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Original Research Article

Predictive Model of Lung Function Disorders in Pesticide-Using Vegetable Farmers in Kanreapia Village, Gowa Regency, Indonesia

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ABSTRACT

The use of pesticides by spraying can cause health problems such as pesticide poisoning, respiratory system problems which can affect lung capacity and can cause death if help is not given immediately. This study aims to determine the factors that influence lung capacity disorders in pesticide-using vegetable farmers in Kanreapia Village, Gowa Regency, Indonesia. The type of research used is quantitative with an analytical approach and uses a cross sectional study design. The population in this study was 216 farmers so that the sample size in this study was 83 farmers. The instruments used in this research were questionnaires and spirometry. The results of this study show that there is a relationship between spraying method p-value 0.003 and lung capacity, while age p-value 0.484, working duration p-value 0.117, working period p-value 0.959 and use of personal protective equipment p-value 0.367 have an insignificant relationship with lung capacity. Working period is the variable that has the greatest influence on lung capacity. It is recommended that farmer group leaders directly monitor work in the field regarding pesticide spraying carried out by farmer group members which could endanger them due to the risk of exposure to pesticides.

Keywords: Farmer; Lung Capacity; Occupational Health and Safety; Pesticide

INTRODUCTION

Agriculture is one of the jobs in the informal sector that is most often carried out as a source of livelihood to support the lives of people in Indonesia. However, the behavior of industrial workers is still far from good regarding risk management and optimal management. Every job carried out by both the worker and the place of work always has potential risks and dangers that can threaten the safety of the worker (Akbar, 2019). According to (Ratanachina et al., 2020), explained that there are two million tons of pesticides used in the agricultural sector, where there is a relationship between exposure to pesticides and respiratory diseases. In the field of epidemiology, it is explained that respiratory symptoms in farmers have a high frequency, one of which is the symptom of chronic bronchitis which has a high frequency for farmers compared to non-farmers (Danuser et al., 2020).

Agricultural workers have the highest risk for pesticide exposure in the processes of transporting, mixing, loading and spraying pesticides. Many farmers are not aware of the risks that arise due to the use of pesticides. When spraying pesticides, not paying attention to the wind

direction will have an impact on farmers' health (Erwin et al., 2019). Acute poisoning or long-term health effects including cancer and adverse effects on reproduction occur when exposed to large amounts of pesticides (WHO, 2018). Factors that influence high exposure to pesticides in agricultural workers are lack of awareness of the use of personal protective equipment, knowledge, direction of pesticide spraying, and safety measures against the potential risk of pesticide exposure to farmers (Thetkathuek et al., 2020).

According to the World Health Organization (WHO) quoted by Inten et al., (2022), that there are 1-5 million cases of pesticide poisoning in the agricultural sector work environment, most of which occur in developing countries. According to the ILO (International Labour Organization) quoted by Rafi'ah et al., (2022), that there are 160 million workers affected by occupational diseases. More than 270 million people experience work accidents, 2 million workers die every year due to work-related diseases, one of which is workers who have respiratory problems, work-related poisoning, skin diseases and infections. Pesticide poisoning in the workplace is a major health problem among agricultural workers. According to Lamichhane et al., (2019), that every year developing regions in Asia experience mild pesticide poisoning, developing countries in Asia use 20% of pesticides in the agricultural sector.

According to data from the national poisoning information center in 2016, there were 771 cases of pesticide poisoning in Indonesia. In South Sulawesi, the average vital lung capacity among farmers is 120.92 L/BTPS. According to data Basic Health Research (2019), South Sulawesi is ranked 7th with the most asthma cases with 33,693 cases. Furthermore, the prevalence of Acute Respiratory Infections (ARI) among farmers was found to be 133,261 cases. Then, the prevalence of pulmonary tuberculosis among farmers was found to be 133,261 cases (Juliandi and Abdurrahman, 2018).

