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Research

The Effect of Organophosphate Pesticides Exposure and Other Factors Associated with Neuropsychiatric Disorders among Rice Farmers: A Path Analysis Evidence from Sukoharjo, Central Java

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ABSTRACT

Background: Pesticide is a cheap and effective substance to eradicate pests, yet it has chronic effects, it causes neuropsychiatric disorders. Neuropsychiatric disorders are associated with affective, cognitive, and behavioral disorders. This study aims to analyze the effects of pesticide exposure and psychosocial determinants on neuropsychiatric disorders (depression and anxiety).
Subjects and Method: This was a retrospective cohort study conducted in Sukoharjo, Central Java, Indonesia. A sample of 200 rice farmers was selected by fixed exposure sampling. The dependent variable was depression nd anxiety. The independent variables were organophosphate pesticide exposure and psychosocial factors. The neuropsychiatric disorders were measured using DASS-42 questionnaires. The data were analyzed by path analysis.
Results: Depression and anxiety were directly increased by high work stress (b= 0.29; 95% CI= 0.19 to 0.38; p< 0.001), depression history of family members (b= 5.71; 95% CI= 3.16 to 8.26; p<0.001), grief and loss (b= 3.21; 95% CI= 0.99 to 5.42; p= 0.005), and past trauma (b= 4.08; 95% CI= 1.81 to 6.34; p<0.001). Depression and anxiety were indirectly affected by the organophosphate pesticide exposure, age through the use of personal protective equipment (PPE), and latest education through the use of PPE.
Conclusion: Depression and anxiety are directly increased by high work stress, depression history of family members, grief and loss, and past trauma. Depression and anxiety are indirectly affected by the organophosphate pesticide exposure, age through the use of personal protective equipment (PPE), and latest education through the use of PPE.

Keywords: Neuropsychiatry, organosphosphate pesticide exposure, and rice farmers

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BACKGROUND

A pesticide is cheap and effective to eradicate pests, plant diseases, and weed if it is applied thoroughly (Stenley, 2016). Organophosphate pesticide is more toxic for vertebrates and invertebrates as a cholinesterase inhibitor leading to neurotransmitter acetylcholine which makes neuro impulses fail to move and muscles move fast and may result to paralysis and death (Yadav et al., 2017). Chronic effects of the organophosphate pesticide, which include neuropsychiatric disorders, memory disturbance, confusion, irritability, exhaustion, and psychosis, are usually temporary (Ghimire et al., 2016).

According to the book of David et al. (2009), organophosphate pesticide is a potential acetyl cholinesterase inhibitor that

could hamper neuro impulses and change membrane functions causing nerve system disorders.

Serrano et al. (2019) stated that chronic exposure to pesticides caused 25% of the study subjects to suffer from severe depression and suicidal desire, 23.9% showed anxiety, 23.5% indicated depression and anxiety, and 22% experienced severe depression but without mental disorder diagnosis.

Based on the field observation in Jombor village, the age of farmers in the area is >40 years old because the youths prefer to work in industries and farmland in the area is inherited from family. Age range, education background, and village culture make the farmers have a low understanding of the use of personal protective equipment (PPE) when they kill pests using the pesticide. The farmers' unsafe behaviors could harm their health, which includes neuropsychiatric disorders among the farmers.

SUBJECTS AND METHOD

1. Study Design

This was a retrospective cohort study conducted in Sukoharjo, Central Java, Indonesia.

2. Population dan Sample

The study population was all rice farmers in Sukoharjo, Central Java, Indonesia. A sample of 200 rice farmers was selected by fixed exposure sampling. The subject criteria to fulfill were:

1) Male.
2) Agree to participate in the study.
3) Age range from 20 to 60 years old.
4) A farmer who has used pesticides for at least one year for the case group.

3. Study Variables

The dependent variable was neuropsychiatric disorders. The independent variables were organophosphate pesticide exposure and psychosocial factors.

