Mal J Nutr 28(1): 001-014, 2022

Farmers' expenditures associated with children's nutritional status in areas affected by Indonesia's Sinabung eruption

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ABSTRACT

Introduction: During the time of volcano eruptions, farmers have to harvest their crops before the stipulated harvest time, which leads to quality and quantity loss. Besides, farmers also have to continue their farming activities, including purchasing farming necessities. These unaddressed issues of the agricultural restoration could be one of the key factors to malnutrition. Therefore, this study assessed the associations between farmers' expenditures and the nutritional status of children in areas affected by Indonesia's Sinabung eruption. **Methods:** A cross-sectional study was carried out among 444 (158 farmers, 228 farmers cum farm labourers, and 58 farm labourers) households headed by farmers. The questionnaire used for data collection was the Indonesian Family Life Survey questions (IFLS). **Results:** Non-food expenditures had a huge impact on household livelihoods, which was significantly associated with children's nutritional status. Among the three groups of farmers, children of farmers and farmers cum farm labourers were prone to malnutrition. This was because these two groups had to limit food expenditures over their farming necessities and cigarettes expenditure, which took more than half of their income. However, the prevalence of malnutrition was highest in children of farmers. Children of farm labourers had better nutritional status compared to children of the other two groups. **Conclusion:** Children of farmers and farmers cum farm labourers were prone to malnutrition due to limited expenditure on food. This study suggests that policymakers in Indonesia should provide food and nutrition security to children who were impacted by the Sinabung eruption.

Keywords: farmers' expenditures, child nutrition, volcano eruption

INTRODUCTION

Geographically, Indonesia is located on the three active tectonic plates (the Eurasian, Pacific, and Indo-Australian). As a result, the country is prone to various kinds of natural disasters, including volcano eruptions (Guha-Sapir *et al.*, 2014; Hariyono & Liliasari, 2018; Djalante, 2018). Other forms of natural disasters like tsunamis, earthquakes, landslides, droughts, floods, and typhoons typically strike at one point in time, and recovery starts shortly after that. In contrast, volcano eruptions can last for days, weeks, months, or even years and their evolution is relatively unpredictable in the medium to long term (Lebon, Sigmundsson &

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doi: https://doi.org/10.31246/mjn-2021-0077

Gislason, 2009). For example, Mount Sinabung in the Karo Regency, North Sumatra Province, Indonesia, has been actively removing its lava and ashes for nine years, from 2010 to 2019, which occurred in August-September 2010, then again from September 2013 to June 2019. Thus, it has erupted episodically, frequently around harvest, leaving farmers uncertain and driving early harvest lest another eruption occurs (Primulyana *et al.,* 2019).

During Sinabung's eruption, over 30,000 citizens were affected by the eruption and needed to be evacuated (Horwell & Baxter, 2006). After they were allowed to return home, socio-economic issues raised as nearly 80 percent of people in the affected areas were heavily dependent on farming (Horwell & Baxter, 2006). During the time of volcano eruptions, farmers have to harvest their crops before the stipulated harvest time, which leads to quality and quantity loss. This situation in turn, causes capital loss for the farmers (Nainggolan *et al.*, 2019). Despite these difficulties, farmers have to continue their farming activities, including purchasing soil fertilisers, pesticides, seeds, and many more. To some extent, they have to manage their expenditures from their limited source of income. Furthermore, there is a lack of programmes from the government explicitly addressing the issues of agricultural restoration (Nainggolan *et al.*, 2019; Fiantis *et al.,* 2019). Hence, these unaddressed issues of agricultural restoration, including soil fertility improvement, could be one of the key factors to severe poverty and malnutrition, especially in children under five years (Bain *et al.,* 2013; Bargout & Raizada, 2013). Besides, there was no previous study that assessed the correlation between farmers' expenditures and the nutritional status of children under five years, specifically in areas affected by volcano eruptions.

Therefore, in this study, we assessed the farmers' expenditures and the nutritional status of children under five years in areas affected by the Sinabung eruption. Specifically, we (1) compared food and other expenditures among different groups of farmers; (2) estimated and compared the prevalence of malnutrition among children under five years according to their parent's occupation; and (3) identified food and other expenditures associated with children's malnutrition between two groups of farmers, namely farmers and farmers cum farm labourers.

METHODS

Study design

A cross-sectional study was carried out to determine the relationship between farmers' expenditures and the nutritional status of children under five years in areas affected by Indonesia's Sinabung eruption. The data was collected from December 2018 to June 2019.

