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Risk factors for typhoid fever in children in squatter settlements of Karachi: A nested case—control study

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Summary Typhoid fever remains a major public health problem in developing countries such as Pakistan. A great majority of cases occur in children living in poor sanitary conditions in squatter settlements in large cities. We conducted a case—control study to identify risk factor for typhoid fever in children under the age of 16 years residing in squatter settlements of Karachi. We enrolled 88 typhoid fever patients, diagnosed by positive blood culture or Typhidot® test, between June 1999 and December 2001. Simultaneously, we enrolled 165 age-matched neighborhood controls. Multivariate analysis done through conditional binary logistic regression analysis technique showed that increasing number of persons in the household (odds ratio [OR] = 1.9; 95% confidence interval [CI] 1.2—3.1), non-availability of soap near hand washing facility (OR = 2.6; 95% CI 1.1—6.3), non-use of medicated soap (OR = 11.2; 95% CI 1.3—97.6) and lack of awareness about contact with a known case of typhoid fever (OR = 3.7; 95% CI 1.6—8.4) were independent risk factors of the disease. Health education with emphasis on hand washing may help decrease the burden of typhoid fever in developing countries.

Introduction

According to recent WHO estimates the global burden of typhoid is 21 million cases per year, with mortality rate of 1—4% [1]. A vast majority of

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these episodes occur in developing countries where typhoid fever is endemic. Quickly emerging and swiftly spreading drug-resistant strains have deteriorated the situation by inflating the morbidity and mortality figures [2—5].

With changing expenditure pattern on health, health related behaviors, hygienic conditions and other social trends, a change in risk factors or strength of association of risk factors with typhoid fever can be expected [6]. Taking this into consideration, efforts are being made in endemic regions to detect any change in known risk factors or identify new modifiable risk factors [7—9]. Several of the identified risk factors are similar even across continents [7,8].

In Karachi, sources of infection identified earlier were certain foods, food related behaviors and contaminated water [10]. Amongst food items, ice and unbranded ice cream have been implicated as vehicles of the infectious agent [10]. Food contamination in turn can occur through water or by food handlers who may be carriers. Simultaneous increase in consumption of chilled foods and drinks in hot weather of May—June and typhoid incidence has been seen consistently in Karachi [11].

However, a second peak of typhoid cases has been observed in the months of September—October after monsoon rains in July—August, which has been primarily associated with the contamination of drinking water sources with overflowing surface water [11]. Besides these seasonal hikes, sporadic typhoid cases are observed round-the-year that are mainly attributed to intermittent mixing of underground sewerage and drinking water due to damaged pipelines. The situation gets still complicated as the much safer tap water is not available to more than 15—40% of the households in different districts in Karachi [12]. This figure rises to above 60% if data of squatter settlements alone are seen (unpublished data).

Overcrowding has also been implicated in the transmission of the organism. National census data show household occupancy of around 6.5 persons in different districts of Karachi [12]. Around 60% of the population of Karachi lives in urban squatter settlements and a large proportion of typhoid cases is from such locales [13]. Risk factors identified earlier in Karachi did not focus such highly underprivileged localities, as cases studied were from all over Karachi. Also the time frame for which exposures were ascertained from cases and controls was different [10]. In this study we identified risk factors more specific to highly endemic areas within cities so that the limited resources could be directed efficiently. Also our study targeted population of <16 years as this group is at much higher risk of developing typhoid fever [14].

Materials and methods

Setting

From an ongoing study on the incidence of typhoid fever in two squatter settlements of district south of Karachi, incident typhoid cases were registered [11]. These two squatter settlements were located on each bank of a 30 m wide open sewer draining liquid waste from large part of the center of the city. Inhabitants were mostly from northern region of Pakistan settled here since years for economical reasons. A proportion of the population was dynamic and moved back and forth. Most belonged to low socio-economic class and spoke Pashto and Hindko languages. Large majority was Muslim with a cluster of Christian residents. There was one study center in each area staffed with a doctor and five community health workers who performed fortnightly household surveillance for the febrile illnesses and referred febrile children to the center. Family physicians practicing in the area also referred patients to the study center.

Design

We conducted a nested, neighborhood and age-matched case—control study. Cases were the patients registered as typhoid cases in the ongoing typhoid incidence study during the period of June 1999 to December 2001.

Typhoid fever was diagnosed either by blood culture (Bectec systems®, Becton Dickinson and Company, Sparks, MD 21152, USA) or serology (Typhidot®; MBDR, Bange, Selangor Darul Ehsan, Malaysia). We excluded any case that traveled outside the area for more than one night within last 4 weeks of onset of the recent illness.

