ORIGINAL ARTICLE

INFLUENCING FACTORS FOR CHOLERA AND DIARRHOEA: WATER SANITATION AND HYGIENE IN IMPOVERISHED RURAL VILLAGES OF BELURAN DISTRICT, SABAH MALAYSIA

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ABSTRACT

The lower percentage of water, sanitation and hygiene are the root causes of diarrhoea and cholera. Cholera is a sudden onset of acute watery diarrhoea which can progress to severe dehydration and death if untreated. The current pandemic, Vibrio Cholera O1 started in 1961. This study explores water, sanitation, hygiene and cholera and diarrhoea in three affected villages of Beluran District, Sabah Malaysia to support effective and timely public health intervention. This cross sectional study uses purposive sampling. All (114) households were interviewed and household water samples collected. The study reported lower coverage improved sanitation facilities (35.3% to 52.3%), no latrine at home (37% to 63%), improved water supply (52% to 60%), and prevalence of hand washing after toilet (57% - 74%). For water quality, Ecoli was present in household water (32% to 37%) but Vibrio cholerae was not isolated in any of the water samples tested. Statistically significant associations were found for; 1) occupation–non-agriculture and unimproved sanitation facility and 2) house ownership and correct knowledge of ORS preparation. Predictors for household water quality were: latrine at home, and improved household toilet. Aggressive strategies to improve water supply, sanitation and hygiene–hand washing after toilet–were recommended for future prevention of cholera and diarrhoea in the affected area.

***Keywords**: cholera and diarrhoea, health, water, sanitation and hygiene*

INTRODUCTION

Diarrhoea and cholera are commonly related to water, sanitation and hygiene problems. The World Health Organization has reported that eighty-eight per cent of cases of diarrhoea worldwide are attributable to unsafe water, inadequate sanitation or insufficient hygiene[1]. Globally, there are about 1.7 billion diarrhoea cases annually which account for more than 4% of the global burden of disease–1.5 million deaths and 52 million DALY loss–with diarrhoeal disease as the third highest cause of morbidity and sixth highest cause of mortality[2-3]. According to UNICEF and WHO, in 2012; 63% of the world population has access to improved sanitation and 89% to improved drinking water[4]. However, universal water and sanitation coverage is still far off. 605 million people are without access to improved drinking water, and 2.4 billion are without improved sanitation facilities[4]. Furthermore, hand washing with soap, household drinking water treatment and appropriate containment of stools, are noted to reduce diarrhoea risk by Curtis and Caincross (2003) "hand washing with soap after faecal contamination" 47%, Esrey et al (1991) "sanitation including proper disposal of child faeces" 36%, proper waste disposal and hand washing after toilet, before meal and food preparation" 33%", Fewtrell et al (2005) "household water treatment" (35% to 39%), and Caincross (2006) "hygiene" 48% and related risk of (1.92)[5-8].

Cholera is a sudden onset of acute watery diarrhoea which can progress to severe dehydration and death if untreated. Cholera originated in the Ganges valley of India and seven pandemics have spread worldwide since 1817 – the seventh pandemic *Vibrio cholerae* (*V cholerae*) O1 (El Tor biotype) started in 1961[9]. A new toxigenic strain "O139" started in south-eastern India in 1992 and spread to the whole Indian subcontinent and neighbouring areas by the end of 1994, however; currently in most regions of Southeast Asia, *V. cholera*e O1 remains dominant[10]. *V. cholerae* O1 is biotyped into classical and El Tor; and further subdivided into two serotypes; Inaba and Ogawa[11].

V. cholerae is an extremely virulent bacteria that survives up to two weeks in fresh water and eight weeks in salt water and can spread to humans through infected drinking water, shellfish, food contaminated by flies or on the hands of carriers, and directly from person to person by faecal oral route[9,11,12]. Cholera has an extremely short incubation period–two hours to five days–which enhances the potentially

explosive pattern of outbreaks, as the number of cases can rise very quickly[11].

The diagnosis of cholera is the presence of *V. cholerae* in stools; dark field microscopy and serotyping by immobilization with specific antiserum. Lab isolation requires use of selective medium thiosulfate-citrate-bile salt-sucrose (TCBS) agar. All types of *V. cholerae* are oxidase test positive[9]. A new rapid diagnostic test (RDT) is now available, however WHO suggests that all samples tested positive with the RDT are re-tested using classic laboratory procedures for confirmation[11]. Clinical diagnosis is easy during an epidemic, otherwise bacteriological confirmation is required.

The study area, Beluran district, is located near Sandakhan, Sabah State, Malaysia. Malaysia is a cholera non-endemic country with 2,293 expected cases and 24 deaths annually[13]. In Sabah, cholera epidemics recorded between 2000 and 2012 showed three peaks –362 cases in 2001, 348 cases in 2005, and 431 and 430 cases in 2010 and 2011–and less than 140 cases in all remaining years[14]. Beluran has many remote rural villages. Cholera was not reported in there from 2004 to 2009. However, one case of cholera was reported in 2010 and seven cases were reported in 2011. This study explored water, sanitation, hygiene and cholera and diarrhoea in three affected villages. The result of the study advises proper, effective and timely public health intervention to prevent further epidemic outbreaks, cholera morbidity and mortality.

