

The Effect of Pesticide Exposure on Women Farmers of Reproductive Age on Growth and Development Disorders of Children Born: A Systematic Literature Review

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Abstract: The large number of children suffering from ADHD and autism today is a result of the increasing use of pesticides in agriculture. This applies to women farmers of childbearing age who work in agricultural settings or women whose work is related to the use of pesticides. Pesticides are a mixture of several chemicals used to control pests and protect plants. With the use of pesticides, yields obtained increased significantly. This study aims to examine the effect of exposure to pesticides on female farmers of childbearing age on growth and development disorders of children born. The review was conducted according to state-of-the-art methods using selected reporting item guidelines for reviews and meta-analyses (PRISMA). We reviewed the literature from several publications and analyzed the effect of exposure to pesticides on female farmers of childbearing age on developmental disorders of the children they were born with. The results of this study are the effect of exposure to pesticides on female farmers of childbearing age on birth defects. The use of pesticides causes pesticide poisoning. Accumulation of pesticides at a certain threshold has a negative impact on the body, namely brain disorders, tumors, cancer, even in pregnant women can cause birth defects. Apart from adults, pesticides also have a negative impact on children.

Keywords: ADHD; Autism spectrum disorder; Pesticide

Introduction

The agricultural sector is one of the jobs that absorbs the most workers, both men and women. The roles of women in agriculture include removing grass from plants, looking for pests, watering plants, and harvesting agricultural products. Although not all pregnant women spray crops, they still run the risk of being exposed to pesticides through other agricultural activities, such as preparing spraying equipment, mixing pesticides to be used, washing clothes and spraying equipment, and being in the same area as the sprayer. The participation of women in agriculture makes it one of the populations at risk of being exposed

to pesticides that cause pesticide poisoning. Knowledge of real-world pesticide exposure and autism spectrum disorder risk is scarce. In this large population-based study, we assessed prenatal and infant exposure to high-use pesticides, which had been selected a priori based on previous evidence for their experimental neurodevelopmental toxicity. The use of this pesticide in intensive farming areas in California, United States of America, is recorded in the state-mandated Pesticide Use Reporting (CA-PUR) program of California. These records are integrated into our geographic information system tool, which links exposure records to addresses from the birth records of the study population (Von Ehrenstein et al., 2019).

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Pesticides are a mixture of several chemicals used to control pests and protect the plant itself. With the use of pesticides, a substantial increase in crop yields is obtained. Pesticides can also control insect vectors, thereby helping to limit the spread of disease. In addition to affecting plants, pesticides can also affect humans. The use of pesticides can cause pesticide poisoning. Accumulation of pesticides at a certain threshold can cause adverse effects on the body, among others, brain disorders, tumors, and cancer, even in pregnant women can cause birth defects. Besides adults, pesticides can also affect children. Children who are still vulnerable to chemical exposure. The effects are most visible in the development of the child's nervous system, where children who are frequently exposed to pesticides tend to experience disturbances such as attention disorders, attention disorders, behavioral disorders, and visuospatial disorders.

This is very worrying about exposure to pesticides in women of childbearing age to disrupt the growth and development of children born. Mothers who are exposed to pesticides since pregnancy will affect the formation of the fetus in the womb. Children who live in agricultural areas have a higher risk of being exposed to pesticides. mother's involvement in agricultural activities during pregnancy, storing pesticides in the house without a special room so that children can easily reach them, and many children who live or often play near agricultural sites. The results of developmental tests on children also showed that out of 16 children aged 3-5 years whose parents worked as farmers, 9 children experienced developmental disorders in terms of communication, motoric, and personal-social aspects.

ADHD is a neurological-based mental health problem that occurs in children who exhibit hyperactive and impulsive behavior (Salari et al., 2023). The characteristics of ADHD are very unique and are characterized by impulsive behavior, hyperactivity, and behavior that is not able to socialize properly. ADHD is a disorder that contains two components, namely: not having attention, the unable to follow orders accompanied by hyperactivity, and impulsivity (De La Peña et al., 2020).

