



**Risk Analysis of Pesticide Poisoning to Farmers in Kenagarian Simpang
Tanjung Nan IV, Solok Regency**

Sari Arlinda¹⁾, Mukhlis²⁾, Suksmerri³⁾, Wijayantono⁴⁾

¹⁾*Departemen of Environmental Health; Health Polytecnic of Padang*

²⁾*Departemen of Environmental Health; Health Polytecnic of Padang*

³⁾*Departemen of Environmental Health; Health Polytecnic of Padang*

⁴⁾*Departemen of Environmental Health; Health Polytecnic of Padang*

Corresponding email: sariarlinda29@gmail.com

1. 1st Author : Sari Arlinda, SKM, M,K,M
Affiliation : Departemen of Environmental Health; Health Polytecnic of Padang
Mailing address : Jl Dr Sutomo I Blok A2 no 5 Kecamatan Padang Timur, Kota Padang, Sumatera Barat-Indonesia 25125
Email of author : sariarlinda29@gmail.com
Orcid ID : [0000-0003-2608-0291](https://orcid.org/0000-0003-2608-0291)
Google Scholar URL :
https://scholar.google.com/citations?user=kxt_pa0AAAAJ&hl=en
Phone number : 085376498034

2nd Author : Mukhlis, MT
Affiliation : Departemen of Environmental Health; Health Polytecnic of Padang
Mailing address : Sarang Gagak Anduring no 2 Kecamatan Kuranji, Kota Padang, Sumatera Barat-Indonesia 25151
Email of author : mukhlis_nabil@yahoo.com
Orcid ID : 0000-0001-5830-235X
Google Scholar URL :
<https://scholar.google.com/citations?hl=id&user=gNhrhy4AAAAJ>
Phone number : 081363311822

3rd Author : Suksmerri, S.Pd, M.Pd, M.Si
Affiliation : Departemen of Environmental Health; Health Polytecnic of Padang
Mailing address : Jl Handayani II Siteba Kecamatan Nanggalo, Kota Padang, Sumatera Barat-Indonesia 25151
Email of author : suksmeri@gmail.com
Orcid ID : [0000-0001-5696-4982](https://orcid.org/0000-0001-5696-4982)
Google Scholar URL :
<https://scholar.google.com/citations?user=Tkh5xggAAAAJ&hl=id>
Phone number : 082288578576

4nd Author : Dr. Wijayantono, SKM, M.Kes
Affiliation : Departemen of Environmental Health; Health Polytecnic of Padang

Mailing address : Jl Handayani II Siteba Kecamatan Nanggalo, Kota Padang,
Sumatera Barat-Indonesia 25151
Email of author : wijz_kl@yahoo.com
Orcid ID : [0000-0002-3621-9982](https://orcid.org/0000-0002-3621-9982)
Google Scholar URL :
<https://scholar.google.co.id/citations?user=Q6egPWgAAAAJ&hl=id>
Phone number : 0811663062

ABSTRACT

Introduction: Farmers employ synthetic pesticides to boost agricultural output, minimize or eradicate crop losses, and uphold elevated product standards. Although synthetic pesticides play a crucial role in increasing agricultural productivity, they also pose risks to the health of farmers. Long-term exposure to pesticides is a risk for farmers and can cause various types of cancer, such as digestive system cancer, stomach cancer, esophageal cancer, lung cancer, intestinal cancer, bladder cancer, and lymphoma. Pesticides also exhibit mutagenic and teratogenic properties. The aim of this study is to evaluate the risk of pesticide poisoning among farmers residing in Kenagarian Simpang Tanjung Nan IV, Solok Regency. Method: This study adopts a descriptive observational approach employing a cross-sectional design and a field study methodology. The research utilizes Environmental Health Risk Analysis (EHRA) to measure pesticide levels in each village and among the farmers within the specified area. The study was conducted from July to December 2023. Results: The research indicates that farmers have, on average, been exposed for a duration of 15.69 years, with an average daily exposure lasting 7 hours. Pesticide concentrations in the air, soil, and water exceed the quality standard value of 0.1 mg/L. All real-time Risk Quotient (RQ) values indicate that farmers are at risk of pesticide poisoning.

