ANALYSIS OF EXTERNAL RISK FACTORS AND CHOLINESTERASE ENZYME LEVELS IN FEMALE FARMERS IN BREBES REGENCY

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Abstract. One of the indicators that can assess the degree of public health is the maternal mortality rate (MMR). One of the causes of maternal death is abortion. World Health Organization (WHO) estimates that around 4.2 million abortions occur annually in Southeast Asia and it is estimated that abortion cases in Indonesia reach 2.3 million incidents annually. This study aimed to analyze external risk factors and levels of cholinesterase enzymes with the incidence of spontaneous abortion in women of childbearing age shallot farmers in Brebes. This type of research is an analytical observational study with a case-control design. The results showed that there was no significant relationship between workload (p=0.195), pesticide exposure level (p=0.364) and levels of the enzyme cholinesterase (p=0.830) with the prevalence of spontaneous abortion in farmers in Brebes; there is a significant relationship between using personal protective equipment (PPE) (p=0.0001) and antenatal care (ANC) quality (p=0.001) with the incidence of spontaneous abortion in farmers in Brebes and there is a significant relationship between the use of PPE (odds ratio (OR) = 6.606; 95% confidence interval (CI): 1.857-23.502, p=0.004) and ANC qualities (OR = 0.175; 95% CI: 0.065-0.471, p=0.001) with the prevalence of spontaneous abortus in childbearing age farmers in Brebes Regency.

Keywords: spontaneous abortus, pesticide exposure, cholinesterase

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INTRODUCTION

The level of public health is a description of the ability or performance of health workers to achieve health indicators. One of the indicators that can assess the degree of public health is the maternal mortality rate (MMR). MMR in Indonesia is currently still quite high, namely there are 305 per 100,000 live births (Central Bureau of Statistics, 2016).

One of the causes of maternal death is abortion (Prasetiya *et al*, 2018). The definition of abortion is the release of the products of conception or the end of a pregnancy with a baby weighing less than 500 grams, a gestational age of less than 20 weeks, and the fetus has not been able to live independently outside the womb (Widhihastuti and Putri, 2020). World Health Organization (WHO) estimates approximately 4.2 million abortus events every year in Southeast Asia (WHO SEARO, 2020) and estimates that abortion cases in Indonesia reach 2.3 million events per year (Darmawati, 2011). Causes of abortion include fetal factors, maternal factors and other external factors (Akbar, 2019). Health and environmental services are one of the external factors of abortus. Environmental factors such as physical trauma, exposure to the influence of radiation, exposure to pollution, being in a magnetic field more than normal limits and exposure to pesticides can cause abortions (Akbar, 2019).

Brebes Regency is one of the largest shallot farming centers in Indonesia. Numbers of pesticides have been used and most farmers experience pesticide poisoning. Pesticide poisoning is one of the external risk factors for abortus events (Bretveld *et al*, 2006). Based on the profile of health data in Central Java in 2019, the maternal mortality rate in Brebes Regency was 116/100.000 live births or as many as 37 cases of maternal deaths from 31.803 live births (Central Bureau of Statistics, 2019). One of the efforts implemented by the government to overcome the occurrence of abortion is to make a policy of antenatal care (ANC) visits which are carried out at least 6 times during pregnancy by referring to the provisions twice during

the first trimester, once during the second trimester and three times during the third trimester (MOH RI, 2020).

Farmers and workers in the agricultural sector are poisoned almost every day by pesticides and every year millions of people involved in agriculture are poisoned by pesticides (Widyawati *et al*, 2018). One of the characteristics of poisoning by pesticides is the decreased activity of the cholinesterase enzyme in the blood. Cholinesterase enzymes, the enzymes that work for the action of acetylcholine by hydrolyzing it into acetic acid and choline, are found in cellular fluids (Dwiyanti *et al*, 2018). Acetylcholine is a neurotransmitter that is present throughout the somatic nervous system, central nervous system (CNS), and also in autonomic nervous system (sympathetic and parasympathetic). Acetylcholine works as a barrier to the flow of nerve vibrations. Normal levels of acetylcholine in women are 3,999-10,800 U/l while in men it is 4,620-11,500 U/l (Marisa and Pratuna, 2018).