4. Operational Definition of Variables

Organophosphate pesticide exposure: The organophosphate pesticide exposure that the study subjects received during their agricultural works through breathing, skin, and digestion were measured from the duration of using the pesticide in years.

The Use of the Personal Protective Equipment (PPE): Tool the farmers used to prevent direct contact with the pesticide when spraying the substance were: long sleeves shirt/t-shirt, trousers, gloves, masks/ nose cover, hat, glasses, and shoes.

Neuropsychiatric Disorders: The neuropsychiatric disorders experienced by the farmers in Sukoharjo district as the study subjects were anxiety and depression.

Depression and Anxiety History of Family Members: Depression and anxiety history of core family members including father, mother, and sibling.

Grief and Loss: actual and potential situation resulted from the emotional reaction that the study subjects experienced as a consequence of partial and thorough loss, divorce, death, and separation.

Post-trauma: Traumatic experiences that the subjects experienced in the past, usually during the first years of their lives.

Work Stress: Situation of the study subjects to face opportunities or demand related to their works as a farmer.

5. Study Instruments

Instruments of the study were questionnaires on the factors causing the neuropsychiatry and Depression Anxiety Stress Scale (DASS)-42 questionnaire.

6. Data Analysis

Variables with continuous data were described in n, Mean, SD, Minimum, and Maximum. Variables with category data were described in n and percentage. Bivariate correlation between two variables with a continuous scale was shown in coefficient correlation (r). The mean difference of continuous variables

between the two groups was examined using the T-test. A direct and indirect multivariate correlation was shown with path analysis.

7. Research Ethic

The study was approved by the Committee of Health Research Ethics of RSUD Dr. Moewardi and received a letter of Ethical Clearance No. 217/II/HREC/ 2020.

RESULTS

A. Univariate analysis

Table 1 reported that the study involved 200 rice farmers aged 25-65 years old, the study results showed that the average age of the farmers was 44.29 years old with average organophosphate pesticide exposure 8.35 years and the maximum exposure was 40 years. The average use of personal protective equipment (PPE) was 2.80 PPE types. The average score for neuropsychiatric disorders for depression scale was 6.85, while the average score for the anxiety scale was 11.2. The average score of the farmers' work stress was 11.28.

Table 2 reported that the latest education of the majority of the farmers involved in the study (129 farmers or 65.5%) was below high school. Most of them (174 farmers or 87.0%) did not have any depression and anxiety history within their family. The majority of the farmers in this study (153 farmers or 76.5%) never experienced grief. Most of the farmers (159 farmers or 79.5%) did not have past trauma.

Table 1. Characteristics of the Subjects (continuous data)

Variable	Mean	SD	Min.	Max.
Farmers' age	44.29	11.81	25	65
Exposure to organophosphate pesticide (year)	8.35	9.71	0	40
Use of PPE	2.80	1.60	0	6
Neuropsychiatric disorders				
Depression	6.85	7.43	0	28
Anxiety	11.12	8.29	0	30
Work stress	11.28	8.54	0	31

Table 2. Characteristics of the Subjects (dichotomy data)

Characteristics	Category	Frequency	Percentage
Education	< High school	129	65.5
	≥ High school	71	35.5
Depression and anxiety history of family members	No	174	87.0
	Yes	26	13.0
Grief and loss	No	153	76.5
	Yes	47	23.5
Past Trauma	No	159	79.5
	Yes	41	20.5

B. The result of bivariate analysis

Results of the bivariate analysis were summarized in table 3, 4, and 5. Table 3 showed that the organophosphate pesticide exposure (r= 0.49; p<0.001), age (r=0.19; p=0.006), work stress (r=0.37; p<0.001) and the use of the PPE (r= -0.43; p< 0.001) were correlated with depression. The organophosphate pesticide exposure (r=0.48; p<0.001), age (r= 0.14; p=0.041), the use of the PPE (r= -0.47; p< 0.001) and work stress (r= 0.38; p<0.001) were correlated with anxiety.

