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Epidemiology of a Mumps Outbreak and Effect of Measles, Mumps and Rubella Vaccination in Nan Province, Thailand, June to December 2010

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Abstract

In early September 2010, a nurse in Pua District Hospital observed an unusual increase in number of mumps cases and an outbreak investigation was conducted on 5 Oct 2010. This study described epidemiological characteristics of the outbreak as well as secondary attack rates and outcome of MMR vaccination campaign conducted during the outbreak. We reviewed medical records at Pua District Hospital and interviewed the cases' family members, classmates and teachers. A clinical case was a person with acute parotitis or acute lymphadenitis at preauricular, submandibular or submental area with onset of illness from 1 Jun to 31 Dec 2010. A confirmed case was a clinical case who tested positive for mumps viral IgM by enzyme-linked immunosorbent assay (ELISA), mumps virus by polymerase chain reaction (PCR) or virus isolation. During the investigation period, we also conducted a single mass measles, mumps and rubella (MMR) vaccination campaign, targeting children aged 1-6 years in 10 sub-districts. From 1 Jun to 13 Oct 2010, 129 clinical cases (attack rate = 0.2%) were found in 11 out of 12 sub-districts. Of which, 70.4% were less than six years old children. Among 10 laboratory confirmed cases, six were positive for mumps IgM by ELISA and four positive for mumps virus by PCR, with one case revealed as genotype J. Secondary attack rate among 1-6 years old children was 31.4%. Attack rate among children aged 1-6 years during the pre-vaccination campaign period was 289.4 per 10,000 populations and decreased to 54.3 per 10,000 after the campaign. This investigation supported the Ministry of Public Health to change from using monovalent measles vaccine to MMR vaccine for 9-month old children in June 2010.

Key words: mumps outbreak, MMR vaccination, Pua District, Thailand

Introduction

Mumps is a contagious viral disease caused by mumps virus (genus Rubulavirus, family Paramyxoviridae). Prodromal symptoms include fever, headache, muscle ache, tiredness and loss of appetite followed by swelling of salivary glands. Complications include encephalitis, orchitis, oophoritis and deafness. The virus has low infectivity and is spread by airborne, droplet or direct contact with saliva of an infected person. Incubation period is 16-18 days (range 12-25 days).[1]

Mumps is a vaccine preventable disease, but continues to be endemic in many regions of the world. In 2012, only 120 (62%) out of 194 World Health Organization (WHO) member countries around the world included mumps vaccine in their immunization program.[2] In Thailand, health officials required to report anyone with mumps through the national disease surveillance system. Most reported cases were children and young adults (Figure 1).

Expanded program on immunization (EPI) in Thailand was commenced in 1980. Monovalent measles vaccine was introduced in 1984 for children at nine months of age. In 1997, measles, mumps and rubella (MMR) vaccine containing the Jeryl Lynn strain was introduced to Grade one students. In June 2010, the monovalent measles vaccine was changed to MMR vaccine (Urabe strain) for children at nine months of age.[3] It induces immunity in more than 90% of recipients, which is long-lasting and may be lifelong.[4]

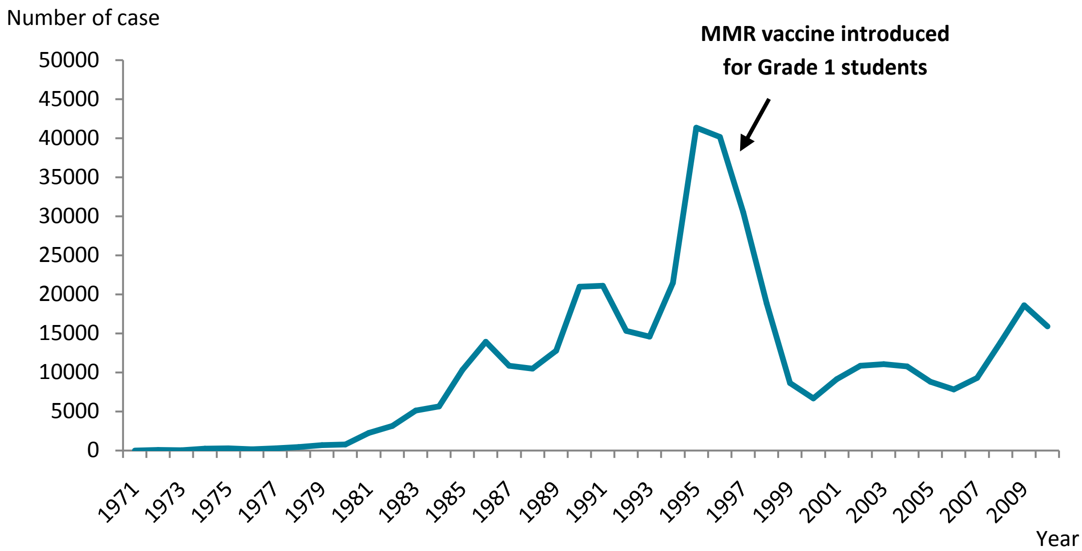

Figure 1. Number of reported mumps cases by year in Thailand, 1971-2010

No mumps outbreak was reported in Pua District during 2004 to 2010. However, in early September 2010, a nurse in out-patient department of Pua District Hospital observed an unusual increase in number of mumps cases and alerted epidemiologist in the hospital. The Bureau of Epidemiology (BOE) received the notification on 1 Oct 2010. Due to unusual rise in number of mumps cases, an outbreak investigation was conducted. This report described epidemiological characteristics of the mumps outbreak in Pua District, including secondary attack rate within households and outcome of implementing a mass MMR vaccination campaign during the outbreak.

Methods

Study Population

Nan Province in northern Thailand composes of 15 districts, including Pua District which is further divided into 12 sub-districts. Pua District is considered to be a rural district and in 2010, had a population of 64,318 in 657 km^2 (97.9 persons per km^2). Average population per sub-district was 5,360 (range 2,775-7,569). Main occupation of residents was agriculture.[5] Two of the poorest villages in Thailand situated in Pua District. Average annual income in these two villages was 442 and 648 Baht.[6]

Case Finding and Surveillance

The study period was from 1 Jun through 31 Dec 2010. We reviewed medical records from 1 Jun to 13 Oct 2010 in Pua District Hospital and five health centers, which included patients diagnosed with mumps cases (ICD-10 codes of B260 and B269) and patients with clinical history compatible with mumps: swelling of salivary gland (K112), epididymo-orchitis (N45) and acute lymphadenitis (L040). Active case finding was conducted by interviewing the cases' family members, classmates and teachers who had onset of illness from 1 Jun to 13 Oct 2010. We also surveyed two villages that had the highest number of reported mumps cases. Moreover, we interviewed cases, physicians and public health workers.