Based on the description above, the fertile age in Brebes Regency is often involved in agricultural activities. This can lead to exposure to various types of pesticides with a frequency that is almost every day, so there is a high possibility of risk from pesticides. External quality in the form of ANC and the level of pesticide exposure which is considered to be a factor associated with the incidence of spontaneous abortion. So, it is necessary to study the external risk factors and levels of cholinesterase enzymes with the incidence of spontaneous abortion at the fertile age of shallot farmers in Brebes.

MATERIALS AND METHODS

This type of research is an analytical observational study with a case-control design, namely research that looks at the relationship between effects (certain diseases or health conditions) and certain risk factors. This research was conducted in Larangan District, Brebes Regency. The affordable population in this study was the fertile age of shallot farmers who were divided into two groups, namely the control group and the

case group. The results of calculations using the Lemeshow formula obtained a minimum sample size with a ratio of 1:1, namely 44 cases and 44 controls taken by purposive sampling, namely sampling based on certain considerations (Sugiyono, 2018). The independent variables used in this study were workload, pesticide exposure, use of PPE, and ANC quality. The dependent variable in this study was the incidence of spontaneous abortion. The confounding variable is the activity of the cholinesterase enzyme in the blood. The activity of the cholinesterase enzyme in a person's blood is expressed as a percentage of cholinesterase activity in the blood. Cholinesterase enzyme activity 76-100% is considered "normal", 51-75% is "mild poisoning", 26-50% is "moderate" and 0-25% is "severe poisoning" (Marisa and Pratuna, 2018).

The primary data source of this study was from the interviews using a questionnaire and the results of cholinesterase enzyme level in the blood. Secondary data sources are monographic data from the health office, community health center, and sub-district in the form of medical record data, ANC visit data, employment data, research results, and other journals.

Case inclusion criteria were women of childbearing age, shallot farmers who had experienced spontaneous abortion who lived in Larangan District, Brebes Regency. Inclusion criteria for control are women of childbearing age, shallot farmers who have never experienced spontaneous abortion and live in Larangan District, Brebes Regency. Exclusion criteria in this study were women of childbearing age who were not farmers, women of childbearing age who had never been pregnant, and subjects who refused to be respondents. The efforts made by researchers to match case and control respondents were that the age of the respondents was limited to between the ages of 20-49 years and the respondents were shallot farmers who lived in the same location with a ratio of 1:1; 44 cases and 44 controls taken by purposive sampling.

The researcher used the Hosmer and Lemeshow Goodness of fit test (GoF) to determine whether the model formed was correct or not. It is said

to be appropriate if there is no significant difference between the model and the observed value (Hosmer *et al*, 2013).

This research has passed the ethical test of the Research Ethics Unit of the Faculty of Public Health, Diponegoro University No.14/EA/KEPK-FKM/2022.

RESULTS

The characteristics of respondents in this study include the age and education of the respondents. Based on Table 1, it can be seen that most respondents (46.6%) were in the age group of 30-39 years with the lowest age of 20 years and the highest of 48 years. Most of the respondents (46.60%) had their primary education/finished elementary school.

Table 1
Characteristics of respondents

Characteristic	Frequency *n* (%)
Age (Years)	
20-29	14 (15.9)
30-39	41 (46.6)
40-49	33 (37.5)
Education	
Uneducated	1 (1.1)
Elementary school graduated	41 (46.6)
Junior high school graduated	31 (35.2)
High school graduated	11 (12.5)
College graduated	4 (4.5)