Keywords: Agriculture, Pesticides, Risk Analysis

ABSTRAK

Pendahuluan: Petani menggunakan pestisida sintetik dalam meningkatkan produktivitas pertanian untuk mengurangi atau menghilangkan kerugian hasil dan menjaga kualitas produk yang tinggi. Meskipun pestisida sintetik mempunyai peranan penting dalam meningkatkan produktivitas pertanian namun juga mempunyai risiko terhadap kesehatan petani. Paparan jangka panjang terhadap pestisida merupakan risiko terhadap petani yang dapat menyebabkan beberapa jenis kanker seperti kanker sistem pencernaan, lambung, kerongkongan, paru-paru, usus, kandung kemih, dan limfoma, bersifat mutagenik, dan teratogenik. Penelitian ini bertujuan untuk menentukan analisis risiko keracunan pestisida kepada petani di Kenagarian Simpang Tanjung Nan IV Kabupaten Solok. Metode: penelitian ini merupakan obeservasional deskriptif menggunakan pendekatan desain cross sectional dan metode field study pendekatan Analisis Risiko Kesehatan Lingkungan (ARKL) untuk mengukur kadar pestisida pada setiap jorong dan petani yang berdomisili di daerah tersebut. Penelitian dilakukan pada Bulan Juli sampai Desember 2023. Hasil: penelitian menunjukkan rata-rata durasi pajanan oleh petani 15,69 tahun dengan rata-rata terpapar dalam satu hari 7 jam. Konsentrasi pestisida pada udara, tanah, dan air melebihi nilai standar baku mutu yaitu 0.1 mg/L. Semua nilai RQ real time menunjukkan petani berisiko untuk keracunan pestisida.

Kata Kunci: Pertanian, Pestisida, Analisis Risiko

Introduction

Farmers in Indonesia heavily rely on pesticides as they are toxic substances that can control the development/growth of pests, diseases, and weeds. The use of pesticides has increased over the years, with the number of pesticide types steadily rising, and insecticides being the most widely used among them.

The application of pesticides in agriculture reveals that not all pesticides reach their intended targets. Approximately only 20% of pesticides hit their targets, while the remaining 80% end up in the soil, contaminating groundwater (Rusydi et al., 2016). With the toxic and persistent nature of pesticides, uncontrolled pesticide use is feared to burden the environment and compromise health. Inappropriate pesticide use can lead to poisoning among farmers and contaminate the environment, including water, soil, and air. Numerous studies have provided evidence of pollution arising from pesticide utilization, with documented instances of water and soil contamination attributed to the application of fertilizers and pesticides. These practices have been shown to impact the quality of soil and water in the upper regions of the Bedadung River Basin (Khoiriyah, 2021; Pangastuti et al., 2022), in Ambon Bay (Souisa et al., 2015). Drawing from literature reviews, pesticide exposure has been linked to a range of cancer types, including but not limited to cancers of the digestive system, stomach, esophagus, lungs, intestines, bladder, and lymphoma. Pesticides also exhibit mutagenic and teratogenic properties. According to the World Health Organization (WHO), At least 20,000 people per year die from pesticide poisoning. It is estimated that 5,000 – 10,000 people per year experience highly fatal impacts, such as developing cancer, physical disabilities, infertility, and liver diseases (Herdianti, 2018; Muslim et al., 2022; Rumambi, 2023).

