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ORIGINAL ARTICLE

Association Between Personal Hygiene Practices and Peripheral Blood Profiles in Agrarian Workers: An Analysis with Socio-demographic and Helminthiasis Considerations

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ABSTRACT

Introduction: Helminthiasis remains a significant public health issue in Indonesia, negatively impacting nutrition and cognitive development, particularly among individuals who are in direct contact with soil. To mitigate this issue, improving personal hygiene and awareness of infection prevention is essential. This study aims to examine the correlation between sociodemographic factors and personal hygiene with blood profiles among workers in agrarian areas. **Methods:** A cross-sectional approach was used, with 144 samples collected through purposive sampling in the agrarian area of Malang Regency. Data were gathered using questionnaires covering sociodemographic factors and personal hygiene, as well as through hematology tests results obtained from blood samples taken from respondents, which were tested at the dr. Saiful Anwar Malang General Hospital. For data analysis, the Chi-square test was utilized for bivariate analysis, while logistic regression was employed for multivariate analysis. **Results:** The mean age of respondents was 48.1 ± 14.1 years, with a majority having attained only an elementary education (51.4%) and primarily working as farmers (66.7%). Approximately 38.2% of respondents demonstrated poor personal hygiene. Significant associations were found between personal hygiene and hemoglobin levels (p=0.031), as well as eosinophil counts (p=0.007). Multivariate analysis showed that respondents who did not wash their hands before eating had 1.8 times higher odds of having abnormal blood profiles compared to those who practiced handwashing. **Conclusion:** The results of this study suggest that sociodemographic factors and personal hygiene are associated with the quality of blood profile among respondents. Enhanced education is needed to raise community awareness regarding personal hygiene.

Keywords: blood profile, farmers, personal hygiene, sociodemographic factors

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INTRODUCTION

Helminth infections remain a major health challenge, especially in tropical regions, such as Indonesia. The geographical conditions, temperature, and humidity in Indonesia are conducive to the habitat and proliferation of worms. Most helminth infections are asymptomatic and only become noticeable when the infection reaches a severe level (Idris, Wintola and Afolayan, 2019). This is what makes worm disease included in neglected or insufficient attention (Nath *et al.*, 2022). Helminthiasis is caused by worm infections, which can cause nutrient deficiencies, anemia, and decreased appetite, which may culminate in stunted growth, hindered cognitive development, and a diminished capacity to learn. Severe infections and polyparasitism are also associated to increased morbidity rates and heightened vulnerability to additional infections (Idris, Wintola and Afolayan, 2019; Nath *et al.*, 2022). Numerous infectious agents, including worms, are linked to chronic anemia (Caldrer *et al.*, 2022). The incidence of anemia due to helminth infections varied between 10,3% to 27,1% (Ntonifor *et al.*, 2021; Tofel *et al.*, 2024).

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One of the groups of worms that can cause infections in humans is soil transmitted helminths (STH), through contact with eggs found in warm and moist soil. Common STH species include roundworms (Ascaris lumbricoides), hookworms (Ancylostoma duodenale and Necator americanus), and whipworms (Trichuris trichiura) (Murni, Lubis and Fujiati, 2018). According to the World Health Organization (2023), more than 1.5 billion people globally, representing about 24% of the total population, experience worm infections (World Health Organization, 2023). Recent data indicate that 819 million people globally are infected with A. lumbricoides, 439 million with hookworms, and 465 million with T. trichura, in addition to 2-4 billion who are at risk of contracting these infections (Aemiro *et al.*, 2022). In Indonesia, the prevalence of helminthiasis is still quite high with the number varying between 2.5% to 6.2% (Prabandari, Sari and Ahtamagara, 2023). In East Java, the prevalence rate of worms reaches 7.95% (Fauzi Sabban *et al.*, 2023).

Worms have a multifactorial mechanism of blood loss, with the severity of the infection, the worm species, iron stores, and other factors like age and underlying medical conditions all influencing the rate of chronic blood loss. Most cases of blood loss are caused by hookworms through disruption of the intestinal epithelial and endothelial barriers. Hookworms will secrete anticoagulants derived from the parasites that inhibit blood clotting and adversely affect the host's inflammatory response (Caldrer *et al.*, 2022). Moreover, worms within the human body actively consume and digest red blood cells, leading to significant blood loss (Loukas *et al.*, 2016).

Helminthiasis can be evaluated by looking for eosinophilia in blood tests (Primadana *et al.*, 2019). Eosinophils are a result of the body's cellular immune response to worm infestations, induced by T helper 2 (Th2) cells, which increase IgE and IL-5, functioning as eosinophil activators (Eren and Aktekin, 2023). Numerous granulocytes called neutrophils move swiftly to areas of tissue damage, infection, or inflammation. They are crucial in fighting off infections in a variety of ways, including engulfing them, releasing toxic granules, and producing reactive oxygen species. Despite the fact that both eosinophil and neutrophil are recruited during worm infections, it is still unclear exactly how neutrophils fight these parasites. However, recent research suggests that neutrophils might help in removing larvae from the lungs (Bouchery *et al.*, 2020; Giacomin *et al.*, 2008).

Worm infections have the potential to irritate and inflame the intestinal mucosa, which can cause bleeding and leading to anemia. Chronic blood loss leads to iron deficiency, which lowers hemoglobin (Hb) production, causing red blood cells to become hypochromic and a contributing factor to anemia (Mutalazimah and Putri, 2021). When assessing anemia, the mean corpuscular volume (MCV) and mean corpuscular hemoglobin (MCH) are crucial parameters in evaluating anemia; MCV represents the typical size of red blood cells, while MCH shows the average amount of hemoglobin in each red blood cell. MCV is frequently low in iron deficiency anemia cases, and MCH may also decrease, underscoring the effect of worm infections on blood health in overall.