Table 4 showed that farmers with education <Senior high school (Mean= 13.05; SD= 8.52) had higher anxiety than those with education ≥Senior high school (Mean= 7.6; SD= 6.59) with p<0.001.

Farmers who had family with anxiety history (Mean= 17.46; SD= 6.21) had higher anxiety than those without anxiety history in their family (Mean= 10.17; SD= 8.16) with p<0.001.

Farmers who experienced grief and loss (Mean= 17.26; SD= 7.34) had higher anxiety than those without grief and loss (Mean= 9.23; SD= 7.65) with p<0.001.

Farmers with past trauma (Mean= 19.49; SD= 6.69) had higher anxiety than those without past trauma (Mean= 8.96; SD= 7.24) with p<0.001.

Table 5 showed that education <Senior high school (Mean= 8.59; SD= 8.38) had lower depression than education ≥Senior high school (Mean= 3.68; SD= 3.64) with p<0.001.

Farmers with depression family history (Mean= 14.15; SD=6.45) had higher depression than those without depression in family history (Mean= 5.76; SD= 6.96) with p<0.001.

Farmers who experienced grief and loss (Mean=11.94; SD= 8.10) had higher depression than those without grief and loss (Mean= 9.23; SD= 7.65 with p<0.001.

Farmers with past trauma (Mean= 12.51; SD= 9.23) had higher depression than those without past trauma (Mean= 5.38; SD= 6.14) with p<0.001.

Table 3. The correlation of age, organophosphate pesticide exposure, use of PPE, work stress, and neuropsychiatric disorders (depression and anxiety)

Independent Variables	Depression		Anxiety	
	r	p	r	p
Age	0.19	0.006	0.14	0.041
Exposure to the organophosphate pesticide	0.49	<0.001	0.48	<0.001
Use of the PPE	-0.43	<0.001	-0.47	<0.001
Work stress	0.37	<0.001	0.38	<0.001

Table 4. Results of t-test on the mean difference of education, depression and anxiety history of family members, grief and loss, and past trauma on anxiety

Independent Variables	Anxiety			
	N	Mean	SD	p
Education				
<High school	129	13.05	8.52	<0.001
≥ High school	71	7.61	6.59	
Depression and anxiety disorders of family members				
No	174	10.17	8.16	<0.001
Yes	26	17.46	6.21	
Grief and loss				
No	153	9.23	7.65	<0.001
Yes	47	17.26	7.34	
Past trauma				
No	159	8.96	7.24	<0.001
Yes	41	19.49	6.69	

Table 5. Results of T-test on the mean difference of education, depression and anxiety history of family members, grief and loss, and past trauma on depression

Independent Variables	Depression			
	N	Mean	SD	p
Education				
< High school	129	8.59	8.38	<0.001
≥ High school	71	3.68	3.64	
Depression and anxiety history of family members				
No	174	5.76	6.96	<0.001
Yes	26	14.15	6.45	
Grief and Loss				
No	153	5.29	6.49	<0.001
Yes	47	11.94	8.10	
Past Trauma				
No	159	5.38	6.14	<0.001
Yes	41	12.51	9.23	

C. The result of path analysis

Figure 1 presented the path analysis diagram on the determinants of neuropsychiatric disorders (anxiety and depression) affected by work stress, family history of depression and anxiety, grief and loss, and past trauma.

