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Factors associated with the recurrence of dengue fever in villages in Chiang Rai, Thailand

A community-based case-control study

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Abstract

Purpose – The purpose of this paper is to determine the factors associated with DF occurrence in recurrence villages in Chiang Rai, Thailand.

Design/methodology/approach – A case-control study was conducted between June 2017 and December 2017. A validated questionnaire was used to detect the factors associated with recurrence of DF. χ^2 and logistic regression were used to detect the associations between variables at $\alpha = 0.05$.

Findings – In total, 213 cases and 436 controls were recruited into the analysis. Cases were recruited from 20 DF recurring villages, while controls were recruited from 20 non-DF recurring villages in Chiang Rai province. At community level, three variables were associated with recurrence of DF; size of the village ($p = 0.007$), number of villagers ($p = 0.009$), tribe ($p = 0.043$) and distance to a hospital ($p = 0.003$). Three variables were associated with DF at personal and family levels in multivariate model: children whose parents worked as daily employees, and government officers and traders were more likely to have DF 1.56 (95%CI = 1.22–2.48) and 4.31 (95%CI = 4.66–9.38) times greater than of those whose parents' worked as agriculturists, respectively; children aged less than one year were 2.89 (95%CI = 2.17–4.33) times more likely to have DF than those aged = 6 and children who were under standard growth and over standard growth were more likely to have DF than those standard growth 1.61 (95%CI = 1.18–2.53) and 7.33 (95%CI = 4.39–10.37) times, respectively.

Originality/value – This is the original research article which was conducted in detecting the factors associated with recurrence of DHF in Northern Thailand.

Keywords Community-based case-control, Dengue fever, Case-control studies, Thailand

Paper type Research paper

Introduction

Dengue fever (DF) is one of the most common diseases in Thailand with a serious impact on individual health and the country's economy. A large amount of government funding has been allocated annually for the implementation of DF prevention and control[1]. The principal vector of DF is the *Aedes aegypti* mosquito[2], which is found in tropical and

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subtropical climates worldwide[3], including, Thailand. DF is classified into three categories: undifferentiated fever, DF and dengue hemorrhagic fever (DHF) according to the WHO classification[4]. Dengue shock syndrome is one of the stages of DHF[4]. It has no specific treatment, but early detection and access to proper medical care result in a lower fatality rate, below 1.0 percent[4]. The reduction of mortality and morbidity rates from DF depends on effective vector control measures, particularly at the community level[3]. In 2018, the World Health Organization (WHO) estimated that the global burden of DF was 390m cases per year, of which 96m manifests clinically[5], and 500,000 infected persons in 128 countries, including Thailand, required hospitalization[6]. The WHO also reported that in 2018, among the countries in the Southeast Asia Region, the Philippines reported more than 53,000 cases with 289 deaths; followed by Thailand, with more than 22,000 cases as of July 2018, with the most cases aged 15–24 years (24.6 percent)[7].

In Thailand, a number of DF cases have been reported by the national surveillance system and have increased from 2015 through 2018 as follows: 110,494 (169.69/100,000 in 2015); 52,562 (80.34/100,000 in 2016); 43,969 (67.20/100,000 in 2017); and 70,146 (106.19/100,000, as of 30 October 2018) cases[8]. Among these, the mortality rates were reported to be between 0.09 and 0.13 percent. The Northern Region of Thailand was ranked 2nd in DF incidence rates in Thailand in 2018[8]. The largest vulnerable populations were 10–14 year olds (355.51/100,000), followed by 5–9 year olds (283.23/100,000), and 0–4 year olds (125.99/100,000)[8]. Chiang Rai Province was ranked as the highest in DF incidence rates in northern Thailand[9].

In 2018, Chiang Rai Province reported the incidence rate at 202.09/100,000, which was the highest epidemic area of DF among the seven northernmost provinces under the responsibility of The Office of Disease Prevention and Control No. 1 Chiang Mai Province[9]. Between January 1, 2018 and November 24, 2018, the Chiang Rai Public Health Provincial Office reported 1,450 (113.45/100,000) cases of all forms from 18 districts in Chiang Rai Province[10]. There have been large financial investments made for the prevention and control of the disease over the past decades.