Ngadas Village is one of the highest areas in Malang Regency, located within the territorial area of the Bromo Tengger Semeru National Park at an elevation of approximately 2,150 meters above sea level. The majority of the population in Ngadas Village works as vegetable farmers (Statistic of Malang Regency, 2021). Vulnerable groups at risk of helminth infection include workers who have close contact with soil, such as farmers, waste pickers, potters, and garbage collectors. Farmers are particularly susceptible to helminthiasis due to their activities closely linked to soil, including digging, planting seeds, fertilizing, weeding, and harvesting (Prabandari, Sari and Ahtamagara, 2023). Agricultural environments often provide breeding grounds for parasites and worms, especially when there is standing water or moist soil. Soil serves as a medium for the development of STH eggs until they reach the infective stage, ready to infect humans. In farmers, STH infections may occur due to inadequate use of protective equipment while working, allowing worm eggs in the soil to adhere to long, dirty nails, which can then be ingested during meals. Infection can also occur directly if the worm larvae penetrate the skin in direct contact with the soil (Apsari *et al.*, 2020). In addition, the practice of not cleansing hands with soap prior to meals and not using footwear, as well as gloves while working can increase the risk of helminthiasis (Fauzi Sabban *et al.*, 2023). The impact of the worldwide environment, the growing human population, and the diminishing consciousness regarding personal hygiene are significant contributors to the spread of parasites like worms.

Helminth infections still receive less attention because most of them do not cause symptoms or only cause mild infections, even though if this is allowed continuously, helminth infections will become more severe and cause manifestations, one of which is anemia (Irawan *et al.*, 2024). Measures such as improved personal hygiene are essential to prevent infections and should be included in a comprehensive strategy aimed at the long-term management of helminth diseases (Mationg *et al.*, 2022). According to this description, it is concluded that studies that examine sociodemographic factors and personal hygiene in relation to blood profiles is still rarely studied. This study aims to investigate the relationship between sociodemographic factors and personal hygiene on peripheral blood profiles in agrarian workers.

METHODS

Study Area

The Malang Regency's agricultural region serves as the study area (Figure 1). Geographically, Malang Regency is situated between 112°17' and 112°57' East Longitude and 7°44' and 8°26' South Latitude. The temperature in this area ranges from 0 to 18˚C (Statistic of Malang Regency, 2021).

The selection of this area is because agricultural practices often involve the use of manure and interaction with the soil can be a factor causing the spread of worms, as well as close contact with livestock. By understanding the prevalence and risk factors in agrarian area, more effective interventions can be designed to prevent and control helminthic diseases in vulnerable populations. All residents in the study area are considered the target population and constitute the research population.

Study Design, Population, and Determination of Sample Size

This study is a cross-sectional that utilized a questionnaire and laboratory hematology data conducted in July 2024. The Lemeshow formula with a 95% confidence interval was used to calculate the sample size. A total sample size of 96 respondents was obtained from this computation. However, to minimize the potential for missing data, the number of respondents in this study was increased to 144, which is considered the final sample.

The criteria for inclusion in this study comprised participants aged 18 and older and who agreed to take part as respondents by signing an informed consent form. Those who refused to complete the questionnaire, declined laboratory hematology testing, or were not willing to sign the informed consent form were excluded from the study. The sampling method used in this study was purposive sampling. This method establishes the study population according to specific inclusion and exclusion criteria that align with the study's objectives. The Universitas Brawijaya Ethics Committee granted approval for the study (No. 353/EC/KEPK/10/2024).

Data Collection

Sociodemographic characteristics and personal hygiene factors influencing helminth infection incidence were collected through a questionnaire. To make sure that respondents fully understood the questions, the questionnaire was provided orally

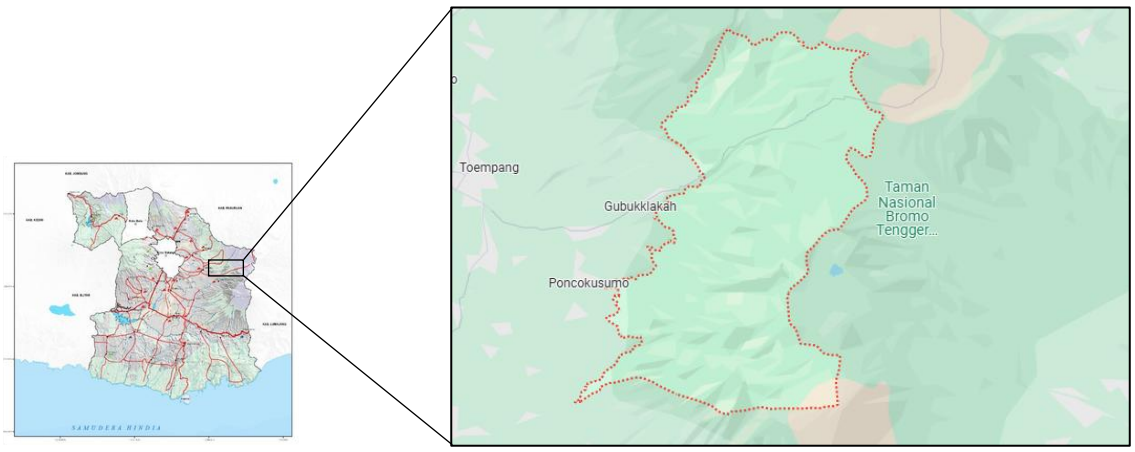

Figure 1. Locations of the agrarian area where this study was conducted

and was available in both Indonesian and Javanese. There are four sections on the questionnaire. The respondent sociodemographic characteristics, including gender, age, marital status, education level, occupation, monthly income, and medical history, are detailed in the first section.

The following part addresses inquiries related to personal hygiene. These questions include whether respondents always wash their hands before eating, always wash their hands after working, always wash their feet after working, always use soap when washing their hands and feet, always wear footwear when going outside, always bathe regularly at least twice a day, always shower immediately after returning from work, and always clean/cut their nails once a week. Respondents were given two response options: "yes" or "no."

Additionally, data collection involved blood sampling from respondents, which was tested at the laboratory of RSUD dr Saiful Anwar Malang on the same day by experienced medical laboratory technologists. The blood profile examined in this study included hemoglobin (Hb), mean corpuscular volume (MCV), mean corpuscular hemoglobin (MCH), neutrophils, and eosinophils. Hb was measured to assess oxygen-carrying capacity and detect anemia, while MCV and MCH were evaluated to determine red blood cell size and hemoglobin content, respectively, aiding in anemia classification. Neutrophils were counted to evaluate the immune response to infection and inflammation, and eosinophils were measured to assess allergic reactions and parasitic infections, particularly helminthiasis.