Lack of knowledge about pesticide use leads to excessive and uncontrolled usage, posing a risk of poisoning for farmers. Pesticide exposure depends on the role of pesticide dosage, duration of exposure, and exposure modification factors (EMF) (Istianah, 2018; Sholikhin, 2018). Unregulated pesticide application constitutes a man-made crisis arising from the behavior of farmers due to the interplay of non-natural elements and human actions. Risk analysis serves as a systematic approach to evaluate or estimate the potential health hazards in the environment. The resulting risk characterization, typically expressed as a risk level, elucidates whether the agents or environmental parameters pose a threat to public health or not (Defriman, 2014; Dewi et al., 2016)(Susanti et al., 2021; Zolanda et al., 2021). Risk analysis comprises three essential elements: risk assessment, risk management, and risk communication. Risk assessment comprises four essential stages that must be completed to ascertain the extent of risk. These stages include hazard identification, determination of dose-response, assessment of exposure, and characterization of risk.

Nagari Simpang Tanjung Nan IV is one of the nagaris in the Danau Kembar sub-district of Solok Regency. Nagari Simpang Tanjung Nan IV, covering an area of 44.10 square kilometers, is an area known for horticultural agriculture with a population of 8,311 individuals (2017), comprising 4,152 males and 4,159 females (Solok, 2017). Pesticides are a solution used by farmers to enhance agricultural yields. Excessive pesticide use, such as not adhering to regulations and creating their own pesticide mixtures, is common among farmers. Based on several research findings, pesticide use can lead to poisoning and have health impacts on farmers. This study aims to examine the pathway of pesticide exposure entering the farmer's body based on risk analysis, focusing on the Risk Quotient (RQ) value. This information can be utilized to establish programs or preventive measures regarding pesticide exposure for farmers.

Method

Research Design

This research utilizes an observational descriptive design employing a cross-sectional approach and a field study method using the Environmental Health Risk Analysis (EHRA) from July to December 2023 in Kenagarian Simpang Tanjung Nan IV, Solok Regency.

Sampling Procedures

The study population encompasses all farmers residing in Kenagarian Simpang Tanjung Nan IV. The sample consists of environmental samples and farmer samples, with inclusion criteria for farmers who have resided for more than a year in Kenagarian Simpang Tanjung Nan IV, Solok Regency, and work as pesticide sprayers.

Data Analysis

Univariate analysis is conducted by examining the description of respondents, health disturbances, and pesticide levels in the agricultural environment. Risk analysis is performed by calculating the Risk Quotient (RQ) value concerning pesticide exposure.

Results

Farmers in Kenagarian Simpang Tanjung Nan IV are exposed to pesticides every day. This is evident in the morning when the air around is strongly scented with the odor of pesticides sprayed by farmers daily. The description of farmers is as follows:

Table 1.
Frequency Distribution of Farmers' General Descriptions

Variable (N=35)	Frequency	Percentage (%)	
Age			
Young	5	14,3	
Adult	17	48,6	
Elderly	13	37,1	
Total	35	100	
Gender			
Male	23	65,7	
Female	12	34,3	
Total	35	100	
Education			
Elementary School	14	40,0	
Junior High School,	10	28,6	
Senior High School	7	20,0	
College	4	11,4	
Total	35	100	
Cholinesterase Enzyme			
Poisoning	23	65,7	
Non-poisoning	12	34,3	
Total	35	100	
	Min – Max	Mean	Std. Deviation
Body Weight (Kg)	33 – 90	59,26	9,865

As indicated in Table 1 above, the data reveals that among the respondents categorized by age, the predominant group is adults, constituting 48.6% of the total with 17 respondents. The majority of respondents are male, comprising 65.7% with a total of 23 respondents. Regarding educational attainment, the majority of respondents, accounting for 68.6%, have completed elementary and junior high school. The majority of farmers experience pesticide poisoning, totaling 23 individuals with a percentage of 65.7%. The mean weight of the participants is 59.26 kg, ranging from a minimum of 33 kg to a maximum of 90 kg, with a Standard Deviation of 9.865 kg.