Sampling

We performed a multistage sampling technique in four sub-districts affected by the eruption of Mount Sinabung. We applied purposive sampling technique to select seven villages amongst 15 villages in four sub-districts. Additionally, we used systematic random sampling to choose every 5th household from the sampling frame. We had a sample size of 444 households.

A child was selected by random draw if a household had more than one child aged between 12-59 months. The children were given numbers starting from 1 for the youngest, 2 for the second youngest, and so on. A small box consisting of numbers was used to select a child randomly. For example, if there were three children in the household,

numbers 1-3 were added into the box. The number drawn from the box matched the child.

Data collection

The questionnaire used for data collection in this research was modified from the Indonesian Family Life Survey questions (IFLS). Meanwhile, before using the questionnaire, we adjusted the questions to fit the local people and culture with 30 farmers. Therefore, the questionnaire is applicable only in these specific research areas.

Three enumerators in each study area interviewed the mothers or guardians that had children under five years in the participating households. The community leader accompanied the enumerators during visits to the chosen households for samples of this survey. A structured questionnaire (IFLS) was used to obtain information on socio-economic indicators, household income, and food and non-food expenditures. The enumerators did not collect data on the value of household food stocks consumed and value of gifts consumed.

Household income, other cash resources, and expenditure variables were collected for the last three months with this information recollected from their memory. All cash resources and expenses were recalculated by researchers in Indonesian Rupiah (IDR) as monthly household income, food, and non-food expenditures, then converted into the United States dollar (USD) (using the exchange rate in January 2019, USD1 = IDR14,033) (Exchange rate.org., 2019).

Data collection was mostly done in the morning, right before the farmers left for work and in the afternoon after they have returned home. In this research, the participants were classified into three different groups of farmers as follows:

a. Farmers: people who worked in their own fields.
b. Farmers cum farm labourers: people who owned fields and worked as day labourers in other fields.
c. Farm labourers: people who did not own any field but worked for others as day labourers.

Additionally, there were farmers who worked slightly differently from the above categories, namely "sharecroppers". This group of farmers worked for a certain period on a contract basis. The field owners provided farming necessities, including seeds, soil fertilisers, and pesticides. The profits were shared by calculating the entire income reduced by total capital, and then the rest of the total profit was divided into two (field owner and sharecropper). Thus, the people who worked only as sharecroppers were also considered as farm labourers. But sharecroppers who also owned fields were considered as farmers cum farm labourers. The data of farmers' expenditures collected are as in Box 1.

Anthropometry measures

Prior to fieldwork, we conducted proper training for the three enumerators to perform anthropometry by using the World Health Organization (WHO) training manual on child growth (WHO, 2008). A taring scale was used to measure the children's body weight. The scale was placed on a flat, hard surface. The children were weighed with minimal clothing by undressing them and removing as much clothing as possible. At the same time, the length of children aged 12-23 months old was measured by using a length board that was placed on a flat and stable surface such as a table. The height of children aged 24-60 months old was measured by using a height board mounted at a right angle between a floor and a straight, vertical surface such as a wall. In this study, the enumerators did not measure the

Box 1. Farmers' expenditures

	Description
Food expenditure	
Rice	a. Self-production b. Government aid + purchase c. Purchase
Protein sources: Salted fish, egg, and *tempeh*/tofu	
Vegetables	a. Self-production b. Self-production/tip + purchase c. Purchase
Condiments	
Sugar	
Vegetable Oil	
Snacks	
Non-food expenditures	
Soil fertilisers, pesticides, and seeds	
LPG, electricity, mobile phone bill	
Household items (i.e., soap, washing detergent)	
Gasoline	a. No vehicle b. Has vehicle
Cigarettes	a. No household member who smokes b. Has household member who smokes
*Ngopi**	a. No household member who *ngopi* b. Has household member who *ngopi*
*Nyuntil***	a. No household member who *nyuntil* b. Has house member who *nyuntil*

Note:
**Ngopi* is a socio-cultural habit practised by the Karo tribes by drinking coffee or tea in the morning and/or night time at small stalls. These stalls have functioned as a gathering place where people can have chats and knowledge sharing, including farming topics. It is done by adult men only.
***Nyuntil* is a socio-cultural habit practised by Karonese women, where they chew some herbs such as betel leaves, betel nut, gambier, and tobaccos.

plane of a child's head. The software for Emergency Nutrition Assessment (ENA) was used to measure the children's nutritional status. The ENA software was used to convert age, length/height, and weight into z-scores. Three indices were used in assessing the nutritional status of children: height-for-age z-score (HAZ), weight-for-age z-score (WAZ), and weight-for-height z-score (WHZ), which were calculated by using the WHO growth reference standard (WHO, 2006).