Data Analysis

Data from questionnaires and laboratory results were input into Microsoft Excel 2010 using the double-entry technique. IBM SPSS Statistics version 26 was used for the following analysis, which involved categorizing variables and examining at the absolute and relative frequency distributions. Prior to utilization, the questionnaire underwent testing for both validity and reliability. If an item's Pearson correlation value was higher than the cut-off value (r), it was considered valid. If an item's Cronbach's alpha value was higher than 0.6, it was considered to be of good reliability. The validity and reliability of the questionnaire used in this investigation were established.

The analysis used in this comprised univariate analysis to describe the research variables through frequency distribution. Subsequently, bivariate analysis was employed to investigate the relationship between the independent variables and the dependent variable. The bivariate analysis was carried out using the Chi-square test. Independent variables with a p-value of less than 0.05 were identified as having a significant association with the dependent variable. All factors that met the p-value threshold of less than 0.25 were incorporated into the model, and logistic regression was executed with a p-value of less than 0.05, presenting the factors in terms of adjusted odds ratio (aOR) and 95% confidence interval (CI).

To assess the personal hygiene questionnaire, scoring was applied to each response. "Yes" responses were assigned a score of 1, while "No" responses were assigned a score of 0. Consequently, respondents' personal hygiene scores ranged from 0 to 7. To evaluate the hematology laboratory results of respondents, categorization was performed according to the predetermined cut-offs for each blood profile, classifying results as "normal" or "abnormal."

RESULT

Sociodemographic Characteristics of Respondents

A total of 144 respondents participated in this study, with an average age of 48.1 ± 14.1 years. The vast majority of the respondents were female (91.7%) and most were married (81.3%). The age distribution of the respondents included those aged 19-30 years (16%), 31-50 years (34.7%), and over 50 years (49.3%). A significant number of respondents reported having completed elementary school as their highest level of education (51.4%) and worked as farmers (66.7%). Respondents had an average monthly income of less than Rp 1,000,000, which applied to 73.6% of them. Furthermore, a small group of respondents had a history of helminth infection (7.6%), while the majority did not report any medical history (92.4%). Table 1 displays the sociodemographic characteristics of the respondents.

Based on the blood profile examination results, it was found that the average respondents had normal levels of Hb (68.8%), MCV (79.9%), MCH (73.6%), eosinophils (92.4%), and neutrophils (62.5%).

Table 1. Sociodemographic Characteristics of Respondents

Variable	Frequency [n(%)] (n=144)
Age (years old), mean ± SD	48.1±14.1
19-30	23 (16.0)
31-50	50 (34.7)
>50	71 (49.3)
Gender	
Male	12 (8.3)
Female	132 (91.7)
Marital Status	
Unmarried	7 (4.9)
Married	117 (81.3)
Widow/widower	20 (13.9)
Education Status	
Did not finish school	8 (5.6)
Elementary school	74 (51.4)
Middle school	46 (31.9)
High school	4 (2.8)
Bachelor degree	12 (8.3)
Occupation	
Unemployed	11 (7.6)
Housewife	23 (16.0)
Private sector worker	14 (9.7)
Farmer	96 (66.7)
Medical History	
There is medical history	11 (7.6)
There is no medical history	133 (92.4)
Monthly Income	
≤Rp 1.000.000	106 (73.6)
Rp 1.000.001 – Rp 3.000.000	38 (26.4)
Hb	
Normal	99 (68.8)
Abnormal	45 (31.3)
MCV	
Normal	115 (79.9)
Abnormal	29 (20.1)
MCH	
Normal	106 (73.6)
Abnormal	38 (26.4)
Neutrophil	
Normal	90 (62.5)
Abnormal	54 (37.5)
Eosinophil	
Normal	133 (92.4)
Abnormal	11 (7.6)

SD = Standard Deviation, n = total

Assessment of Respondents' Personal Hygiene

In this study, the majority of respondents reported consistently practicing handwashing before meals (91.7%), always washing their hands after work (75.0%), always washing their feet after work (59.7%), consistently using soap every time they wash their hands and feet (67.4%), always wearing footwear when leaving the house (86.8%), regularly bathing at least twice a day (59.0%), and always cleaning/cutting their nails once a week (72.2%). This data are presented in Table 3.

Based on the results of the personal hygiene questionnaire, the average score among respondents was 5.87 ± 1.12 SD, with scores ranging from a minimum of 4 to a maximum of 7. A total of 61.8% of respondents achieved scores above the average, indicating that they have good personal hygiene, while the remaining 38.2% have poor personal hygiene (Table 4). This indicates that the results of this study reveal a greater number of respondents exhibiting good personal hygiene behavior than those exhibiting poor behavior. In this study, respondents who did not wash their hands before meals had 1.8 times the risk compared to those who did wash their hands. Additionally, respondents who did not wear footwear when leaving the house had a 6.1 times higher risk compared to those who did wear footwear, and respondents who did not clean/cut their nails once a week had a 1.2 times higher risk compared to those who did.

Factors Affecting Respondents' Blood Profile

According to the results from the bivariate and multivariate analyses (Table 3) of sociodemographic factors associated with respondents' hemoglobin levels, age (p=0.001), education level (p=0.001), marital status (p=0.005), gender (p=0.006), and medical history (p=0.016) have a significant relationship with respondents' hemoglobin levels. After adjustment, respondents over 50 years old had higher odds of having lower hemoglobin levels compared to those under 50 years (aOR=2.9; 95% CI=1.1-7.5). Additionally, female respondents had significantly higher odds of low hemoglobin levels compared to male respondents (aOR=5.1; 95% CI=1.4-18.8).

Regarding MCV, bivariate and multivariate analysis (Table 4) indicate that marital status (p=0.030) and employment status (p=0.001) have a significant association. Notably, respondents

who had only completed elementary school had significantly higher odds 6.4 times of having low MCV levels compared to those who had graduated from junior high school, high school, or university.