A clinical case was defined as a person who lived in Pua District with onset of illness from 1 Jun to 31 Dec 2010 and had acute swelling at preauricular, submandibular or submental areas; or was diagnosed as mumps or acute lymphadenitis at preauricular, submandibular or submental areas; or had a complication due to mumps. A confirmed case was defined as a clinical case that met at least one of the following criteria: positive for mumps virus by polymerase chain reaction (PCR) or viral isolation, or positive for mumps virus immunoglobulin M (IgM) antibody by enzyme-linked immunosorbent assay (ELISA).

Buccal swabs for PCR and viral isolation were collected from cases within seven days from onset of illness. Single serum specimens for mumps IgM antibody were collected from cases within 8-30 days after onset. All specimens were tested at the Thai National Institute of Health (NIH).

In addition, we reviewed the national database of reported mumps cases from Pua District during 2005 to 2009 to understand the epidemiology of mumps in this area. The team, including officers from BOE, local district health office and provincial health office, also conducted passive surveillance from 1 Jun to 31 Dec 2010. When cases went to hospital or health centers and were diagnosed as mumps, epidemiologist reported the cases by a computer program.

Secondary Attack Rate in Households and Effectiveness of Mumps Vaccine

We surveyed 265 out of 382 households in two villages with the highest number of reported cases to describe transmission in the households and assess effectiveness of mumps vaccine. We interviewed at least one member per household about history of mumps, clinical presentation and vaccination history of all family members. Households with at least one mumps case were included in the study.

A primary case was a clinical or confirmed case who had the earliest onset in each household. A co-primary case was a clinical or confirmed case with onset date of less than seven days after the primary case. A secondary case was a clinical or confirmed case who had an onset date of 7-30 days after the primary case. Household contacts included any household member who were not primary or co-primary cases. We calculated secondary attack rate by the following equation: (number of secondary cases / number of household contacts) x 100.

For calculating effectiveness of mumps vaccine in the households, we limited our analyses to household contacts who aged 1-20 years without history of mumps before 1 Jun 2010. The age range was chosen based on eligibility for routine mumps vaccination in Thailand and reliability of vaccination history. Vaccine effectiveness (VE) was assessed using the equation: $VE = [(SAR_U-SAR_V)/SAR_U] \times 100\%$, where SAR_U is secondary attack rate among unvaccinated contacts and SAR_V is secondary attack rate among vaccinated contacts. We used Epi Info software (version 3.5.3) for statistical analyses.[7]

MMR Vaccine Intervention

During the investigation period, the Ministry of Public Health conducted a single mass MMR vaccination campaign for children aged 1-6 years without history of mumps or MMR vaccination and lived in one of 10 sub-districts (Pa Klang, Pua, Sathan, Woranakhon, Chai Watthana, Sila Phet, Sila Laeng, Chedi Chai, Ngaeng and Uan Sub-districts). We calculated age-specific attack rates for the period before (12 Sep to 11 Oct 2010) and after (7 Nov to 31 Dec 2010) the mass MMR vaccination.

Data Analysis

We described quantitative and qualitative findings using median and range for quantitative variables, and proportion and ratio for qualitative variables. VE was calculated in point and 95% confidence interval estimation.

Results

Study Population

In addition to passive surveillance, we conducted active case finding and assessed secondary attack rates in two villages: Village 3 in Pa Klang Sub-district (749 people in 143 households) and Village 1 in Pua Sub-district (435 people in 122 households). People in Village 3 belonged to hill tribes. Average number of family members in Village 3 was five, with 16.2% of population aged 1-6 years. Village 1 was an urban area, with average number of family members of four and 6.2% of population as 1-6 years of age.

In Pua District, attack rates of mumps were approximately 5-10 during 2003-2009 and rose over the baseline since May 2010 (Figure 2).

The index case had onset on 5 Jun 2010 and number of cases gradually increased from August to September, which showed a propagated source and most of the cases were children (Figure 3). From 1 Jun through 13 Oct 2010, 129 clinical cases and 10 laboratory confirmed cases (attack rate two per 1,000) were reported. Of which, 124 cases were reported from passive surveillance and 15 cases were identified from active case finding. Male and female ratio was 1.2:1. Median age was 6 years (interquartile range 4-10.5 years). Majority of the cases were 1-6 years old (70.4%) followed by those of at least 20 years (19.3%), 7-12 years (8.1%) and 13-19 years (2.2%). Most of the cases had swollen salivary glands (91.0%) and fever (64.0%). One orchitis case was reported, but no encephalitis or fatality.

Case Finding and Surveillance

Cases were reported from 11 out of 12 sub-districts in Pua District. Sub-districts with the highest attack rates were Pa Klang (5.8 per 1,000), Pua (4.2 per 1,000), Sathan (3.0 per 1,000), Worranakhon (2.7 per 1,000) and Sila Laeng (1.6 per 1,000). Furthermore, MMR vaccine coverage among Grade one students in these five sub-districts was more than 95% in 2009 and pre-vaccination period of 2010 (Table 1).

Laboratory specimens were collected from 20 cases (11 buccal swabs and nine single sera). PCR results were tested positive for four specimens (36.4%) and one revealed as genotype J (wild type). Viral isolation was not possible as none of the specimens showed any growth. Single serum for mumps IgM antibody was positive by ELISA in six (66.7%) out of nine specimens.

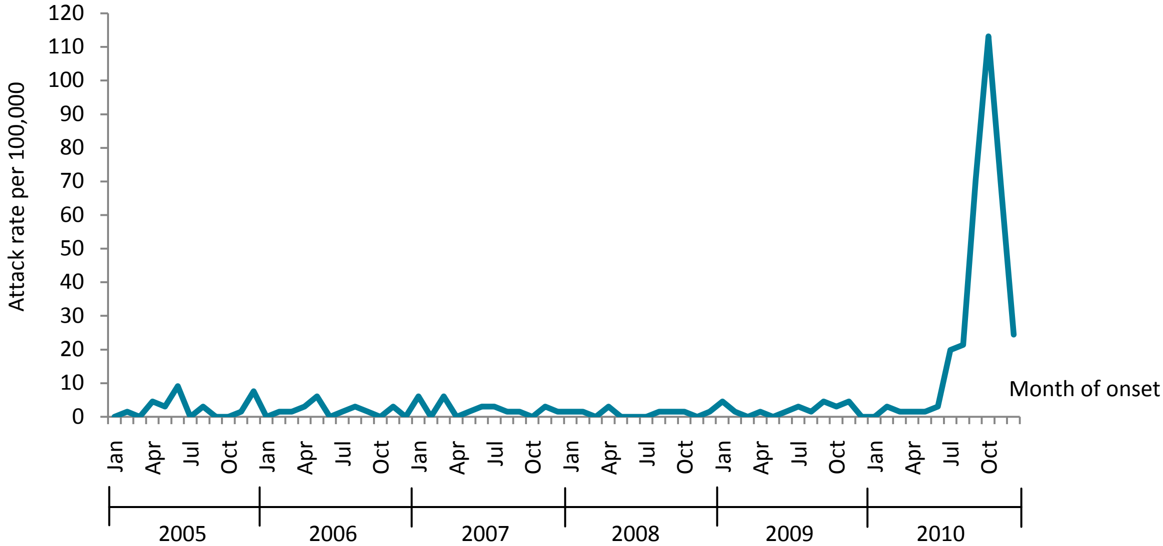

Figure 2. Attack rate of mumps per 100,000 populations by month of onset in Pua District, Nan Province, Thailand, 2005-2010