Table 2

Frequency Distribution of Farmers' Health Disorders

Health Disorders	Frequency	Percentage (%)
Not experiencing disorders	5	14,3
Experiencing disorders	30	85,7
Total	35	100

According to the findings presented in Table 4.2, the majority of respondents, totaling 85.7%, report experiencing health disorders. These health issues encompass symptoms such as nausea, vomiting, stomach cramps, diarrhea, dizziness, headaches, blurred vision, salivation disorders, skin problems, shortness of breath, chest pain, and sore throat.

Table 3
Total Pesticide Concentrations in the Air, in Simpang Tanjung Nan IV

Sample Number	Total Pesticides (The quality standard specified in Minister of Health Regulation No. 32 of 2017 is 0.1 mg/L)	
	Sample Concentration	Description
1	0,39	exceeding quality standards
2	1,47	exceeding quality standards
3	1,70	exceeding quality standards
4	1,39	exceeding quality standards
5	1,38	exceeding quality standards
6	1,50	exceeding quality standards
7	0,43	exceeding quality standards
8	1,46	exceeding quality standards
9	1,55	exceeding quality standards

According to the data presented in Table 3, the pesticide concentrations documented in the agricultural area of Simpang Tanjung Nan IV, Solok Regency, exceed the quality standards outlined in Regulation No. 32 of 2017 by the Minister of Health of the Republic of Indonesia. This regulation sets a maximum permissible total pesticide concentration of 0.1 mg/L.

Table 4
Risk Characteristics of Pesticides in the Air in Simpang Tanjung Nan IV, Solok Regency

Sample Number	Exposure Time (hours)	Exposure Frequency (days/year)	Exposure Duration (years)	Time Passed Intake (mg/Kg/day)	30-Year Projection Intake (mg/Kg/day)	Characteristics (RQ) Real Time	Characteristics (RQ) Risk for 30 Years
1	8	350	16	0,68	0,02	6,84	0,23
2	4	350	45	4,70	0,16	47,03	1,57

3	5	350	2	0,30	0,01	3,02	0,10
4	5	350	20	2,78	0,09	27,85	0,93
5	6	350	2	0,32	0,01	3,25	0,11
6	4	350	18	1,47	0,05	14,75	0,49
7	8	350	15	0,67	0,02	6,70	0,22
8	8	350	10	1,70	0,06	16,99	0,57
9	9	350	20	5,36	0,18	53,57	1,79
10	9	350	4	0,20	0,01	1,95	0,07
11	8	350	12	2,08	0,07	20,84	0,69
12	7	350	35	6,15	0,20	61,50	2,05
13	8	350	30	5,09	0,17	50,92	1,70
14	8	350	15	2,89	0,10	28,93	0,96
15	8	350	40	8,82	0,29	88,24	2,94
16	8	350	13	0,61	0,02	6,06	0,20
17	8	350	15	3,06	0,10	30,58	1,02
18	8	350	10	2,29	0,08	22,89	0,76
19	3	350	20	0,40	0,01	4,01	0,13
20	6	350	33	4,99	0,17	49,88	1,66
21	8	350	8	1,34	0,04	13,39	0,45
22	6	350	11	1,42	0,05	14,23	0,47
23	7	350	20	3,31	0,11	33,14	1,10
24	2	350	5	0,28	0,01	2,76	0,09
25	4	350	2	0,06	0,00	0,62	0,02
26	8	350	10	1,25	0,04	12,46	0,42
27	8	350	10	2,13	0,07	21,26	0,71
28	10	350	10	0,87	0,03	8,70	0,29
29	5	350	7	0,88	0,03	8,82	0,29
30	7	350	1	0,16	0,01	1,63	0,05
31	5	350	50	6,08	0,20	60,75	2,03
32	7	350	12	1,99	0,07	19,89	0,66
33	5	350	12	1,69	0,06	16,87	0,56
34	7	350	10	0,57	0,02	5,71	0,19
35	8	350	6	1,25	0,04	12,46	0,42
Average	6.7	350	15,69	2,22	0,07	22,24	0,74
Maximum	2	350	70	8,82	0,29	88,24	2,94
Minimum	10	350	45	0,06	0	0,62	0,02

Based on Table 4, the results for the risk characteristics (RQ) of pesticide risk agents while staying at home (Real Time) are 97% at risk, and for the risk characteristics (RQ) at 30 years, it is 25.7% at risk. This is because, to obtain the value of the non-carcinogenic effect, a comparison of the non-carcinogenic intake of each risk agent

with the reference dose (RFC) is carried out, where it is declared at risk, and efforts are needed to control the pesticide risk agent.