Ethical considerations

Permission to carry out the study was obtained from the Naresuan University Institutional Review Board (NU-IRB), Thailand (IRB Certificate No. 0098/62). Informed consent was obtained from the mothers or guardians before their child was assessed in the study.

Statistical analysis

The USD unit was used for mean expenditure, and percentage (%) unit for mean proportion of expenditure. The proportion (in % unit) was calculated from the expenditures on food and non-food divided by total expenditure multiplied by one hundred. Expenditures on food and non-food of the participants, as well as their children's age, gender, weight and height, and nutritional status, were compared among groups of farmers with the use of chi-square test for categorical variable (gender) and the Welch's analysis of variance (ANOVA) test for continuous variables (children's nutritional status such as HAZ, WAZ, and WHZ). The Welch's ANOVA test was used because the homogeneity of variances assumption was not supported by the Levene's test (Jan & Shieh, 2014).

To analyse the correlation between food and non-food expenditures with the nutritional status of children, we used binomial logistic regression. Researchers did a binomial logistic regression with food expenditures (protein sources, vegetables, condiments, snacks) and non-food expenditures (farming essentials, cigarettes, *nyuntil*, *ngopi*) as continuous variables (independent variables), and nutritional status of children under five years (underweight, stunting, wasting) as a binary (dependent variables). All analyses were conducted using the IBM SPSS, version 17, and $p<0.05$ was considered significant for all statistical tests.

RESULTS

Table 1 shows that the average age of the three groups of participants was statistically different ($p<0.001$), where the mean age of farmers was 31.9 years, followed by the mean age of farm labourers (28.4 years), and farmers cum farm labourers (27.9 years). In contrast, schooling in years had no significant difference ($p=0.305$). The average schooling years of farmers were 9.7 years, farmers cum farm labourers were 9.8 years, and farm labourers were 10.3 years.

Apparently, the participants' marital status was also homogenous,

Table 1. Characteristics of participants in each group

Characteristics	*Farmers* (*n=158*)	*Farmers cum farm labourers* (*n=228*)	*Farm labourers* (*n=58*)	$p^{\dagger}$
Participant				
Age (years)	31.9±6.7	27.9±6.2	28.4±6.7	<0.001
Schooling (years)	9.7±2.5	9.8±2.4	10.3±2.6	0.305
Marital status				
Married	149 (94.3)	221 (96.9)	55 (94.8)	0.427
Single, divorced, or widow	9 (5.7)	7 (3.1)	3 (5.2)	
Households				
Family size	5.7±1.1	4.6±1.1	4.7±1.2	<0.001
Total income per month (USD)	169.7±21.6	153.3±18.7	127.1±19.4	<0.001
Proportion food expenditure (%)	27.1±9.2	42.8±12.9	57.1±18.2	<0.001
Poportion non-food expenditure (%)	72.9±9.2	57.2±12.9	42.9±18.2	<0.001

Data are presented as *n* (%) or mean±*SD*

†Calculated using the chi-square test for categorical variables and the Welch's ANOVA test for continuous variables

USD1 = IDR14,033

as its *p*-value was 0.427 ($p>0.05$). This showed that >94% of participants in all groups were mainly married or cohabiting. Furthermore, the participants' household characteristics were significantly different ($p<0.001$). By family size, farmers had an average family member of 5.7 (5-6 people), while the mean number of family members for farm labourers and farmers cum farm labourers were 4.6 (4-5 people) and 4.7 (4-5 people), respectively.

From the aspect of household income, the mean total income per month showed that farmers earned the highest (169.7 USD) compared to farmer labourers (153.3 USD), and farmers cum farm labourers (127.1 USD). In contrast, farmers allocated less amount for food compared to other groups, which was 27.1% of the total expenditure. Farmers cum farm labourers spent slightly higher (42.8%) and the highest was farm labourers (57.1%). This phenomenon happened as a result of the fact that farmers needed to spend more of their income on non-food expenditures (such as financing farming needs) forced by unfavourable situations during the Sinabung eruption. As shown, the proportions of the amount spent on non-food expenditures by different groups were: farmers as the highest (72.9%), followed by farmers cum farm labourers (57.2%), and farm labourers (42.9%) as the lowest.