Chiang Rai Province has a unique geographical makeup with mountains, and a large proportion of the hill tribe people live in this area accounting for 30.0 percent of the total population in the 749 villages of the province[11]. A sub-district administration office and a health promoting hospital are the major organizations fighting against DF at a community or village level[12]. The financial aid used for DF prevention and control was allocated by the central government through several channels, such as the annual budgetary plans from the sub-district administration offices, activity-based budgetary allocations from the Ministry of Public Health[13] and community-based public health interventions from The National Health Security Office (NHSO)[14]. However, some villages had no DF case reports, while others reported more cases every year having mostly implemented comprehensive protocols or methods, especially from the government. Therefore, this study aimed to determine the factors associated with recurrence of DF at the individual, family and community levels.

Materials and methods

Study design

A community-based case-control study was used to elicit information from cases who lived in the DF recurrence villages and controls from the DF non-recurrence villages in Chiang Rai Province using personal, family and community information.

Study setting

Based on the information from the DF surveillance system in 2016, villages in seven districts reported DF recurrence in Chiang Rai Province and were selected as the study settings; these districts were Muang, Mae Chan, Mae Sai, Chiang Sean, Chiang Khong, Wiang Ken and Mae Fah Luang[15].

A total of 101 of 846 villages in seven districts reported recurring DF cases in three consecutive years from 2014 to 2016; 19 of 256 villages from Muang district, 18 of 138 villages from Mae Chan district, 14 of 87 villages from Mae Sai district, 6 of 70 villages from Chiang Sean district, 3 of 102 villages from Chiang Khon district, 5 of 41 from Wiang Ken district, and 9 of 77 villages from Mae Fah Luang district reported DF recurrences[15].

Study population

The study population included children and their parents who lived in the DF recurrence and non-recurrence villages in Chiang Rai Province in 2016.

Study sample

The study sample was selected randomly from children aged less than 12 years who lived in the selected study settings in Chiang Rai Province.

Sample size

The sample size was calculated by using the formula of Schlesselman in 1990[16] at a 95.0% confidence interval, an 80.0 percent power of the test, and a 1:2 ratio of cases and controls:

$$n = \frac{\left[Z_{\alpha/2}\sqrt{(1+m)\bar{p}'(1-\bar{p}')}+Z_{\beta}\sqrt{p_1(1-p_1)+mp_0(1-p_0)}\right]^2}{(p_1-p_0)^2},$$

$$\bar{p}' = \frac{p_1+p_0/m}{1+1/m},$$

$$p_1 = \frac{p_0\psi}{1+p_0(\psi-1)},$$

$$n_c = \frac{n}{4}\left(1+\sqrt{1\frac{2(m+1)}{nm|p_0-p_1|}}\right)^2,$$

where n = sample size; α = level of type I error (5.0 percent); $Z_\alpha = 1.96$; β = level of type II error (20.0 percent); Z_β = standard score for power of test ($Z_{0.20} = 0.84$); 1–β = power is probability; $P0$ (p_0) = probability of exposure in controls (1.30 percent)[17]; $P1$ (p_1) = probability of exposure in cases (10.70 percent)[17]; m = number of matched controls per case (1:2); Ψ(psi) = odds ratio (OR) = 1.96[17].

Therefore, 213 cases and 426 controls were required for the analysis.

Inclusion criteria

Inclusion criteria for controls were as follows: children aged less than 12 years without DF diagnosis of any form (DF, DHF and DSS) in 2016 and lived in the nearest village where cases were raised. Children whose parents could not provide information regarding the research protocols, for reasons such as the inability to use Thai language, were excluded from the study. Children whose parents could not clearly identify whether their children had DF in previous years were excluded from the study as well.

DF recurrence village referred to a village that has found and reported a case of DF in three consecutive years (2014–2016) through the Chiang Rai Public Health Surveillance System.