METHODOLOGY

This cross sectional observational study was conducted in three cholera affected villages–four cases of cholera were reported from Kg Dalamas, Kg Tebatu and Kg Simpangan–of Beluran district. The villages are side by side along the river (Sungai Paitan) in a remote forest area. Minimal required sample size was (323), calculated by $n = \{Z^2 * P(1-P)\} \div \Delta^2$ where confidence limit Z = 1.96, precision Δ = 0.05 and prevalence of improved water supply and sanitation coverage; moderate estimate 70%, assuming lower than 95% of national coverage (2010)[4] and Sabah State coverage (2004)[15]. Purposive sampling was used and all (114) households (689) populations were surveyed in three villages. All household heads were interviewed with validated questionnaires for socio-demographics, household water, sanitation and hygiene (Fig 1). Ethical approval was submitted to the University Malaysia Sabah, School of Medicine Ethic Committee before the study and approved by Jawatankuasa Etika Penyelidikan Perubatan UMS - JKEtika 1/13 (3).

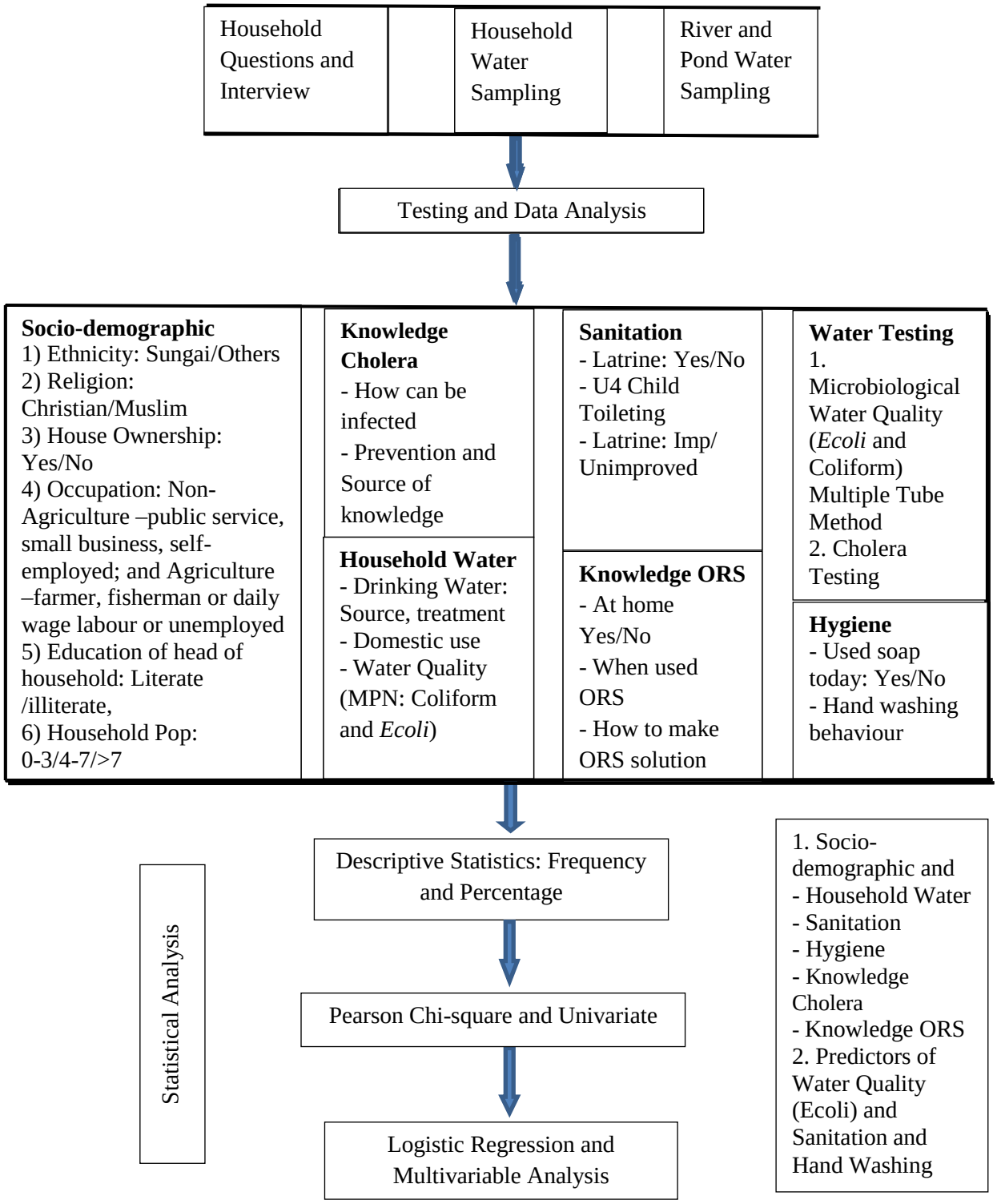
Questionnaires were adapted from LSHTM-UNICEF cholera investigation questionnaires and WHO UNICEF Water and Sanitation Joint Monitoring programme[4,16]. Validity and reliability of questionnaires are important for our findings. The adopted English questionnaires were thoroughly examined by bi-lingual (English and Malay) content experts and public health specialists, then translated into Malay and back into English. The back translated version was compared with the original English version for semantic equivalence and necessary corrections were made. The finalized version of the Malay questionnaire was reviewed for face, semantic and conceptual equivalence. The reliability testing of the final questionnaires showed Kappa statistics (0.8-1.0) and Cronbach's alpha 1.0 – excellent agreement and complete reliability[17-18].