Table 2 shows the difference between food expenditure among different groups of farmers in areas affected by the Sinabung eruption. Based on the mean value of expenditure on rice, we found that farmers spent the least (19.9 USD) and farmers cum farm labourers spent 27.8 USD, followed by farm labourers (32.2 USD) with the highest. This could be explained by the percentage of rice access among these three groups, relying on self-production, government aid plus purchase, and purchase only. The data found that most farmers (71.5%) received access from government aid plus purchase, and 10.8% of them met their rice needs by self-production. A total of 64.5% of farmers cum farm labourers and 74.1% of farm labourers must purchase their rice. Therefore, statistically, rice access and rice expenditure were significantly different ($p<0.001$) among these three groups of farmers, and so was the mean value of the proportion of rice expenditure with its $p<0.001$.

Interestingly, the $p<0.001$ shown in the food expenditure of protein sources meant that there were significant differences among the three groups of farmers in protein consumption. The expenditures on protein sources were 9.1 USD by farmers, 13.9 USD and 14.1 USD by farmer cum farm labourers, and farm labourers, respectively. The mean value of the proportion of protein sources expenditure showed a similar trend (5.4% of farmers, 9.0% of farmers cum farm labourers, and 11.2% of farm labourers).

Furthermore, the participants accessed vegetables through self-production, self-production/gift plus purchase, and purchase only. Among the three groups of farmers, the data remained to show a significant difference ($p<0.001$). The mean proportion of vegetable expenditure showed that farmers spent less (1.3%), farmers cum farm labourers spent a little more (2.1%), and farm labourers spent the largest proportion (2.8%). Thus, the mean of their expenditure was undeniably different (farmers 2.2 USD, farmers cum farm labourers 3.3 USD, and farm labourers 3.5 USD).

Besides the three main food expenditures (rice, protein sources, and vegetables), there were other complementary food sources such as condiments, sugar, vegetable oil, and snacks. The average expenditure for

condiments showed that all three groups of farmers were significantly different, as farmers spent 7.1 USD, while farmers cum farm labourers, and farm labourers spent slightly higher (9.0 USD vs 9.5 USD). Likewise, the proportion of condiments expenditure was seen to be statistically different, with farmers spending the lowest proportion compared to the rest. Similarly, the proportion of sugar and vegetable expenditures showed significant difference (p<0.001) among the three groups. However, interestingly, the average of sugar and vegetable oil expenditures found that farmers and farm labourers spent the same amounts (sugar 1.3 USD, and vegetable oil 1.7 USD). Finally, the expenditure on snacks also showed a significant difference.

In the areas affected by Sinabung's eruption, we found that the participants' non-food expenditures (Table 2) had taken a significant proportion of their income. One of the dominant non-food expenditures was farming necessities (soil fertilisers, pesticides, seeds), with a significant difference among the three groups of farmers. Importantly, farm labourers were free of this expenditure as they were just labourers. In contrast, farmers spent the highest (54.2 USD) for buying farming necessities, even more than half of their total expenditure, and so did its average proportion, at p<0.001.

The expenditure for LPG, electricity, and mobile phone bill was found similar among the groups. Farm labourers spent the most (5.9 USD), while farmers and