Cases were children less than 12 years old who lived in one of the recurrence districts and villages in Chiang Rai Province with three consecutive year reports of DF, DHF or DSS (2014–2016) according to the classification of WHO[1] and who were diagnosed with any form of DF by a medical doctor from May 1, 2016 to April 30, 2017.

Controls were children less than 12 years old who were not diagnosed with DF, DHF or DSS in the previous year and who lived in a village classified as a non-DF recurrence village nearest to a village with DF cases.

Case and control recruitment

A total of 768 DF cases were reported through the Chiang Rai Public Health Surveillance System between May 1, 2016 and April 30, 2017 from 211 recurrence villages. A simple random method was used to select 213 cases. The controls were selected from the villages nearest to cases and selected by a simple random method from the list of children provided by the village headman, who were not diagnosed with any form of DF in the previous year. All selected controls were asked about their experiences with any forms of DF and diagnosis in the previous year. The ratio of cases to controls was 1:2.

Research instruments

A questionnaire was developed from the literature review and discussion with experts in the field, including health professionals who were working in a community. The questionnaire was divided into seven parts. Part I was used to collect information at the village level, such as the number of households, number of fresh markets, distance to a health care setting, number of public health professionals at the health promoting hospital, number of private clinics and size of the village (<50 households = small size, 51–100 households = middle size, and >100 households = large size). Part II was used to collect the children's information, such as age, sex, growth (weight for height), congenital diseases (G6PD, birth defects, thalassemia, asthma, etc.), breastfeeding, etc. Part III was used to collect parents' information such as the number of family members, occupation (daily wage employee status, agriculturist, government officer and trader), income, education, area of residence (rural as non-municipality area and urban as municipality area), etc. Part IV was used to determine parents' knowledge regarding DF prevention and control, which consisted of ten questions. Part V was used to determine parents' attitudes regarding DF prevention and control, which consisted of ten questions. Part VI was used to determine parents' practice regarding DF prevention and control. Part VII was used to collect information on environmental factors, such as the number of containers, whether larvae were found, and household structure.

The questionnaire was tested for its content validity using the IOC method (Index of Item Objective Congruence) from three external experts in the field (two public health professionals and one pediatrician).

In the section on knowledge, those who scored <60.0 percent were defined as low level, 60.0–70.0 percent were defined as moderate level and $\geqslant$80.0 percent were defined as high level. In the attitude section, those who scored <60.0 percent were defined as low level, 60.0–70.0 percent were defined as moderate level and $\geqslant$80.0 percent were defined as high level. In the section on practice, those who scored <60.0 percent were defined as poor level, 60.0–70.0 percent were defined as moderate level and $\geqslant$80.0 percent were defined as a good level[18]. Cronbach's α coefficient in the knowledge section was 0.84, in the attitude section was 0.79 and in the practice section was 0.81.

Data collection process

A list of villages with a recurrence of DF was provided by the Chiang Rai Provincial Public Health Office, which was recorded from the public health surveillance system. DF cases from recurrence villages are listed. A simple random method was used to select the cases from recurrence villages. Access to villages to collect the data was granted by a district government officer. Village headmen were contacted according to the selected list of villages with cases of DF recurrence. Thereafter, an appointment was made before going to the villages for collecting data.

Parts I–VI of the questionnaire were used to gather information from the parents. Parents were also tested for their knowledge, attitude and practice regarding DF prevention and control, including environmental factors. The interview was conducted after obtaining informed consent. Questionnaire part VII was used to gather information from the village headmen.

Data analysis

Information from the questionnaires was coded and double-entered into Microsoft Excel. Data were checked for missing values and errors before entering them into SPSS for analysis (version 20; IBM, Armonk, NY). Descriptive statistics were used to explain the general characteristics of the participants: mean, standard deviation and percentage. χ^2 and logistic regression were used to identify factors associated with DF at a p-value of 0.05 (two-tailed) considered to be statistically significant.

Ethical consideration

The study proposal and its protocols were approved by the Mae Fah Luang Human Research Ethical Committee (REH-59116).

Results

There were 213 cases from 40 DF recurrence villages and 426 controls from 40 non-DF recurrence villages recruited into the study.