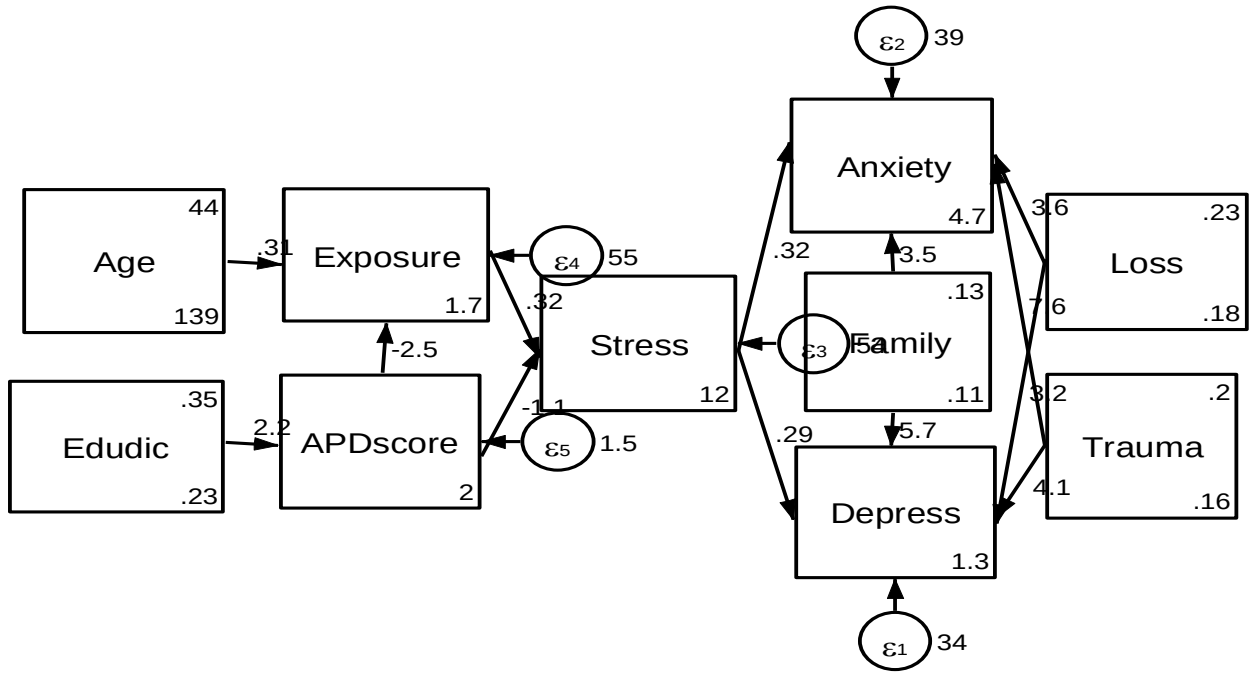

Figure 1. Path model

Table 6 showed results of the path analysis of the dependent and independent variables with log-likelihood score 4120.164.

Table 6 showed that depression was directly affected by family history of depression, grief and loss, and past trauma.

There is a direct effect of work stress on depression risk. The farmers experiencing the work stress had a risk probability (logodd) of suffering from depression 0.29 units higher than those who did not experience the work

stress (b= 0.29; 95% CI= 0.19 to 0.38; p< 0.001).

There is a direct effect of the depression and anxiety history of family members on depression risk. The farmers with depression and anxiety history in their family had a risk probability (logodd) of suffering from depression 5.71 units higher than those without depression and anxiety history in their family (b= 5.71; 95% CI= 3.16 to 8.26; p< 0.001).

Table 6. Results of path analysis of factors affected neuropsychiatric disorders

Dependent Variables	Independent Variables	Path Coefficient (b)	95% CI		p
			Lower Limit	Upper Limit	
Direct effects					
Depression	← Work stress	0.29	0.19	0.38	<0.001
	← Depression and anxiety history of family members	5.71	3.16	8.26	<0.001
	← Grief and loss	3.21	0.99	5.42	0.005
	← Past trauma	4.08	1.81	6.34	<0.001
Anxiety	← Work stress	0.32	0.22	0.42	<0.001
	← Depression and anxiety history of family members	3.53	0.82	6.24	0.011
	← Grief and loss	3.57	1.22	5.92	0.003
	← Past trauma	7.63	5.22	10.04	<0.001
Indirect effect					
Work stress	← Exposure to organophosphate pesticide	0.32	0.19	0.45	<0.001
	← Use of PPE	-1.12	-1.87	-0.36	0.004
Organophosphate pesticide exposure	← Use of PPE	-2.49	-3.18	-1.82	<0.001
	← Age	0.31	0.21	0.40	<0.001
Use of PPE	← The latest education	2.19	1.84	2.54	<0.001
N observation = 200					
Log likelihood = -4120.164					

There is a direct effect of the grief and loss on depression risk. The farmers who had and were experiencing grief and loss had a risk probability (logodd) of suffering from depression 3.21 units higher than those who never experienced grief and loss (b= 3.21; 95% CI= 0.99 to 5.42; p=0.005).