The Tamaona Community Health Center, which is located in Tombolo Pao District, reported the 10 biggest diseases in 2022, where ISPA is in second place out of the top 10 diseases (Gowa Health Office, 2022). Based on research by Mahawati, 2022, it was found that the results of a survey of all respondents showed that 12% had lung function restrictions, 32% had lung function obstruction, and 56% had normal lung function. Work period, hours of spraying pesticides per day, spraying against the wind, changing clothes when exposed to pesticides, bathing directly when exposed to pesticides with "farmer's lung function" based on the results of statistical tests have an influence on the results of the survey conducted on all respondents.

Exposure to pesticides can result in impaired lung function for workers exposed to them at work (Hansen et al., 2021). According to by Habibi et al., (2022), explained that pesticide poisoning is a health problem related to the agricultural environment, pesticide poisoning, especially in horticultural agriculture producing garden crops. Gowa Regency, especially in Kanreapia Village, farmers grow various crops (horticulture). Lung capacity can be measured using a spirometry tool (Ratanachina et al., 2023).

Based on this background, the aim of this research is to determine lung capacity disorders in pesticide-using vegetable farmers in Kanreapia Village, Gowa Regency, Indonesia.

METHOD

In this research, quantitative analysis is used with an analytical approach and uses cross-sectional design. This research was conducted in Kanreapia Village, Tombolo Pao District, Gowa Regency in May 2023. The population in this study was as large as 216 farmers. The sampling technique used in this research used purposive sampling.

The sampling criteria included:

Inclusion criteria:

1. Farmers residing in Kanreapia Village

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2. Actively using pesticides

Exclusion criteria:

1. Farmers who were sick
2. Unwilling to participate

The sample size for this study was determined using the Slovin formula, resulting in a total of 131 respondents. However, only 83 respondents met the inclusion and exclusion criteria, resulting in a total sample size of 83.

The instruments used in this research were questionnaires and spirometry. Primary data used in this research was collected based on observation methods, interviews with questionnaires, and measurements using a spirometry measuring instrument. Then the data obtained in this research was managed using the SPSS application. Meanwhile, secondary data in this research was obtained from books, research journals, and profile data obtained from farmers in Kanreapia Village, Gowa Regency, Indonesia.

Questionnaire sheet to determine lung capacity in farmers, namely age, working duration, working period, spray method, and use of personal protective equipment. Meanwhile, the characteristic data in this study consists of two questions, namely name, initials and level of education. Meanwhile, spirometry is used to measure lung capacity in farmers. In this research, the data obtained is presented in the form of mean (standard deviation) or frequency (percent). Analysis T test was used to compare the average lung function with the variables in this study. Spearman correlation analysis was used to determine the relationship between lung capacity and study variables. Next, multiple regression was used to confirm predictors of lung capacity. Then statistical analysis is processed using SPSS tools.

RESULTS AND DISCUSSION

Farmers are a group that is vulnerable to exposure to pesticides. This research aims to determine the factors that influence lung capacity disorders in vegetable farmers who use pesticides. Respondents consisted of 83 farmers who worked as pesticide sprayers.

Tabel 1. Distribution of Respondents Based on Age, Working Duration, and Working Period among Vegetable Farmers Using Pesticides in Indonesia

Variables	Mean	Median	Standard Deviation	Min-Max
Age	39.84	39.00	12,637	20-73
Working Duration	7.42	8.00	1,398	3-8
Working Period	21.57	20.00	13,111	5-60
Lung Capacity	44.94	39.86	20.54603	11.52-100

The study results showed that the average age of farmers was 39.84 years, with an age range of 20 to 73. This average age indicates that most respondents were in the productive adult age group, who generally still have sufficient physical capacity to perform heavy field work. However, the involvement of older farmers, up to 73 years of age, suggests that pesticide spraying activities are also carried out by individuals with physiological conditions that indicate decreased metabolic function, respiratory capacity, and immune system function. Recent studies have shown that older workers are more susceptible to certain toxicities due to decreased respiratory function and the body's reduced detoxification ability (Shekhar et al., 2024). This suggests that exposure in older age groups may pose greater health risks than in younger age groups.