Controls were recruited by selecting the third door on the left hand side of the case's house. If no eligible child was found then next house was checked and so on until either the age-matched child was found or there were no houses, in which case door in front of the last house was checked and then continuing on the left side of the last house until there were no more houses. At this point further search of the control was stopped. For age, caliper matching was done. If age of the case was <12 months then age of the control was ±3 months; for age 12—24 months, ±6 months; 2—5 years, ±1 year; 6—10 years, ±2 years and for age 11—15 years control was ±3 years. Controls that had traveled outside the area for at least one night within last 4 weeks were not selected. Similarly controls who had fever for more than 3 days at the time of contact or had fever of longer than 5 days during 4 weeks preceding the date of interview were not selected. Adopting this methodology we were able to recruit 88 cases and 165 controls. Out of the 88 cases 17 (19.3%) had positive blood cultures while 71 (80.7%) had positive Typhidot® test. If for any case even only one control was available then that case was included in the analysis but if no controls could be identified then the case was excluded; five cases were discarded on this basis. Final case-to-control ratio remained 1:1.9.

Informed consent was obtained from all cases and controls before interviews. Trained interviewers through a pre-tested, standardized structured questionnaire interviewed both cases and controls. Mother was interviewed in case where the child (case or control) was too young to respond. We asked the study participants about their housing, family members, water and sewerage facilities, solid waste disposal, drinking water storage and treatment, hand washing and cooking practices. We also inquired about the contact of the participant with any typhoid patient as well as sharing of food with others at school or work place. Type of milk and practices regarding its use too were enquired about besides the consumption of ice cream. We also recorded information through direct observation of the practices to assess the extent of misreporting.

Blood samples of the cases were taken on the first contact with the physician at the study center for culture and sensitivity (c/s) and serology. Five milliliters of blood was drawn from children aged 5 years or above and 3 ml from children younger than that. Bectec® culture bottles were used for c/s. Three milliliters blood was taken for Typhidot®, malarial parasite and complete blood count in plain vacuum tubes. Urine samples for urinalysis were also taken from all patients. Samples were transported to the Aga Khan University Hospital laboratory within 6 h of collection where they were analyzed.

Statistical analysis

Data were doubly entered and cleaned using Epi-Info 6.04d. For statistical analysis SPSS® 10.0.5 was used. Matched analysis was done. For univariate analysis we evaluated the difference in categorical exposures between cases and controls by calculating the matched odds ratio (OR) and *p*-values using maximum likelihood estimates. We also calculated exact confidence limits. Binary logistic regression analysis technique was applied to identify exposures associated with the outcome with the *p*-value of <0.25. The exposures thus selected were then put in a conditional logistic regression model together. We then removed variables that did not contribute significantly to fit the model one by one while looking at the effect of removal on the association on other variables and signs of multicollinearity. Variables bringing a change in the parameter values of other variables by 15% were considered as confounders. Possible interactions were also checked. Most exposures were categorized into meaningful categories however number of person per household was kept continuous as it was, first, linearly associated with the outcome and secondly, no cut off value could be justified.

Results

Table 1 describes study participants as regards their characteristics. Age and sex matching was successful as cases and controls did not differ in their mean ages [cases: mean (S.E.) 8.3 (0.4) years vs. controls: mean (S.E.) 8.0 (0.3) years; *p*-value 0.54. Females: cases: 41% (as given in Table 1) vs. controls: 36%; *p*-value: 0.51]. Household income of cases and controls is also not different (*p*-value: 0.80).

Univariate analysis (Table 2) showed that increasing numbers of persons in a household has a significant association with typhoid fever [OR (95% CI): 1.3 (1.1—1.5)].

As regards environmental sanitation cases were not different from controls in methods of disposing solid waste and location of waste dumps (Table 2). Most cases and controls did not use covered bin for solid waste and majority of the cases and control lived away from solid waste dumps.

Although most of characteristics — i.e. availability of soap near hand washing facility, not using medicated soap, not washing hands regularly before meals and after using toilet — related to personal hygiene of the cases and controls were not significantly different but by looking at the confidence intervals, which are skewed, some effect could be sensed (Table 2). However, cases were more likely to not to wash hands after using toilet as compared to controls [4.0 (1.6—10.2)].

Practices related to taking water out of container also did not differ significantly among cases and controls; both groups usually dipped utensils into the water container. Some eating habits were significantly different between cases and controls. Cases were more likely to never refrigerate left over food [2.4 (1.3—4.7)], never reheat the leftover

Table 1 Characteristics of the participants registered for nested typhoid case—control study in Karachi, Pakistan, 1999—2001 (cases = 88; controls = 165).