There was a direct effect of past trauma on depression risk. The farmers with past trauma had a risk probability (logodd) of suffering from depression 4.08 units higher than those who did not have past trauma (b= 4.08; 95% CI= 1.81 to 6.34; p< 0.001).

Table 6 showed that anxiety was directly affected by work stress, family history of depression and anxiety, grief and loss, and past trauma.

There is a direct effect of work stress on anxiety risk. The farmers experiencing work stress had a risk probability (loggod) of suffering anxiety 0.32 units higher than those who did not experience the work stress (b= 0.32; 95% CI= 0.22 to 0.42; p< 0.001).

There is a direct effect of the family members' depression and anxiety history toward anxiety risk. The farmers who had depression and anxiety history in their family had a risk probability (logodd) of suffering from anxiety 3.53 units higher than those without family depression and anxiety history (b= 3.53; 95% CI= 0.82 to 6.25; p= 0.011).

There is a direct effect of grief and loss on anxiety risk. The farmers who had and

were experiencing grief and loss had a risk probability of suffering from anxiety (logodd) 3.57 units higher than those who did not undergo grief and loss (b= 3.57; 95% CI= 1.22 to 5.92; p= 0.003).

There is a direct effect of past trauma toward anxiety risk. The farmers with past trauma had a risk probability of suffering from anxiety 7.63 units higher than those without the past trauma (b= 7.63; 95% CI= 5.22 to 10.04; p<0.001).

Exposure to organophosphate pesticides and the use of PPE were indirectly associated with depression and anxiety through work stress.

The use of the PPE and age were indirectly associated with depression and anxiety through exposure to organophosphate pesticide.

Education was indirectly associated with depression and anxiety through PPE.

DISCUSSION

1. Effects of Organophosphate Pesticide Exposure toward Neuropsychiatric Disorders

The study results indicated that the farmers exposed to the organophosphate pesticide had depression and anxiety level 0.32 units higher than those who were not exposed to the organophosphate pesticide (b= 0.32; 95% CI= 0.19 to 0.45; p< 0.001).

This result is in line with a study by Serrano et al. (2019) stating that chronic exposure to pesticides among agricultural workers decreased acetyl cholinesterase activities of red blood cells, which resulted in general neuropsychiatric disorders, anxiety, and high suicidal risk. This type of insecticide is absorbed into the body through the digestive tract, inhalation, and skin.

Another study by Harrison et al. (2016) reported that the farmers exposed to the pesticide had a risk of suffering anxiety 13.44 times than those who were not exposed to the pesticide after controlling covariate as the confounding factor (OR= 13.44; p= 0.002).

Lopez et al. (2019), who did an observation to a different subject, teenagers in the agricultural community, reported that high pesticide exposure (lower acetyl cholinesterase activities) had a risk (log odd) of suffering depression 1.09 units higher than the agricultural community with lower pesticide exposure (higher acetyl cholinesterase activities) (b=1.09; 95% CI= 0.02 to 2.16; p<0.05). The decreasing acetyl cholinesterase activities in the study of Santana et al. (2018) were deemed correlated to the duration and frequency of pesticide exposure.

Further, Koh et al. (2017) reported that the farmers with high pesticide exposure had a risk of suffering depression 2.33 times than those without such exposure (OR=2.33; 95% CI= 1.40 to 3.88; p<0.001). The farmers experiencing pesticide poisoning had a risk of suffering depression 5.83 times than those were not exposed to the substance (OR= 5.83; 95% CI= 1.80 to 18.86; p=0.004).