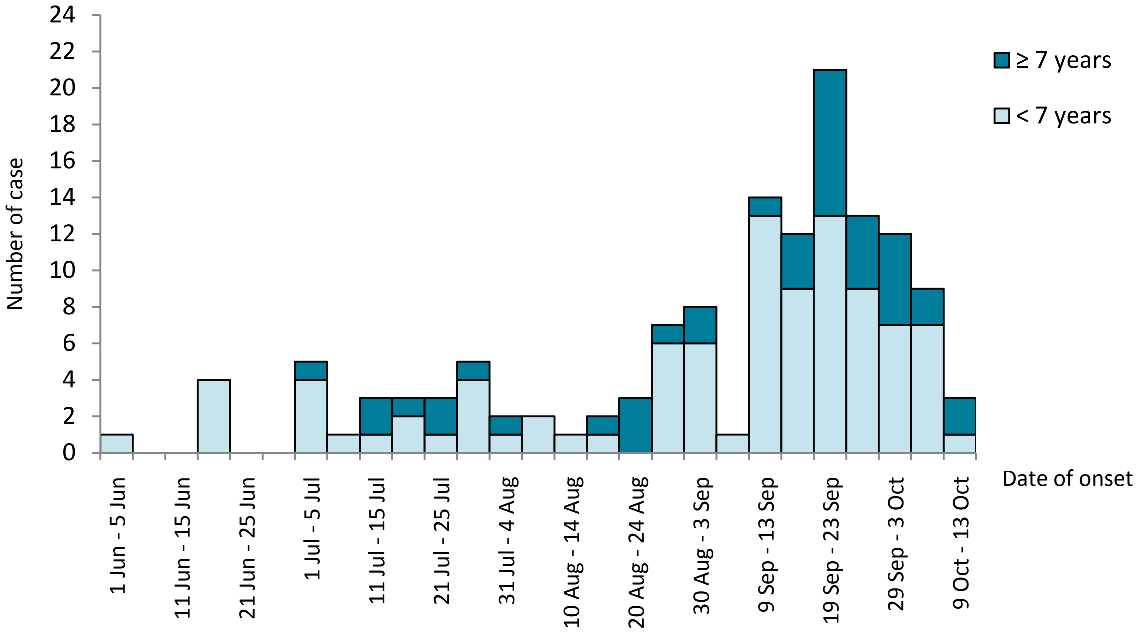

Figure 3. Number of mumps cases by date of onset and age group in Pua District, Nan Province, Thailand, 1 Jun to 13 Oct 2010 (n=136)

Secondary Attack Rate in Households and Effectiveness of MMR Vaccine

Of 265 households surveyed, 57 households had at least one mumps case. Among 364 members in 57 households, there were 57 primary cases, two co-primary cases and 305 contacts.

Total 22 secondary cases were identified with secondary attack rate of 7.2%. Most secondary cases were aged 1-6 years (50.0%) and 7-12 years (27.3%). Secondary attack rate was the highest among 1-6 years (31.4%) followed by those aged 7-12 years (14.6%). Though Village 1 had no secondary case, Village 3 had secondary attack rate of 8.2% (Table 2).

Among 128 contacts aged 1-20 years in both villages, 89 (69.5%) had received one dose of MMR vaccination and 39 (30.5%) were unvaccinated before 1 Jun 2010. There were five cases among vaccinated contacts (5.6%) and 12 cases among unvaccinated contacts (30.8%). VE was 82% (95% CI= 52-93%).

MMR Vaccine Intervention

A single mass MMR vaccination was conducted for 1-6 years old children in 10 sub-districts from 12-17 Oct 2010 as children in that age group had the highest attack rate. Of total 2,979 children, 2,364 children (79.4%) received the MMR vaccination while 615 children did not receive the vaccine because they were

Table 1. Number of clinical and confirmed mumps cases, and MMR vaccine coverage of 5 sub-districts with the highest attack rates in Pua District, Nan Province, Thailand, 1 Jun to 13 Oct 2010

Rank	Sub-district	Number of case	Total population	Attack rate (per 1,000)	Percent of MMR vaccine coverage among Grade 1 students	
					2009	2010
1.	Pa Klang	43	7,421	5.8	95	100
2.	Pua	32	7,569	4.2	100	100
3.	Sathan	19	6,173	3.0	96	100
4.	Woranakhon	17	6,110	2.7	100	100
5.	Sila Laeng	8	4,865	1.6	97	100

Table 2. Epidemiologic characteristics of primary cases and secondary attack rates within households in Village 3, Pa Klang Sub-district and Village 1, Pua Sub-district of Pua District, Nan Province, Thailand, 1 Jun to 31 Oct 2010

Characteristic	Number of primary case	Number of household member	Attack rate of secondary case (%)
Total	57	305	22 (7.2)
Age group (year)			
<1	0	12	0
1-6	46	35	11 (31.4)
7-12	9	41	6 (14.6)
13-19	2	48	1 (2.1)
>20	0	169	4 (2.4)
Gender			
Male	33	150	12 (7.5)
Female	24	155	10 (6.5)
Village			
Village 3	47	269	22 (8.2)
Village 1	10	36	0

absent during the intervention period. After 21 days of mass vaccination, five children who received the vaccine and seven children who did not receive the vaccine developed mumps.

Attack rate of 1-6 years old children during pre-vaccination period (12 Sep to 11 Oct 2010) was 289.4 per 10,000 populations and attack rate during post-vaccination period (7 Nov to 31 Dec 2010) was 54.3 per 10,000 populations. This indicated a decline after the mass vaccination. However, attack rates of other age groups which were not targeted in the mass vaccination did not decline obviously (Figure 4).

Discussion

The 2-3 months delay in reporting of this outbreak might be due to lack of awareness on diagnosis of mumps among public health workers. Epidemiologists did not know about rise in number of mumps cases until a nurse in Pua Hospital alerted them and hence, triggered relevant control measures. Provincial or district health officers should train public health workers to identify, detect and report clinical mumps cases, and implement control measures in time to prevent further spread. Immediate and thorough investigation and response were imperative in preventing secondary cases of mumps.[8] In addition, epidemiologists in district level should have awareness to detect unusual surge in notifiable diseases and report to provincial level.