Discussion

Farmers in Kenagarian Simpang Tanjung Nan IV are mostly young and old, with education levels ranging from elementary school to junior high school. The average exposure of farmers to pesticides is 6.7 hours per day. Pesticide exposure in farmers occurs through inhalation because every time they breathe in the air on the agricultural land, they unknowingly inhale pesticides that have been sprayed on the plants (M G Catur Yuantari et al., 2013; Maria G. Catur Yuantari et al., 2015, 2018). In addition, pesticide exposure can occur through the skin, as farmers do not use gloves during pesticide mixing. Also, through the process of digestion, farmers wash their hands, utensils, food ingredients, and cooking necessities in water sources located in agricultural land that is already contaminated by pesticides. Pesticide exposure can cause symptoms that may lead to health problems for farmers. Health issues due to pesticide exposure can include nausea, vomiting, abdominal cramps, diarrhea, dizziness, headache, blurred vision, salivation disorders, skin issues, shortness of breath, chest pain, and sore throat (Akbar, 2019; O. S. Pamungkas, 2016; R. E. Pamungkas et al., 2017).

Most farmers experience health issues, but the symptoms that arise are considered common and not perceived as harmful to farmers. The belief that the symptoms of health issues will only become dangerous if they persist continuously without proper treatment indicates chronic poisoning symptoms among farmers. Workers exposed to pesticides have decreased cholinesterase levels compared to the control group. If workers are unaware of the exposure within their bodies, it can lead to an increase in chronic pesticide poisoning incidents among farmers (Zein, 2020). Exposure to pesticides among women of reproductive age (WUS) who assist their husbands or fathers in agricultural fields leads to subjective complaints such as easy fatigue and restlessness. Additionally, 62.87% of them experience headaches, although the examination results for cholinesterase levels are still within the normal range (Maria G. Catur Yuantari et al., 2018).

Recording related to pesticide use and its impacts in Pakistan has not been extensively carried out, although literature indicates that they are aware of the negative effects of pesticide use on soil, water, air, and human health. There is an increase in pesticide poisoning in Korean farming areas due to unsafe behavior, such as not following instructions on packaging, not using masks or gloves, and not paying attention to wind direction, which are risk factors accelerating pesticide exposure in farmers' bodies (Fazal et al., 2022). Pesticide poisoning can result in various symptoms, including but not limited to vomiting, diarrhea, difficulty breathing (dyspnea), blurred vision, tingling or numbness (paresthesia), slurred speech, and chest pain (Kim et al., 2013). The extent of pesticide exposure is contingent on factors such as the dosage of the pesticide, the duration of exposure, and modifying elements like the utilization of Personal Protective Equipment (PPE) (Istianah, 2018).

Pesticides entering the farmer's body can occur through the farmer's treatment of pesticides, and there is minimal or no elimination of pesticide exposure from the farmer's body. Additionally, the use of active ingredients in some types, when mixed, can cause various effects, including independence (no mutual influence), additive (addition according to the quantity of active ingredients), synergy (toxic effects produced are stronger than the sum of the individual effects), antagonism (penetration of chemicals against the harmful effects of other chemicals). If the education and knowledge level of farmers regarding the toxic effects of pesticide mixing is inadequate, and it turns out to be synergistic, this can endanger the health of farmers and the environmental microorganisms around agriculture (Maria G. Catur Yuantari et al., 2015). The

risk characteristics of pesticide risk agents categorized as unsafe are those with an RQ (Risk Quotient) greater than 1. Based on the measurement results of 35 samples, the risk characteristics of pesticide risk agents while in agricultural fields (real-time) show an RQ greater than 1 (100% at risk). This occurs because to obtain the non-carcinogenic effect value, a comparison of the non-carcinogenic intake of each risk agent with the reference dose (RFC) is performed, and values exceeding 1 are considered at risk of causing health problems and even death.