Major characteristics of recurrence villages were middle size villages, hill tribe villages, the presence of fresh markets and proximity to hospitals. Major characteristics of non-recurrence villages were small villages and small numbers of villagers, as well as being located far away from hospitals and having several private clinics.

Four variables had significant differences between recurrence and non-recurrence villages: size of the village ($p = 0.007$), number of villagers ($p = 0.009$), tribe ($p = 0.043$) and distance to a hospital ($p = 0.003$) (Table I).

Parents' characteristics

Characteristics of parents: more than half were males (56.3 percent). The average age of the parents of cases was 29.6 years (SD = 18.8) and that of the parents of controlled cases was 34.6 years (SD = 14.2). The majority worked in agricultural and daily employed settings (77.6 percent), 43.3 percent graduated from high school,and 70.0 percent had an income of less than 10,000 baht/month. More than half were Buddhist and lived in urban areas. Most parents had high knowledge, high attitude and good practice on DF prevention and control (Table II).

Seven variables had significant differences between characteristics of the parents of cases and controls: sex ($p < 0.001$), age ($p < 0.001$), occupation ($p < 0.001$), education ($p = 0.005$), income ($p < 0.001$), religion ($p < 0.001$) and area of residence ($p < 0.001$) (Table II).

Characteristics	Total	Recurrencen (%)	Non-recurrencen (%)	χ^2	*p*-value
Total size of village	80 (100.0)	40 (50.0)	40 (50.0)	na	na
Small	22 (27.5)	5 (22.7)	17 (77.3)	9.70	0.007*
Middle	39 (48.8)	25 (64.1)	14 (35.9)		
Large	19 (23.7)	10 (52.6)	9 (47.4)		
Number of villagers (person)					
⩽ 400	16 (20.0)	3 (18.8)	13 (81.2)	9.35	0.009*
401–600	12 (15.0)	5 (41.7)	7 (58.3)		
⩾ 601	52 (65.0)	32 (61.5)	20 (38.5)		
Tribe					
Thai	37 (46.3)	14 (37.8)	23 (62.2)	2.65	0.043*
Hill tribe	43 (53.7)	26 (60.5)	17 (39.5)		
Highway passing through the village					
No	13 (16.3)	8 (61.5)	5(38.5)	0.82	0.363
Yes	67 (83.7)	32 (47.8)	35 (52.2)		
Fresh market					
Yes	55 (68.8)	25 (45.5)	30 (54.5)	1.45	0.227
No	25 (31.2)	15 (60.0)	10 (40.0)		
Number of fresh markets					
⩽3	27 (33.8)	15 (55.5)	12 (44.5)	0.50	0.478
⩾ 4	53 (66.2)	25 (47.2)	28 (52.8)		
Distance to a hospital (km)					
⩽ 5	57 (71.3)	29 (50.8)	28 (49.2)	0.06	0.804
⩾ 6	23 (28.7)	11 (47.8)	12 (52.2)		
Distance to a health promoting hospital (km)					
⩽ 5	72 (90.0)	32 (44.4)	40 (55.6)	8.88	0.003*,a
⩾ 6	8 (10.0)	8 (100.0)	0 (0.0)		
Number of health professionals (person)					
⩽ 5	14 (17.5)	9 (64.3)	5 (35.5)	1.38	0.239
⩾ 6	66 (82.5)	31 (47.0)	35 (53.0)		
Private clinics					
Yes	16 (20.0)	6 (37.5)	10 (62.5)	1.25	0.263
No	64 (80.0)	34 (53.1)	30 (46.9)		
Weekly DF prevention and control activity					
Yes	11(13.8)	5 (45.5)	6 (54.5)	0.10	0.745
No	69 (86.2)	35 (50.7)	34 (49.3)		

Notes: [a]Fisher's exact test. *Statistically significant at $p < 0.05$

Table I. Comparison of village characteristics between recurrence and non-recurrence villages

Case and control characteristics

More than half of the cases were females, were aged less than one year at the time of DF diagnosis, had more than standard growth, were immunized, had no congenital diseases and were breastfed. In controls, 72.2 percent were males, the majority were aged ⩾ 6 years and reported normal growth (80.0 percent) (Table III).