Table 2. Expenditures on food and non-food of study participants in each group

	Farmers (n=158)	*Farmers cum farm abourers (n=228)*	*Farm labourers (n=58)*	$p^{\dagger}$
Food expenditures				
Rice access				
a. Self-production	17 (10.8)	21 (9.2)	0 (0.0)	<0.001
b. Government aid + purchase	113 (71.5)	60 (26.3)	15 (25.9)	
c. Purchase	28 (17.7)	147 (64.5)	43 (74.1)	
Rice expenditure (USD)	19.9±9.8	27.8±12.5	32.2±11.3	<0.001
Proportion rice expenditure (%)	11.8±5.9	18.0±7.9	25.6±9.2	<0.001
Protein sources: Salted fish, egg, and *tempeh*/tofu expenditure (USD)	9.1±3.5	13.9±4.4	14.1±4.8	<0.001
Proportion protein salted fish, egg, *tempeh*/tofu expenditure (%)	5.4±2.1	9.0±2.7	11.2±4.0	<0.001
Vegetables access				
a. Self-production	33 (20.9)	14 (6.1)	0 (0.0)	<0.001
b. Self-production/gift + purchase	105 (66.5)	112 (49.1)	25 (43.1)	
c. Purchase	20 (12.7)	102 (44.7)	33 (56.9)	
Vegetables expenditure (USD)	2.2±1.4	3.3±1.3	3.5±1.1	<0.001
Proportion vegetables expenditure (%)	1.3±0.9	2.1±0.9	2.8±0.9	<0.001
Condiments expenditure (USD)	7.1±2.2	9.0±2.8	9.5±2.7	<0.001
Proportion condiments expenditure (%)	4.2±1.3	5.9±1.9	7.6±2.6	<0.001
Sugar expenditure (USD)	1.3±0.2	1.4±0.2	1.3±0.2	<0.001
Proportion sugar expenditure (%)	0.8±0.2	0.9±0.2	1.1±0.3	<0.001
Vegetable oil expenditure (USD)	1.7±0.0	1.7±0.1	1.7±0.0	0.675
Proportion oil expenditure (%)	1.0±0.1	1.1±0.2	1.4±0.2	<0.001
Snacks expenditure (USD)	4.4±3.5	8.8±4.5	9.4±5.0	<0.001
Proportion snacks expenditure (%)	2.6±2.0	5.7±2.9	7.4±2.9	<0.001

Table 2. Expenditures on food and non-food of study participants in each group [Cont'd]

	Farmers (n=158)	*Farmers cum farm abourers (n=228)*	*Farm labourers (n=58)*	*p*†
Non-food expenditures				
Soil fertilisers, pesticide, seeds expenditure (USD)	54.2±7.5	30.6±6.9	0.0±0.0	<0.001‡
Proportion fertiliser expenditure (%)	32.2±4.8	20.3±5.4	0.0±0.0	<0.001‡
LPG, electricity, mobile phone bill expenditure (USD)	5.6±1.0	5.6±1.0	5.9±1.1	0.201
Proportion LPG, electricity, mobile phone bill expenditure (%)	3.4±0.7	3.7±0.8	4.7±1.2	<0.001
Household items (i.e., soap, washing detergent) expenditure (USD)	2.5±0.7	2.6±0.6	2.5±0.7	0.449
Proportion household items (i.e., soap, washing detergent) expenditure (%)	1.5±0.4	1.7±0.5	2.0±0.7	<0.001
Gasoline				
a. No vehicle	21 (13.3)	33 (14.5)	6 (10.3)	0.546
b. Has vehicle	137 (86.7)	195 (85.5)	52 (89.7)	
Gasoline expenditure (USD)	10.5±5.7	10.8±6.1	11.7±5.9	0.710
Proportion gasoline expenditure (%)	6.1±3.3	7.0±3.9	9.2±4.8	0.384
Cigarettes				
a. No household member who smokes	15 (9.5)	43 (18.9)	15 (25.9)	0.060
b. Has household member who smokes	143 (90.5)	185 (81.1)	43 (74.1)	
Cigarettes expenditure (USD)	40.4±17.4	27.3±17.1	27.2±20.6	<0.001
Proportion cigarettes expenditure (%)	23.4±9.5	17.7±10.9	20.7±16.4	<0.001
Ngopi				
a. No household member who *ngopi*	48 (30.4)	84 (36.8)	29 (50.0)	0.028
b. Has household member who *ngopi*	110 (69.6)	144 (63.2)	29 (50.0)	
Ngopi expenditure (USD)	7.5±5.3	6.4±5.3	4.8±5.0	0.003
Proportion *ngopi* expenditure (%)	4.3±3.1	4.1±3.4	3.7±4.1	0.502
Nyuntil				
a. No household member who *nyuntil*	104 (65.8)	136 (59.6)	39 (67.2)	0.354
b. Has house member who *nyuntil*	54 (34.2)	92 (40.4)	19 (32.8)	
Nyuntil expenditure (USD)	3.4±4.9	4.2±5.3	3.4±5.1	0.298
Proportion *nyuntil* expenditure (%)	2.0±2.8	2.7±3.4	2.6±3.9	0.100

Data are presented as n (%) or mean±*SD*
†Calculated using the chi-square test for categorical variables and the Welch's ANOVA test for continuous variables
‡Calculated using the *t*-test
USD1 = IDR14,033

farmer cum farm labourers spent equally (5.6 USD). However, its proportion showed $p<0.001$ due to differences in the monthly total expenditure. Accordingly, the expenditure on household items showed a similar trend; meaning that the average proportion was significantly different, yet its average expenditure was not.

