ambiental. Amb. jun. 2014; 54(1): 9-19,. Acesso em 22 de agosto de 2020.

21.González JG et al. Association of reproductive disorders and male congenital anomalies with environmental exposure to endocrine active pesticides. Reproductive Toxicology. 2017; 71: 95-100, DOI: 10.1016/j.reprotox.2017.04.011. Acesso em 26 de abril de 2021.

22.Cremonese C et al. Exposição a agrotóxicos e eventos adversos na gravidez no Sul do Brasil, 1996-2000. Cadernos de Saúde Pública. 2012; 28(7): 1263-1272. DOI: 10.1590/S0102-311X2012000700005. Acesso em 20 de dezembro de 2020.

23.Chrisman JR. et al. Prevalence of very low birthweight, malformation, and low Apgar score among newborns in Brazil according to maternal urban or rural residence at birth. Journal of Obstetrics and Gynaecology. May 2016; 42(5): 496-504. DOI: 10.1111/jog.12946. Acesso em 27 de abril de 2021.

24.Cunha JPAR. Simulação da deriva de agrotóxicos em diferentes condições de pulverização. Ciência e Agrotecnologia. Lavras, 2008; 32(5): 1616-1621. DOI: 10.1590/S1413-70542008000500039. Acesso em 10 de maio de 2021.

25.Freire MHS et al. Análise geoespacial dos nascimentos com anomalias congênitas, Paraná, 2008-2015: estudo ecológico. Revista Brasileira de Enfermagem. 2020; 73(3): 1115-1123. DOI: 10.1590/0034-7167-2018-0741. Acesso em 24 de janeiro de 2021.

26.Dutra LS, Ferreira AP. Malformações congênitas em regiões de monocultivo no estado de Minas Gerais, Brasil. Medicina (Ribeirão Preto, Online.). 2017; 50(5): 285-296. DOI: 10.11606/issn.2176-7282.med.2017.160621. Acesso em 24 de julho de 2020

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