FACTORS ASSOCIATED WITH OPEN BURNING BEHAVIORS AMONG THAI AND HILL TRIBE FARMERS IN NORTHERN THAILAND

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ABSTRACT:

Background: Air pollution is a major public health problem. In 2016, 936,000 deaths were attributed to ambient air pollution in Southeast Asia. For over a decade, it has been associated with several health problems to residents of northern Thailand. The study aimed to investigate the factors associated with open burning behavior among Thai and hill tribe famers in northern Thailand.

Methods: A cross-sectional study design was applied to elicit information from the participants by a validated questionnaire using the face-to-face method. The study was conducted in the Mae Fah Luang and Muang District, Chiang Rai Thailand. A logistic regression model was used for determining the association between variables at alpha level=0.05.

Results: A total of 354 participants were recruited into the study, 177 each from Mueang and Mae Fah Luang Districts Chiang Rai province. One hundred and seventy-seven were Thais while the same number were hill tribe farmers. The mean age of the respondents was 51.3. About 58.5% were males, 84.5% were married, 69.2% had received formal education, 78.2% were Buddhists, and the average monthly income was 5,977.7 THB. Two factors were found to be significantly associated with open burning behavior after controlling for all possible compounding factors: those within the low environmental health knowledge group had a greater likelihood of engaging in open burning than those within the high level of environmental health knowledge group (OR= 98.39, 95%CI= 22.02-439.54), and the lesser the land cultivated, the lower the likelihood of open burning (OR_{adj} =0.01, 95% CI 0.00 – 0.04).

Conclusion: Low levels of environmental health knowledge, an aspect of environmental health literacy and size of cultivated land were found to be the major factors associated with open burning behavior in Chiang Rai Province, Thailand. There is a need to develop strategic intervention policies in order to enhance the environmental health literacy level of farmers in the area and by extension, reduce the rate of open burning.

Keywords: Open burning; Farmers; Hill tribe; Environmental health literacy; Thailand

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INTRODUCTION

Open burning, which entails "any outdoor fire that does not burn within a container equipped with a chimney or stack" [1], is the single largest source of black carbon globally, at 42% dwarfing all other sources [2]. Air pollution emanating from sources including open burning is recognized as an important determinant of health and a public health problem [3, 4]. In 2012, 3.7 million deaths were attributed to ambient air pollution. In a regional breakdown, it was found that the Western Pacific

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Region had the highest number of deaths (1,670,000) while the Southeast Asian Regions was the second highest with 936,000 deaths [3]. The smoke from open field burning not only produce smokes that affect health but also impacts climate change [5].

Moving from an agrarian society to an industrialized one, Thailand is faced with various environmental problems, especially air pollution, leading to adverse health effects [6]. Open burning, a common method of managing rice residue and control of weeds by farmers in Thailand is one of the major sources of air pollution in Thailand [6] and this constitutes a serious public health problem in Thailand [7]. It has been recognized as smog crisis since 2007 especially in the northernmost part of the country [8]. Every year, between February and April, dry-season aridity and rising temperatures coincide with forest fires which are as a result of people hunting for wild items like earth star mushrooms for its high market value [9], as well as agricultural burning which continues to envelope the Northern part of Thailand in smoke during this period [10]. Dust is another serious environmental problem. The level of fine particulate matter (PM10), which is the most important air pollutant [6] continues to rise higher than the acceptable standard [7]. Recently (in March 2016), Mae Sai District of Chiang Rai Province had a record of 410 micrograms per cubic metre (u/cg) of harmful air particles. Previous studies reported that air pollution producing PM10 and PM2.5 from hotspot areas was associated with chronic obstructive pulmonary disease (COPD) and respiratory illnesses [10, 11]. In Northern Thailand especially in Chiang Rai province, it reportedly has the highest rates of lung cancer, and high incidence of chest diseases and cardiac conditions. Moreover, it affects the tourism industry, socio-economic development, public health and causes a disturbance to the daily life of the population in the region [12, 4]. Despite the message from the UN Office for the Coordination of Humanitarian Affairs that the amount of greenhouse gas in the atmosphere is already above the threshold that can potentially cause dangerous climate change [13], the end to environment destruction induced by human activities and anti-environmental behavior (poor/ineffective waste management, environmental degradation, man-made pollution etc.) is nowhere in sight.