Based on Table 2, it is known that there are two variables that statistically have a significant relationship with the prevalence of spontaneous abortion (p<0.005) namely the use of PPE with a p-value of 0.0001 and the quality of ANC with a p-value of 0.001. Respondents who did not use PPE had have a 7.6 times greater risk of experiencing spontaneous abortion compared to respondents with full use of PPE when in agricultural areas (95% CI: 2.316-24.941), while respondents with unqualified ANC visits had a 4.6 times greater risk of developing spontaneous abortion compared to respondents who had quality ANCs (95% Cl: 1.877-11.327). There was no statistically significant relationship with the incidence of spontaneous abortion, namely workload (p=0.195), level of pesticide exposure (p=0.364), and levels of the cholinesterase enzyme (p=0.830). Table 3 shows that the variables that affect the incidence of spontaneous abortion were tested simultaneously, namely the use of PPE (OR = 6.606; 95% CI: 1.857-23.502, p=0.004) and ANC quality (OR = 5.704; 95% CI: 2.124-15.315, p=0.0001). Based on the research, it was found that the results of Hosmer and Lemeshow revealed p-value of 0.839 (p>0.05) so the data matched the logistic regression model and obtained an r-square value = 0.350 which means that the variables of PPE completeness and ANC quality contributed to the incidence of spontaneous abortion by 35% while 65% came from other factors outside the model that explained spontaneous abortion.

DISCUSSION

The results showed that there was no relationship between workload and the incidence of spontaneous abortion (p-value 0.195). This finding is supported by the research of Wahyuni *et al* (2017) which states that there is no relationship between workload and the incidence of spontaneous abortion in Ungaran Hospital, Central Java. In contrast to the results of a study conducted by Putri (2018) who stated that there was a meaningful relationship between workload and spontaneous abortion events (p=0.004). Excessive workloads of pregnant women that are not in accordance with physical abilities and

Table 2

Relationship between workload, pesticide exposure rate, proper PPE, quality of ANC, and cholinesterase enzyme levels with spontaneous abortion cases

Variable	Abortion		OR (95% CI)	*p*-value
	Yes, *n* (%)	No, *n* (%)		
Workload* (hours/day)			1.933 (0.819-4.564)	0.195
High	29 (65.9)	22 (50.0)		
Low	15 (34.1)	22 (50.0)		
Exposure to pesticide[†]			1.679 (0.683-4.126)	0.364
High	33 (75.0)	27 (61.4)		
Low	11 (25.0)	17 (38.6)		
PPE use[‡]			7.600 (2.316-24.941)	0.0001
Incomplete	40 (90.9)	25 (56.8)		
Complete	4 (9.1)	19 (43.2)		
ANC quality[§]			4.610 (2.316-11.327)	0.001
Not Quality	31 (70.5)	15 (34.1)		
Quality	13 (29.5)	29 (65.9)		
Cholinesterase level			0.832 (0.359-1.928)	0.830
Low	25 (56.8)	23 (52.3)		
High	19 (43.2)	21 (47.7)		

*Workload is the length of time a person in carrying out work activities in accordance with the capacity and ability of the body in accepting a job. Excessive workload on pregnant women that is not in accordance with

their abilities and physical capacity is categorized as high if working hours are more than 5 hours a day in agricultural areas.

†The involvement of pregnant women in agricultural activities can increase the risk of exposure to pesticides. The level of exposure to pesticides was measured through in-depth interviews with agricultural activities. Pesticide exposure is high if the total questionnaire score ≥ median (risk of pesticide exposure > median value, namely 6.0). Details of involvement in agricultural activities include spraying pesticides, mixing pesticides, cleaning pests, harvesting shallots, and cleaning crops). The level of exposure to pesticides is low if the total score of the questionnaire is < median value.

‡The use of PPE was measured based on the results of observations during activities on the farm and in-depth interviews. The results of research on the use of PPE show that the data are not normally distributed, so that the category of proper PPE is determined by the median value as the limit. Based on the cutoff point value, if the PPE total questionnaire score < the median value (<5.0) then it is included in the incomplete category. On the other hand, if the PPE total questionnaire score ≥ the median value (≥ 5.0) then it is included in the complete category. The PPE questionnaire includes the use of head coverings, glasses, masks, long-sleeved shirts, gloves, trousers, and footwear.

§The quality of ANC in this study was measured based on gestational age at ANC visits, number of visits and completeness of ANC services. Categorized as quality ANC if the recommended number of ANC visits has been fulfilled, receipt of all essential components of ANC services, there are no serious complaints about pregnancy and there are no signs of serious illness.