Characteristic	Categories	*n* (%)	
		Case	Control
Age[a]		8.3 (0.4)	8.0 (0.3)
Gender	Male	52 (59.1)	106 (64.2)
	Female	36 (40.9)	59 (35.8)
Father's occupation	Skilled labor	17 (19.3)	25 (15.2)
	Unskilled labor	6 (6.8)	10 (6.1)
	Self employed	23 (26.1)	37 (22.4)
	Private employee	22 (25.0)	40 (24.2)
	Govt. employee	10 (11.4)	38 (23.0)
	Professional	4 (4.5)	9 (5.5)
	Unemployed	6 (6.8)	6 (3.6)
Persons per household	*Mean* (*S.E.*)	7.8 (0.17)	7.1 (0.15)
Construction of house	*Pucca*[b]	61 (69.3)	121 (73.3)
	Katcha pucca[c]	21 (23.9)	28 (17.0)
	Katcha[d]	6 (6.8)	16 (9.7)
Type of toilet	With flush	54 (61.4)	103 (62.4)
	Without flush	34 (38.6)	62 (37.6)
Method of waste disposal	Covered bin	16 (18.2)	45 (27.3)
	Open bin	56 (63.6)	91 (55.2)
	Throw on street	8 (9.1)	22 (13.3)
	Others	8 (9.1)	7 (4.2)
Drinking water source	Tap	72 (81.8)	143 (86.7)
	Others	16 (18.2)	22 (13.3)
Total monthly income of the household (Pakistani rupees; 1 United States dollar = 75 rupees)	<2000	8 (9.1)	8 (4.8)
	2001—4999	41 (46.6)	93 (56.4)
	5000—9999	29 (33.0)	50 (30.3)
	10,000—19,999	8 (9.1)	11 (6.7)
	≥20,000	2 (2.2)	3 (1.8)

[a] Mean (S.E.).
[b] Pucca = roof made of concrete cement; wall made of cement blocks.
[c] Katcha pucca = roof made of asbestos sheets; walls made of cement blocks.
[d] Katcha = roof made of asbestos sheets; wall made of baked bricks.

food before use [2.8 (1.1—7.0)] and finally more likely to eat food out (Table 2).

Cases were less likely to be aware of their contact with the typhoid patient in last 4 weeks as compared to control [2.1 (1.1—3.8)]. Cases were more likely to have had prolonged fever of 3 or more days in the last 3 months as compared to controls [1.8 (1.0—3.2)]; however, this was not the case with diarrhea.

Multivariate analysis (Table 3) done through conditional binary logistic regression analysis technique showed that increasing number of persons in the household, lack of soap availability near hand washing facility, non-use of medicated soap and lack of awareness about contact with a case of typhoid fever were independent risk factors for contracting typhoid fever.

Discussion

Typhoid fever has emerged as a formidable foe of developing countries after acquiring resistance to many of the first line antibiotics. Although universal provision of safe drinking water and sanitary conditions should be the ultimate goal of the public health professionals and policy makers, nevertheless as a short and mid term strategy prevention of typhoid fever by addressing identified risk factors may improve the situation.

Overcrowding is one of the main features of squatter settlements. The household occupancy figures are not different for the squatter settlements as compared to the well-planned dwellings. However, the area of house should be considered which is rarely above 60 square yards in such

Table 2 Crude odds ratio (OR) and 95% confidence interval (CI) of characteristics of study participants from a nested typhoid case—control study in Karachi, Pakistan 1999—2001 (cases = 88; controls = 165).