Trained health volunteers carried out household interviews and collected water samples from household storage tanks and water sources – river and ponds. Sampling bottles were sterile, 120 ml capacity and can fill up to 100 ml. Refer to WHO recommendations for bacteriological water quality testing, sterilization of storage tank outlet and hand washing were performed before the water collection, and samples were cooled rapidly by immediate placing in a lightproof insulated box containing frozen ice packs[19]. All water samples collected were transported through cold chain to the University Malaysia for microbiological examination within one day of collection.

Multiple tube method–more sensitive than membrane filtration–is an indirect assessment of microbial density in the water sample by reference to statistical tables to determine the most probable number (MPN) of microorganisms present in the original sample[19]. Five test tubes containing 10 mls of double strength (DS) McConkey broth and Durham's tube were used to test one water sample. From one water sample, 10 mls of water were added to 10 mls each of five (DS) McConkey broth and incubated at 37°C overnight. Next day the tubes were observed for change in colour of the broth as well as collection of gas inside the Durham's tube. The negative tubes were incubated for another 24 hours and examined again as above. MPN was determined according to Table 1[20-21].

For the positive samples, a loopful of broth was inoculated onto McConkey agar and incubated overnight at 37°C. The next day the inoculated agar was observed for the growth of pink lactose fermenter (LF) colonies and the LF colonies were subjected to indole and citrate tests. Indole positive, citrate negative isolates were identified as *Escherichia coli (Ecoli)*.

Figure1. Data Collection and Statistical Analysis Flow



Water quality testing for bacteriological contamination was classified according to the target values (Table 1)[22-23]. According to the international standard organization (ISO) and World Health Organization guidelines, there was no detectable level of pathogenic microorganism—*Ecoli* and coliform—in all water intended for drinking[20,22,23].

Method for isolation and identification of *Vibrio cholerae*; Ten mls water sample was added into one tube containing 10 mls of double strength Alkaline Peptone Water (APW) and incubated at 37°C for 6 hours. After that a loopful of inoculated double strength APW was transferred to 5 ml of single strength APW and incubated overnight. Next day, a loopful of inoculated single strength APW was sub cultured on TCBS agar and incubated for 24 hours. Next day the plates were observed for the presence of golden yellow colonies suggestive of *Vibrio cholera*. These colonies were subjected to oxidase test and typing was done using *Vibrio cholera* O1 antisera.

Table1. Water Quality Testing: MPN Index and 95% Confidence Limits by using Five 10 ml Portions and Target Values for Bacteriological Contamination of Water[19-22]

MPN Index and 95% Confidence Limits			Water Quality Testing for Bacteriological Contamination		
No. of Tubes Giving Positive Reaction out of 5 of 10 ml each	MPN Index per 100 mL	95% CI (approximate)	Coliform count in MPN/100ml	*Ecoli*	Interpretation (by Coli form and *Ecoli* count)
0	<2.2	0, 6.0	0	0	Excellent
1	2.2	0.1, 12.6	0-3	0	Satisfactory
2	5.1	0.5, 19.2	4 to 10	0	Suspicious
3	9.2	1.6, 29.4			
4	16.0	3.3, 52.9		1 or more	Unsatisfactory
5	>16.0	8.0, Infinite			

Statistical analysis was done through SPSS version 21 available in School of Medicine, Universiti Malaysia Sabah. Findings about household water, sanitation, hygiene, and knowledge about cholera and diarrhoea were reported with frequency, percentage and association. Furthermore, statistical association using univariate and multivariable analysis was calculated. All significant findings were reported in odds ratios OR, confidence interval CI, and respective p value. (Figure 1)