‖The results of examining the activity of the cholinesterase enzyme in the respondent's blood show a measure of the level of poisoning experienced by carrying out laboratory tests. It is categorized as low if the cholinesterase enzyme level in the blood is less than 8.25 μg/l.

ANC: antenatal care; CI: confidence interval; OR: odds ratio; PPE: personal protective equipment

Table 3
Results of multiple logistic regression of free variables (PPE use and ANC quality) with spontaneous abortus cases in Brebes Regency in 2022

Variables	B	Wald	*p*-value	Exp (B)	95% CI
PPE use	1.888	8.503	0.004	6.606	1.857-23.502
ANC quality	1.741	11.936	0.0001	5.704	2.124-15.315
Constant	-2.302	12.712	0.0001	0.100	

ANC: antenatal care; B: coefficient Beta; CI: confidence interval; Exp (B): Exponent B; PPE: personal protective equipment

capacities, such as too high lifting load, heavy workload, working hours of more than 5 hours a day, attacks on vibrations, exposure to pesticides and psychological stress, can trigger spontaneous abortion (Sari *et al*, 2019). The difference in this study may occur due to other factors that can affect the incidence of spontaneous abortion such as the zygote factor, fetus, embryo, and placenta (Wahyuni *et al*, 2017).

The results of research conducted in Larangan District, Brebes Regency in March 2022, indicates that there was no relationship between the level of pesticide exposure and the incidence of spontaneous abortion (p-value 0.364). This is in line with the research conducted by Pamungkas (2016) who did not find the relationship between the level of pesticide exposure and the incidence of spontaneous abortion in Semarang Regency (p=0.491). Contrary to the results of a study that found a meaningful relationship between the level of pesticide exposure and the incidence of spontaneous abortion (p=0.004) (Rahayu *et al*, 2015). The level of pesticide exposure was based on the interaction of respondents in agricultural activities. Spraying and mixing pesticides are the highest agricultural activity involving with pesticide exposure. The results showed that, in general, the level of exposure to respondents tended to be low, because most farmers were not directly involved with pesticides, only 2 respondents helped in spraying pesticides and 7 respondents helped in mixing pesticides.

The results showed that there was a significant relationship between the use of PPE and the incidence of spontaneous abortion (p=0.0001). The results of this study are in line with research conducted by Septiana *et al* (2021) who found a significant relationship between the use of PPE and the occurrence of pesticide poisoning (p=0.0001). Improper use of PPE allows pesticides to enter the body through the respiratory tract, eyes, mouth, nose, and skin. If the pesticide is absorbed in the body, it will cause thyroid hormone disorders (Sundani, 2020). As a result, these disorders will result in the insufficient thyroid hormone production (hypothyroidism). This event experienced by pregnant women can be an antagonist to the growth and development of the fetus in the womb and can cause abortion (Sundani, 2020).

In this study, respondents with a history of spontaneous abortion tended not to use PPE properly when carrying out activities in agricultural areas. According to the regulation of the Minister of Manpower and Transmigration of the Republic of Indonesia No. PER.08/MEN/VII/2010, it is stated that minimum PPE must be used in accordance with the type of work and classification of pesticides (Ministry of Manpower and Transmigration, 2010). Several types of PPE that must be worn when spraying outside buildings including headgear (caps or caps), face shields or respiratory protection (masks), work clothes (long-sleeved shirts and pants in overalls or separately), hand protection (gloves gloves) and leg protectors (boots with long soles, made of rubber, not easy to tear and not easy to shrink) (Ministry of Manpower and Transmigration, 2010). Respondents would have had a 7.6 times greater risk of experiencing spontaneous abortion if they do not use complete PPE. When in agricultural areas, PPE decreases the pesticide exposure. Spraying pesticides on land will spread in the air in the form of aerosols. The light mass of aerosol makes it easy to enter the body through the respiratory tract (Fatmawati and Windraswara, 2016). Most farmers do not use footwear when in agricultural areas; as a result pesticide residues that are still on plants and soil layers can enter the body through the skin (Pamungkas, 2016).