The average daily workday of 7.42 hours for farmers indicates that most respondents worked beyond the recommended safe limit for workers exposed to pesticides, which is no more than 5 hours per day, according to occupational health guidelines. Long working hours increase

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the intensity of exposure through inhalation and skin contact. Recent research reports that longer spraying durations are significantly associated with respiratory distress, increased respiratory complaints, and a higher risk of lung function decline due to accumulated pesticide exposure (Mahawati et al., 2022). The 3–8-hour work periods found in this study indicate that a large proportion of farmers are potentially experiencing chronic daily exposure, which can damage their lung health over the long term.

The average tenure of farmers was 21.57 years, with a range of 5 to 60 years. This long tenure indicates that farmers are exposed to pesticides for many years, allowing the accumulation of toxic substances in the body. Recent literature indicates that long-term pesticide exposure is a major contributing factor to obstructive pulmonary disease, decreased lung capacity, and the risk of other chronic respiratory diseases (Lee et al., 2022). The longer a person works in an environment containing hazardous chemicals, the higher the risk of lung tissue damage and impaired respiratory function due to chronic inflammation and repeated exposure (Armend et al., 2024).

The results of the lung capacity examination showed an average of 44.94%, far below the normal value (≥80%). This indicates that most farmers experienced a significant decrease in lung capacity. The range of lung capacity between 11.52 and 100% indicates a large variation in the respiratory health of farmers, including individuals with severe lung disorders. Recent research has shown that pesticide exposure can cause airway inflammation, chronic irritation, and airway obstruction, which contribute to decreased FEV_1, FVC, and other lung function impairments (Mahawati et al., 2022; Veeraiyan et al., 2024). These findings are consistent with general patterns in studies of specific exposures on respiratory health, which show a significant association between exposure intensity and decreased lung function.

Table 2. Distribution of Respondents Based on Spraying Method and use of personal protective equipment among Vegetable Farmers Using Pesticides in Indonesia

Variables	n	Percentage (%)
Age		
Teenage Age (12-25 Years)	12	14.5
Adult Age (26-45 Years)	45	54.2
Elderly Age (46-65 Years)	26	31.3
Lung Capacity		
Abnormal	73	88.0
Normal	10	12.0
Working Duration		
>5 Hours/Day	13	15.7
≤5 Hours/Day	70	84.3
Working Period		
Old (>5 Years)	75	90.4
New (≤5 Years)	8	15.7
Spray Method		
Not eligible	40	48.2
Qualify	43	51.8
use of personal protective equipment		
Not eligible	43	51.8
Qualify	40	48.2

The data shows that the study respondents had quite diverse characteristics. In terms of

age, 54.2% were in the adult age group (26–45 years). This group is considered of productive age and generally still has sufficient physical capacity to perform pesticide spraying tasks that require strength and stamina. However, 31.3% of respondents were in the elderly age group (46–65 years). The presence of this age group indicates that pesticide spraying is still carried out by individuals whose physiological abilities have declined, increasing their vulnerability to the toxic effects of pesticides. Meanwhile, 14.5% of respondents were adolescents (12–25 years), indicating that pesticide exposure begins at an early age, potentially leading to long-term health impacts (Shekhar et al., 2024).

Regarding lung capacity, 88% of farmers were found to have abnormal lung capacity. This finding indicates that the majority of farmers experience reduced respiratory function, likely related to long-term or high-intensity pesticide exposure. Only 12% of farmers demonstrated normal lung capacity, confirming the significant respiratory impacts for most respondents.

Daily work duration data shows that 84.3% of farmers work ≤5 hours per day, meaning most are within the recommended working hours for workers exposed to pesticides. However, 15.7% work more than 5 hours per day, indicating a group of farmers exposed to pesticides for longer periods. Working hours exceeding safe limits increase the risk of acute poisoning and chronic health problems due to continued exposure (Mahawati et al., 2022).