Farmers are vulnerable to contamination by pesticide ingredients through the process of buying, storing, mixing, spraying, and handling used pesticide containers. To avoid the danger of contamination, there are several instructions for using pesticides, starting from buying pesticides, transporting pesticides, storing pesticides, preparing pesticides, spraying pesticides, finishing spraying, and securing pesticide cans (Aziz, 2021; Maria G. Catur Yuantari et al., 2018).

Risk characterization is undertaken to assess whether a risk agent, analyzed in an Environmental Health Risk Assessment (EHRA) at a specific concentration, has the potential to induce health issues in the community. These characteristics encompass the Concentration of the risk agent (C), Body weight (Wb), Ingestion rate (R), Exposure time (Te), Duration of exposure (Dt), Frequency of exposure (fE), and Average time period (Tavg) to determine whether the risk agent causes interference or not. The risk characteristics are assessed by comparing (dividing) the intake with the Reference Dose (RFC). The variables used include intake values obtained from exposure analysis and reference concentrations from existing literature (Arlinda et al., 2022; Putri et al., 2023).

The use of risk analysis to assess pesticide exposure in farmers is not easy because it greatly depends on the level of exposure, the type of pesticide used, environmental characteristics, and farmers' behavior in using pesticides. These factors collectively influence the extent of the risk that farmers may face regarding pesticide exposure (Damalas & Koutroubas, 2016). However, the stages in risk analysis can predict pesticide exposure in the bodies of farmers and the environment, enabling the determination of preventive actions for both human health and environmental pollution.

Conclusion and Recommendations

Based on the research conducted in Kenagarian Simpang Tanjung Nan IV, Solok Regency, it can be concluded that the source of activities causing pesticide pollution comes from pesticide mixing activities that do not comply with the rules stated on the packaging and the mixing of several pesticides for a single spraying. The highest concentration of pesticides found was 1.70 mg/L. The risk characteristics of pesticide poisoning in farmers due to risk agents during work activities in agricultural land in real-time are 100% at risk, indicating the need to reduce exposure. It is imperative for every farmer to employ comprehensive Personal Protective Equipment (PPE) while engaging in spraying and handling activities, placing particular emphasis on the appropriate use of protective clothing and spraying equipment.

Farmers are workers in the informal sector, heavily relying on the government's role in health and occupational safety for farmers. Therefore, the government needs to control and supervise farmers in using pesticides, which can be done by the Department of Agriculture. The Health Department should monitor farmers' health by regularly examining farmers' cholinesterase enzymes to detect pesticide poisoning. In addition, periodic counseling or awareness programs about the dangers of pesticides should be conducted for farmers, enhancing their knowledge about the hazards of pesticides and encouraging more prudent pesticide use.