The results of statistical tests on relationship between the quality of

the ANC and the incidence of spontaneous abortion obtained a p-value of 0.001, indicating a significant relationship. The results of the study are in line with research conducted by Putri (2018) in Koto District, Agam Regency. OR calculations show respondents with unqualified ANCs have a 4.6 times greater risk of developing spontaneous abortus compared to respondents who have the qualified ANCs.

The quality of ANC in this study was measured based on the gestational age at the time of the ANC visit, the number of visits, and the completeness of ANC services. A total of 72.7% of respondents did not do syphilis, Human Immunodeficiency Virus/Acquired Immunodeficiency Syndrome (HIV/AIDS), and hepatitis tests during pregnancy. In fact, based on the rules of the Ministry of Health (2017), ANC services are of quality if every pregnant woman who visits a health care facility checks for hepatitis, HIV, and syphilis as a triple elimination program in pregnancy (MOH RI, 2017). Pregnant women are a vulnerable population infected with HIV, syphilis, and hepatitis. These three diseases can be transmitted from mother to fetus leading to fetus morbidity and mortality (WHO, 2018). Maternal infection can carry risks to the developing fetus especially at the end of the first trimester which can finally lead to spontaneous abortion (Astriani, 2018).

Based on research conducted in Larangan District, Brebes Regency, it was shown that there was no significant relationship between cholinesterase enzyme levels and the incidence of spontaneous abortion (p=0.830). This is in line with the research conducted by Shinta and Sonata, 2019) who found no relationship between cholinesterase enzyme levels in the blood and the incidence of spontaneous abortion (p=0.363). Based on research conducted by Rio (2019), there was a significant relationship between cholinesterase levels and hypertension while hypertension itself can increase the risk of abortion (Yuandra, 2019). This can happen because the blood sample is not taken when the respondent experienced an abortion directly. Respondents in this study were childbearing-age farmers with a history of abortion in the last 5 years. Organophosphate (pesticide) is an anticholinesterase agent that works as a cholinesterase inhibitor by inactivating the acetylcholinesterase

(AchE) enzyme (Sihombing, 2017). Anionic region of the cholinesterase enzyme binds to the acetylcholine (Ach) quaternary nitrogen atom and the esteric region binds to the Ach carboxyl group. Pesticide exposure is reversible so that the levels of the cholinesterase enzyme can return to normal or almost normal conditions (Dwiyanti *et al*, 2018). Activity of the cholinesterase enzyme in plasma will return to normal within 3 weeks after exposure, while blood cholinesterase levels take 2 weeks without pesticide exposure to return to normal. The return of cholinesterase enzyme activity depends on the synthesis of new enzymes by the liver (Dwiyanti *et al*, 2018).

Based on multivariate analysis using the binary logistic regression method, it was found that properly use of PPE and quality of ANC had a significant effect on the incidence of spontaneous abortion. Properly use of PPE has an effect on the incidence of spontaneous abortion as indicated by *p*-value of 0.004. Female farmers who are not fully equipped with PPE when carrying out their activities have a 6,606 times risk of experiencing spontaneous abortion compared to respondents who use complete PPE. The use of PPE in agricultural areas greatly affects the number of pesticide particles entering the body (Aisyah *et al*, 2013). This is in line with Lisniawati (2017) who states that the use of PPE can prevent and reduce the impact of pesticide poisoning. The use of PPE minimizes direct contact with pesticides, so the risk of pesticide entering the body can be avoided. The more toxic pesticides entering the body, the higher the risk of poisoning (Lisniawati, 2017). Exposure to pesticides that enter the body of pregnant women either by inhalation or direct contact from the skin can enter the lungs and the mother's bloodstream which will be distributed to the fetus through the placenta; this will result in impaired fetal development and increase the risk of spontaneous abortion in early pregnancy (Istiklaili, 2009).

This study proves that mothers with poor ANC quality have a 5.704 times risk of experiencing spontaneous abortion compared with good ANC quality. This is in line with previous research which stated that there was an effect of ANC quality on the incidence of spontaneous abortion (p=0.021 with 95% CI Exp B 6.871) which showed that pregnant women with poor quality

ANC had 6.871 times the chance to have an abortion in their pregnancy (Putri, 2018). ANC services have a good influence on the development of the fetus or the time available, both through diagnosis and by regular treatment of the presence of pregnancy compilation. An ANC visit is when a pregnant woman is first aware of the delay, including steps that are very important to take to minimize fetal loss and loss, including spontaneous abortion (Sundani, 2020).