For (MCH levels, employment status (p=0.001) and medical history (p=0.039) were significantly associated (Table 5). Respondents working as farmers had 2.8 times higher odds of having low MCH levels compared to those working as housewives, in the private sector, or who are unemployed.

In terms of neutrophil levels, age (p=0.041) showed a significant association (Table 6). Respondents over 50 years old had 1.1 times higher odds of having abnormal neutrophil levels respectively, compared to those under 50 years old.

Table 2. Assessment of Respondent's Personal Hygiene

Questions	Distribution of Answer (n[%])		p-value	OR (95% CI)	Mean ± SD	Good (n)	Poor (n)
Personal Hygiene	**Yes**	**No**				**n(%)**	
Always Wash Hands before Meals	132 (91.7)	18 (8.3)	0.398	1.8 (0.4-7.0)			
Always Wash Hands after Working	108 (75.0)	36 (25.0)	0.117	0.4 (0.16-1.2)			
Always Wash Feet after Working	86 (59.7)	58 (40.3)	0.691	0.8 (3.3-2.0)			
Always use Soap when Washing Hands and Feet	97 (67.4)	47 (32.6)	0.584	0.7 (0.2-2.1)	5.87 ± 1.12	89 (61.8)	55 (38.2)
Always Wear Footwear when Leaving Home	125 (86.8)	19 (13.2)	0.008*	6.1 (1.6-23.6)			
Always Bathe Regularly at Least Twice a Day	85 (59.0)	59 (41.0)	0.844	0.9 (0.3-2.2)			
Always Clean/Cut Nails once a Week	104 (72.2)	40 (27.8)	0.712	1.2 (0.4-3.5)			

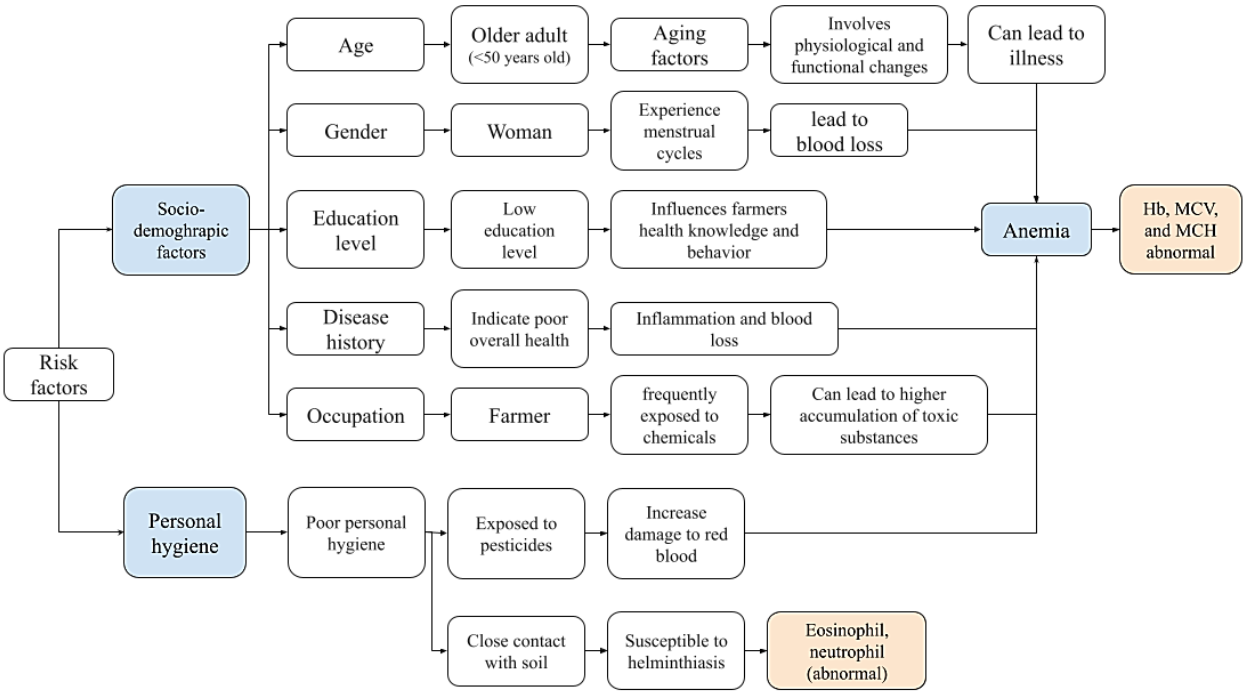

Figure 2. Flowchart Illustrating Research Results: Socio-demographic Factors and Personal Hygiene that Influence Blood Profile

In addition, personal hygiene also demonstrated a significant influence on blood profiles. Hemoglobin levels (p = 0.031) and eosinophil levels (p = 0.007) were significantly correlated with personal hygiene, according to the findings of bivariate and multivariate tests (Table 8). Respondents with poor personal hygiene had 2.1 times higher odds of having abnormal hemoglobin levels and 1.1 higher odds of having abnormal eosinophil levels compared to those with good personal hygiene.

DISCUSSION

Sociodemographic Characteristics of Respondents

In this study, the majority of respondents were female (91.7%), married (81.3%), and aged over 50 years (49.3%), with an average age of 48.1 years. Most had a maximum education level of elementary school (51.4%) and worked as farmers (66.7%). This