It may be concluded that high cumulative exposure to the pesticide which enters the farmers' body through breathing, skin, and digestion, may cause neuropsychiatric disorders, such as depression, anxiety, and suicide, through decreasing acetyl cholineesterase in the farmers' body, work stress, and history of pesticide poisoning.

2. Effects of the use of PPE toward Neuropsychiatric Disorders

The study found that the farmers wearing PPE had a risk probability (logodd) of suffering from depression and anxiety 1.12 units lower than those who did not use the PPE (b= -1.12; 95% CI= -1.19 to -0.36; p=0.004). The farmers who wore PPE had a risk probability of suffering from depression and anxiety 2.49 units lower than those who did not wear the PPE (b= -2.49; 95% CI= -3.18 to -1.81; p< 0.001).

The use of PPE is correlated with health issues, which means that the PPE is a risk factor for health problems (Joko et al., 2020). This is in line with the study by Suhaili et al. (2020) which reported that the subjects who wore the PPE when mixing or spraying pesticide had less exposure to the organophosphate pesticide compared to those who did not wear the PPE as a higher percentage of decreasing cholinesterase percentage was observed among the subjects who did not wear the PPE.

Daulay et al. (2020) reported a correlation between the use of personal protective equipment with pesticide poisoning among the sprayers (p= 0.002). The use of personal protective equipment also contributed to the toxicity among the sprayers of PT Langkat Nusantara Kepong Lama Gohor, 71.4% of farm workers who did not wear PPE had unhealthy cholinesterase level.

In summary, the farmers who do not wear PPE when mixing or spraying pesticides may experience neuropsychiatric disorders from pesticide exposure which causes a decrease of acetyl cholinesterase level, pesticide poisoning, and through work stress.

3. Effect of Work Stress on Neuropsychiatric Disorders

The study found that the farmers who experience work stress had a risk probability (log-odd) of suffering from depression 0.29 units higher than the farmers who did not experience work stress (b= 0.29; 95% CI= 0.19 to 0.38; p<0.001). The farmers who experienced work stress had a risk probability (logodd) of suffering from anxiety 0.32 units higher than those who did not undergo work stress (b= 0.32; 95% CI= 0.22 to 0.42; p< 0.001).

These study findings are in line with that of Sato et al. (2020) which identified a relationship between certain work environments and depression symptoms in both sexes. Among male farmers, the higher job demand is associated with depression symptoms. The male farmers with high job demand had a risk of suffering depression symptoms 2.16 times than those with low job demand (OR= 2.16; 95% CI= 1.17 to 4.00; p= 0.014). Lower job control is correlated with depression symptoms. The male farmers with lower job control had a risk of suffering depression 0.48 times than higher job control (OR= 0.48; 95% CI= 0.25 to 0.95; p= 0.034). Job demand and job control are work environment factors that increase the risk of psychological health issues (work stress). Physiological issues do not only cause bad health for the farmers but also consequences for agriculture sustainability.

Another study on urban migrant workers in China reported that employees with high work stress also experienced high depression symptoms. Work stress is a significant predictor for depression symptoms, the workers who experience work stress had a risk of suffering depression 1.23 times than those who did not experience work stress (OR=1.23; p<0.01) (Li *et al.*, 2019).

It can be concluded that work stress such as job demand, job control, workload, assignment, and education (work environment factors which may increase health issues) may elevate neuropsychiatric disorders—anxiety and depression. Work stress can increase psychological issues for farmers and such problems will impact on the sustainability of agricultural results.

4. Effect of Depression and Anxiety History of Family Members on Neuropsychiatric Disorders

This study showed that the farmers with depression history in their family had a risk probability (logodd) of suffering from depression 5.71 units higher than those without depression and anxiety history in their family (b= 5.71; 95% CI= 3.16 to 8.26; p< 0.001). The farmers with anxiety history in their family had a risk probability (logodd) of suffering from anxiety 3.53 units higher than those

without depression and anxiety history in their family (b= 3.53; 95% CI= 0.82 to 6.25; p= 0.011).