Only small numbers of specimens were tested because asymptomatic cases could not be identified. About 20% of people infected with mumps virus could be asymptomatic.[9] Although secondary attack rate within households in this outbreak (31% of 1-6 years old age group) did not deviate from that of the other outbreaks (31% in less than 15 years old children)[10], mumps virus can be spread even seven days before

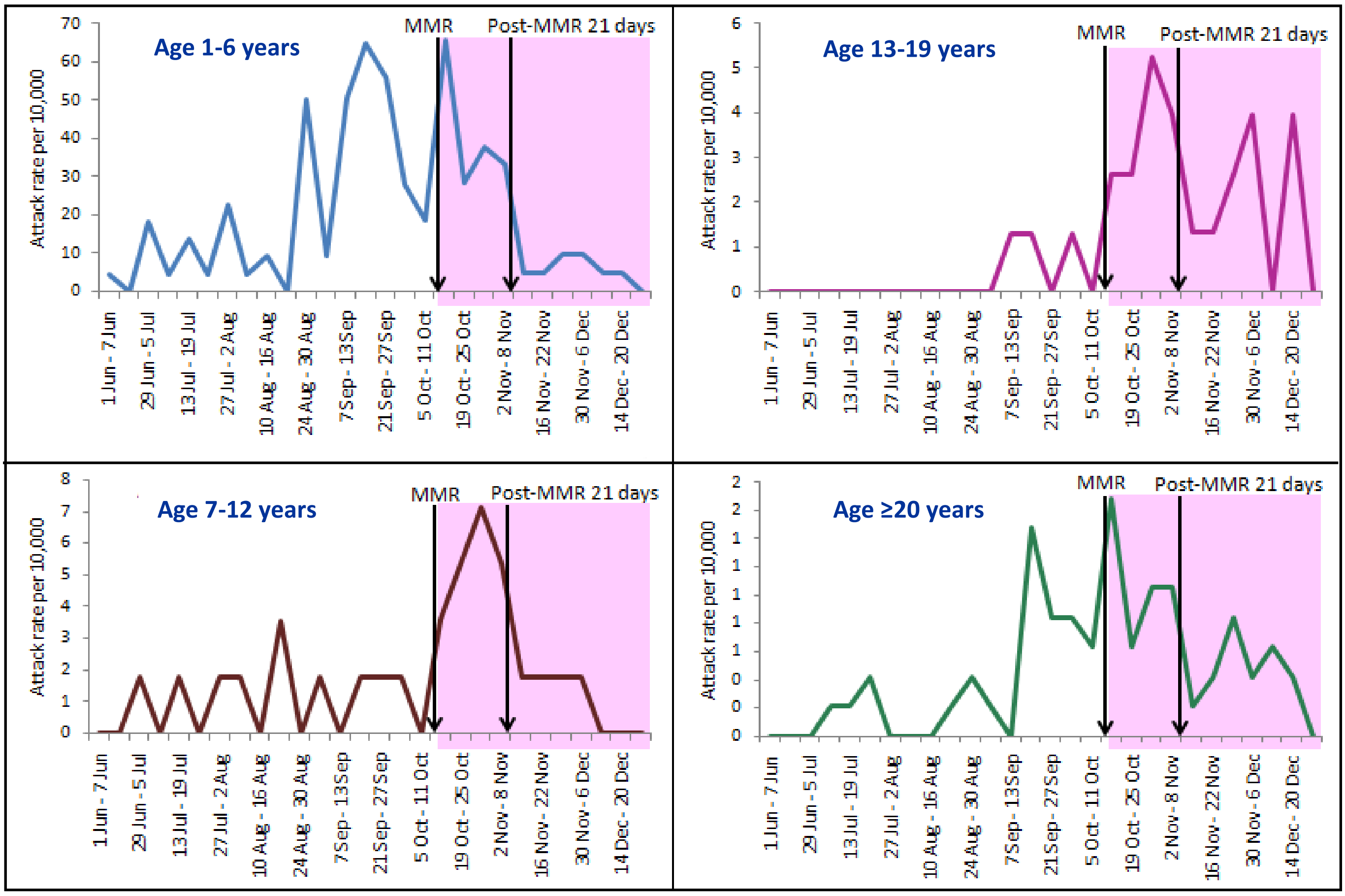

Figure 4. Attack rates of mumps cases by age group and date of onset in Pua District, Nan Province, Thailand, 1 Jun to 31 Dec 2010 (n=236)

onset of symptoms. Most cases were young children who played closely with others and made it difficult to isolate ill children from well children. Perhaps quarantine should be introduced as a control measure. People at risk in the family and neighbors should be protected by personal protection. Village 1 had no secondary case because their families had small number of children compared with 1-4 children per family in Village 3.

One dose of MMR vaccine had been estimated to be 73-91% effective in preventing clinical mumps.[11] During this outbreak, the vaccine performed as expected.

Unvaccinated 1-6 years old children had the highest attack rate. People aged 7-20 years might have received MMR vaccination from EPI program in Thailand as the MMR vaccine has been providing for Grade one students since 1997. The attack rate of 1-6 years old age group decreased 81.2% after 21 days of the mass MMR vaccination. This decline was more apparent than attack rates of other age groups which were not included in the mass vaccination.

Four specimens were tested positive by PCR and one specimen resulted to be genotype J (wild type). The Thai NIH reported genotype J had been identified in Thailand: Bangkok in 2007,[12] Phangnga[13] and Phayao Provinces in 2008 and Phitsanulok Province in 2010 (data from Thai NIH, unpublished report).

Limitations

Active case finding in community was conducted in only two villages. Lab confirmation was not possible for all clinical cases. In addition, specimen transportation which took more than 24 hours might result negative for mumps virus culture. We identified genotype in only one positive specimen because of limited budget.

Estimation of VE might be biased because obtaining vaccination status was only based on their recall. Nevertheless, the study population was limited to 1-20 years old contacts who had more reliable vaccination history because of school vaccination program since 1997 which had achieved over 95% vaccine coverage during 2009-2010.

Conclusion

This was the largest mumps outbreak in Nan Province since 2003. Majority of cases were in 1-6 years age group that was not included in EPI program. Attack rate of 1-6 years old might have decreased due to the mass MMR vaccination campaign during the outbreak. The secondary attack rate was similar to a previous study. Children may require their first dose of MMR vaccination prior to Grade one (seven years of age). This investigation confirmed the great benefit of replacing monovalent measles vaccine with MMR at nine months old children in June 2010.

Acknowledgements

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Suggested Citation

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Q Fever among Dairy Cattle in Chiang Mai Province, Thailand, 2012: A Preliminary Study

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Abstract

Q fever is an emerging zoonosis in Thailand caused by *Coxiella burnetii*. The purpose of this study was to explore the presence of *C. burnetii* antibody in dairy cattle, an important reservoir of Q fever, in Chiang Mai Province. Sera collected from dairy cattle by convenience sampling in San Pa Tong, Mae Wang and Mae On Districts in Chiang Mai were analyzed by the National Institute of Animal Health using indirect enzyme-linked immunosorbent assay (ELISA). Proportions of seropositive dairy cattle at herd and individual levels were 62% (13/21) and 5% (28/581), respectively. Mae On District had the highest proportion of seropositive dairy cattle in this study. This result suggested that dairy cattle might be an important carrier of Q fever in farming communities and further investigation on Q fever burden in both livestock and farmers was warranted.