RESULTS

In our study of 114 households, 51 participants were from Dalamas (44.7%), Simpangan 38 (33.3%), and Tebatu 25 (21.9%). In three villages; ethnicity was mostly Sungai (86% - 100%), and house ownership was (80% - 100%). Occupations of the household were mainly agriculture –farmer/fisherman 65% in Dalamas, 60% in Tebatu, and 32% in Simpangan, and daily wage labour (16% - 18%) in all three villages. The remainder are non-agriculture group–public services and small businesses. The sources of drinking water in the villages (UNICEF/WHO JMP classification)[4] were improved– rain water (52% - 60%) and combined improved and unimproved–rain and surface water (40% - 48%). Most people (92% - 100%) in three villages treated water (boiling) for drinking. Latrine at home (Yes) was lowest in Dalamas (37%) while Simpangan and Tebatu were 63% and 52% respectively. Sanitation facility (household toilet) classified as improved (Flush/pour flush to septic tank/pit latrine or pit latrine with slab) (UNICEF/WHO JMP)[4] type was also lowest in Dalamas 35%, followed by Tebatu 40% and Simpangan 52%. Prevalence of hand washing with soap after toilet was: Dalamas 57%, Simpangan 68%, and Tebatu 74%. Knowledge about diarrhoea and cholera: how cholera can infect humans (correct: from the dirty toilet or contact with cholera or drinking non-treated water or poor personal and food hygiene)[10,12,13] was high at 84% – 92% in all three villages. However there was a moderate proportion of correct method of ORS preparation[24]–one liter boiling water to one pack ORS, used within 24 hours, no colour change of ORS pack–(41% - 58%) and have ever used ORS when someone got diarrhoea, sick, tired, vomiting–(69% - 72%) in the three villages. (Table 2, Figure 2 and 3)

For microbial water quality, 114 household water samples and 17 water source samples were tested for presence of coliform, *Ecoli* and *Vibrio Cholerae*. Water quality results for households were satisfactory– Simpangan 5.8% and Tebatu 8%–and suspicious–Dalamas 5.9%–and unsatisfactory–all the remaining households (>90%) and source water samples (100%). Among the unsatisfactory results, the presence of *Ecoli* in the water samples were: households– Dalamas 37.2%, Simpangan 36.8% and Tebatu 32%; river/pond– Dalamas 66.7%, Simpangan 40% and Tebatu 33%. For *Vibrio cholerae* testing, five households and one river water sample in Simpangan and three river water samples in Tebatu revealed yellow colonies on TCBS agar as well as oxidase test positive. However, none of the colonies showed agglutination with *V. cholerae* O1 antisera. *V. cholerae* was not isolated in any of the water samples tested in this study. (Table 3)

In statistical analysis (Table 4), multivariable logistic regression was done to find predictors for household water, sanitation, hygiene, and knowledge about cholera and diarrhea. Sanitation facility (Unimproved)[4] was associated with 1) ethnicity–others races group OR: unadjusted (4.57; CI 0.88, 23.73, p=.071) and adjusted (2.81; CI 0.5, 15.8, p=.240)–and 2); occupation– non-agriculture OR: unadjusted (3.5; CI 1.5, 8.16, p=.004) and adjusted (3.06; 1.28, 7.33, p=.012). ORS preparation correct knowledge was associated with 1) ethnicity–Sungai OR: unadjusted (8.45; CI 1.00, 71.16, p=.049) and adjusted (5.11; CI 0.55, 47.18, p=.150); 2) house ownership–yes OR: unadjusted (11.34; CI 1.38, 92.84, p=.024) and adjusted (8.82; CI 1.04, 75.02, p=.046); and 3) occupation: agriculture OR: unadjusted (2.02; CI 0.89, 4.62 and p=.094) and adjusted (1.59; CI 0.66, 3.84 and p=.3). Independent predictors for hand washing with soap after toilet were; 1) water sufficiency– yes OR: unadjusted (4.32; CI 1.37, 13.53, p=.012) and adjusted (4.45; CI 1.40, 14.14, p=.01); 2) Latrine at Home–no OR:

unadjusted (2.07; CI 0.94, 4.55 and p=.07) and adjusted (2.15; 0.95, 4.85 and p=.065). Presence of E Coli in Household Water (no/yes) was associated with 1) latrine at home– yes OR: unadjusted (2.94; CI 1.32, 6.67, p=.008) and adjusted (5.23; CI 1.10, 24.74, p=.037); and 2) type of household toilet–improved OR: unadjusted OR (2.09; CI 0.96, 4.56, p=.063) but reduced risk at; adjusted (0.50; CI 0.10, 2.36, p=.388).

Table 2. Socio-demographic, Household Water-Sanitation-Hygiene and Knowledge about Diarrhoea-Cholera among three Villages