Moreover, for gasoline expenditure, all groups of farmers spent similarly with a $p=0.710$ for expenditure (USD) and a $p=0.380$ for its proportion (%). This showed that most of them owned a personal motorcycle. It was observed that owning a vehicle was essential to escape during the time of Sinabung's eruption. There were non-food expenditures that were spent only by men: cigarettes and *ngopi* expenditures. Additionally, many farmers smoked and did *ngopi* daily. The average proportion was significantly different among the three groups of farmers ($p<0.001$). The highest expenditure spent on cigarettes was farmers (40.4 USD), followed by farmers cum farm labourers, and farm labourers with an equal average of 27.3 USD and 27.2 USD, respectively. In contrast, in the expenditure of *ngopi*, the average value had a significant difference ($p=0.003$). Nonetheless, its proportion was not significantly different ($p=0.502$). Whilst men spent on cigarettes and *ngopi*, *nyuntil* expenditure was another non-food expenditure that was spent only by women. The mean expenditure (USD) and the mean proportion of expenditure (%) for *nyuntil* had no a significant difference. Figure 2 shows the trends of expenditures on foods and non-foods.

Table 3 shows the anthropometry of children under five years with respect to their parent's occupation. The children of farmers, farmers cum farm labourers, and farm labourers showed similar characteristics ($p=0.555$) irrespective of gender. Anthropometric measurements showed that z-scores of weight-for-age, height-for-age, and weight-for-height were statistically different; whereby children of farmers tended to have lower z-scores in each indicator. The prevalences of underweight (32.2% vs. 19.3% vs. 15.5%, $p<0.001$, respectively), stunting (46.8% vs. 33.8% vs. 27.6%, $p=0.070$, respectively), and wasting

Table 3. Anthropometry of children under five years according to parent's occupation

Characteristics and anthropometrics	*Farmers (n=158)*	*Farmers cum farm labourers (n=228)*	*Farm labourers (n=58)*	$p^{\dagger}$
Gender				0.555
Boys	82 (51.9)	112 (49.1)	33 (56.9)	
Girls	76 (48.1)	116 (50.9)	25 (43.1)	
Weight-for-age z-score	-1.34±1.22	0.08±1.55	0.46±1.63	<0.001
Height-for-age z-score	-1.58±1.36	-0.33±1.78	0.03±1.81	<0.001
Weight-for-height z-score	-0.94±1.21	0.51±1.30	0.66±1.46	<0.001
Underweight	51 (32.3)	44 (19.3)	9 (15.5)	
Stunting	74 (46.8)	77 (33.8)	16 (27.6)	
Wasting	26 (16.5)	20 (8.8)	4 (6.9)	

Data are presented as *n* (%) or mean±*SD*

[†]Calculated using the chi-square test for categorical variables and the Welch's ANOVA test for continuous variables

Table 4. Odds ratios (ORs)† of malnutrition (underweight, stunting, and wasting) by farmers' food and non-food expenditures