Key words: Q fever, dairy cattle, Chiang Mai

Introduction

Q fever is a zoonosis caused by *Coxiella burnetii*, strict obligate intracellular Gram negative bacteria highly resistant to the environment. Domestic animals have commonly been identified as reservoirs, including cattle, sheep and goats. It was estimated that up to 30% of people in agriculture communities may be exposed to Q fever, including farmers, veterinarians and others in contact with animals.[1] The bacteria can be transmitted through inhalation of contaminated particles with *C. burnetii*, physical contact with vaginal mucus, milk, feces, urine or semen of infected animals, and bites by infected tick.[2] In Thailand, the first Q-fever antigen was detected in sera collected from workers in a slaughter house of Bangkok during 1966.[3] Nine acute clinical cases were also reported in 2003.[4] Seroprevalence of Q fever in asymptomatic domestic animals was the highest in dogs (28.1%) while prevalence in goats, sheep and cattle varied from 2.3-6.1%.[3] However, there was no updated information on seroprevalence of Q fever among animals in Thailand. In 2011, a study on human endocarditis in Khon Kaen Province identified four confirmed cases of Q fever related to endocarditis.[5] All patients had a history of contact with dairy and beef cattle.

The aim of this study was to explore presence of *C. burnetii* antibody among dairy herds in San Pa Tong, Mae Wang and Mae On Districts of Chiang Mai Province, Thailand.

Methods

Study Area and Population

This was a retrospective cross-sectional study conducted in San Pa Tong, Mae Wang and Mae On Districts of Chiang Mai Province between January and March 2012. Serum was tested for brucellosis and paratuberculosis as part of an annual survey program in Chiang Mai Province. Total 10 ml of whole blood was collected from each cow aged more than one year. Samples tested positive for tuberculosis in the annual survey were stored in a frozen serum bank and were included in this study. Total 581 specimens from 21 dairy herds were taken by convenience sampling and sent to the National Institute of Animal Health for Q fever testing.

Laboratory Testing

Serum samples were thawed and tested for presence of antibodies against *C. burnetii* using indirect enzyme-linked immunosorbent assay (ELISA) kit based on bovine antigen (Chekit-Q-fever, IDEXX) according to the manufacturer's instructions. A conjugate that detected a specific ruminant immunoglobulin G (IgG) antibody was used to provide evidence of exposure to *C. burnetii* infection. A seropositive case was defined as an ELISA optical density (OD) greater than 40%. Test sensitivity for cattle was 62.5% (35.4-84.8) and specificity was 90.4% (85.9-94.5) as indicated by Horigan et al.[6]

Statistical Analysis

Data were collected from farmers using a questionnaire and extracting from history records of dairy cows. Proportion positive of *C. burnetii* antibody were calculated at individual and herd levels.

Results

Proportions positive at herd and individual levels were 61.9% (13/21) and 4.8% (28/581) respectively. San Pa Tong District had the highest proportion of positive herd (100%) while Mae On District had 50.0% and Mae Wang District had 45.4% (Table 1). Geographical distribution of Q fever in villages of San Pa Tong, Mae Wang and Mae On Districts was illustrated in figures 1-4.

In San Pa Tong District, samples from 215 dairy cattle were tested for Q fever and 14 were resulted positive. While eight out of 54 dairy cattle were revealed positive for Q fever in Mae On District, only six out of 312 dairy cattle in Mae Wang District were positive (Table 2). The highest proportion of positive samples at individual cattle level was 14.8% in Mae On District followed by San Pa Tong (6.5%) and Mae Wang (1.9%).

Table 1. Proportion positive of Q fever at dairy herd level in San Pa Tong, Mae Wang and Mae On Districts, Chiang Mai Province, Thailand, 2012

District	Number of dairy herd (herd)		Percent of proportion positive	95% CI
	Total	Positive		
San Pa Tong	6	6	100.0	54.1-100.0
Mae Wang	11	5	45.4	16.7-76.6
Mae On	4	2	50.0	6.8-93.2
Total	21	13	61.9	38.4-81.0

Discussion

This was the preliminary finding on Q fever among dairy cattle in San Pa Tong, Mae Wang and Mae On Districts in Chiang Mai. Although this study used convenience sampling on tuberculosis herd with poor sanitation, it was shown that some herds in these three districts were exposed to *C. burnetii*.

Table 2. Proportion of Q fever at individual cattle level in San Pa Tong, Mae Wang and Mae On Districts, Chiang Mai Province, Thailand, 2012

District	Number of dairy cattle (head)				Percent of Q fever positive	95% CI
	Total	Positive	Suspected	Negative		
San Pa Tong	215	14	3	198	6.5	3.6-10.7
Mae Wang	312	6	0	306	1.9	0.7-4.1
Mae On	54	8	1	45	14.8	6.6-27.1
Total	581	28	4	549	4.8	3.2-6.9

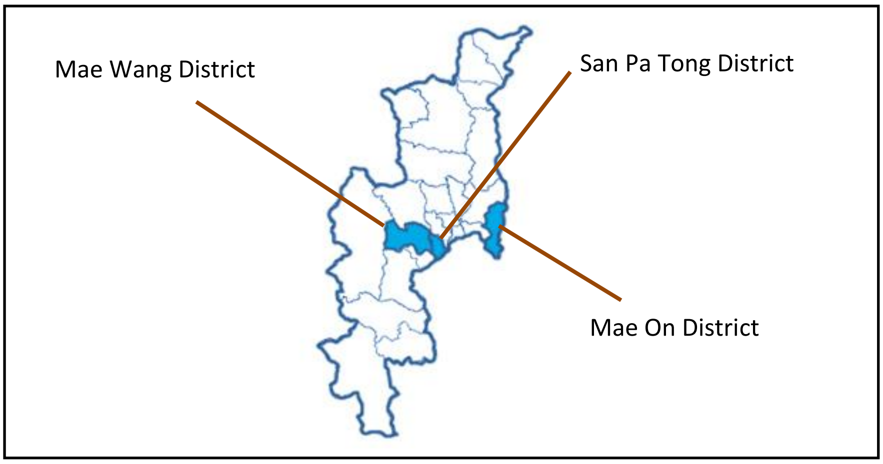

Figure 1. Map of San Pa Tong, Mae Wang and Mae On Districts in Chiang Mai Province, Thailand

Proportion of *C. burnetii* seropositive cattle (14.8%) was less than the average seroprevalence in dairy cow (10.1%) in northeastern China which used ID Screen® Q Fever Indirect ELISA kit.[7] Nevertheless, there was potential opportunity of exposure to farmers, abattoir workers, veterinarians and laboratory personnel who were high risk contacts.