Based on estimates, it shows that shallot farmers who do not use complete PPE and do not carry out quality ANC during pregnancy have a 79% chance of experiencing spontaneous abortion. Education on the use of PPE to shallot farmers and providing quality ANC services are needed to reduce the risk of mothers experiencing spontaneous abortion.

In summary, there is no significant relationship between workload (p=0.195), level of pesticide exposure (p=0.364), and levels of the enzyme cholinesterase (p=0.830) with the incidence of spontaneous abortion in farmers in Brebes. There is a significant relationship between the completeness of PPE (p=0.001) and ANC quality (p=0.001) with the incidence of spontaneous abortion in farmers in Brebes. There is a joint effect between the use of PPE (p=0.004; OR = 6.606; 95%CI: 1.857-23.502) and ANC quality (p=0.001; OR = 0.175; 95%CI: 0.065-0.471) on the incidence of spontaneous abortion on childbearing age farmers in Brebes Regency. Education on the use of PPE to shallot farmers and offering quality ANC services are needed to reduce the risk of mothers experiencing spontaneous abortion.

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CONFLICT OF INTEREST DISCLOSURE

The authors declare no conflicts of interest

REFERENCES

Aisyah K, Setiani O, Nugraheni SA. Factors related to pesticides exposure and anemia on horticultural farmers in Gombo Village Belik Subdistrict Pemalang Central Java, 2013 [cited 2022 Oct 19]. Available from: URL: https://ejournal.undip.ac.id/index.php/jkli/article/view/8549/6985 [in Indonesian]

Akbar A. Factors causing abortion in Indonesia 2010-2019: meta-analysis study, 2019 [cited 2022 Oct 05]. Available from: URL: https://ejournal.unsrat.ac.id/index.php/biomedik/article/download/26660/26283 [in Indonesian]

Astriani T. Factors influence the incidence of abortion in mothers at Labuang Baji Hospital in Makassar Periode 2012 (abstract), 2018 [cited 2022 Oct 08]. Available from: URL: https://digilibadmin.unismuh.ac.id/upload/29687-Abstrak.pdf

Bretveld RW, Thomas CM, Scheepers PT, Zielhuis GA, Roeleveld N. Pesticide exposure: the hormonal function of the female reproductive system disrupted? *Reprod Biol Endocrinol* 2006, 4:30.

Central Bureau of Statistics. Profile of Indonesia Population (Results of SUPAS 2015), 2016 [cited 2022 Oct 08]. Available from: URL: https://www.bps.go.id/publication/download.html?nrbvfeve=NjNkYWE0NzEwOTJiYjJjYjdjMWZhZGE2&xzmn=aHR0cHM6Ly93d3cuYnBzLmdvLmlkL3B1YmxpY2F0aW9uLzIwMTYvMTEvMzAvNjNkYWE0NzEwOTJiYjJjYjdjMWZhZGE2L3Byb2ZpbC1wZW5kdWR1ay1pbmRvbmVzaWEtaGFzaWwtc3VwYXMtMjAxNS5odG1s&twoadfnoarfeauf=MjAyMy0wMi0xMSAxODoxOToxMg%3D%3D [in Indonesian]

Central Bureau of Statistics. The number of babies born, infant mortality, maternal and maternal mortality according to Districts in Brebes Regency in 2019, 2019 [cited 2022 Oct 09]. Available from: URL: https://brebeskab.bps.go.id/statictable/2020/03/26/1088/banyaknya-kelahiran-bayi-kematian-bayi-ibu-melahirkan-dan-kematian-ibu-melahirkan-menurut-kecamatan-di-kabupaten-brebes-tahun-2019.

html [in Indonesian]

Darmawati. Recognize abortion and its related factors, 2011 [cited 2022 Sep 10]. Available from: URL: https://jurnal.unsyiah.ac.id/INJ/article/download/6354/5220 [in Indonesian]