Table 3. Potential Risk Factors Associated with Hemoglobin Levels

Variable	Normal n (%)	Abnormal n (%)	p-value (X2)	aOR	95% (CI)	p-value
Age (years old)						
19-30	8 (34.8)	15 (65.2)	0.001*	Ref.	na	na
31-50	43 (86.0)	7 (14.0)		0.2	0.09-0.6	0.007*
>50	48 (67.6)	23 (32.4)		2.9	1.1-7.5	0.025*
Gender						
Male	4 (33.3)	8 (66.7)	0.006*	Ref.	na	na
Female	95 (72.0)	37 (28.0)		5.1	1.4-18.08	0.011*
Marital Status						
Unmarried	4 (57.1)	3 (42.9)	0.005*	Ref.	na	na
Married	75 (64.1)	42 (35.9)		1.3	0.2-6.2	0.711
Widow/widower	20 (100.0)	0 (0.0)		na	na	0.998
Education Status						
Did not finish school	8 (100.0)	0 (0.0)		Ref.	na	na
Elementary school	51 (68.9)	23 (31.1)	0.001*	na	na	0.999
Middle school	28 (60.9)	18 (39.1)		na	na	0.999
High school	0 (0.0)	4 (100.0)		na	na	0.999
Bachelor degree	12 (100.0)	0 (0.0)		na	na	1.000
Occupation						
Unemployed	8 (72.7)	3 (27.3)		Ref.	na	na
Housewife	16 (69.9)	7 (30.4)	0.823	0.8	0.1-4.2	0.850
Private sector worker	11 (78.6)	3 (21.4)		1.3	0.2-8.6	0.735
Farmer	64 (66.7)	32 (33.3)		0.7	0.1-3.0	0.686
Medical History						
There is medical history	4 (36.4)	7 (63.6)	0.016*	Ref.	na	na
There is no medical history	95 (71.4)	38 (28.6)		0.22	0.06-0.82	0.024*
Monthly Income						
≤Rp 1.000.000	72 (67.9)	34 (32.1)	0.721	Ref.	na	na
Rp 1.000.001 – Rp 3.000.000	27 (71.1)	11 (28.9)		1.1	0.5-2.6	0.721

aOR = adjusted odds ratio, calculated via multivariate logistic regression; CI = confidence interval; * = significant at 5% (p<0.05); a = significant at 25% (p<0.25); Ref = reference; X2 = chi-square

sociodemographic profile reflects the characteristics of rural agrarian communities, where farming is the predominant occupation and educational attainment is generally lower.

Furthermore, more than two-thirds of respondents reported a monthly income of ≤Rp 1,000,000, which aligns with national data indicating that small-scale farmers in rural Indonesia often live below the minimum wage standard (Statistic of Malang Regency, 2021). Socioeconomic status, especially low income and education level, has been associated with limited access to healthcare and poor nutritional outcomes, both of which are critical factors influencing blood health (Taj *et al.*, 2016).

Although the majority of respondents reported no history of helminth infection (92.4%), this figure may be underestimated due to underreporting or limited access to diagnostic services in rural areas. Nonetheless, the 7.6% who reported previous infections remain important, given that

Table 4. Potential Risk Factors Associated with MCV Levels

Variable	Normal n (%)	Abnormal n (%)	p-value (X2)	aOR	95% (CI)	p-value
Age (years old)						
19-30	16 (69.6)	7 (30.4)	0.276	Ref.	na	na
31-50	39 (78.0)	11 (22.0)		1.5	0.5-4.7	0.439
>50	60 (84.5)	11 (15.5)		2.3	0.7-7.1	0.120
Gender						
Male	8 (66.7)	4 (33.3)	0.234[a]	Ref.	na	na
Female	107 (81.1)	25 (18.9)		2.1	0.5-7.6	0.243
Marital Status						
Unmarried	7 (100.0)	0 (0.0)	0.030*	Ref.	na	na
Married	96 (82.1)	21 (17.9)		na	na	0.999
Widow/widower	12 (60.0)	8 (40.0)		na	na	0.999
Education Status						
Did not finish school	4 (50.0)	4 (50.0)		Ref.	na	na
Elementary school	64 (86.5)	10 (13.5)	0.057[a]	6.4	1.3-29.7	0.018*
Middle school	35 (76.1)	11 (23.9)		3.1	0.6-14.8	0.141
High school	4 (100.0)	0 (0.0)		na	na	0.999
Bachelor degree	8 (66.7)	4 (33.3)		2.0	0.3-12.5	0.459
Occupation						
Unemployed	11 (100.0)	0 (0.0)		Ref.	na	na
Housewife	8 (34.8)	15 (65.2)	0.001*	na	na	0.999
Private sector worker	8 (57.1)	6 (42.9)		na	na	0.999
Farmer	88 (91.7)	8 (8.3)		na	na	0.999
Medical History						
There is medical history	11 (100.0)	0 (0.0)	0.083a	Ref.	na	na
There is no medical history	104 (78.2)	29 921.8)		0.7	0.7-0.8	0.999
Monthly Income						
≤Rp 1.000.000	87 (82.1)	19 (17.9)	0.268	Ref.	na	na
Rp 1.000.001 – Rp 3.000.000	28 (73.7)	10 (26.3)		0.6	0.2-1.4	0.271

aOR = adjusted odds ratio, calculated via multivariate logistic regression; CI = confidence interval; * = significant at 5% ($p<0.05$); a = significant at 25% ($p<0.25$); Ref = reference; X2 = chi-square

soil-transmitted helminths are still endemic in many agrarian regions and can negatively impact nutritional absorption and hematological parameters (Amalia *et al.*, 2023).

Assessment of Respondents' Personal Hygiene

One of the things people do to avoid getting sick is to practice good personal hygiene. Cleanliness refers to practices associated with good health. Hygiene is the study and practice of preventing disease or halting its spread by maintaining cleanliness (Nurudeen and Toyin, 2020). In the field of public health, good hygiene is essential to preventing illness and promoting health. In order to lower exposure to infectious agents, good hygiene practices, such as bathing, handwashing, and wearing footwear, are crucial.