Seropositive cattle did not show typical or apparent clinical signs. Thus, further specimen collection such as aborted fetus, placenta, milk or fluid secretion from these dairy herds must be confirmed for presence of *C. burnetii* by polymerase chain reaction (PCR). In addition, it may be useful to investigate other animals in the farms and design a specific study to determine prevalence of Q fever in dairy cattle and animal keepers. The results of this preliminary study could be used to estimate an adequate sample size required to detect antibodies against *C. burnetii* in dairy cattle and promote understanding of Q fever at the human-animal interface.

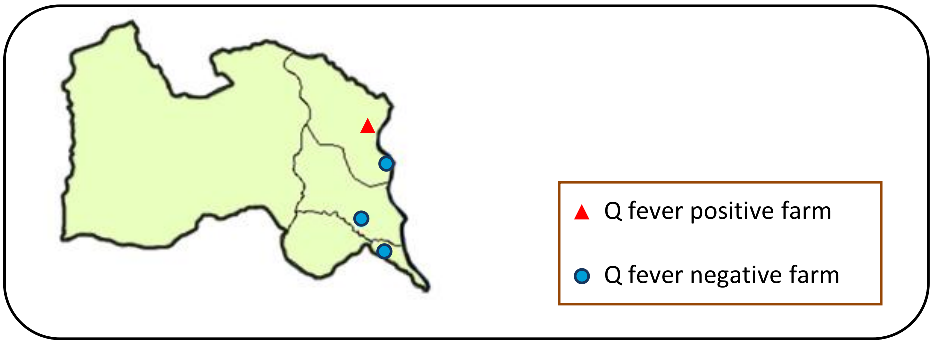

Figure 2. Distribution of Q fever in Mae Wang District, Chiang Mai Province, Thailand, 2012

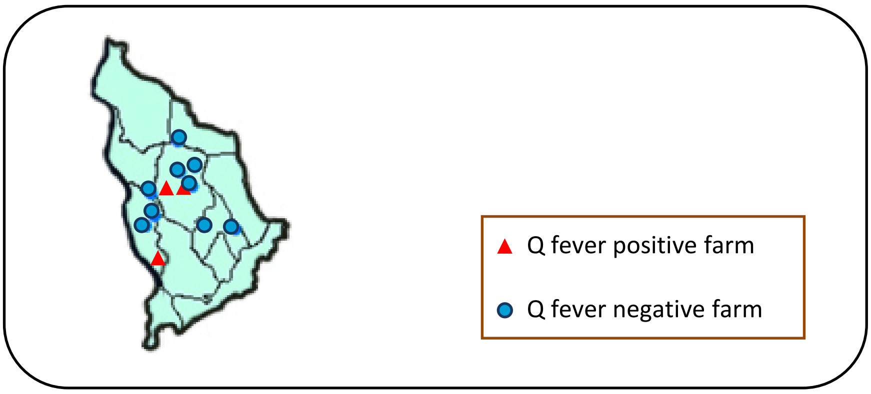

Figure 3. Distribution of Q fever in San Pa Tong District, Chiang Mai Province, Thailand, 2012

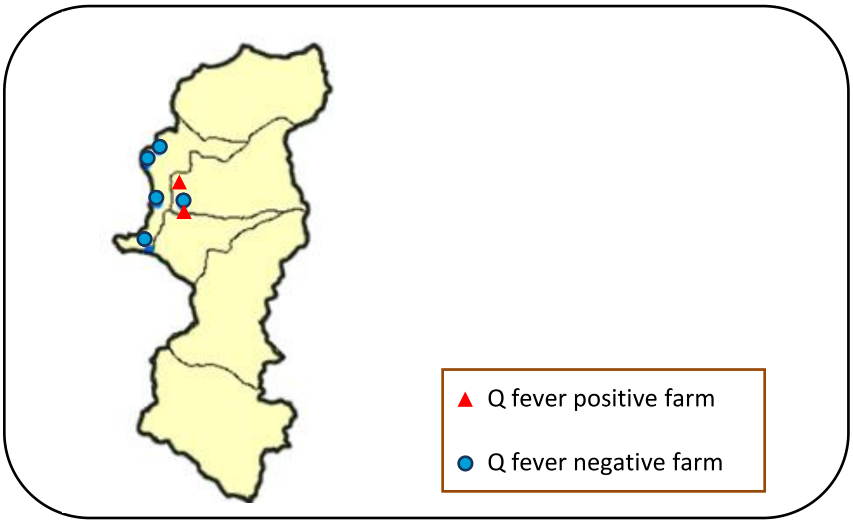

Figure 4. Distribution of Q fever in Mae On District, Chiang Mai Province, Thailand, 2012

Among samples collected from an annual survey program in Chiang Mai Province, only samples tested positive for tuberculosis were included in this study. Thus, either sampling from all samples of the annual survey or stratified sampling in future studies would provide higher representativeness of cattle population. In addition, this study could not identify relationship between tuberculosis and Q fever in dairy cattle, which should be studied more in the future.

Conclusions and Recommendations

Although no human Q fever cases was reported in northern part of Thailand, serological evidence of Q fever exposure among dairy cattle in San Pa Tong, Mae Wang and Mae On Districts in Chiang Mai Province was observed. In order to prevent transmission of the disease from dairy cattle to human, farmers should ensure to pasteurize milk properly, disinfect animal facilities regularly especially in parturition areas, keep pregnant animals in separate pens, remove and dispose all birthing matters such as aborted fetuses quickly and properly to prevent contact with domestic animals or wildlife, and keep manure of infected herds away from gardens and populated areas.

Most importantly, good farm practice could help to reduce human and animal health risks. Prevention and control of Q fever in human include maintaining good personal hygiene, handling animals with water-proof gloves and using additional personal protective equipment (face masks and goggles) for high risk activities such as birth assistance, placenta removal, handling carcass, milking and farm cleaning. In addition, all late abortions in animals should be investigated for Q fever. Communication and public education for high risk occupational groups should be conducted. All farmers, workers, livestock officers, veterinarians and their families should be advised on precautions to be taken when handling animals. Moreover, pregnant women should avoid exposure to animals during delivery or post-partum period.

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Estimation of Acute Diarrhea and Acute Respiratory Infections among Children under Five Years Who Lived in a Peri-urban Environment of Myanmar

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Abstract

Exposures to multiple environmental contaminants place children under five years of age at a greater risk to acute diarrhea and acute respiratory tract infections (ARI). To assess this phenomenon, a cross-sectional survey was conducted to examine relationships between environmental conditions and occurrence of acute diarrhea and ARI in peri-urban areas of Yangon Region, Myanmar. Mothers or caretakers of 620 children under five years were interviewed using a structured questionnaire. Of these children, 1% had acute diarrhea only, 45% had ARI only and 3.7% had both conditions during last four weeks. Children suffered from acute diarrhea were 2.1 times more likely to suffer ARI in age group of 24-59 months (stratum-specific odds ratio = 2.1, 95% CI = 0.7-6.5). Multivariate analyses identified that bamboo housing and unsafe method of waste disposal were significantly associated with occurrence of acute diarrhea. However, no significant association was identified between ARI attack rate and environmental factors such as house condition and ventilation. Integrated community-based strategies to improve environmental conditions, water, sanitation and hygiene should be considered to reduce the dual burden of these illnesses in children under five years.