Dwiyanti FL, Darundiati YH, Dewanti NAY. Relationship of working period, length of work, duration of spraying and frequency of spraying on blood cholinesterase levels in farmers in Sumberejo Village, Ngablak District, Magelang Regency, 2018 [cited 2022 Sep 06]. Available from: URL: https://ejournal3.undip.ac.id/index.php/jkm/article/download/22167/20382 [in Indonesian]

Fatmawati M, Windraswara R. Risk factors of pesticide exposure during pregnancy on the incidence of LBW in vegetable farmers, 2016 [cited 2022 Sep 15]. Available from: URL: https://journal.unnes.ac.id/sju/index.php/ujph/article/view/11372/7628 [in Indonesian]

Hosmer DW Jr, Lemeshow S, Sturdivant RX. Applied logistic regression. 3rd ed. New York, NY: Wiley; 2013.

Istiklaili F. Relationship between pesticide exposure and spontaneous abortion incidence in Ngablak District, Magelang Regency, Central Java [thesis]. Semarang, Indonesia: Diponegoro University; 2010. [in Indonesian]

Lisniawati E. The relationship between the use of personal protective equipment (PPE) and respiratory disorders in farmers using pesticides in the Puskesmas Balung Region [undergraduate research], 2017 [cited 2022 Sep 20]. Available from: URL: http://repository.unmuhjember.ac.id/1022/ [in Indonesian]

Marisa, Pratuna ND. Analysis of cholinesterase levels in blood and health complaints in potato farmers Kilometer X in Sungai Penuh City, 2018 [cited 2022 Oct 20]. Available from: URL: https://media.neliti.com/media/publications/275199-analisa-kadar-cholinesterase-dalam-darah-1ed3539c.pdf [in Indonesian]

Ministry of Health of the Republic of Indonesia (MOH RI). Guidelines for antenatal, childbirth, postpartum, and newborn services in the new adaptation era, 2020 [cited 2022 Oct 21]. Available from: URL: https://covid19.go.id/storage/app/media/Materi%20Edukasi/2020/Oktober/revisi-2-a5-pedoman-pelayanan-antenatal-persalinan-nifas-dan-bbl-di-era-adaptasi-kebiasaan-baru.pdf [in Indonesian]

Ministry of Health of the Republic of Indonesia (MOH RI). Regulation of the Minister of Health of the Republic of Indonesia Number 52 of 2017 concerning elimination of transmission of HIV, syphilis and hepatitis B from mother to child, 2017 [cited 2022 Sep 10]. Available from: URL: https://peraturan.bpk.go.id/Home/Download/103103/Permenkes%20Nomor%2052%20Tahun%202017.pdf [in Indonesian]

Ministry of Manpower and Transmigration. Regulation of the Minister of Manpower and Transmigration of the Republic of Indonesia concerning personal protective equipment, 2010 [cited 2022 Sep 23]. Available from: URL: https://toolsfortransformation.net/wp-content/uploads/2017/05/8-tahun-2010-Permen-Nakertrans-ttg-Alat-Pelindung-Diri.pdf [in Indonesian]

Pamungkas OS. The hazard of pesticide exposure to human health, 2016 [cited 2022 Sep 12]. Available from: URL: https://jurnal.unej.ac.id/index.php/BIOED/article/download/4532/3355/ [in Indonesian]

Prasetiya A, Andayani SRD, Kurdi F. Relationship of age with abortion incidence in mothers in the Ponek Room at RSUD Jombang, 2018 [cited 2022 Sep 20]. Available from: URL: https://journal.stikespemkabjombang.ac.id/index.php/jikeb/article/download/151/144/436 [In Indonesian]

Putri LM. The main maternal risk factors causing abortion at the Public Health Center IV Koto District, Agam Regency, 2018 [cited 2022 Aug 28]. Available from: URL: https://ejournal.lldikti10.id/index.php/endurance/article/download/3144/1082 [in Indonesian]

Rahayu A, Astuti R, Sayono. History of pesticide exposure as a risk factor for spontaneous abortion (Study on pregnant women at