Kelly et al. (2017) reported a correlation between the history of the family experiencing anxiety and depression symptoms and general anxiety disorders. Someone whose family had a history of anxiety and depression had a risk probability of suffering from general anxiety 1.13 times than a person whose family did not have history of depression and anxiety (OR= 1.13; 95% CI= 0.74 to 1.72).

It was in line with the study Benatti et al. (2016) which reported that a higher prevalence of positive family history had a significant relationship with psychiatric diseases among the general anxiety patients (p <0.05). In another study on depression, family history has a positive correlation with depression. When the number of family members with depression history is bigger, the risk of someone experiencing depression is higher (r=0.19; p< 0.001) (Vornanen et al., 2016).

It can be concluded that the history of neuropsychiatric disorders in the family is correlated to neuropsychiatric disorders (depression and anxiety).

Yet, having a genetic tendency to such disorders does not make someone suffer the problems directly. This finding only shows that the person is more susceptible to depression than someone who does not depression genetics.

5. Effect of Grief and Loss on Neuropsychiatric Disorders

The study found that the farmers who had ever been and were in grief and loss had a risk probability (logodd) of suffering from depression 3.21 units higher than those who never experienced grief and loss (b= 3.21; 95% CI= 0.99 to 5.42; p= 0.005). The farmers who had ever been and were in grief and loss had a risk probability (logodd) of suffering from anxiety 3.57 units higher than the farmers who never experienced grief and loss (b= 3.57; 95% CI= 1.22 to 5.92; p= 0.003).

The study is in line with that of Nielsen et al. (2017) which reported a correlation between after a loss and depression symptoms. Someone who had a history of a loss had a risk probability of suffering from depression 10.7 times than those who never experienced a loss (OR= 10.7; 95% CI= 7.3 to 15.8).

Bellini et al. (2018) studied the mental health of an individual who was in grief or had a loss. The study found that the individual who was in grief and loss had a significant correlation with suicide. Based on the research, the more severe the sadness was, the person had higher depression risk (r=0.53; p<0.01).

A study by Wahyuningsih et al. (2019) showed that there was a statistically significant effect of loneliness on the depression among elders. Lonely elders were apt to suffer depression than those who were not lonely. There was a statistically significant effect of loneliness on depression among the elders. The lonely elders were 7.14 times more likely to suffer depression than those who were not lonely (OR=7.14; 95% CI= 1.62 to 31.41; p= 0.009).

In summary, grief and loss are correlated to neuropsychiatric disorders (depression and anxiety). The grief and loss include sudden death, conflicting relationship, witnessing the death of the loved ones, receiving family and social supports, and loneliness.

6. Effect of Post-Trauma on Neuropsychiatric Disorders

The study showed that the farmers with past trauma had a risk probability (logodd) of suffering from depression 4.08 units higher than those without the past trauma (b= 4.08; 95% CI= 1.81 to 6.34; p<0.001). The farmers with post-trauma had a risk probability of

suffering from anxiety 7.63 units higher than those without the past trauma (b= 7.63; 95% CI= 5.22 to 10.04; p<0.001).

The study was in line with Hopfinger et al. (2016), which found that past trauma (during childhood) predicted depression severity significantly. Someone who had trauma (during their childhood) had a risk probability (logodd) of suffering from depression 0.08 units higher than those without childhood trauma (b=0.08; p<0.001).

Finding of a study by Thabet et al. (2016) reported that the most common traumatic war-related incidence among children in 2009 was hearing artillery shelling, hearing sonic sound from jetfighters, watching mutilated bodies on TV, and hearing shooting and bombing.