Key words: acute diarrhea, acute respiratory infections, dual burden, under five children, environmental contaminants

Introduction

Globally, millions of children under five years of age die every year from environmental related diseases such as acute respiratory infections (ARI) and acute diarrhea.[1] Children in developing countries are at the highest risk. In 2012, estimated 6.6 million of children were under five years old in Myanmar. Acute diarrhea and ARI were the leading causes of morbidity and mortality among these children.[2]

Environmental conditions such as contaminated water and inadequate sanitation can contribute to acute diarrhea while poor air quality can be a factor to ARI. Multiple exposures to environmental contaminants may increase occurrence of acute diarrhea and ARI among children under five years of age.[3] Acute diarrhea can lead to acute weight loss, malnutrition and stunting, which are risk factors for ARI in a low income setting. This association has a considerable public health importance.[4] Burden of both diseases can be duly reduced by implementing community-based prevention strategies such as improved water quality, sanitation and hygiene, and better quality of fuel for cooking.[5] Studies have shown that these interventions could significantly reduce child mortality by more than 25%.[6]

Objectives of this study were to assess occurrence of acute diarrhea and ARI in a 4-week period and determine contribution of exposure to environmental conditions on acute diarrhea and ARI among children under five years of age in peri-urban areas of Yangon Region. These findings would be useful for assessing scope and magnitude of these diseases, and identifying vulnerable households and risk factors that would lead to an integrated approach to reduce burden of these diseases.

Methods

We conducted a cross-sectional survey in North Dagon Township, Yangon Region from September to November 2012. We interviewed mothers or caretakers of children under five years of age who lived in six randomly selected wards in North Dagon Township. A structured questionnaire was pretested and then administered by six trained interviewers in face-to-face interview with eligible mothers or caretakers. In household study, mothers or caretakers reported, at most, only one episode of ARI and acute diarrhea within past two weeks. However, when extending the self-reporting period for additional two weeks, one to two additional episodes of morbidity were reported. Thus, the study period was extended to 4-week period.

Cluster sampling method was used as it can increase efficiency and cost effectiveness of the study. Sampling frame from a recently completed research project was used to identify six clusters to be sampled.[7] The selected clusters contained 525 households and 620 children. The number of households was based on the assumption that 20% of households had a child under five years with acute diarrhea and ARI within past four weeks, with 5% precision, design effect of two and 10% non-response rate. All children under five years in these households were included in the study (range 1-2 children).

For this study, acute diarrhea was defined as one of the followings: passage of three or more loose watery motion, more than usual loose watery motion, a single large watery motion in a day, or mother's assessment that her child passed more frequent liquid stools.[8] Other symptoms recorded were bloody stools, vomiting or dehydration. ARI could be an upper or lower respiratory tract infection and was defined as any acute episode of runny nose, cough, ear discharge, hoarseness of voice, difficult or fast breathing with or without fever, or chest indrawing.[7] Environmental conditions were defined as any modifiable condition of indoor or outdoor air pollution, housing infrastructure, source of water supply, water treatment and storage, hand washing facilities, latrines and solid waste disposal, exclusive of meteorological conditions.

Quantitative data were entered in EpiData software after thorough checks. Frequency distributions and cross-tabulations were done for variables of interest such as social and demographic characteristics, and related environmental variables. Attack rates for acute diarrhea and ARI, and 95% CI were computed. For bivariate analyses, chi-square test or Fisher's exact test was used as appropriately to ascertain relationship and p-value of 0.05 or less was considered as statistically significant. Stratum-specific odds ratios (OR) and 95% CI were computed to identify confounding effects of children's age. Logistic regression was also done to identify confounding effects of environmental factors in occurrence of acute diarrhea and ARI within past four weeks.

All participants were informed about objectives and procedures of the study, and steps to protect privacy, anonymity and confidentiality of information collected. Only those who gave their voluntary consent were interviewed.

Results

In this survey, 46.0% of children were between 12-35 months old and only 17.3% were under 12 months. Mean age and standard deviation of children was 29.0±16.4 months. Boys (51.3%) comprised slightly more than half of the study population. Most respondents (65.6%) were mothers of children and 41% were between 25 to 34 years old. Almost one fourth of respondents had high school level education and one third constituted working mothers.

Monthly per capita income was computed by dividing total monthly family income by total number of people living in that household. Median monthly per capita income was 25,000 Kyat (approximate 25 USD) and 41.6% of the respondents were residing in households with low (1667 to 14,286 Kyat) to middle (14,287 to 20,000 Kyat) monthly per capita income.

Attack Rates of Acute Diarrhea and ARI

Of 620 children in the surveyed households, 29 (4.7%, 95% CI=3.3-6.9) had an acute diarrhea episode in preceding four weeks of the interview. Attack rates of ARI during the same period was 48.7% (95% CI=46.1-54.2). Attack rates of acute diarrhea and ARI within past four weeks were the highest among age group of 12-23 months (Table 1).

For acute diarrhea, 3.2% of 620 children had one episode within past one month and only 1.5% suffered from two episodes. Regarding to ARI, 26.5% of 620 children had one episode within past one month and 22.3% suffered from two episodes (Table 2).

Simultaneous occurrence of acute diarrhea and ARI in past month was reported in 23 children as 3.7% (95% CI=2.4-5.7), and 312 children (50.3%) were free from morbidity of acute diarrhea or ARI. Findings indicated that children under five years in the study population were nearly 10 times more likely to suffer from one or two episodes of ARI (302/620, 48.7%) compared to acute diarrhea (29/620, 4.7%).

Children suffered from acute diarrhea were 2.1 times more likely to suffer ARI in age group of 24-59 months (95% CI = 0.7-6.5) (Table 3). Although it was not significant, children suffered from acute diarrhea were 1.7 times more likely to suffer ARI in age group of 12-23 months. Older age group had higher risk for simultaneous morbidity of ARI and diarrhea within past month compared to younger children (Table 3).