Sidamulya Health Center, Brebes Regency), 2015 [cited 2022 Sep 13]. Available from: URL: https://publikasiilmiah.ums.ac.id/bitstream/handle/11617/6847/%284%29%20RIWAYAT%20PAJANAN%20PESTISIDA%20SEBAGAI%20FAKTOR%20RISIKO.pdf?sequence=1&isAllowed=y [in Indonesian]

Sari RDP, Rahmanisa S, Citra E. The relationship between mental workload and abortion incidence in factory workers at PT. Great Giant Pineapple, 2019 [cited 2022 Oct 15]. Available from: URL: https://juke.kedokteran.unila.ac.id/index.php/JK/article/view/2214/2183 [in Indonesian]

Septiana D, Suhartono, Dewani NAY. Relationship between pesticide exposure before pregnancy and hypertension incidence in pregnant women in the agricultural area of Sumowono District, Semarang Regency, 2021 [cited 2022 Sep 12]. Available from: URL:https://ejournal3.undip.ac.id/index.php/jkm/article/download/29440/25128 [in Indonesian]

Shinta DW, Sonata H. Pesticide poisoning and hemoglobin levels in chili farmers, 2019 [cited 2022 Aug 16]. Available from: URL: https://repository.unri.ac.id/bitstream/handle/123456789/9900/33.%20sinta.pdf?sequence=1&isAllowed=y [in Indonesian]

Sihombing DB. Pesticides use behavior of shallot farmers in Silalahi I Village, Silahisabung District, Dairi Regency in 2017, 2017 [cited 2022 Aug 16]. Available from: URL: https://repositori.usu.ac.id/bitstream/handle/123456789/1577/131000449.pdf?sequence=1&isAllowed=n [in Indonesian]

Sugiyono. Quantitative research methods. Bandung, Indonesia: ALFABETA; 2018. [in Indonesian]

Sundani IP. Factors associated with the incidence of low birth weight (LBW) in onion farmers in Keuntungan District, Brebes Regency, Central Java Province in 2017, 2020 [cited 2022 Aug 20]. Available from: URL: https://jurnal.syntaxliterate.co.id/index.php/syntax-literate/article/view/1326/1405 [in what Indonesian]

Wahyuni S, Ngadiyono, Sumarni S. Risk factors associated with abortion in Ungaran Hospital, Central Java, 2017 [cited 2022 Sep 23]. Available from: URL: https://www.researchgate.net/profile/Sri-Sumarni/publication/326851872_Faktor_Resiko_yang_Berhubungan_dengan_Kejadian_Abortus_di_Rsud_Ungaran_Jawa_Tengah/Links/5c827235299bf1268d453dbe/Faktor-Resiko-yang-Berhubungan-dengan-Kejadian-Abortus-Di-RSUD-Ungaran-Jawa-Tengah.pdf [in lndonesian]

Widhihastuti AD, Putri IM. Determinants associated with abortion incidence, 2020 [cited 2022 Oct 01]. Available from: URL: http://repository.urecol.org/index.php/proceeding/article/view/1071/1041 [in Indonesian]

Widyawati SA, Siswanto Y, Pranowowati P. Potential pesticide exposure and impact on reproductive health of female farmers in Brebes, 2018 [cited 2022 Sep 12]. Available from: URL: https://journal.ppnijateng.org/index.php/jikm/article/view/107/76 [in Indonesian]

World Health Organization (WHO). Regional framework for the triple elimination of mother-to-child transmission of HIV, Hepatitis B and syphilis in Asia and the Pacific, 2018-2030, 2018 [cited 2022 Jul 28]. Available from: URL: https://apps.who.int/iris/rest/bitstreams/1148575/retrieve

World Health Organization Regional Office for South-East Asia (WHO SEARO). Policies, programme and services for comprehensive abortion care in South-East Asia Region, 2020 [cited 2022 Sep 15]. Available from: URL: https://apps.who.int/iris/bitstream/handle/10665/338768/9789290228233-eng.pdf?sequence=38&isAllowed=y

Yuandra RF. Relationship between pesticide exposure and cholinesterase levels with hypertension in farmers in Juhar District, Karo Regency in 2019 [thesis]. Medan, Indonesia: Sumatera Utara University; 2019. [in Indonesian]