According to this study, respondents who practice good personal hygiene behavior were more than those who practiced poor personal hygiene behavior. This shows that respondents have a good awareness of the importance of maintaining personal

Table 5. Potential Risk Factor Associated with MCH Levels

Variable	Normal n (%)	Abnormal n (%)	p-value (X2)	aOR	95% (CI)	p-value
Age (years old)						
19-30	16 (69.9)	7 (30.4)	0.117[a]	Ref.	na	na
31-50	42 (84.0)	8 (16.0)		2.2	0.7-7.3	0.162
>50	48 (67.6)	23 (32.4)		0.9	0.3-2.5	0.861
Gender						
Male	8 (66.7)	4 (33.3)	0.569	Ref.	na	na
Female	98 (74.2)	34 (25.8)		1.4	0.4-5.0	0.570
Marital Status						
Unmarried	7 (100.0)	0 (0.0)	0.108[a]	Ref.	na	na
Married	87 (74.4)	30 (25.6)		na	na	0.999
Widow/widower	12 (60.0)	8 (40.0)		na	na	0.999
Education Status						
Did not finish school	4 (50.0)	4 (50.0)	0.381	Ref.	na	na
Elementary school	55 (74.3)	19 (25.7)		2.8	0.6-12.7	0.159
Middle school	35 (76.1)	11 (23.9)		3.1	0.6-14.8	0.141
High school	4 (100.0)	0 (0.0)		na	na	0.999
Bachelor degree	8 (66.7)	4 (33.3)		2.0	0.3-12.5	0.459
Occupation						
Unemployed	7 (63.6)	4 (36.4)	0.001*	Ref.	na	na
Housewife	8 (34.8)	15 (65.2)		0.3	0.6-1.3	0.120
Private sector worker	11 (78.6)	3 (21.4)		2.0	0.3-12.3	0.413
Farmer	80 (83.3)	16 (16.7)		2.8	0.7-10.9	0.125
Medical History						
There is medical history	11 (100.0)	0 (0.0)	0.039*	Ref.	na	na
There is no medical history	95 (71.4)	38 (28.6)		na	na	0.999
Monthly Income						
≤Rp 1.000.000	79 (74.5)	21 (25.5)	0.677	Ref.	na	na
Rp 1.000.001 – Rp 3.000.000	27 (71.1)	11 (28.9)		0.8	0.3-1.9	0.677

aOR = adjusted odds ratio, calculated via multivariate logistic regression; CI = confidence interval; * = significant at 5% ($p<0.05$); a = significant at 25% ($p<0.25$); Ref = reference; X2 = chi-square

hygiene, which includes behaviors such as washing hands before meals, cleaning hands and feet after work, using soap when washing hands and feet, wearing footwear outside, showering at least twice daily, and cleaning/cutting nails weekly. This is in accordance with the findings by Amalia *et al.* (2023), which indicated that 55.6% of respondents practiced good personal hygiene.

Poor hygiene practices, such as not washing hands, can cause harmful germs to enter the body directly through the mouth, nose, or eyes or indirectly through contaminated food and beverages (Farodis and Purnadianti, 2020; Lestari and Saktiansyah, 2017). Poor personal hygiene and sanitation, particularly in rural or agricultural areas, have been associated with a greater risk of parasitic infections. This is in accordance with research by Lalangpuling, Manengal and Konoralma (2020) which identified a correlation between worm infections and clean living practices.

In this study, the risk of developing health problem was 1.8 times higher in participants who

Table 6. Potential Risk Factors Associated with Neutrophil Levels

Variable	Normal n (%)	Abnormal n (%)	p-value (X2)	aOR	95% (CI)	p-value
Age (years old)						
19-30	20 (87.0)	3 (13.0)	0.041*	Ref.	na	na
31-50	50 (100.0)	0 (0.0)		na	na	0.997
>50	63 (88.7)	8 (11.3)		1.1	0.2-4.8	0.818
Gender						
Male	12 (100.0)	0 (0.0)	0.298	Ref.	na	na
Female	121 (91.7)	11 (8.3)		1.09	1.0-1.1	0.999
Marital Status						
Unmarried	7 (100.0)	0 (0.0)	0.068[a]	Ref.	na	na
Married	110 (94.0)	7 (6.0)		na	na	0.999
Widow/widower	16 (80.0)	4 (20.0)		na	na	0.999
Education Status						
Did not finish school	8 (100.0)	0 (0.0)	0.538	Ref.	na	na
Elementary school	66 (89.2)	8 (10.8)		na	na	0.999
Middle school	43 (93.5)	3 (6.5)		na	na	0.999
High school	4 (100.0)	0 (0.0)		na	na	1.000
Bachelor degree	12 (100.0)	0 (0.0)				1.000
Occupation						
Unemployed	11 (100.0)	0 (0.0)	0.379	Ref.	na	na
Housewife	20 (87.0)	3 (13.0)		na	na	0.999
Private sector worker	14 (100.0)	0 (0.0)		na	na	1.000
Farmer	88 (91.7)	8 (8.3)		na	na	0.999
Medical History						
There is medical history	11 (100.0)	0 (0.0)	0.321	Ref.	na	na
There is no medical history	122 (91.7)	11 (8.3)		na	na	0.999
Monthly Income						
≤Rp 1.000.000	99 (93.4)	7 (6.6)	0.435	Ref.	na	na
Rp 1.000.001 – Rp 3.000.000	34 (89.5)	4 (10.5)		0.6	0.1-2.1	0.324

aOR = adjusted odds ratio, calculated via multivariate logistic regression; CI = confidence interval; * = significant at 5% ($p<0.05$); a = significant at 25% ($p<0.25$); Ref = reference; X2 = chi-square

did not wash their hands prior meals compared to those who washed their hands. Hands become contaminated with harmful microorganisms from dirty surfaces and then transmit infections to themselves and others (Amalia *et al.*, 2023). Washing hands with soap and water can remove viruses, bacteria, and parasites that cause disease (Ejemot-Nwadiaro *et al.*, 2021). Additionally, the risk was 6.1 times higher for people who went outside without wearing footwear than those who wore. Furthermore, unclean or untrimmed hands and nails make it easier for bacteria to enter the body which are swallowed during meals (Suraya *et al.*, 2020). For this reason, good personal hygiene practices are one of the necessary steps in living a clean and healthy lifestyle.