Three variables had significant differences between cases and controls: sex ($p < 0.001$), age at DF diagnosis ($p < 0.001$) and growth ($p < 0.001$) (Table III).

In univariate analysis, ten variables were found to be associated with DF at personal and family levels: parents' sex, parents' age, parents' occupation, parents' education, parents' income, religion, child's sex, child's growth and child's age at DF diagnosis (Table IV).

Characteristics	Total	Case parents n (%)	Control parents n (%)	χ^2	p-value
Total	639 (100.0)	213 (33.3)	426 (66.7)	na	na
Sex					
Male	360 (56.3)	100 (27.8)	260 (72.2)	11.45	< 0.001*
Female	279 (43.7)	113 (40.5)	166 (59.5)		
Age (years)					
⩽ 29	197 (30.8)	98 (49.7)	99 (50.3)	51.10	< 0.001*
30–40	191 (29.9)	53(27.8)	138 (72.2)		
41–50	163 (25.5)	24 (14.7)	139 (85.3)		
⩾ 51	88 (13.8)	38 (43.2)	50 (56.8)		
Occupation					
Daily employed	221 (34.6)	66 (29.9)	155 (70.1)	85.04	< 0.001*
Agriculturalist	275 (43.0)	55 (20.0)	220 (80.0)		
Other	143 (22.4)	92 (64.3)	51 (35.7)		
Education					
Illiterate	118 (18.5)	41 (34.7)	77 (65.3)	12.57	0.005*
Primary	109 (17.1)	33 (30.3)	76 (69.7)		
High school	277 (43.3)	109 (39.4)	168 (60.6)		
Vocational and University degree	135 (21.1)	30 (22.2)	105 (77.8)		
Income(baht/month)					
⩽5,000	251 (39.3)	133 (53.0)	118 (47.0)	72.13	< 0.001*
5,001–10,000	196 (30.7)	38 (19.4)	158 (80.6)		
⩾ 10,001	192 (30.0)	42 (21.9)	150 (78.1)		
Religion					
Buddhist	439 (69.0)	88 (20.0)	351 (80.0)	111.44	< 0.001*
Christian	200 (31.0)	125 (62.5)	75 (37.5)		
Residence area					
Rural	219 (34.3)	104 (47.5)	115 (52.5)	30.04	< 0.001*
Urban	420 (65.7)	109 (26.0)	311 (74.0)		
Larva in the living area					
Yes	258 (40.4)	87 (33.7)	171 (66.3)	0.029	0.864
No	381 (59.6)	126 (33.1)	255 (66.9)		
Knowledge of DF prevention and control					
Low to moderate	104 (16.3)	36 (34.6)	68 (65.4)	0.09	0.761
High	535 (83.7)	177 (33.1)	358 (66.9)		
Attitude on DF prevention and control					
Low to moderate	63 (9.9)	17 (27.0)	46 (73.0)	1.26	0.260
High	576 (90.1)	196 (34.0)	380 (66.0)		
Practice on DF prevention and control					
Low to moderate	182 (28.6)	55 (30.2)	127 (69.8)	1.11	0.292
Good	457 (71.4)	158 (34.6)	299 (65.4)		

Note: *Statistically significant at $p < 0.05$

Table II.
Comparison of the characteristics between case parents and control parents

Only three variables were found to be associated with DF at the personal and family levels in the multiple logistic regression model: children whose parents worked as daily employees or as government officers and traders were 1.56 (95%CI: 1.22–2.48) and 4.31 (95%CI: 4.66–9.38) times more likely to have DF than those whose parents worked as agriculturists,