Environmental health literacy, defined as an understanding the link between environmental exposures and health, is an emerging and developing concept. It entails elements of health literacy and environmental literacy [14]. It focuses on preventing and reducing environmental exposures that may lead to poor health. As an emerging discipline, not enough has been done in the area of environmental health literacy and its link to behavior. However, studies explained [11, 15-19] the nearness between environmental health knowledge and environmental behavior with some results showing the associations with opening burning but others had results in opposite explanations. Therefore, this study aimed to investigate the factors associated with open burning behavior among Thai and the hill tribe farmers in northern Thailand.

METHODS

Study design

A cross-sectional study was performed to evaluate the factors influencing open burning behaviors among Thai and the hill tribe farmers in Chiang Rai province, Thailand.

Study setting

The study settings were Mueang and Mae Fah Luang districts where data was collected for both Thai and hill tribe farmers.

Study population

The study populations were recruited from Thai and Hill tribe people who were farmers and living in Chiang Rai province.

Study sample

Using Leslie Kish formula [20], the sample size derived for both districts was 322, with 10.0% added for any possible errors in the process of the study, a total of 354 participants were required.

Research instrument

Prior to this study, literature searches regarding environmental health literacy was done on journal databases, after which a tool was developed by the researchers for a preliminary stage which involved focus group discussions and in-depth interviews [21] to gather the information from the subjects. The questionnaire was validated by two experts from the environmental health science and one expert from public health through the Item Objective Congruence Index (IOC) [22, 23] before use. The reliability of the questionnaire was determined by conducting a pilot study on 20 Thai 20 hill tribe farmers in Mae Chan district of Chiang Rai province. The knowledge section was tested using

KR-20 [24] with an overall value of 0.72. Attitude and practice sections were tested for reliability by Cronbach's alpha [25] with an overall value of 0.72 and 0.76 respectively.

The questionnaire consisted three parts namely: (1) basic and essential knowledge of environmental health issues, and understanding of the link between environmental exposures e.g. air pollution and health; (2) attitude and (3) practices (defined to include attitude, perceptions, and general practices with regards to environmental health at both personal and community levels). Knowledge section contained 15 multiple choice questions for the total possible score of 15. Using tertiles, it was classified as follows: 0-5= low knowledge, 6-10= average knowledge and 11-15= high knowledge. The attitude section had 15 questions with three answer options: "Disagree", "Undecided" and "Agree". The negative attitude questions were re-coded as 3, 2, and 1. Possible scores ranged from 15-45. Classification was predetermined [26] ≤25 = Negative attitude, 26 – 35 = Neutral attitude, 36 - 45 = Positive attitude. The practice section included questions relating to general practices with regards to environmental health at both personal and community levels. For example, *"Do you engage in hunting that involves burning?"*, *"How often do you work with others in your community to manage air pollution?"*, *"Whenever there is air pollution, do you go to the hospital if you notice symptoms?"* Likert scale of five points was used to represent the scores for practice section: "Never", "Rarely", "Sometimes", "Often" and "Very often" [27]. Scores of 1, 2, 3, 4 and 5 were given to "Never", "Rarely", "Sometimes", "Often" and "Very often" respectively. For negatively phrased statements, scores were re-coded as 5, 4, 3, 2, and 1. This section contained 15 questions, therefore possible scores ranged from 15 to 75. Using tertiles, classification was in the following order, ≤35 = Bad practice, 36-55 = Moderate practice, ≥56 = Good practice.

Data gathering procedures

The researcher requested approval from community leaders and liaised with health promoting hospital staff. Participants were recruited based on the inclusion and exclusion criteria. The inclusion criteria was Thai and Hill tribe people who were farmers and living in Chiang Rai province, while the exclusion criteria was those who did not understand Thai language. At the Mueang Chiang Rai area, participants were recruited from Bandu, Mae Yao, Thasud, Nanglae and Maekathom villages, while at Mae Fah Luang, they were recruited from Thoet Thai, Maesalong Nok and Maesalong Nai villages.

Participants were informed on the purpose of the study before eliciting information and granted confidentiality on the ground that information provided shall be treated as confidential requested to provide information according to the questionnaire.

Statistical analysis

Data were coded and entered into Microsoft excel spreadsheet and analysis was done using SPSS version 20.0 (SPSS, Chicago, IL). Descriptive statistics such as mean, percentage and standard deviation were used to present the general characteristics of the participants. Chi-square test was done to determine the differences in general characteristics, environmental health knowledge, attitude and practices between Thai and hill tribe farmers. Logistic regression was done to determine the association between variables at significant level $\alpha = 0.05$.

Ethical considerations

This study was approved by The Mae Fah Luang University Research Ethics Committee on Human Research, Based on The Declaration of Helsinki (No.REH-58085). Participants were given a token for participating in the research. Permission was obtained from the community leaders and local authorities to conduct the research. Participants were informed of the content of the study and had the option to discontinue their participation.