Factors Affecting Respondents Blood Profile

Blood profiles play a crucial role in assessing various aspects of health, including general condition, disease diagnosis, and treatment monitoring. Through this examination, healthcare

Table 7. Potential Risk Factors Associated with Eosinophil Levels

Variable	Normal n (%)	Abnormal n (%)	p-value (X2)	aOR	95% (CI)	p-value
Age (years old)						
19-30	16 (69.9)	7 (30.4)	0.163	Ref.	na	na
31-50	26 (52.0)	24 (48.0)		0.4	0.1-1.3	0.162
>50	48 (67.6)	23 (32.4)		0.9	0.3-2.5	0.861
Gender						
Male	8 (66.7)	4 (33.3)	0.755	Ref.	na	na
Female	82 (62.1)	50 (37.9)		0.8	0.2-2.8	0.234
Marital Status						
Unmarried	7 (100.0)	0 (0.0)	0.017*	Ref.	na	na
Married	67 (57.3)	50 (42.7)		na	na	0.999
Widow/widower	16 (80.0)	4 (20.0)		na	na	0.999
Education Status						
Did not finish school	8 (100.0)	0 (0.0)		Ref.	na	na
Elementary school	43 (58.1)	31 (41.9)	0.085[a]	na	na	0.999
Middle school	27 (58.7)	19 (41.3)		na	na	0.999
High school	4 (100.0)	0 (0.0)		na	na	1.000
Bachelor degree	8 (66.7)	4 (33.3)		na	na	0.999
Occupation						
Unemployed	3 (27.3)	8 (72.7)		Ref.	na	na
Housewife	16 (69.6)	7 (30.4)	0.049*	6.0	1.2-30.0	0.027
Private sector worker	11 (78.6)	3 (21.4)		9.7	1.5-61.6	0.015
Farmer	60 (62.5)	36 (37.5)		4.4	1.1-17.8	0.035
Medical History						
There is medical history	7 (63.6)	4 (36.4)	0.935	Ref.	na	na
There is no medical history	83 (62.4)	50 (37.6)		1.05	0.2-3.7	0.213
Monthly Income						
≤Rp 1.000.000	75 (70.8)	31 (29.2)	0.001*	Ref.	na	na
Rp 1.000.001 – Rp 3.000.000	15 (39.5)	23 (60.5)		0.27	0.12-0.58	0.001*

aOR = adjusted odds ratio, calculated via multivariate logistic regression; CI = confidence interval; * = significant at 5% ($p<0.05$); a = significant at 25% ($p<0.25$); Ref = reference; X2 = chi-square

professionals can determine whether a person has an infection, anemia, or other hematological disorders. Thus, blood profile provides a comprehensive insight into an individual's health and serves as a beneficial tool in clinical settings. Numerous factors can influence a person's blood profile, including demographic factors like age and gender, nutritional status, health problems, lifestyle habits, and more.

When hemoglobin (Hb) is within the normal range, anemia does not present, and the blood's oxygen-carrying capacity will be adequate. Mean corpuscular hemoglobin (MCH) refers to the average hemoglobin contained in each red blood cell, while ,mean corpuscular bolume (MCV) describes the average size of red blood cells. Normal levels of MCV and MCH suggest optimal oxygen transport. Meanwhile, white blood cells components known as neutrophils and eosinophils play a role in the immune defense system—neutrophils function to fight bacterial infection and inflammation, while eosinophils play a role in overcoming allergic reactions and parasitic infections (Ramirez *et al.*, 2018).

Neutrophils and eosinophils have important functions in the body's immune system. About 50-70% of all white blood cells are neutrophils with the main function of fighting infections, especially those caused by bacteria, as well as helping to manage tissue damage and produce antimicrobial compounds to eradicate bacteria and fungi, in addition, neutrophils also play an important role in the inflammatory response (Ley *et al.*, 2018), while eosinophils comprise about 1 to 4% of the total white blood cells and have a function in allergic reactions and the fight against parasitic infections.

Hemoglobin levels in this study were significantly correlated with some of the respondent sociodemographic characteristics, including age, gender, and education level. Respondents aged over 50 years had 2.9 times higher odds of experiencing low hemoglobin levels than those under 50. Low hemoglobin can indicate that individuals are anemic. An elderly person faces an increased risk of anemia as a result of aging, which brings about physiological and functional changes that can lead to health issues. Nevertheless, aging should not be viewed as the sole contributing factor, since other factors can also cause anemia, such as diet (Lopes *et al.*, 2022).

Female respondents had 5.1 times higher odds of low hemoglobin levels than male respondents. This is attributed to women experience a menstrual cycle that can lead to blood loss, particularly when iron intake is insufficient to replenish this loss. A study conducted among women in horticulture area, showed that the prevalence of anemia among who work as farmers is 27.5% (Yushananta *et al.*, 2021). Where this condition can also lead to increased morbidity and mortality, hinder neurological development, illness, and cognitive challenges, as well as lower productivity due to fatigue (Chaparro and Suchdev, 2019; Teshale *et al.*, 2020).

Education level also had a significant relationship with respondents' hemoglobin levels. Low hemoglobin levels are more common among

Table 8. Multivariate Logistic Regression of Personal Hygiene Factors on Respondents' Blood Profile

Personal Hygiene	Normal n (%)	Abnormal n (%)	p-value (X^2)	aOR	95% (CI)	p-value
Hemoglobin						
Poor Personal Hygiene	32 (58.2)	23 (41.8)	0.031*	2.1	1.0-4.4	0.033*
Good Personal Hygiene	67 (75.3)	22 (24.7)		Ref.	na	na
MCV						
Poor Personal Hygiene	43 (78.2)	12 (21.8)	0.639	1.1	0.5-2.7	
Good Personal Hygiene	72 (80.9)	17 (19.1)		Ref.	na	
MCH						
Poor Personal Hygiene	43 (78.2)	12 (21.8)	0.328	0.6	0.3-1.4	0.329
Good Personal Hygiene	63 (70.8)	26 (29.2)		Ref.	na	na
Neutrophil						
Poor Personal Hygiene	39 (70.9)	16 (29.1)	0.101	0.5	0.2-1.1	0.103
Good Personal Hygiene	51 (57.3)	38 (42.7)		Ref.	na	na
Eosinophil						
Poor Personal Hygiene	55 (100.0)	0 (0.0)	0.007*	1.1	1.0-1.2	0.997
Good Personal Hygiene	78 (87.6)	11 (12.4)		Ref.	na	na

respondents with lower education. This may be partly due to the fact that the majority of respondents worked as farmers, whose occupation inherently exposes them to health risks such as prolonged contact with pesticides and other chemicals. Study conducted by Taj *et al.*, (2016) indicates that farmers with lower education are more susceptible to developing anemia. This vulnerability arises because farmers health knowledge and behavior will be impacted by education. Farmers with low levels of education might not be fully awareness about the risk associated with chemical exposure and the necessary precautions to mitigate them. Farmers are better equipped to comprehend the risks of chemical exposure and how to address them as their educational attainment increases (Taj *et al.*, 2016).