Description		Village			
		Dalamas	Simpangan	Tebatu	p
Socio demographic					
Ethnicity of Participants	Sungai	50 (98%)	31 (81.6%)	25 (100%)	.003
	Others; Rongus, Kudasan- Duson, Bajau,Chinese, Sulu	1 (2%)	7 (18.4%)	0	
Religion	Christian	46 (90.2%)	2 (5.3%)	0	.000
	Muslim	5 (9.8%)	36 (94.7%)	25 (100%)	
House Ownership	No	2 (3.9%)	8 (21.1%)	0	.004
	Yes	49 (96.1%)	30 (78.9%)	25 (100%)	
Occupation : Agriculture	Fisherman/Farmer	33 (64.7%)	12 (31.6%)	15 (60%)	.005
	Daily Wage Labour/Unemployed	9 (17.6%)	7 (18.4%)	4 (16%)	
Occupation : Non-Agriculture	Public Service	3 (5.9%)	12 (31.6%)	1 (4%)	
	Small Business/Self Employed	6 (11.8%)	7 (18.4%)	5 (20%)	
Education	Schooling	37 (72.5%)	37 (97.4%)	21 (84%)	.008
	No Schooling	14 (27.5%)	1 (2.6%)	4 (16%)	
Household Water Sanitation and Hygiene					
Source of Drinking Water	Rain Water	27 (52.9%)	23 (60.5%)	13 (52%)	.724
	Rain and Surface Water	24 (47.1%)	15 (39.5%)	12 (48.0%)	
Drinking Water Treatment	YesBoiling and Sediment/ Filter/Mineral Water	50 (98%)	35 (92.1%)	25 (100%)	.180
	No Treatment	1 (2%)	3 (7.9%)	0	
Latrine at Home/ Neighbour	Yes at Home	19 (37.3%)	24 (63.2%)	13 (52%)	.051
	No (At Forest/Beach/ Neighbourhood Latrine)	32 (62.7%)	14 (36.8%)	12 (48%)	
Type of Hh Toilet (Sanitation Facility)	Improved (Flush/pour flush to septic tank/pit latrine OR Pit latrine with slab)	18 (35.3%)	20 (52.3%)	10 (40%)	.254
	Unimproved (Pit latrine without slab/ open pit OR No facilities/bush or field/shared)	33 (64.7%)	18 (47.4%)	15 (60%)	
Prevalence of hand washing with soap after toilet[a]	Good (hand washing after toilet and or food and or personal hygiene)	29 (56.9%)	17 (68%))	28 (73.7%	.180
	Poor (hand for food and or personal hygiene, no hand washing after toilet)	22 (43.1%)	8 (32%)	10 (26.3%)	
Knowledge about Diarrhoea-Cholera					
Knowledge about how cholera can be infected to human	Correct Knowledge (>1: From the dirty toilet or contact with cholera or drinking non-treated water or food and personal hygiene)	44 (86.3%)	36 (94.7%)	23 (92%)	.389
	Incorrect Knowledge (DK, Will of God)	7 (13.7%)	2 (5.3%)	2 (8%)	
Knowledge about ORS preparation	Correct method (one litre-one pack ORS, boiling water, used within 24 hours, no colour change of ORS pack)	21 (41.2%)	22 (57.9%)	12 (48%)	.295
	Incorrect method	30 (58.8%)	16 (42.1%)	13 (52%)	
Have you ever used ORS	Yes - when someone get diarrhoea/sick /tired/vomiting	35 (68.6%)	27 (71.1%)	18 (72%)	.945
	No - Never/DK	16 (31.4%)	11 (28.9%)	7 (28%)	

a- multiple response, answer more than one

DISCUSSION

Diarrhoea and cholera result from faecal oral transmission and are the most common diseases in the world[2-3]. In Malaysia, notification of cholera, dysentery, typhoid and food poisoning is mandatory under Prevention & Control of Infectious Disease Act 1988[25]. In a recent article about global cholera outbreak, two most common risk factors for cholera were water source contamination (29%), rainfall and flooding (25%)[26].

Household water treatment is the best option in resource limited areas for reducing diarrhoea and water borne diseases[27]. More than 90% of the households in the study area treated water for drinking by boiling or boiling and filtration/sedimentation. Boiling of drinking water can kill all classes of waterborne pathogens (viruses, bacteria and bacterial spores, fungi and protozoans and helminth ova)[28]. After boiling for one to five minutes and cooled, water can safely be drunk[28]. The high rate of drinking water treatment in studied villages would be protective against further diarrhea and cholera outbreaks.