References

- Akbar, F. K. R. (2019). Analisis Risiko K3 Pemberantasan Hama Pekerjaan Pertanian Jeruk. *Journal of Public Health Research and Community Health Development*, 3(1), 01. <https://doi.org/10.20473/jphrecode.v3i1.13067>
- Arlinda, S., Sukmerri, S., Mukhlis, M., & Mahaza, M. (2022). Risk Analysis of Community Water Quality in Alahan Panjang Agricultural Area, Solok Regency, West Sumatera, Indonesia. *Jurnal Kesehatan Lingkungan*, 14(3), 193–200. <https://doi.org/10.20473/jkl.v14i3.2022.193-200>
- Aziz, M. F. (2021). Analisis risiko kesehatan pada petani tomat terhadap paparan pestisida klorpirifos di Kabupaten Enrekang. *Universitas Hasanuddin*, 51.
- Damalas, C. A., & Koutroubas, S. D. (2016). Farmers' exposure to pesticides: Toxicity types and ways of prevention. *Toxics*, 4(1), 1–10. <https://doi.org/10.3390/toxics4010001>
- Defriman, D. (2014). Prinsip dan metode analisis risiko kesehatan lingkungan. *Jurnal Kesehatan Masyarakat*, 94, 99–103. [https://doi.org/ISSN 1978-3833 Diterima](https://doi.org/ISSN%201978-3833%20Diterima)
- Dewi, S. N., Joko, T., & Dewanti, N. A. Y. (2016). Environmental Health Risk Analysis of Nitrate Pollution (No3) in Dug Well Water in the Agricultural Area of Tumpukan Village, Karangdowo District, Klaten Regency. *Journal of Public Health*, 4(3), 204–212. <https://doi.org/10.14710/jkm.v4i5.14511>
- Fazal, A., Ismail, A., Naeem, I., Oliveira, C. A. F., Shaukat, S., Saleem, M. U., Saima, S., Nasir, U., Alam, A., Aslam, Z., & Aslam, R. (2022). Exposure assessment of selected pesticide residues using occurrence data in foods and serum samples in Pakistan. *Food Science and Technology (Brazil)*, 42. <https://doi.org/10.1590/fst.01222>
- Herdianti, H. (2018). Hubungan Lama, Tindakan Penyemprotan, Dan Personal Hygiene Dengan Gejala Keracunan Pestisida. *PROMOTIF: Jurnal Kesehatan Masyarakat*, 8(1), 72. <https://doi.org/10.31934/promotif.v8i1.232>
- Istianah. (2018). Hubungan Masa Kerja, Lama Menyemprot, Jenis Pestisida, Penggunaan APD dan Pengelolaan Pestisida dengan Kejadian Keracunan Pada Petani di Brebes. *Public Health Perspective Journal*, 2(2), 117–123.
- Khoiriyah, D. R. A. N. (2021). Analisis Daya Tampung Beban Pencemar Amonia dan Nitrat di Sungai Winongo dengan Metode Qual2Kw. 1–103.
- Kim, J. H., Kim, J., Cha, E. S., Ko, Y., Kim, D. H., & Lee, W. J. (2013). Work-related risk factors by severity for acute pesticide poisoning among male farmers in South Korea. *International Journal of Environmental Research and Public Health*, 10(3), 1100–1112. <https://doi.org/10.3390/ijerph10031100>
- Muslim, A., Dadang, D., Indrasti, N. S., & Syaukat, Y. (2022). Application of Structural Equation Model-Partial Least Square for Factors Affecting the Risk of Pesticide Poisoning. *Jurnal Aisyah : Jurnal Ilmu Kesehatan*, 7(1), 317–324. <https://doi.org/10.30604/jika.v7i1.939>
- Pamungkas, O. S. (2016). Dangers of Pesticide Exposure to Human Health. *Bioedukasi*, XIV, 27–31. <https://doi.org/10.1146/annurev.polisci.11.053106.153836>
- Pamungkas, R. E., Sulistiyani, & Rahardjo, M. (2017). Analisis Risiko Kesehatan Lingkungan (ARKL) Akibat Paparan Karbon Monoksida (CO) Melalui Inhalasi pada Pedagang di Sepanjang Jalan Depan Pasar Projo Ambarawa Kabupaten Semarang. *Jurnal Kesehatan Masyarakat*, 5(5), 824–831.
- Pangastuti, E. I., Nurdin, E. A., Mujib, M. A., Alfani, A. F., Nalurita, V. A., & Fatmawati, D. (2022). Analisis dan Pemetaan Tingkat Pencemaran Air Sungai Pada Sub DAS Bedadung Tengah Kabupaten Jember. *JPIG (Jurnal Pendidikan Dan Ilmu Geografi)*, 7(2), 137–149. <https://doi.org/10.21067/jpig.v7i2.7191>