Regarding the length of service variable, 90.4% of respondents have worked as pesticide sprayers for more than 5 years. This indicates that most farmers have experienced long-term chronic exposure. Years of exposure increase the accumulation of toxins in the body and result in a higher risk of health problems, particularly those affecting lung function and the nervous system. Only 9.6% of farmers were relatively new to the industry (≤5 years) (Armend et al., 2024).

Pesticide spraying methods were also a concern. 48.2% of respondents still used spraying methods that did not meet safety criteria. This indicates that nearly half of farmers do not practice safe spraying techniques, increasing the risk of direct exposure to workers. Meanwhile, 51.8% used adequate methods, but this proportion was relatively balanced, resulting in widespread unsafe spraying practices.

The use of personal protective equipment (PPE) showed a similar pattern. 51.8% of farmers did not meet the criteria for proper PPE use. This means more than half of respondents worked without adequate protection, such as masks, gloves, or protective clothing. This directly increases the risk of pesticide exposure through inhalation or skin contact. Only 48.2% used PPE according to standards (Table 2).

Table 3. Relationship Between Age, Working Duration, and Working Period and Lung Capacity in Pesticide Using Vegetable Farmers in Indonesia

Variables	N	P-Value
Age	83	0.484
Working Duration	83	0.117
Working Period	83	0.959

The results of bivariate analysis with correlation obtained p-values for the variables working duration (p=0.117), working period (p=0.959), and age (p=0.484) with the farmer's lung capacity. This indicates that these three variables do not have a significant relationship with lung capacity. However, there is 1 variable, namely working duration, with a p-value <0.25. Thus, these three variables can continue to enter multivariate modeling. Meanwhile, the variables of work experience and age have a p-value > 0.25 so they cannot be entered into multivariate. However, because substantially work experience and age are very important factors influencing farmers' lung capacity, these variables were still included in the multivariate analysis (Table 3).

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The relationship between age and lung capacity in vegetable farmers who use pesticides

In this study, the results obtained from the crosstab test were carried out using the Spearman correlation test, obtained p-value =0.484 (> 0.05) on age on the lung capacity of farmers using pesticides. It was found that there was no significant relationship between lung capacity and age in pesticide-using vegetable farmers in Kanreapia Village, Gowa Regency, Indonesia.

Age is the length of time a person has lived, starting from birth until now (Sembiring et al., 2019). The age referred to in this research is the age of farmers from birth until this research was carried out. The ages of the farmers in this study varied from teenagers, adults and the elderly. The physiological anatomy of human organs will worsen after a person reaches the age of 30, this can cause a decrease in lung function (Novianto, 2019). The physiological function of human organs can be influenced by increasing a person's age. As a person ages, the physiology of the body's organs decreases (Prastiwi & Darnoto, 2017).

This research is in line with research conducted by Sulan et al., (2020), that it is known from the results of the analysis of the relationship test with the Chi-Square test that the results were 0.056 > 0.05. Therefore, it was found that there was no relationship between age and lung capacity in workers in the Tampung Cinae stone carving industry, Tanete Riaja District, Barru Regency. Other research also confirms that there is no relationship between age and lung capacity with a p-value of 0.324 (Zahra et al., 2020).

This research is inversely proportional to the previous study by Prastiwi and Darnoto (2017), that the crosstab results using the Fisher's Exact test, obtained p-value = 0.006 < 0.05. In order to ho is rejected, thus it can be seen that there is a relationship between age and lung function capacity in the Surakarta Supeltas.

In this study there was no relationship that was in accordance with the statement put forward by Prastiwi and Darnoto (2017), because in this study it was found that adult age dominated the age of farmers spraying pesticides. This is because the livelihood of the people in Kanreapia Village is predominantly as farmers, thus people start working as farmers from when they are teenagers until they are elderly. Parents start encouraging their children to garden when they are young, thus when they graduate from school many people do not continue their education, but instead immediately work as farmers following in their parents' footsteps.