Total traumatic incidences are significantly correlated to the score of post-traumatic depression, avoidance, symptoms of arousal, anxiety, and depression. Traumatic incidences are significantly correlated to anxiety. The more traumatic an incidence is, the anxiety risk is higher (r=0.36; p=0.01).

Gamache et al. (2016) also reported that youths with trauma and physically emotional assault profile had a risk of suffering from severe depression 2.92 times than those who did not have trauma and physically emotional assault profile (OR=2.92; 95% CI= 1.16 to 7.32; p<0.05). The youths with trauma and physically emotional assault profile had a risk of suffering traumatic stress 4.33 times than those who did not have trauma and physically emotional assault profile (OR=4.33; 95% CI= 1.34 to 14.03; p<0.05).

It can be concluded that post-trauma is correlated to neuropsychiatric disorders (depression and anxiety). The trauma includes childhood trauma, physically emotional assault profile, trauma from the war such as hearing artillery shelling, hearing sonic sound from jetfighters, watching mutilated bodies on TV, and hearing shooting and bombing, and unfulfilled basic needs, which include security, parenting, and stability.

7. Effect of Age on Neuropsychiatric Disorders

The study showed that old farmers aged >44 years old had a risk probability (logodd) of suffering from depression and anxiety 0.31 unit higher than the young farmers aged ≤ 44 years old (b=0.31; 95% CI= 0.21 to 0.40; p <0.001).

Gardner *et al.* (2019) reported that age had an effect on depression symptoms among 334 teenagers aged 10 to 18 years old studying in high schools (from grade 6 to 13) in Jamaica (p<0.05; b=0.08).

In another study with two study cohorts in the U.S, most of the risk factors are significantly associated with depression in all ages; especially for five risk factors, the strength of association depends on age. A strong association of younger age with depression was found in child assault, pain, higher body mass index (BMI), and several chronic diseases. The strong association of older age with depression was found in lower-income (Schaakxs et al., 2017).

It can be concluded that age is correlated to neuropsychiatric disorders (depression and anxiety) through organophosphate pesticide exposure. It means that the older the people are, the risk of being exposed to the organophosphate pesticide is higher and the individuals with higher exposure also have an increasing risk of depression. For children, this kind of association is strengthened with childhood trauma or assault, body mass index, and chronic diseases. For adults, the association is worsened with a marriage issue (lower income).

8. Effect of Education on Neuropsychiatric Disorders

The study showed that the farmers whose latest education was ≥high school had risk probability (logodd) of suffering from depression and anxiety 2.19 units higher than

those who graduated from <high school (b= 2.19; CI 95%= 1.84 until 2.54; p<0.001).

Rasyiid et al. (2016) found that the education level of ≥last year of high school affected the decreasing depression among people living with AIDS and such effect was statistically significant. Depression of the people living with AIDS, whose education level was ≥middle year of high school, was 7.86 units lower than those studied until <Senior high school (b=-7.86; 95% CI= -14.05 to 1.67; p=0.014).

The results of a study by Shinta *et al.* (2019) also indicated the indirect effects of education level at ≥high school on depression. Lower education is a risk factor for emotional issues in anxiety and gives pressure on ions among cancer patients.

Another study also found that depression symptoms among elders were indirectly affected by education and job through work, supports from family and colleagues (Tunurrohmin et al., 2018).

It can be concluded that education affects neuropsychiatric disorders (depression and anxiety) through the use of PPE. Individuals with higher education are more knowledgeable on the use of PPE and they try to follow the procedure as they understand the danger compared to those with lower education. This practice is also affected by other factors such as job types, supports from family and colleague for neuropsychiatric disorders (depression and anxiety).

AUTHOR CONTRIBUTION

Ayu Laela Fitriyani is the lead researcher. She implemented the study, collected data, processed data, and prepared the final study report. Bhisma Murti formulated the theoretical framework and analyzed the research data. Setyo Sri Rahardjo formulated the study background and research discussion.

CONFLICT OF INTEREST

There is no conflict of interest in the study.

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