Prenatal exposure to organophosphate pesticides (OPP) has been associated with attention-hyperactivity disorder (ADHD) in children in community farming and those exposed to insecticides applied at home. To examine this association in a population exposed mainly through diet, we estimated the association between prenatal OPP exposure and preschool ADHD in the Norwegian Mother, Father, and Child Cohort Study (MoBa), and described modifications by a variant of the paraoxonase 1 (PON1) gene (Manley et al., 2022). Prenatal exposure to organophosphorus pesticides was associated with poorer ratings by parents and teachers

on emotional control, inhibition, and working memory. One log- Σ DMP increase was associated with worse teacher ratings of EF on the BRIEF-P (e.g. emotion control domain: $\beta = 0.55$, 95% CI: 0.35, 0.74), when weighted to account for decision-making procedures sample (Thistle et al., 2022). Assessing the association between prenatal pyrethroid pesticide exposure and Autism Spectrum Disorder (ASD) or non-typical development (non-TD) at 3 years. The corrected median specific gravity for the 3-PBA concentration of all samples was 1.46 ng/mL. Greater second-trimester 3-PBA concentrations are associated with relative risk ratio (RRR) for Autism Spectrum Disorder (ASD) (Barkoski et al., 2021). The widespread use of Organophosphate (OP) pesticides to control insects has resulted in ubiquitous human exposure. High exposure to OP pesticides is responsible for poisoning and death, especially in developing countries. Convincing evidence suggests that low levels of prenatal exposure place children at risk for cognitive and behavioral deficits and neurodevelopmental disorders (Hertz-Picciotto et al., 2018).

Special services for children with Attention Deficit Hyperactivity Disorder (ADHD). very much needed to be able to help children with special needs in meeting their needs. Attention Deficit Hyperactivity Disorder (ADHD) in Indonesia is quite high, reaching 26.4%. This is reinforced by data from the National Statistics Center for 2007 that there are 82 million children in Indonesia, one in five children and adolescents under the age of 18 experience mental health problems, and at least 16 million children experience mental problems including ADHD. This hyperactivity disorder can be found in everyday life in school-aged children to adolescents, even if it is not treated immediately it will affect a person's future. Based on the background described above, it is necessary to study the effect of exposure to pesticides on female farmers of childbearing age on the growth and development disorders of children born.

Method

We conducted this research as a systematic review by following the PRISMA guidelines. The PRISMA guidelines provide several items that need to be considered in preparing a systematic review. In this study, we will mainly focus on several key items: ADHD, pesticides, and autism spectrum disorder. This helps form the basis of our assessment. Initially, we collected the latest studies on the effect of pesticide exposure on women farmers of reproductive age on growth and development disorders of children born, based on a few selected keywords. Then, we apply eligibility criteria to the collection. We only selected literature published in 2017 or later to provide an

overview of recent trends. In addition, we limit the types of literature, namely only literature in the form of journals and proceedings.

Result and Discussion

Selected Reporting Items for Systematic Review (PRISMA) is the reporting technique used in this study. The research was carried out methodically during the necessary research phases. The information provided is comprehensive and impartial and aims to incorporate the results of relevant studies. The steps of a systematic literature review include developing research questions, searching the literature, screening and selecting relevant articles, screening and selecting the best research results, analyzing, synthesizing qualitative results, and preparing research reports. Writing the background and purpose of the study, collecting research questions, searching the literature, selecting articles, extracting articles, assessing the quality of the baseline study, and

summarizing material are steps in the research process of a systematic literature review.