- Putri, T. R., Kusumahadi, K. S., Widowati, R., & Camin, Y. R. (2023). Development of An Air Quality Model For Public Health Risk Analysis (Case Study of Dangku Village Special Coal Terminal, Muara Enim, South Sumatra). *Jurnal Aisyah : Jurnal Ilmu Kesehatan*, 8(1), 567–574. <https://doi.org/10.30604/jika.v8i1.1808>
- Rumambi, F. J. (2023). Environmental Effects on Health: The Role of Sustainable Environmental Management. *Jurnal Aisyah : Jurnal Ilmu Kesehatan*, 8(2), 787–794. <https://doi.org/10.30604/jika.v8i2.2028>
- Rusydi, A. F., Naily, W., & Lestiana, H. (2016). Pencemaran Limbah Domestik Dan Pertanian Terhadap Airtanah Bebas Di Kabupaten Bandung. *Jurnal Riset Geologi Dan Pertambangan*, 25(2), 87. <https://doi.org/10.14203/risetgeotam2015.v25.201>
- Sholikhin, heru faris. (2018). Hubungan Pengetahuan, Sikap, Tindakan Penggunaan Pestisida Dengan Gangguan Penglihatan Petani Di Desa Munggangsari Kecamatan Kaliangkrik Kabupaten Magelang. *Skripsi*.
- Solok, D. K. K. (2017). *Profil Kesehatan*.
- Souisa, G. V., Mallongi, A., Hasyim, H., & Hatta, M. (2015). MODEL DINAMIS PENCEMARAN CADMIUM (Cd) DAN TIMBAL (Pb) DI TELUK AMBON. *Media Kesehatan Masyarakat Indonesia*, 11(3), 168–173. <https://journal.unhas.ac.id/index.php/mkmi/article/view/527>
- Susanti, W. E., Faisya, A. F., & Novrikasari, N. (2021). Analysis of Environmental Health Risks of Cement Dust in Cement Grinding and Packing. *Jurnal Aisyah : Jurnal Ilmu Kesehatan*, 6(2), 341–346. <https://doi.org/10.30604/jika.v6i2.471>
- Yuantari, M G Catur, Widiarnako, B., & Sunoko, H. R. (2013). Tingkat Pengetahuan Petani dalam Menggunakan Pestisida (Studi Kasus di Desa Curut Kecamatan Penawangan Kabupaten Grobogan). *Seminar Nasional Pengelolaan Sumberdaya Alam Dan Lingkungan 2013*, 142–148.
- Yuantari, Maria G. Catur, Widianarko, B., & Sunoko, H. R. (2015). Analisis Risiko Pajanan Pestisida Terhadap Kesehatan Petani. *Jurnal Kesehatan Masyarakat*, 10(2), 239. <https://doi.org/10.15294/kemas.v10i2.3387>
- Yuantari, Maria G. Catur, Widianarko, B., & Sunoko, H. R. (2018). Pesticide Exposure Risk Analysis on Farmers' Health. *Jurnal Kesehatan Masyarakat*, 10(2), 239. <https://doi.org/10.15294/kemas.v10i2.3387>
- Zein, S. S. (2020). Hubungan Paparan Pestisida Organofosfat terhadap Jumlah Kadar Enzim Kolinesterase dalam Darah pada Petani Cabai dan Semangka di Desa Karang Gading Kecamatan Labuhan Deli Kabupaten Deli Serdang. In *Fakultas Kesehatan Masyarakat*. <http://repository.uinsu.ac.id/id/eprint/15646>
- Zolanda, A., Raharjo, M., & Setiani, O. (2021). Risk Factors and Association of Environmental with The Incidence of Acute Respiratory Infection in Toddlers: Study on Working Area of Lubuk Kilangan Public Health Center. *Jurnal Aisyah : Jurnal Ilmu Kesehatan*, 6(3), 585–590. <https://doi.org/10.30604/jika.v6i3.729>