Figure 2. Socio-Demographic Factors among Households in three Villages

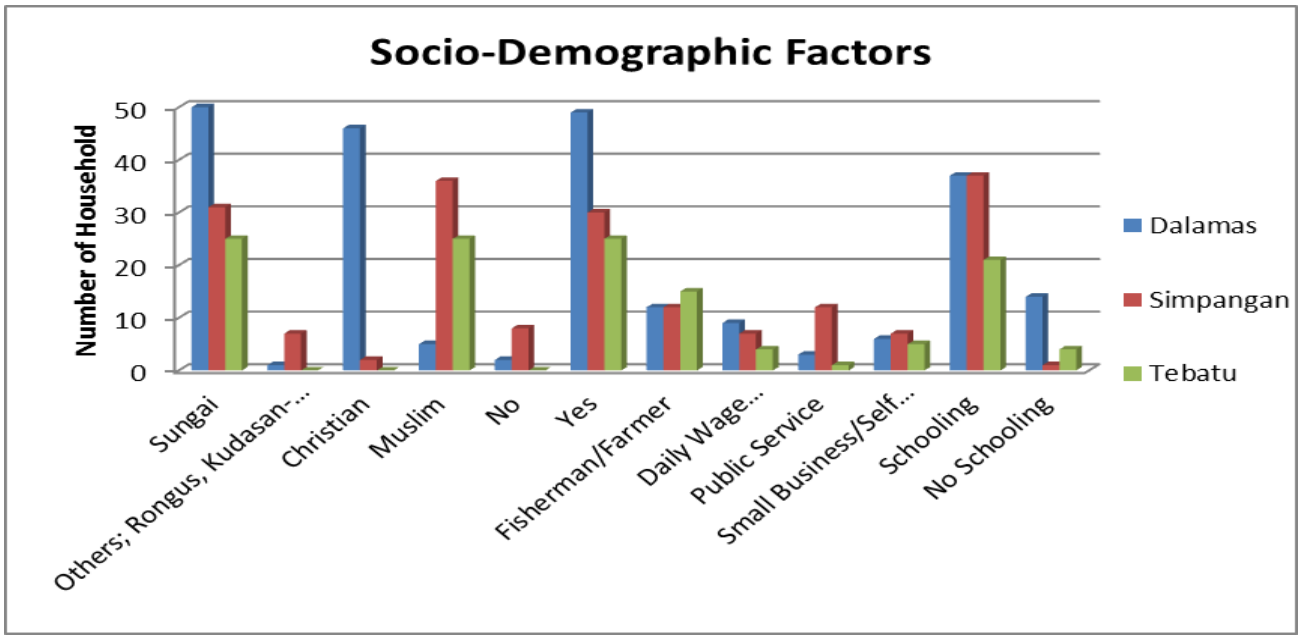
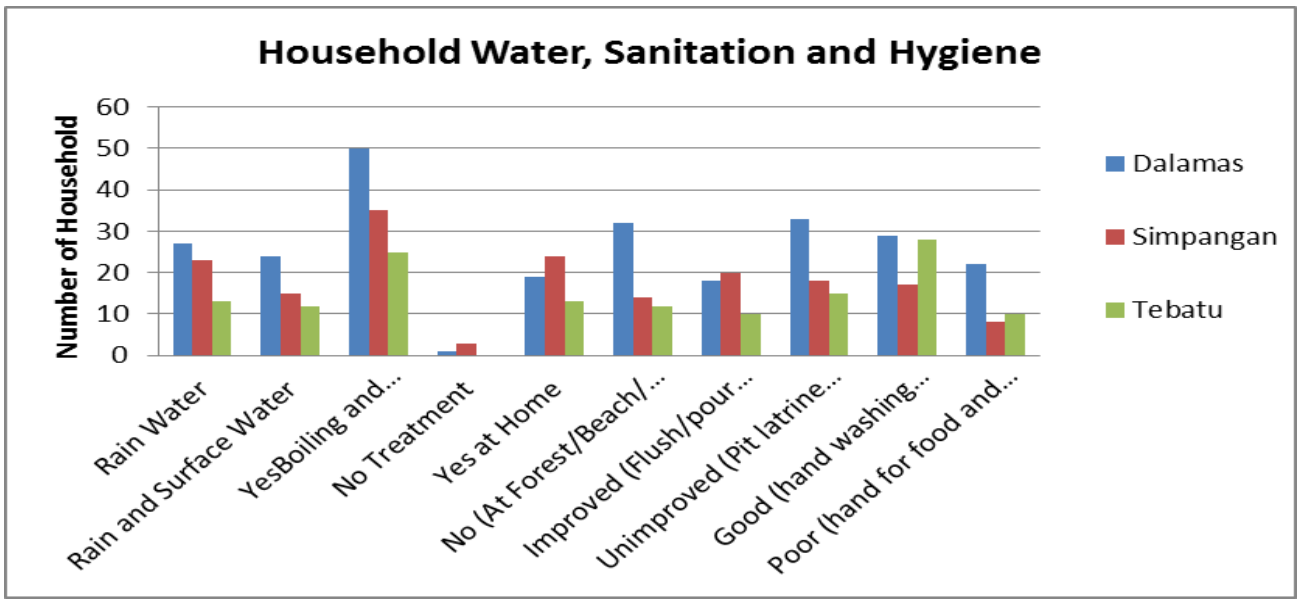


Figure 3. Household Water, Sanitation and Hygiene among Households in three Villages



Water quality is important for diarrhoea, cholera, typhoid and hepatitis A; an estimated 80% of all diseases and over one-third of deaths in developing countries are caused by the consumption of contaminated water[19]. Vibrio species are one of the most common bacteria in surface water worldwide[29]. Water quality improvement for diarrhoea and cholera is important for both source water and water at the point of use (household water). It is reported that post-source contamination may be collection, transportation, storage and drawing in the home[27]. In our study, sources of drinking water in the villages were - improved rain water -52% to 60%, and combined improved and unimproved- rain and surface water - 40% to 48%. However, water quality results by multiple tube method[20-21] were mostly unsatisfactory (>90% of households and all source water samples). Among the unsatisfactory results, the presence of Ecoli was; 32% to 37% in household water and 33% to 67% of river/pond water. In some studies,

a lower percentage of satisfactory household water quality was reported in Mangalore, India and >60% suspicious and unsatisfactory results for bacteriological quality of sachet water for drinking in Ghana[23,30]. *Vibrio cholerae* was not isolated in any of the water samples tested in this study (Table 3).