RESULTS

A total of 354 farmers, 177 each from Mueang and Mae Fah Luang, Chiang Rai province, was recruited for this study. The mean age of the respondents was 51.3 (max= 75, min= 19, S.D= 10.8). There were 207 males (58.5%) and 147 females (41.5%); 299 (84.5%) were married; 69.2% of the respondents had formal education while 30.8% had none. One hundred and seventy-seven were Thai while the same number was hill tribe farmers. Majority of the respondents were Buddhists accounting for 78.2% while 21.8% were Christians. The average monthly income was 5,977.7 THB.

There were significant differences between Thai and hill tribe famers in terms of educational level (p-value<0.001) and religion (p-value<0.001); 55.4% of the hill tribe farmers indicated none education compared to 6.2% of their Thai counterparts, 78.5 % of Thai farmers had primary

Table 1 General characteristics

Characteristics	Total		Ethnicity				χ^2	*p*-value
			Thai		Hill tribe			
	n	%	n	%	n	%		
Age in years								
≤24	5	1.4	0	0.0	5	2.8	42.35	<0.001*
25-49	142	40.1	44	24.9	98	55.4		
≥50	207	58.5	133	75.1	74	41.8		
Sex								
Male	207	58.5	123	69.5	84	47.5	17.69	<0.001*
Female	147	41.5	54	30.5	93	52.5		
Education								
None	109	30.8	11	6.2	98	55.4	126.83	<0.001*
Primary	181	51.1	139	78.5	42	23.7		
High school	52	14.7	25	14.1	27	15.3		
Degree	12	3.4	2	1.1	10	5.6		
Religion								
Buddhism	277	78.2	176	99.4	101	57.1	93.35	<0.001*
Christianity	77	21.8	1	0.6	76	42.9		
Monthly household income in THB								
<15,000	328	92.7	160	90.4	168	94.9	4.05	0.132
15,000 – 30,000	23	6.5	16	9.0	7	4.0		
>30,000	3	0.8	1	0.6	2	1.1		
Number of family members								
<5	205	57.9	124	70.0	81	45.8	22.32	<0.001*
5-9	143	40.4	52	29.4	91	51.4		
≥10	6	1.7	1	0.6	5	2.8		
Total size of cultivated land in Rai								
≤5	90	25.4	47	26.6	43	24.3	0.23	0.625
≥6	264	74.6	130	73.4	134	75.7		

*Significance level at $\alpha = 0.05$

education compared to 23.7% of hill tribe farmers. Majority of the Thai farmers 99.4% practiced Buddhism compared to the hill tribe farmers who practiced Buddhism and Christianity at 57.1% and 42.9% respectively. There was significant difference (*p*-value<0.001) in number of family members as most of the Thai farmers 124 (70.0%) had <5 family members compared to 81 (45.8%) of the hill tribe farmers (Table 1).

The overall prevalence rate of open burning among farmers in Chiang Rai province stood at 72.6%; hill tribe (71.2%) and Thai (74.0%) respectively. Regarding sources of information on air pollution and open burning, results indicated that 25.7% of the respondents received information through community meetings while 35.0% received information from more than one source. However, 8.2% of the respondents did not receive any form of information regarding open burning and air pollution (Table 1).

With regards to land use and practices, results indicated that most farmers cultivated on one parcel of land (83.9%) while 11.0%, 3.1%, 2.0% cultivated on two, three, and four parcels of land respectively. Our results revealed that 56.6% of those who cultivated on one parcel of land farmed once a year while 44.4% farmed twice or more than twice in a year. Also, those who farmed on one parcel of land cultivated one type of crop 63.6% compared to 36.4% who farmed two or more types of crops. Results also indicated that 43.0% of the respondents grew rice, 27.7% grew corn, 9.3% grew both while 19.5% grew other types of crops respectively on one parcel of land. Majority (62.4%) of those who farmed on one parcel of land owned it compared to 37.6% who had to rent.