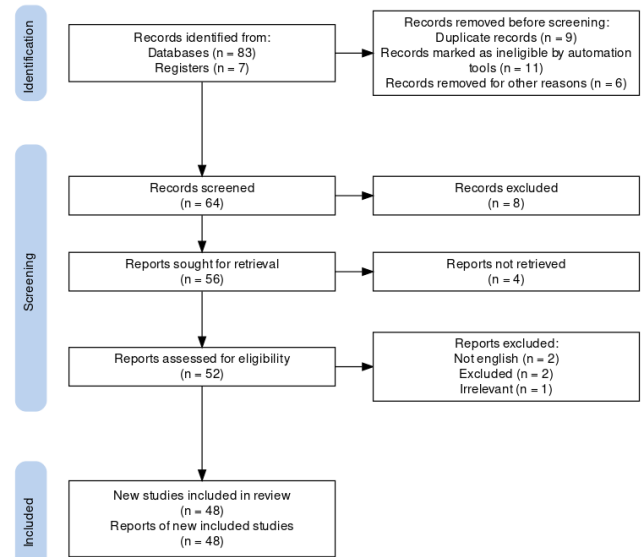


Figure 1. Flow process literature search based on PRISMA guidelines

Table 1. Pesticide Exposure

Source	Impact of Pesticides on the Environment
(Rani et al., 2021); (Lopes-Ferreira et al., 2022); (Sharma et al., 2019)	Impact on human health
(Riyaz et al., 2022); (Sabran & Abas, 2021); (Zhang et al., 2018)	Impact on the environment and agricultural products
(Karpouzias et al., 2022); (Raffa & Chiampo, 2021); (Cheng et al., 2023)	Impact of Pollution on soil microbes

Complete articles published in international journals from 2015-2023, indexed in Scopus and Google Scholar databases and themed the effect of pesticide exposure on women farmers of reproductive age on growth and development disorders of children born.

The use of pesticides on plants is very beneficial, if used excessively and continuously it can leave residues, namely impacts on human health. ; The impact on the environment and agricultural products, namely pesticides in the soil can undergo various processes

including degradation, adsorption, desorption, and transportation depending on the chemical properties of the pesticide; The impact of pollution on soil microbes is the association of microbes with plant roots, encouraging growth and maintaining plants, dispelling pathogens through the phytohormones, antimicrobials, toxins, and enzymes they produce. The use of pesticides in the long term has caused a decrease in soil microbial populations and algae diversity.

Table 2. Autism Spectrum Disorder

Source	Causes of Autism
(Codina-Sola et al., 2019);(Bai et al., 2019); (Genovese & Butler, 2023)	Genetic Factors
(Hampton et al., 2022); (Qin et al., 2022); (DeVilbiss et al., 2017)	Problems in Pregnancy and Childbirth
(Singh et al., 2022); (Naidu et al., 2021); (Werheni Ammeri et al., 2021)	Impact of Pollution on soil microbes
(Mohammed et al., 2022); (Qian et al., 2020)	MMR vaccine (Measles, Mumps, and Rubella)
(Błażewicz & Grabrucker, 2022); (Frye et al., 2020); (Filon et al., 2020); (Rajaram, 2023)	Toxins and Heavy Metals from the Environment

Five possible factors cause children to be born with autism, namely genetic factors which are related to genetic factors, related factors such as the age of the mother during pregnancy, the age of the father when the wife is pregnant, and problems that occur during pregnancy and the birth process. The conclusion is that there is a possibility of autistic disorder because there are

family members who show the characteristics of autistic disorder and there are environmental factors that trigger it; Problems in Pregnancy and the Childbirth Process where the risk for autistic children is related to problems that occur during the 8th week of pregnancy. Mothers who consume alcohol and illegal drugs are thought to increase the risk of autism. Babies born prematurely are

also more likely to experience brain disorders than normal babies; The MMR vaccine is also one of the factors that are strongly suspected of causing autism, although it is still being debated; Toxins and Heavy Metals from the Environment, namely Environmental factors have a major role in the emergence of autistic

disorders. Various toxins that come from pesticides, air pollution, and wall paint can affect the health of the fetus. Research on several autistic children shows high levels of heavy metals in their blood, so metal poisoning is suspected as one of the causes of autistic disorders.

Table 3. Knowledge of the Types of children with ADHD

Source	Types of ADHD Children
(Solanto, 2000); (Slobodin & Davidovitch, 2019); (Hoang et al., 2021)	Combined Type of ADHD
(Lee et al., 2021); (Ekinci, 2019); (McDougal et al., 2022)	The ADHD type is inattentive
(Junghänel et al., 2022); (George, 2022); (Montagna et al., 2020)	Impulsive hyperactive type of ADHD

To determine this type of ADHD or hyperactivity, there are several types, namely: Combined type of ADHD which can be diagnosed by the presence of at least 6 of the 9 criteria for attention, plus at least 6 of the 9 criteria for impulsive hyperactivity; To identify this type of inattentive ADHD, it can be diagnosed by the presence of at least 6 of the 9 symptoms for 'attention' and recognizing that certain individuals experience

profound inattentiveness without hyperactivity; The hyperactive impulsive type of ADHD, which is the third type, requires at least 6 of the 9 symptoms listed in the hyperactivity-impulsivity section. This type of inattentive ADHD refers to children who have greater difficulty with their memory (memory) and perceptual motor speed (perception of movement), tend to daydream, and are often socially withdrawn.