Table3. Water Quality Testing for Coliform (Most Probable Number MPN), and *Ecoli* Isolation

Coliform (MPN) and *Ecoli* Isolation				Water Source						Total
				Dalamas		Simpagnan		Tebatu		
Test Tube Positive per Total Five	Coliform Count (MPN)	*E Coli* Isolation	Water Quality (Rapid Testing)	House hold	River	House Hold	River	House hold	River/ Pond	
0 -1	0 - <3	No *Ecoli*	Satisfactory	0	0	2 (5.8%)	0	2 (8%)	0	4
2 - 3	5 to <10	No *Ecoli*	Suspicious	3 (5.9%)	0	0	0	0	0	3
5	> 16	No *Ecoli*	Un-satisfactory	29 (56.9%)	2 (33.3%)	22 (57.9%)	3 (60%)	15 (60%)	4 (66.7%)	75
5	> 16	Yes *Ecoli*	Un-satisfactory	19 (37.2%)	4 (66.7%)	14 (36.8%)	2 (40%)	8 (32%)	2 (33.3%)	49
Total				51	6	38	5	25	6	131

Sanitation is important for diarrhoea and cholera reduction reported as (1.56) relative risk for diarrhoea reduction by excreta disposal, and sanitation without improved drinking water had (11.2) higher relative risk of reducing diarrhoea in China[8,31]. Furthermore, sanitation facilities for human waste disposal had 68% cholera incidence reduction as well as less likelihood of spreading and producing secondary cholera cases in the community indicating sanitation improved control of cholera[32]. Moreover, a study in Kenya reported the risk factor of cholera was no latrine at home or sharing a latrine with three or more households (OR 2.17)[32].

Our study reported a lower percentage of latrine at home (37% to 63%) and improved sanitation facility (35.3% to 52.3%) in the three villages which is lower than (>95%) for both Malaysian national and Sabah state coverage[4,15]. In statistical analysis, determinants of improved sanitation facility were 1) ethnicity - others races group was three to four times more likely to have improved sanitation at OR (unadjusted 4.57 and adjusted 2.81), statistically not significant; and 2) occupation – non-agriculture was three times more likely to use unimproved sanitation facility at OR (unadjusted 3.5 and adjusted 3.06), statistically significant. Gurpreet et al Malaysia study reported higher diarrhoea rate among lower income group (< RM 700) and Other Bumiputras (compared to Chinese, Indian and Malay)[33].

Hand washing is also important for faecal oral diseases. Hand washing with soap after toilet, food preparation and before meals had (33% - 48%) diarrhoea reduction[5,8]. Hand washing with soap at recommended times had statistically significant reduction in childhood diarrhoea –before food preparation (OR 0.32) and after defecation (OR 0.45); no hand washing with soap before meals was four times more likely to spread cholera (OR 4.0)[34-35]. The effect of hand washing is protective; however, the prevalence of hand washing in the three studied villages was moderate; 57% - 74% hand washing with soap after toilet and or food and or personal hygiene; and 26% - 43% no hand washing after toilet which was still higher than Asia, Africa and South America of <35% hand washing with soap after toilet from Scott et al report[36]. Furthermore, hand washing with soap after toilet had only statistically significant association with water sufficiency–yes. In multivariable analysis, there were 1) water sufficiency–yes OR: unadjusted 4.32, adjusted 4.45, and statistically significant; and 2) latrine at home–no OR: unadjusted 2.07, adjusted 2.15 and statistically not significant.

Ecoli is an indicator of microbiological water quality and the presence of *Ecoli* indicates faecal contamination of water. In our study among three villages 1) latrine at home (Yes) was three to five times more likely to be (No) *Ecoli* in household water at OR: unadjusted 2.94, adjusted 5.23 and statistically significant; and 2) sanitation facility (type of household toilet) improved was two times more likely to be (No) *Ecoli* OR: unadjusted (2.09), statistically marginally significant but reduced probability of (No) *Ecoli;* adjusted OR (0.5), statistically not significant. Many studies have already reported a relation between improved sanitation facility or latrines at home and reduction of diarrhoea and cholera as well as consumption of contaminated water and diarrhoea diseases[8,19,27,37]. No latrine at home was a risk factor of cholera with odds ratio (2.17) in a Kenya study[32].