Relationship between working duration and lung capacity in vegetable farmers who use pesticides

In this study, the results obtained from the crosstab test were carried out using the Spearman correlation test, obtained p-value = 0.117 (> 0.05) on the length of working duration on the lung capacity of farmers using pesticides. It can be seen that there is no significant relationship between lung capacity and working duration among pesticide-using vegetable farmers in Kanreapia Village, Gowa Regency, Indonesia.

Pesticide poisoning that occurs is caused by the intensity of pesticide exposure that occurs in farmers and over a long period of time. The length of time a farmer sprays pesticides in a day can provide an idea of the intensity of exposure to pesticides. The longer a farmer is exposed to pesticides, the more pesticides enter his body. When spraying, it should not last longer than 5 hours because if it exceeds the specified limit, the risk of farmers experiencing poisoning due to exposure to pesticides will be greater (Darmiati, 2020).

This research is in line with the findings of research conducted on farmers' working duration by Habibi et al., (2022), using the Chi-Square test on farmers in Kanreapia Village, Tombolo Pao District, Gowa Regency. Where in this research it was found that the working duration of farmers was not related to pesticide poisoning.

In contrast to the previous study by Istianah and Yuniastuti (2018), that was obtained from the

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results of statistical analysis using the Chi-Square test with a p-value = 0.044 (< 0.05). These results show that there is a significant relationship between the duration of each spraying and the incidence of poisoning. Other studies also confirm that there is a relationship between working duration and lung capacity (Novziransyah et al., 2022).

In this study it was discovered that there was no significant relationship between work duration and lung capacity. This happens because the agricultural activities carried out by farmers do not continue to spray for 5 hours/day. Most farmers provide a place to rest in the garden, thus when they feel tired, farmers immediately rest in the garden house they have prepared or usually farmers rest under a large tree. Therefore, farmers are not always exposed to pesticides because their time in the garden is also used for rest. Usually, farmers start leaving for the plantation at 06.00 am and if the farmers do not bring food, they will return home at 11.00 am. Farmers will return to the plantation from 13.00 pm to 17.00 pm.

The relationship between working period and lung capacity in vegetable farmers who use pesticides

In this study, the results of the crosstab test carried out using the Spearman correlation test were obtained, p-value = 0.959 (> 0.05) during the working period on the lung capacity of farmers using pesticides. It was found that there was no relationship between working period and lung capacity in farmers pesticide-using vegetables in Kanreapia Village, Gowa Regency, Indonesia.

The period of work as a farmer can have an impact according to the time spent as a farmer. Where, the longer the working period of a farmer can cause lung function disorders. The work period referred to in this research is the length of time farmers have worked as farmers until the time the research was conducted. The results of this research are supported by Suma'mur's theory, the longer a person spends at work, the greater their exposure to the dangers posed by the work environment (Fahmi, 2012). This research is in line with the previous study by Tamuntuan et al., (2019), based on the results of the chi-square test with p-value = > 0.05, it was found that there was no significant relationship between work experience and lung capacity.

However, this is inversely proportional to research conducted by Istianah and Yuniastuti (2018), that from the results of statistical analysis using the Chi-Square test (p-value = 0.049) it was found that there was a relationship between the period of work as a spray farmer and the incidence of poisoning in farmers. This observation is also inversely proportional to research conducted in Medan Denai District which stated that based on the results of statistical tests it was found that there was a relationship between work experience and lung capacity (Novziransyah et al., 2022). Meanwhile, in this research, looking at the condition of farmers in Kanreapia Village, the majority of farmers did not spray pesticides from the start of becoming farmers but instead employed other people or were assisted by their families, thus farmers were not always exposed to pesticides.

Table 4. The Relationship Between Spray Method and use of personal protective equipment and Lung Capacity in Vegetable Farmers Using Pesticides in Indonesia

Variable	n	Mean±SD	P
Spray Method			
Qualify	43	51.3805±22.49835	0.003
Not eligible	40	38.0288±15.73822	
use of personal protective equipment			
Qualify	40	470702±23.27231	0.367
Not eligible	43	42.9698±17.68962	

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The results of the analysis of the relationship between spray methods and farmers' lung capacity in Kanreapia Village produced a p-value of 0.003, therefore there is a significant relationship between spraying methods and farmers' lung capacity. Meanwhile, the variable use of personal protective equipment or masks has a p-value of 0.367, which means there is an insignificant relationship between the use of personal protective equipment and lung capacity in farmers. From these results it can be concluded that the spraying method variable has a p-value <0.25, thus this variable can continue to enter multivariate modeling. Meanwhile, the PPE use variable was still included in the multivariate model because it was considered substantially related (Table 4).