Characteristics	Total	Case *n* (%)	Control *n* (%)	χ^2	*p*-value
Total	639 (100.0)	213 (33.3)	426 (66.7)	na	na
Sex					
Male	360 (56.3)	100 (27.8)	260 (72.2)	11.45	< 0.001*
Female	279 (43.7)	113 (40.5)	166 (59.5)		
Age at DF diagnosis (years)					
< 1	197 (30.8)	98 (49.7)	99 (50.3)	34.97	< 0.001*
1–5	191 (29.9)	53 (27.7)	138 (72.3)		
⩾ 6	251 (39.3)	62 (24.7)	189 (75.3)		
Growth					
Under normal	221(34.6)	66 (29.9)	155 (70.1)	85.04	< 0.001*
Normal	275 (43.0)	55 (20.0)	220 (80.0)		
Over normal	143 (22.4)	92 (64.3)	51 (35.7)		
Immunization					
No or not complete	118 (18.5)	41 (34.8)	77 (65.2)	0.12	0.718
Yes	521 (81.5)	172 (33.0)	349 (67.0)		
Congenital disease					
No	543 (84.9)	175 (32.2)	368 (67.8)	1.98	0.158
Yes	96 (15.0)	38 (39.6)	58 (60.4)		
Breastfeeding					
Yes	603 (94.8)	199 (33.0)	404 (67.0)	0.529	0.466
No	36 (5.2)	14 (38.9)	22 (61.1)		

Note: *Statistically significant at $p < 0.05$

Table III. Comparison of the characteristics of cases and controls

respectively; children aged less than one year were 2.89 (95%CI: 2.17–4.33) times more likely to have DF than those aged ⩾ 6 years; children who were under standard growth and over standard growth were 1.61 (95%CI: 1.18–2.53) and 7.33 (95%CI: 4.39–10.37) times more likely to have DF than those with standard growth.

Discussion

Large size, high population density and remote hill tribe villages were associated with DF recurrence in northern Thailand. This coincides with the study of Nagao *et al.*[19], who reported that villages with high population density and remote location were associated with DF occurrence and its epidemic in northern Thailand.

It found that large village size and high population density were associated with DF occurrence and recurrence in Northern Thailand. A study conducted in Bangkok, Thailand also presented a similar conclusion that the density of households and population of a village were major factors for DF occurrence and recurrence[20]. Siregar *et al.*[21] also reported that the number of family members and the population density of a village were key determinants of DF in Indonesia. Moreover, a study conducted in an urban area of south Thailand reported that population density was a significant predictor of DF[22].

We also found that people who lived in remote hill tribe villages are more at risk of DF and its recurrence than those who lived in the city, particularly those whose parents worked as daily wage employees and government officers. People living in remote areas might have less opportunity to obtain health information and less opportunity to attract health and other government offices, particularly in implementing DF prevention and control measures[23]. Moreover, the hill tribe people in Thailand live in poor settings, lower than the national poverty line[24, 25], and most of them focus on their own job to maintain their

Characteristic	OR	95%CI	p-value	OR_{adj}	95%CI	p-value
Parent's sex						
Male	1.00					
Female	1.76	1.26–2.46	< 0.001*			
Parent's age (years)						
⩽ 29	1.00					
30–40	0.78	0.49–1.24	0.180			
41–50	0.17	0.10–0.29	< 0.001*			
⩾ 51	0.76	0.46–1.27	0.185			
Parent's occupation						
Daily wage employee	1.70	1.12–2.57	0.007*	1.56	1.22–2.48	0.005*
Agriculturalist	1.00			1.00		
Other	7.21	4.59–11.34	< 0.001*	4.31	4.66–9.38	< 0.001*
Parent's education						
Illiterate	1.86	1.06–3.24	0.019*			
Primary	1.51	0.85–2.70	0.100			
High school	2.27	1.41–3.64	< 0.001*			
Vocational or University degree	1.00					
Parent's income (baht/month)						
⩽ 5,000	4.02	2.63–6.14	< 0.001*			
5,001–10,000	0.85	0.52–1.40	0.315			
⩾10,001	1.00					
Religion						
Buddhist	1.00					
Christian	6.64	4.59–9.61	< 0.001*			
Parent's knowledge of DF prevention and control						
Moderate	1.07	0.68–1.66	0.421			
High	1.00					
Parent's attitude on DF prevention and control						
Moderate	0.71	0.44–1.15	0.101			
High	1.00					
Parent's practice on DF prevention and control						
Moderate	0.81	0.56–1.18	0.168			
Good	1.00					
Child's sex						
Male	1.00					
Female	1.76	1.26–2.46	< 0.001*			
Child's age at DF diagnosis (years)						
< 1	3.01	2.02–4.50	< 0.001*	2.89	2.17–4.33	< 0.001*
1–5	1.17	0.76–1.79	0.269	1.08	0.81–1.78	0.278
⩾ 6	1.00			1.00	1.00	
Child's growth						
Under normal	1.70	1.12–2.57	0.007*	1.61	1.18–2.53	0.006*
Normal	1.00			1.00	1.00	
Over normal	7.21	4.59–11.3	< 0.001*	7.33	4.39–10.27	< 0.001*
Child's immunization						
No	1.08	0.70–1.64	0.397			