Table 4. Independent Predictors for Household Water, Sanitation, Hygiene and Cholera Related Knowledge

Outcome	Predictors	Pearson Chi-Sq	Logistic Regression (OR, CI) and p value	
			Unadjusted	Adjusted
Socio-demographic and Outcomes Variable in three villages				
Household Toilet (Unimproved/ Improved)[a]	**Ethnicity**	.057		
	Sungai		1	1
	Others[b]		4.57 (0.88, 23.73), .071	2.81 (0.5, 15.8), .240
	Occupation	.003		
	Agriculture[d]		1	1
	Non-Agriculture[c]		3.5 (1.5, 8.16), .004	3.06 (1.28, 7.33), .012
Proper Preparation of ORS (Correct/ Incorrect)[e]	**Ethnicity**	.024		
	Others[b]		1	1
	Sungai		8.45 (1.00, 71.16,), .049	5.11 (0.55, 47.18), .150
	House Ownership	.006		
	No		1	1
	Yes		11.34 (1.38, 92.84), .024	8.82 (1.04, 75.02), .046
	Occupation	.069		
	Non-Agriculture[c]		1	1
	Agriculture[d]		2.02 (0.88, 4.61), .094	1.59 (0.66, 3.84), .3
Water Sanitation and Outcomes Variables in three villages				
Hand Washing Practice (Good /Poor)[f]	**Water Sufficiency**	.006		
	No		1	1
	Yes		4.32 (1.37, 13.53), .012	4.45 (1,40, 14.14), .01
	Latrine at Home	.051		
	Yes		1	1
	No		2.07 (0.94, 4.55), .07	2.15 (0.95, 4.85), .065
Presence of E Coli in Household Water (No/Yes)	**Latrine at Home**	.006		
	No		1	1
	Yes		2.94 (1.32, 6.67), .008	5.23 (1.10, 24.74), .037
	Household Toilet[a]	.047		
	Unimproved		1	1
	Improved		2.09 (0.96, 4.56), .063	0.50 (0.10, 2.36), .388

a. Improved: Flush/pour flush to septic tank/pit latrine/elsewhere OR Pit latrine with slab, and Unimproved: Pit latrine without slab/open pit OR No facilities or bush or field or any other.
b. Rongus, Kudasan- Duson, Bajau, Chinese, Sulu
c. Public Service/Small Business/Self-Employed
d. Fisherman/Farmer/Daily Wage Labour/unemployed
e. Correct method (one liter-one pack ORS, boiling water, used within 24 hours, no colour change of ORS pack)
f. Good: After toilet (AND OR) Food and Personal Hygiene, Poor: Food OR Personal Hygiene without Hand Washing after Toilet

Oral Rehydration therapy with ORS solution is a mainstay for treatment of cholera and diarrhoea. However, most clinicians significantly underestimate the potential for serious dehydration in relatively mild gastroenteritis[9,38]. ORS reduces mortality of cholera from >50% (if untreated) to <1%[12,38]. On the other hand, proper use of ORS was relatively low with inadequate mother knowledge of ORS volume to prepare and amount of infant drink (Bangladesh), six-hundred times greater faecal coliforms in ORS solution prepared with unboiled water than boiled water on day 0 (Burma/Myanamr)[38-39]. Correct method of ORS preparation from WHO and UNICEF was ORS one pack, one liter clean/boiled water, clean container, stir and make solution, and drink within 24 hours[24]. A comprehensive public-health package for prevention and control of cholera by WHO included provision of safe water, proper sanitation, and food safety and health education for basic hygiene and good food hygiene behaviour[12]. Testing preparation of ORS and risk factors for correct knowledge were 1) ethnicity – Sungai was five to eight times more likely to be correct OR: unadjusted 8.45, statistically significant and adjusted 5.11, statistically not significant; 2) house ownership–yes was nine to eleven times more likely to be correct OR: unadjusted 11.39, adjusted 8.82 and statistically significant; and 3) occupation – agriculture was two times more likely to be correct OR : unadjusted 2.02, adjusted 1.59 and statistically not significant.

CONCLUSION

Three villages had lower coverage of improved water supply (52% to 60%), latrine at home (37% to 63%), and improved sanitation facility (35.3% to 52.3%). For water quality: presence of *Ecoli* was 32% to 37% in household water and 37% to 67% in source (river/pond) water. *Vibrio cholerae* was not isolated in any of the water samples tested in this study. The study also

reported a higher rate of drinking water treatment in the villages which would protect against cholera outbreak. Furthermore, prevalence of hand washing after toilet was 57% to 74%. In analysis, statistically significant associations were found for 1) occupation − non-agriculture and unimproved sanitation facility OR: unadjusted 3.5 and adjusted 3.06; and 2) house ownership and correct knowledge of ORS preparation OR: unadjusted 11.39, adjusted 8.82. Finally, predictors for household water quality−(No) *Ecoli*−were; latrine at home OR: unadjusted 2.94, p=.008, adjusted 5.23, p=.037, and type of household toilet (improved) OR: unadjusted 2.09, p=.063, however; statistically not significant at adjusted OR: 0.50, and p=.388. Some limitations are that a cross sectional study does not give effect over time, no comparison with non-cholera area and neither cholera cases nor their risk factors are reported. Our study recommends more aggressive strategies to increase improved water supply, sanitation and hygiene −hand washing after toilet− in the cholera affected area. Malaysia has a routine surveillance for cholera under mandatory notification; however, advantage of improved water supply and sanitation facility, availability and proper use of ORS should be promoted in the cholera affected remote villages.

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Conflict of Interest
Non declared

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