Expenditures	*Farmers (n=158)*			*Farmers cum farm labourers (n=228)*		
	Underweight	*Stunting*	*Wasting*	*Underweight*	*Stunting*	*Wasting*
	p-value *OR (95% CI)*	*p-value* *OR (95% CI)*	*p-value* *OR (95% CI)*	*p-value* *OR (95% CI)*	*p-value* *OR (95% CI)*	*p-value* *OR (95% CI)*
Rice	0.090 0.95 (0.89, 1.01)	0.003 1.07 (1.02, 1.13)	0.666 1.02 (0.95, 1.09)	0.941 1.00 (0.92, 1.08)	0.110 1.03 (0.99, 1.07)	0.800 1.02 (0.89, 1.16)
Protein sources	0.001 1.47 (1.18, 1.83)	0.103 1.17 (0.97, 1.42)	0.075 1.23 (0.98, 1.56)	0.019 1.74 (1.10, 2.77)	0.517 1.07 (0.86, 1.34)	0.239 1.45 (0.78, 2.68)
Vegetable	0.869 0.97 (0.66, 1.43)	0.058 1.48 (0.99, 2.22)	0.025 1.61 (1.06, 2.43)	0.085 1.82 (0.92, 3.61)	0.037 1.75 (1.03, 2.95)	0.727 1.19 (0.46, 3.09)
Condiments	0.040 1.26 (1.01, 1.56)	0.511 0.93 (0.76, 1.15)	0.292 1.14 (0.89, 1.46)	0.910 0.98 (0.68, 1.42)	0.141 1.17 (0.95, 1.45)	0.723 1.11 (0.63, 1.97)
Snacks	0.233 1.12 (0.93, 1.35)	0.988 1.00 (0.85, 1.17)	0.021 1.53 (1.06, 2.20)	0.129 1.38 (0.91, 2.10)	0.306 1.09 (0.92, 1.28)	0.202 1.60 (0.78, 3.30)
Fertiliser, pesticide, seeds	0.440 1.38 (1.03, 1.83)	0.011 1.53 (1.39, 1.98)	0.159 1.36 (1.10, 1.62)	0.267 1.01 (0.96, 1.38)	0.046 1.03 (1.00, 1.40)	0.237 1.01 (0.92, 1.23)
Cigarettes	0.253 1.09 (1.04, 1.13)	0.011 1.04 (1.01, 1.06)	0.744 1.01 (0.97, 1.04)	0.245 0.97 (0.91, 1.02)	0.046 0.97 (0.94, 1.00)	0.579 0.98 (0.90, 1.06)
Nyuntil	0.264 0.96 (0.88, 1.03)	0.317 0.96 (0.89, 1.04)	0.118 0.93 (0.86, 1.02)	0.726 0.97 (0.84, 1.13)	0.899 1.00 (0.93, 1.08)	0.164 0.87 (0.71, 1.06)
Ngopi	0.246 1.04 (0.97, 1.12)	0.640 0.98 (0.92, 1.05)	0.624 1.02 (0.94, 1.11)	0.812 1.02 (0.88, 1.18)	0.944 1.00 (0.93, 1.07)	0.908 1.01 (0.83, 1.23)

†Odds ratios (ORs) have been adjusted by age and sex of the children

(16.5% vs. 8.8% vs. 6.9%, $p<0.001$, respectively) were higher in children of farmers.

Table 4 shows that food expenditures especially rice, protein sources, and condiments of farmers had a significant association with underweight children. While children with stunting were significantly associated with only rice expenditure. In the case of wasting, we found that expenditures on vegetables and snacks were significantly correlated. The non-food expenditures of farmers showed that farming necessities and cigarettes expenditure were associated considerably with children with stunting. Among children of farmers cum farm labourers, underweight was related to the expenditure on protein sources, while vegetables expenditure was correlated with stunting cases. Additionally, the correlation of children's malnutrition case with non-food expenditures showed that the expenditures on farming necessities and cigarettes were also significantly associated with stunting in children.

DISCUSSION

We found that rice expenditure of the three groups of farmers was significantly different. The people whose occupation was farmer, tended to utilise rice from the government aid in order to allocate their income for other expenditures. Having free rice during post-Sinabung eruption was financially helpful; however, this type of rice was problematic due to its low quality in smell and taste. The low quality of rice was due to long time storage in the Bureau of Logistics (BULOG) (United States International Trade Commission, 2015). As a result, this rice was less likely edible as most people hardly ate them. Children showed less interest to eat this rice, which then leads to inadequate carbohydrate intakes (Naylor, 2014). Referring to Block *et al.*, (2004) low quality rice had an impact towards fewer calories intake and could affect malnutrition, especially in children under five years during Indonesia's crisis.

The farmers group had the lowest average expenditure on protein sources (9.1 USD). Consequently, children were prone to have inadequate protein intakes in their daily meals. Similarly, the study showed that in comparison to other groups, farmers spent the least part of their income on vegetables, which are sources of vitamins and minerals. This was partially caused by the higher need on non-food expenditures of the farmers (Figure 2). Children need an adequate amount of food intake, including protein, vitamins and minerals for optimal growth. In the case of children who consume less nutrition, they tend to acquire a high risk of chronic malnutrition (Steyn *et al.*, 2006; WHO, 2013). Besides food expenditures, as farming activities in the areas were affected by Sinabung's eruption, the study found that non-food expenditures of households had taken their income in a larger proportion. Households who were working as farmers only generally spent approximately >54% of their total income to purchase farming necessities, such as soil fertilisers, pesticides, seeds etc. They then tended to reduce their food expenditures so that they could fund their farming activities in the upcoming seasons. Moreover, under the circumstances of natural disasters, especially volcanic eruptions, farming activities require even higher amounts of capital. The results published by Bargout & Raizada showed that no or very little attention has been given to improve soil fertility, which led to poverty and chronic malnutrition in children (Bargout & Raizada, 2013).