Table 1. Attack rates of acute diarrhea and acute respiratory infections (ARI) in children under five years within past four weeks, North Dagon Township, Yangon Region, Myanmar, September to November 2012 (n=620)

Age group (month)	Total	Acute diarrhea			ARI			Both		
		Number	Percent	95% CI	Number	Percent	95% CI	Number	Percent	95% CI
1-11	107	1	0.9	0-5.0	40	37.4	29.0-47.0	4	3.7	1.0-9.0
12-23	144	2	1.4	0-5.0	72	50.0	42.0-58.0	7	4.9	2.0-10.0
24-59	369	3	0.8	0-2.0	167	45.3	40.0-50.0	12	3.3	2.0-6.0

Table 2. Episodes of acute diarrhea and acute respiratory infections (ARI) in children under five years within past four weeks, North Dagon Township, Yangon Region, Myanmar, September to November 2012 (n=620)

Characteristic	Number	Percent
Episode of acute diarrhea		
None	591	95.3
One	20	3.2
Two	9	1.5
Episode of ARI		
None	318	51.3
One	164	26.5
Two	138	22.3
Both acute diarrhea and ARI	23	3.7
Acute diarrhea only	6	1.0
ARI only	279	45.0
None	312	50.3

Bivariate analyses revealed significant associations between attack rate of acute diarrhea and living in a bamboo house, storage of drinking water in a clay pot, using a cloth filter for drinking water and unsafe method of waste disposal. In adjusted model, bamboo housing and unsafe method of waste disposal had statistically significant higher odds in occurrence of acute diarrhea compared to their reference categories (Table 4).

Presence of smoke around the house was associated with chances of having ARI more likely than the reference category. However, when adjusted for other variables, ORs were revealed not significant (Table 5).

Discussion

This was the first study carried out in Myanmar to identify dual burden of acute diarrhea and ARI in an expanding peri-urban areas. Occurrence of ARI is more predominant than acute diarrhea among children under five years in households during four weeks prior to the survey date. The attack rate of acute diarrhea was found to be 4.7% in past four weeks, which was lower than the rates reported in studies in Asia and Africa.[9-11] This might be due to the fact that this survey took place in late rainy season. Usually, prevalence of acute diarrhea is very high in April to May and also in cool season from December to January in Myanmar.[12]

In this study, children between 12 to 23 months of age had significant higher attack rates of acute diarrhea (6.3%) and ARI (54.9%) in the past month as compared to children 1-11 months and 24-59 months of age. This might be due to higher level of care given to infants, regarding water, sanitation and hygiene compared to older children. Only 3.7% of children under five years suffered from both acute diarrhea and ARI within past four weeks.

There are significant location differentials between rich and poor areas based on per capita income level. Poor areas are particularly vulnerable because many people are living in camp-like setting where overcrowding and poor sanitation increase chance of disease occurrence. In this study area, most people were living in poor housing conditions and ventilation

Table 3. Relationship between acute diarrhea and acute respiratory infections (ARI) within past four weeks stratified by age group, North Dagon Township, Yangon Region, Myanmar, September to November 2012

Age group (month)	Number of acute diarrhea		Number of ARI		Stratum-specific OR	95% CI
			No	Yes		
1-11	No	102	45	40	Reference	
	Yes	5	1	4	1.3	0.2-7.9
12-23	No	135	42	72	Reference	
	Yes	9	2	7	1.7	0.4-11.2
24-59	No	354	14	167	Reference	
	Yes	15	3	12	2.1	0.7-6.5

Table 4. Environmental conditions associated with acute diarrhea reported among children under five years within past four weeks, North Dagon Township, Yangon Region, Myanmar, September to November 2012 (n=620)

Characteristic	Total	Number of case	Crude OR	95% CI	Adjusted OR	95% CI
Housing material						
Pucca, semi-pucca, wood	503	24	Reference		Reference	
Bamboo	117	20	4.1	2.2-7.7	2.1	1.0-4.2
Storage of drinking water in a clay pot						
No	414	21	Reference		Reference	
Yes	206	23	2.4	1.3-4.4	1.3	0.7-2.8
Using cloth filter for drinking water						
No	376	19	Reference		Reference	
Yes	244	25	2.2	1.2-4.0	0.8	0.4-1.7
Safe disposal of waste						
Yes	489	17	Reference		Reference	
No	131	27	7.2	3.8-13.7	5.6	2.6-12.2

Table 5. Environmental conditions associated with acute respiratory infections (ARI) reported among children under five years within past four weeks, North Dagon Township, Yangon Region, Myanmar, September to November 2012 (n=620)

Characteristic	Total	Number of case	Crude OR	95% CI	Adjusted OR	95% CI
Number of room in house						
>1 rooms	421	275	Reference		Reference	
1 room	199	108	0.6	0.5-0.9	1.3	0.9-1.9
Cross-ventilation						
Yes	567	352	Reference		Reference	
No	53	31	0.9	0.5-1.5	1.4	0.8-2.6
Usual cooking place						
Kitchen and outside the house	316	210	Reference		Reference	
In the house	304	173	0.7	0.5-0.9	0.9	0.7-1.3
Smoke around house						
No	546	323	Reference		Reference	
Yes	73	59	2.9	1.6-5.3	0.5	0.3-0.9

was not adequate in most of the houses. Using unclean cloth filters and keeping drinking water in unclean clay pots might aggravate contamination of drinking water, especially for children under five. However, in this study, significant associations were not detected for ARI probably due to seasonal effect and small sample size. Poor housing and unsafe waste disposal were significant environmental contributors for occurrence of acute diarrhea, leading to higher chance of ARI occurrence within one month. Role of water and waste on children's health had been demonstrated in low income neighborhoods previously. Multiple risk factors for both conditions were widely prevalent in the Southeast Asia Region.[13]

This study addressed alarmingly lack of simple, safe and relatively inexpensive environmental interventions in the study area. Therefore, it was essential to facilitate discussions with stakeholders for high level of community involvement for water, sanitation and hygiene interventions to mitigate the dual burden in vulnerable sites.

Limitations

In this study, self-reported answers might subject to recall and reporting bias. Since the study was a cross-sectional one and conducted with small sample size, causality could not be determined. There was a likelihood of unidentified predictors or confounders and effect modifiers concerning with malnutrition, food sanitation and seasonality.

Conclusions and Recommendations

Findings of this study might help to improve understanding about influence of indoor and outdoor environment on children's health in fast developing peri-urban areas of Yangon Region. Risk factors for acute diarrhea and ARI in this study were linked to socio-economic conditions of household and community levels. There was a likelihood of ARI occurrence among children if they suffered acute diarrhea within previous four weeks. This was especially true for older children and follow-up studies would be necessary to prove the causal link.

Preventing the dual burden of acute diarrhea and ARI among low and middle income households requires a multi-sectoral strategy beyond bounds of health sector such as provision of safe water supply, sanitation and decent housing. Coping strategies for environmental exposure and health impacts in children might aim to fill up knowledge gaps, and priorities should be redefined after multi-stakeholder discussions. Integrated interventions to augment disease control program by innovative risk communication approaches should cover all children under five years. Integrated community-based strategies to improve indoor and outdoor environmental conditions, water, sanitation and hygiene should be considered to reduce the dual burden of acute diarrhea and ARI in children. Risks and social protection of households in the study area required attention to avoid further implications on inequity in universal health coverage.

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