(*continued*)

Table IV.
Univariable and multivariable analyses on factors associated with DF at personal and family levels

Characteristic	OR	95%CI	p-value	OR_{adj}	95%CI	p-value
Yes	1.00					
Child's congenital disease						
No	1.00					
Yes	1.37	0.88–2.15	0.099			
Child's breastfeeding						
No	1.29	0.64–2.57	0.288			
Yes	1.00					
Larva in the living area						
Yes	1.02	0.73–1.43	0.465			
No	1.00					

Notes: Multiple logistic regression adjusted for age and sex of children. *Statistically significant at $p < 0.05$

Table IV.

family members. Therefore, they might not be interested in the practice of larval control in their household space. This is supported by the study of Pham *et al.*[26], which was conducted in remote hill tribe villages in Vietnam and presented that people who lived in remote and far away health care settings were at risk of DF.

Younger children, particularly less than one year, and those who are either over- or below-standard growth are vulnerable to DF in Northern Thailand. However, a study in Saudi Arabia[27] and a study in Taiwan[28] showed that those who are older and over standard growth had a greater chance of being diagnosed with DF. A report in Indonesia presented a greater proportion of DF in older children with over standard growth[29]. Conroy *et al.*[30] reported that children with younger age and over standard growth had a greater chance of DF and DHF development compared to older children in Colombia. The global review article by Sanyaolu *et al.*[31] also reported that young children with over standard growth were the major vulnerable population of DF infection globally.

We found that children whose parents worked as daily wage employees and officers were an at risk population for DF. This coincides with the studies by Harish *et al.*[32] and Takahashi *et al.*[33], which reported that children with low education parents, low economic status, and working as daily wage employees were at a greater risk of having DF compared to children whose parents work in professional jobs.

We found that in both cases and controls, parents had high knowledge and attitude regarding DF prevention and control; however, several DF cases were also reported regularly. This is likely because people in Thailand, including those who live in remote areas, have been exposed to DF disease for a long time and are familiar with health information from several channels. However, high knowledge and attitude alone do not guarantee the reduction of DF cases in a given area. This coincides with a study in Sri Lanka, which reported that having a high knowledge and attitude on DF prevention and control of villagers did not correlate with the decrease of DF cases[34].

Conclusion

A large village size, high density of villagers and remote location far away from a hospital are associated with DF recurrence, while at individual and household levels, children whose parents work as daily employees, government officers and traders, children who are less than one year old and children who are under and over standard growth are associated with DF recurrence, particularly in large and crowded hill tribe villages.

Policy makers should emphasize their mission in large size remote hill tribe villages with high population density to minimize the recurrence of DF. Future public interventions should focus on young children with normal growth deficiency (under and over standard growth) and those whose parents work as officers and traders, particularly in remote areas. In addition to the interventions and budgetary allocations provided by the government sector, villagers must regularly practice DF prevention and control, particularly in their household environment. Most people in both DF recurrence and non-recurrence villages have high knowledge and attitudes regarding DF prevention and control. This reflects that people in Thailand know about the etiology of DF, including methods to prevent and control the disease, even though they live in remote areas. However, they need to practice DF prevention and control regularly, thereby reducing all stages of the vector (*Aedes aegypti*) in their village. DF prevention and control measures should be more focused on the remote and large villages and on children less than one year of age with under- or over-standard growth.

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