For households who had extra jobs apart from working as farmers only, they were able to earn additional income. As

they were not working as farmer only, they indirectly received benefits for having lower percentages of expenditures on farming necessities. Apart from that, we found that households working as farmers only tended to smoke more compared to farm labourers. By observation, we figured out that the different types of workloads explained this. Farm labourers had to spend more time working in the field, which made them smoke only during resting time. In contrast, farmers with fewer workloads found plenty of time for smoking. In the aspect of non-food expenditures, both farming necessities and cigarettes have therefore taken a huge portion of their income. Accordingly, these led to reduction on food expenditures. Therefore, children with parents working as farmers who lived in areas affected by the Sinabung eruption tended to have a higher risk of malnutrition.

Under these circumstances, the occupation as farm labourers had a better opportunity to have children with good nutritional status, given the reason that most of them earned incomes without the need to spend on farming activities. Consequently, they could allocate their income to provide for their daily household needs, including food. A study in Madagascar in areas affected by cyclones had also found that >50% of the farmers having a temporary outside job had effective coping strategies to earn income to provide for daily needs, including food (Rakotobe *et al.,* 2016).

Conducting research in areas affected by natural disasters (especially volcano eruptions) has indeed brought some challenges and limitations. We admit that we faced either technical or non-technical problems in the field. For example, during the data collection process, we struggled to have an appointment with the participants at the appropriate time, specifically with groups of farm labourers who mostly go to work early in the morning and returned only in the late afternoon. Sometimes, we had to stay overnight with them after interviews as it was quite hard to travel at night in those areas. Additionally, many of the mothers or guardians that were interviewed barely focused during the session, as they were distracted by household activities, including childcare. Hence, we even had to reschedule our appointments for interviews.

Furthermore, we expected that both fathers and mothers (or guardians) could provide information on household expenditures together at the time of the interview, but the data collected were mostly from mothers or guardians only, which may affect the imbalance of information on non-food expenditures. This was caused by the socio-cultural aspect where men (fathers) tended to go out often for *ngopi* either in the morning before work or/and in the evening after returning from work. Therefore, for future research, we strongly suggest that researchers find appropriate ways to solve these challenges so that they will be able to do data collection with both fathers and mothers at the same time to gain deeper and more balanced information.

CONCLUSION

Non-food expenditures had a huge impact on household livelihoods, which was significantly associated with children's nutritional status. Among the three groups of farmers, children of farmers and farmers cum farm labourers were prone to malnutrition. This was because these two groups had to limit food expenditures over their farming necessities (soil fertilisers, pesticides, and seeds) and cigarettes expenditure, which took more than half of their income. However, the prevalence of malnutrition among children was highest in children of farmers.

Children of farm labourers had better nutritional status compared to the other two groups. Although this group earned less than the rest of the groups, they allocated more on food expenditures. The other two groups had major non-food expenditures, especially farming necessities, but working as farm labourers only had an advantage of zero expenditure on farming necessities. Even though their job as farm labourers only was insufficient in the time of Sinabung's eruption, they could meet the needs of nutrition for their children.

It is suggested that the policymakers should provide accessible loans for farmers to fund their farming activities during unpredictable circumstances like the Sinabung eruption, given that the farmers were unable to access private loans from banks or any other financial institutions. Additionally, policymakers in Indonesia should provide food and nutrition security to children who were impacted by the Sinabung eruption.

Acknowledgments

We hereby acknowledge the farmers who participated in this study. Particularly, we express our gratitude to Dr. Michelle Miller at the Asia Research Institute of the National University of Singapore (NUS) for her contributive suggestions**.**

Authors' contributions

SG, principal investigator, conceptualised and designed the study, led the data collection, data analysis and interpretation, and prepared the draft of the manuscript; NK, advised on the study design, data analysis, interpretation, and reviewed the manuscript; SM, advised on data analysis and interpretation, and reviewed the manuscript.

Conflict of interest

The authors reported no potential conflict of interest.

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