There was no significant statistical difference in levels of environmental health knowledge among Thai and hill tribe farmers. However, there was significant statistical difference in levels of attitude and practice between the Thai and hill tribe farmers (*p*-value=0.009 and *p*-value=0.022). Furthermore, 61.3% of all the respondents had low knowledge of environmental health issues, 71.1% had neutral

Table 2 Association between general characteristics, environmental health knowledge, attitude, behavior and open burning using simple logistic regression

Characteristic	Open burning				OR	90%CI	*p*-value
	Yes		No				
	n	%	N	%			
Total size of cultivated land (rai)							
≤5	17	(18.9)	73	(81.1)	10.0	0.013 – 0.041	<0.001*
≥6	240	(90.9)	24	(9.1)	1		
Types of crops cultivated							
Rice	112	(72.7)	42	(27.3)	1.23	0.73 – 2.09	0.482
Corn	70	(71.4)	28	(28.6)	1.17	0.66 – 2.05	0.645
Both	28	(84.8)	5	(15.2)	2.62	1.06 – 6.47	0.080*
Other	47	(68.1)	22	(31.9)	1	0.73 – 2.09	0.482
Land ownership							
Self-owned	152	(68.8)	69	(31.2)	0.58	0.38 – 0.89	0.039*
Rented	105	(78.9)	28	(21.1)	1		
Environmental health knowledge level							
Low	192	(88.5)	25	(11.5)	58.88	20.22 – 171.40	<0.001*
Average	62	(55.9)	49	(44.1)	9.70	9.70 – 3.36	<0.001*
High	3	(11.5)	23	(88.5)	1		
Level of environmental health attitude							
Negative	25	(92.6)	2	(7.4)	5.74	1.56 – 21.10	0.027*
Neutral	195	(71.4)	78	(28.6)	1.14	0.67 – 1.95	0.667
Positive	37	(68.5)	17	(31.5)	1		
Level of environmental health practice							
Bad	187	(81.7)	42	(18.3)	5.64	2.99 – 10.62	<0.001*
Moderate	55	(60.4)	36	(39.6)	1.93	0.99 – 3.77	0.104*
Good	15	(44.1)	19	(55.9)	1		

*Significance level at α=0.1

Table 3 Factors associated with open burning behavior using multiple logistic regression

Characteristic	Open burning				OR_{Adj}	95% CI	*p*-value
	Yes		No				
	n	%	n	%			
Environmental health knowledge level							
Low	192	(88.5)	25	(11.5)	98.39	22.02-439.54	<0.001*
Average	62	(55.9)	49	(44.1)	15.01	3.57-63.06	<0.001*
High	3	(11.5)	23	(88.5)	1		
Size of cultivated land in Rai							
≤5	73	(81.1)	17	(18.9)	0.01	0.00-0.04	<0.001*
≥6	240	(90.9)	24	(9.1)	1		

* Significance level at α=0.05

attitude while 64.7% accounted for bad environmental practices.

In order to determine the level of association between general characteristics and open burning behavior among farmers in Chiang Rai Province, the simple logistic regression was performed for all variables in the study at 90% confidence interval. Findings indicated that open burning increased with total size of cultivated land. Those who cultivated on ≥ 6 Rai (≥ 9,600 square meters) were more likely (10 times) to practice open burning compared to those who cultivated on ≤5 (8,000 square meters) (90%CI=0.013 – 0.041). Those who grew both rice and corn were more likely to practice open burning compared to those who grew other kinds of crops. Those who rented land were 0.58 times less likely to practice open burning (90%CI=0.38 – 0.89) compared to those who owned the land farmed on (Table 2).

Those with low knowledge levels were more likely to engage in open burning (OR = 58.88, 90%CI=20.22-171.40) compared to those have

average and high knowledge levels. Those with negative attitudes and bad practices were more likely to engage in open burning (OR = 5.74, 90%CI=1.56-21.10 and OR = 5.64, 90%CI=2.99-10.62 respectively) compared to those with average and positive attitude; and neutral and good practices respectively (Table 2).

In multiple logistic regression model, two factors were found to be significantly associated with open burning behavior after controlling for all possible confounder factors: environmental health knowledge level and size of cultivated land. Low environmental health knowledge (OR_{adj} =98.39, 95%CI = 22.02 – 439.54) as well as size of cultivated land (OR_{adj} =0.01, 95% CI 0.00 – 0.04) were factors influencing open burning (Table 3). The lower the environmental health knowledge level compared to those with higher level of environmental health knowledge, the higher the likelihood of practicing open burning. The lesser the land cultivated, the lower the likelihood of open burning compared to those with less than five Rai.

DISCUSSION

There were some limitations from the study that could have been impacted the results. Firstly, the eliciting information during the off season of open burning (November, December and January) impacted results of the study as only 72.6% of the respondents owned up to engaging in open burning of farm residues contrary to what is typically obtainable. Secondly, an on-season study would have provided evidence of open burning activities and perhaps given room for more people to own up and as a result provide more information regarding the problem.