Significantly, occupational status especially farmer, was associated with lower levels of Hb, MCV, and MCH. Farmers are regularly exposed to agricultural chemicals during the fertilization and spraying processes, such as pesticides and arsenic. Long-term exposure to these substances may lead to the body accumulate toxic compounds, including sulphemoglobin and methemoglobin, which impair red blood cells' ability to carry oxygen and ultimately cause anemia (Asif Syed *et al.*, 2021; Radi, Rejeki and Octaviana, 2024; Sulistyawati *et al.*, 2019; Yushananta *et al.*, 2021). Moreover, it is known that pesticides cause oxidative stress and damaging red blood cells, which further reduces MCV and MCH values. This indicates that hematological parameters, especially those related to anemia, are significantly impacted by occupational exposure in agricultural settings.

Age is also significantly associated with eosinophil levels, where respondents over 50 years of age have lower odds of elevated eosinophil levels than those under 50 years. After the age of fifty, the number of eosinophils can decrease. This may be due to a decreased immune system function age, especially if they are farmers who frequently handle soil and fertilizer. As a result, they might be more susceptible to infections such as worm infestations if personal hygiene is neglected. Since eosinophils are an indicators of the body's immune response to worm infections, eosinophilia found in blood tests can be a sign of the worms (Primadana *et al.*, 2019).

Besides sociodemographic factors, in this study personal hygiene practices also have significant relationship with the blood profile of respondents. Blood profiles are impacted by risk factors such as wearing footwear and washing hands before eating, whereby normal blood profiles are usually found in people with good personal hygiene. The concept of personal hygiene, which focuses on disease prevention, is widely applied in the medical and public health domains (Nurudeen and Toyin, 2020).

This is in line with study by Fattah *et al.* (2020) which found that personal hygiene factors, such as hand washing practices, are correlated to worm infections, which are connected to anemia (Fattah *et al.*, 2020; Listiana 2016). This is because worm infections can cause acute and chronic intestinal infections caused by exposure to pathogens in the gastrointestinal tract and can cause enteric and systemic inflammation. Environmental enteropathy (EE) is a subclinical condition in which decreased nutrient absorption and reduced intestinal absorption surface area are caused by intestinal inflammation and chronic villus atrophy (Amalia *et al.*, 2023). Long-term exposure to this infection can inhibit iron absorption in the intestine and ultimately result in anemia (Prentice *et al.*, 2019).

In this study, respondents with poor personal hygiene were 2.1 times more likely to have abnormal hemoglobin levels and 1.1 times more likely to have abnormal eosinophil levels. Other studies have also found a significant correlation between hygiene practices and the number of people with anemia (Kothari *et al.*, 2019). People who do not wash their hands before meals, bath regularly, keep their clothes and footwear clean, and take care of their hair are at higher risk.

A study by Aryadnyani, Inderiati and Ulfah (2020) found that increasing rates of parasitic worms infections correlated with diminished hemoglobin levels. Worm infestations inhibit nutrient absorption because parasites consume those nutrients, leading to various health problems such as anemia, intestinal obstruction, diarrhea, gastritis, and others (Amalia *et al.*, 2023). Worm infections worsen anemia because they make it difficult to obtain clean drinking water. Hygiene, access to clean water, and proper sanitation are all important for reducing anemia rates because they help stop infections caused by parasites (Baranwal, Baranwal and Roy *et al.*, 2014).

Consequently, sociodemographic characteristics and behavioral factors, including personal hygiene, have a major impact on blood profiles. Reducing anemia rates and improving general health require improving hygiene habits and health awareness, especially in rural agricultural areas.

Recommendations, Strengths and Limitations

The findings of this study can serve as an importance guideline for conducting targeted public health initiatives in rural areas. Improving personal hygiene habits, such as such as consistent hand washing and wearing of footwear, as well as raising awareness of the health risks associated with pesticide exposure and inadequate sanitation should be the primary objectives of health promotion strategies. To reduce the prevalence of anemia and helminthiasis, especially among agricultural workers, it is also recommended that educational campaigns and deworming programs be conducted periodically.

This study has several limitations that need to be recognized, such as the potential respondent bias related to health status and hygiene practices. Additionally, the study was conducted in a single location, which might limit the applicability of the findings to other settings with different demographic or environmental factors. Furthermore, although a number of blood parameters were assessed, important variables that may have an impact on the results were overlooked, including dietary practices, socioeconomic status, and genetic predisposition.

The strength of this study lies in its comprehensive analysis of how sociodemographic characteristics and personal hygiene affect the blood profiles of farmers in agrarian areas. Through the systematic data collection method and the incorporation of various variables, this research is capable of offering elaborate details on the determinants of blood health. Additionally, focusing on the farmer population enables researchers to investigate particular issues relevant to the agrarian setting, which can help create more focused and efficient health interventions.

CONCLUSION

This study highlights that sociodemographic characteristics and personal hygiene practices significantly influence respondents' blood profiles in agricultural settings. Factors such as age, gender, occupation, and hygiene behaviors—particularly handwashing and footwear use—are associated with abnormalities in hemoglobin, MCV, MCH, and eosinophil levels. Farmers with poor hygiene are more vulnerable to anemia and helminth infections. Therefore, improving hygiene practices and implementing targeted health education and deworming programs are essential to enhance the health of farming communities.

CONFLICT OF INTEREST

The authors state that there are no significant competing financial, professional, or personal conflicts of interest that might have influenced their performance.

AUTHORS' CONTRIBUTION

DI: Designed the study, collected data, prepared questionnaire, drafted the manuscript, supervised, and edited the final manuscript. MGR and HS: supported research implementation, collected data, participated in the manuscript writing. DC and NB: supported research implementation, collected data, and supervised the research. SS: Contributed to the manuscript's writing, conducted data analysis, and edited the finished product. The final manuscript was read and approved by all authors.

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