Table 4. Symptoms of Pesticide Use in Children with ADHD Related to Emotional Control, Inhibition, and Working Memory

Source	Symptoms in Children with ADHD in Attention
(Gallen et al., 2021); (Mioni et al., 2019); (Muna et al., 2021); (Joekar et al., 2017)	In attention
(Athanasiadou et al., 2020); (Thompson et al., 2023); (Ra et al., 2018)	Hiperaktifitas
(Silk et al., 2019); (Van Hoorn et al., 2022); (Faizah, 2022); (Antoniou et al., 2021)	Implisif

There are several symptoms in children with ADHD, including: In attention with the following characteristics: Often fails to pay close attention clearly or makes uncontrolled mistakes, Often has difficulty maintaining attention and concentration in receiving assignments or playing activities, Often looks unsteady listens when spoken directly, Difficulty organizing tasks and activities, Avoids or is unhappy or reluctant to do tasks that require effort, Often loses things needed for tasks or activities, Often easily distracted from outside

stimuli that are not related; Hyperactivity is characterized by the following: Often feels restless in hands, feet and squirms in seat, Often leaves seat in class, Often runs from things or climbs excessively in inappropriate situations, Difficulty playing, Often behaves like driving a machine, Often talk excessively; Characteristics of impulsive Speech without thinking, Difficulty waiting in line or queue, Often pushes or interrupts others, Often points fingers in class.

Table 5. Prevention of the Dangers of Pesticides for the Farming Community in Fertile Women so as Not to Interfere with the Growth and Development of the Child Being Born

Source	Efforts to prevent the dangers of pesticides for the farming community in fertile women so as not to interfere with the growth and development of the child being born
(Rahman et al., 2015); (Widianto et al., 2019); (Mahyuni et al., 2021)	Farmer Health Examination and FGD
(Saiz-Rubio & Rovira-Más, 2020)	Extension and Video Screening

Prevention efforts from public health in preventing pesticides in agricultural areas, especially for fertile women, namely Farmer Health Checks and FGDs with this activity aiming for farmers in the Sinar Tani group to get a picture of health, especially hemoglobin, hematocrit, uric acid, and glucose levels. The service team also conducted blood pressure screening for

farmers; Counseling and Video Shows like this activity aim to make farmers in the Sinartani group know and understand the importance of pesticide exposure prevention behavior. There are various health impacts, both acute and chronic, that can be experienced by farmers and disrupt productivity, so it is important to make efforts to prevent the effects of pesticides.

Conclusion

Exposure to pesticides associated with developmental disorders in children aged 3-5 years is the result of activities carried out by mothers in the agricultural area during pregnancy and breastfeeding. Children who are still vulnerable to chemical exposure. The effects are most visible in the development of the child's nervous system, where children who are frequently exposed to pesticides tend to experience disturbances such as attention disorders, attention disorders, behavioral disorders, and visuospatial disorders.

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Author Contributions

Conceptualization, F. E. F., N. A. S., J., and Y. L.: methodology, F. E. F.; validation, N. A. S., and J.; formal analysis, Y. L.; investigation, F. E. F. and N. A. S.; formal analysis, J.; investigation, Y. L. and F. E. F.; resources, N. A. S., and J.; data curation, Y. L.: writing – original draft preparation, F. E. F., and N. A. S.; writing – review and editing, J.: visualization, Y. L., F. E. F. and N. A. S.; supervision, J.; project administration, Y. L.; funding acquisition, F. E. F. and N. A. S. All authors have read and agreed to the published version of the manuscript.

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Conflicts of Interest

The authors declare no conflict of interest.

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