Relationship between spray methods and lung capacity in vegetable farmers who use pesticides

In this study, the results were obtained from the crosstab test which was carried out using the Spearman correlation test, the p-value = 0.003 (< 0.05) on the spraying method on the lung capacity of farmers using pesticides. It was found that there was a significant relationship between lung capacity and spraying method among pesticide-using vegetable farmers in Kanreapia Village, Gowa Regency, Indonesia.

Spraying methods that match the wind direction can reduce pesticide exposure to farmers' bodies. Likewise, if you spray pesticides in the opposite direction of the wind, it will have a high impact of pesticide exposure on the farmer's body. Because pesticides that are sprayed against the wind will be blown back by the wind onto the farmer's body, thus the farmer is accidentally exposed to the pesticide. Pesticide spraying techniques that are not in accordance with those recommended can cause pesticides to enter a person's body, pesticides that enter the body will have an impact on human health (Mawaddah et al., 2022).

This research is in line with research conducted by Mahawati et al., (2017), that from the results of the ordinal regression test, a p-value of 0.000 was obtained, which means there is a relationship between the direction of spraying and the degree of chronic obstructive pulmonary disease (COPD).

In the research carried out, it was found that the research carried out was in line with Mawaddah's statement (2022), where there was a relationship between spraying method and lung capacity. This happens because in this research it was found that most farmers spray according to the condition of the plantation land they own, thus the spraying method used by farmers is uncertain. Farmers who spray according to the garden area and do not pay attention to the wind direction can endanger farmers. This is because pesticides that are sprayed in the opposite direction can hit farmers' bodies so that farmers can experience poisoning and problems with lung function due to exposure to the pesticides used when spraying. In this research, 43 farmers were found who sprayed according to the wind direction, consisting of 19 people who used masks and 24 people who did not use masks. Meanwhile, there were 40 farmers who sprayed against the wind, consisting of 21 farmers who used masks and 19 farmers who did not use masks. Researchers assume that this occurs due to farmers' lack of awareness regarding the use of masks when spraying pesticides. According to direct observations made by researchers, farmers said they experienced breathing problems when using masks. This is in line with the previous study by Zaenab et al., (2022), where farmers said that using masks was troublesome when spraying pesticides on shallots in Tampo Village, Anggeraja District, Enrekang Regency.

The relationship between use of personal protective equipment and lung capacity in vegetable farmers who use pesticides

In this study, the results were obtained from the crosstab test which was carried out using the Spearman correlation test, the p-value =0.367 (< 0.05) on the use of personal protective equipment on the lung capacity of farmers using pesticides. It was found that there was no

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relationship between lung capacity and the use of personal protective equipment among vegetable farmers using pesticides in Kanreapia Village, Gowa Regency, Indonesia.

Exposure to pesticides can be anticipated by using personal protective equipment, this is recommended by WHO and ILO (Tarmure et al., 2020). The personal protective equipment used cannot protect perfectly from exposure to disease, but the use of personal protective equipment can reduce the risk of severity that may occur to a person (Anugrah, 2014). Therefore, masks are very important for farmers to protect farmers' health from exposure to pesticides from the work environment and to maintain normal lung capacity and not be contaminated by exposure to pesticides due to spraying.