Language was the third limitation of this study. Several ethnic groups were recruited for the study other than Thais. Some participants did not thoroughly understand Thai. Nevertheless, an interpreter was effectively attempted to pass the message across among the hill tribe participants. Therefore, in the future, hill tribe participants who understood Thai language would be encouraged to be including.

Also, there was significant difference in terms of educational level and religion, 55.4% of the hill tribe farmers had no education compared to 6.2% of Thai counterparts, while 78.5 % of Thai farmers had primary education compared to 23.7% of hill tribe farmers. Generally, most of the farmers fall under the primary school level. This finding is consistent with another study [28] which indicated that although the general level of literacy is quite high in Thailand compared to many other Asian countries, the level of education for farmers is low.

Our findings also showed association between open burning behavior and level of environmental health knowledge, attitude and practices. Those with low knowledge levels were more likely to engage in open burning than those who have average and high knowledge levels. Those with negative attitudes and bad practices were more likely to engage in open burning than those who with average and positive attitude and neutral and good practices respectively.

However, after adjusting for all confounders, multiple logistic regression model was performed on 2 simple logistic regression significant variables (on open burning behavior): environmental health knowledge level and size of cultivated land. Studies have been done regarding the problem of open burning, air pollution and its effects in Thailand [4, 6, 8, 10], however, not much was said regarding environmental health knowledge level of farmers, particularly in the studied areas. The high confidence interval could have been due to the fact that most participants fall under the first two categories (low and average environmental health knowledge levels). This finding correlates with the findings of other studies which indicated the nexus between knowledge and behavior. For example, Levine and Strube, [19] posited that correct knowledge predicts behavior. Hines et al., [17], noted that among other issues, knowledge of issues and knowledge of action strategies are significant correlates of responsible environmental behavior. Making informed pro-environmental choices are difficult if one has incorrect or no knowledge [29]. The finding which indicated the link between open burning behavior and size of cultivated land is consistent with the findings of a previous study which showed an association between large scale commercial farming and open burning [21]

This study showed that income was not associated with open burning behavior, compared to the study by Ahmed and Ahmad [30], who found that knowledge of risk and environment were not major factors influencing open burning behavior, instead, finance and lack of knowledge of alternative methods of waste disposal were factors influencing open burning behavior among farmers in Pakistan. This could have been due to geographical differences or the interplay of other factors. Contrary to other studies which found ethnicity [31]

and religious practices [32] to be associated with open burning behavior, this study found no association between open burning and ethnicity or between Thai and hill tribe farmers. Although patterns may seem different at some point but overall, there was no significant difference.

CONCLUSION

Regardless of efforts to control open burning situation through existing policies, the problem of open burning which leads to air pollution bringing about several health concerns in northern Thailand persists as farmers do not have alternative ways of disposing agricultural residues. Even though the perception and attitude towards environmental health issues was neutral, environmental practices were found to be bad among the participants. Low level of environmental health knowledge (an aspect of environmental health literacy) and size of cultivated land were found to be the major factors influencing open burning behavior in Chiang Rai Province, Thailand. Other factors such as cultural practices, types of crops cultivated, environmental health attitude and practices also contribute to open burning behavior.

RECOMMENDATIONS

There is need for positive change in attitude and better practice regarding environmental health issues, particularly air pollution and how it is managed. Farmers can be advised to adopt other alternative ways of disposing agricultural residues like composting for example, instead of resorting to open burning which comes with several health consequences. During cultural festivities that take place on the mountain side, sometimes, forests are set afire for entertainment and consequently leading to unintentional wide scale forest fires. The community members can be advised on how to better manage such situations before it degenerates into wide forest fires

More so, farmers can be advised on how to better protect themselves during the haze period as some did not consider it very harmful. Instead of resorting to inaction, they can act proactively or engage in better practices when faced with issues of air pollution. Intervention can be made in terms of diversifying the type of crops that are cultivated and the size of cultivated land. Instead of focusing on rice and corn which were the major crops cultivated over a large parcel of land as revealed in the study, and consequently leading to large amount of wastes which are often disposed of by open burning, considering that it is cheap and fast, other types of crops which do not require large expanse of land and large amounts of wastes can be introduced.

Lastly, there is need to develop a proper and strategic intervention policy in order to enhance environmental health knowledge level of farmers in the area and by extension reducing the rate of open burning and its attending health consequences as studies have really shown the importance of knowledge in influencing behavioral change. “Knowledge of environmental issues is generally considered a prerequisite to environmental concern” [33] “The relationship between human activities and the environment has the potential to either impair or improve health. One of the ways that can help in mitigating the adverse effects from human and environmental relationship is through environmental health education [34].

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