This research is in line with the previous study by Oviera and Jayanti (2016), The percentage of workers who have abnormal lung function capacity is more common among workers who do not wear masks, namely 60%. The results of the Chi-Square contingency correlation test obtained a significant value (p-value) of 0.097. This value is greater than 0.05, therefore, it can be concluded that there is no relationship between wearing masks and vital lung capacity in wood processing industry workers at PT. X, Jepara. This research is also in line with research conducted at PT. Semen Tonasa Unit Packing Plant Lapuka where it was found that there was no relationship between the use of personal protective equipment and lung capacity (Alam et al., 2019). Meanwhile, this study contradicts research conducted in Medan Denai District which stated that there was a relationship between the use of personal protective equipment and lung capacity (Novziransyah et al., 2022).

In the research conducted, it was found that the use of personal protective equipment when spraying pesticides was almost equal between farmers who used masks and farmers who did not use masks. Farmers who do not use masks when spraying pesticides think that if they wear a mask, they will feel short of breath, thus they prefer not to use a mask when spraying pesticides.

Table 5. Multivariate Linear Regression Models for Determining Factors Predicted the Lung Capacity

Variable	B	S.E	B	P	VIF	R2
(Constant)	85.975	13.349		0.000		0.145
Age	-0.452	0.348	-0.278	0.198	4.186	
Duration Period	0.285	0.338	0.182	0.400	4.233	
Spray Method	-13.815	4.323	-0.338	0.002	1.021	
use of personal protective equipment	-5.733	4.362	-0.140	0.193	1.039	

Based on the results of the multivariate test, it is known that there is one independent variable that must be excluded, namely working duration because it does not meet the requirements for multivariate analysis. It is known that this final model can explain 14.5% of the variation in lung capacity variables. In other words, the variables of age, working period, spray method, and use of personal protective equipment can explain variations in lung capacity variables of 14.5%. Based on the independence assumption from the test results, the Durbin Waston coefficient is 2.226, which means the independence assumption is met. Based on the linearity assumption of the output results, an anova test obtained 0.015, which means the linearity assumption is met. Based on the existence assumption, the output shows a residual figure with a mean of 0.000 and a standard deviation of 18.9, thus, the existence assumption is met. Based on the normality assumption from the histogram graph and normal PP plot graph, it is proven that the

shape of the distribution is normal, which means the normality assumption is met. Then, based on the homoscedascity assumption from the plot results, it can be seen that the distribution of points has the same pattern between the points above and below the 0 diagonal line, which means the homoscedascity assumption is met.

The p-value of this multivariate analysis is 0.015, which means that at an alpha value of 5%, it can be said that the regression model fits the existing data or that the variables age, work period, spraying method and use of personal protective equipment are significantly related to the lung capacity of farmers in Kanreapia Village (Table 5).

The results of the regression equation from this model are:

Lung Capacity = 85,975 – 0.452 Age + 0.285 Working Period – 13,815 Spray Method – 5,733 Use of Personal Protective Equipment

With the equation model above, it is known that:

1. The younger the farmer (1 year younger), the farmer's lung capacity will decrease by 0.452% after controlling for the variables of work period, spraying method, and use of personal protective equipment.
2. For every additional 1 year of work, the farmer's lung capacity will increase by 0.285% after controlling for the variables of age, spraying method and use of personal protective equipment.
3. Farmers whose spraying method does not match the direction of the wind will reduce the farmer's lung capacity by 13,815% after controlling for the variables of age, working duration and use of personal protective equipment.
4. Farmers who do not wear masks when working are at risk of decreasing lung function by 5.77% after controlling for variables such as age, working duration and spraying method.
5. The variable that has the greatest influence on farmers' lung capacity is spraying method.

CONCLUSION

This study shows that farmers spraying pesticides work in conditions that put them at high health risk. Pesticide exposure affects all age groups, including those with more physiological susceptibility, and has resulted in reduced lung capacity for many farmers. Factors such as long working days, long working hours, substandard spraying techniques, and suboptimal use of PPE increase the risk of exposure and long-term health impacts. These findings have important relevance for society, as farmer health directly impacts the sustainability of food production and the well-being of farming communities. Protecting farmers means maintaining food security, agricultural quality, and environmental health. Therefore, improving education, safer work practices, and supporting occupational health policies for farmers need to be a shared concern for all levels of society.

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