Characteristic	Categories	*n* (%)		Crude OR (95% CI)
		Case	Control	
Number of persons in household[a]		7.8 (0.17)	7.1 (0.15)	1.3 (1.1, 1.5)
Use covered bin for waste disposal	No	72 (81.8)	120 (72.7)	1.9 (0.9, 3.8)
	Yes (*Reference*)	16 (18.2)	45 (27.3)	1
Distance of waste dump from house	Within 200 m	29 (33.0)	48 (29.1)	2.2 (0.8, 5.8)
	Absent (*Reference*)	59 (67.0)	117 (70.9)	1
Soap available near hand washing facility[b]	No	40 (45.5)	87 (53.0)	1.8 (0.9, 3.5)
	Yes (*Reference*)	48 (54.5)	77 (47.0)	1
Use medicated soap	No	83 (94.3)	147 (89.1)	2.8 (0.9, 9.0)
	Yes (*Reference*)	5 (5.7)	18 (10.9)	1
Wash hands before meal regularly	No	37 (42.0)	55 (33.3)	1.6 (0.9, 2.9)
	Yes (*Reference*)	51 (58.0)	110 (66.7)	1
Wash hands after using toilet	Sometimes	31 (35.2)	58 (35.2)	1.4 (0.7, 2.8)
	Never	17 (19.3)	11 (6.7)	4.0 (1.6, 10.2)
	Don't know	2 (2.3)	3 (1.8)	2.8 (0.4, 19.2)
	Always (*Reference*)	38 (43.2)	93 (56.3)	1
Method of taking out water from container[b]	Unhygienic	68 (77.3)	111 (68.9)	1.8 (0.9, 3.6)
	Hygienic (*Reference*)	20 (22.7)	50 (31.1)	1
Food kept in fridge[b]	Sometimes	10 (11.4)	29 (17.8)	1.1 (0.4, 2.6)
	Never	56 (63.6)	74 (45.4)	2.4 (1.3, 4.7)
	Always (*Reference*)	22 (25.0)	60 (36.8)	1
Food reheated for child[b]	Sometimes	22 (25.0)	35 (21.3)	1.6 (0.8, 3.1)
	Never	17 (19.3)	21 (12.8)	2.8 (1.1, 7.0)
	Don't know	7 (8.0)	4 (2.4)	5.6 (1.3, 24.6)
	Always (*Reference*)	42 (47.7)	104 (63.4)	1
Frequency of taking meal outside home[b]	At least once daily	18 (20.9)	18 (11.0)	6.3 (1.8, 22.0)
	1—6 times per week	18 (20.9)	33 (20.2)	4.4 (1.2, 15.8)
	1—3 times per month	46 (53.5)	86 (52.8)	4.0 (1.2, 12.8)
	Not eaten outside (*Reference*)	4 (4.7)	26 (16.0)	1
Aware of contact with known typhoid case	No	37 (42)	46 (27.9)	2.1 (1.1, 3.8)
	Yes (*Reference*)	51 (58)	119 (72.1)	1
History of diarrhea[b]	Yes	27 (30.7)	44 (26.8)	1.2 (0.7, 2.1)
	Don't know	1 (1.1)	10 (6.1)	0.2 (0.0, 1.3)
	No (*Reference*)	60 (68.2)	110 (67.1)	1
History of fever in the last 3 months[b]	Yes	45 (52.3)	63 (39.1)	1.8 (1.0, 3.2)
	Don't know	3 (3.5)	7 (4.3)	1.2 (0.3, 4.8)
	No (*Reference*)	38 (44.2)	91 (56.5)	1

[a] Mean (S.E.).
[b] Some data missing.

locales in contrast to 240—1500 square yards in well-planned areas with comparable number of occupants in both situations. This congestion provides the organism favorable environment to be transferred from one person to another through fomites. A study from Turkey also reported over crowding a risk factor for typhoid fever [3.31 (1.6—6.9)] [15]. Poor housing acts in parallel as a co-factor. Inadequate sewerage and solid waste disposal have been linked to the occurrence of typhoid fever [16]. As the number of persons in a household increases the pressure on this poor infrastructure increases leading to frequent failures.

Salmonellae are transmitted through oral-fecal cycle in which hands play an important role. Habit of hand washing is very important especially where environmental hygiene is poor. Use of soap for hand washing improves the hygiene even further [17]. While asking about such behaviors element of misreporting is always expected. This is also evident from our own data. We found that 50% of those who did not have soap available near hand washing facility said that they *regularly* wash hands with soap before meals and 32% of such respondents told that they *always* wash hands with soap after using toilet. Furthermore the question which directly asked about the habit did not have significant association with typhoid fever whereas direct observation of soap availability did come up as a significant factor. To avoid any such effect regarding soap use we used direct observation in our model as a proxy for the use of soap for hand washing.

Personal hygiene is usually very poor in residents of such areas due to various reasons resulting in larger number of bacteria on the skin that need extra treatment to attain required clean status [18]. It has been found that medicated soaps are more effective in removing bacteria from hands as compared to the regular soaps [19]. Our findings are in accord of this evidence. Controls used medicated soap more as compared to the cases possibly providing protection against salmonella infection. As there is negligible difference in the costs of medicated and regular soaps in Pakistan, no additional cost is involved with some extra protection.

We found that cases were less likely to know about contact with a typhoid fever patient. It is obvious that an unaware person is less likely to take precautionary measures to protect herself from contracting the disease, and hence has more likelihood of getting infected.

Some known risk factors were not found to be significantly associated with typhoid fever in our study including food and water. We have asked about taking 'main meal' outside home. In such communities main meal is almost always composed of thoroughly cooked food that is served hot so the chances of transmission are also low through this food.

Drinking water quality has been linked with the transmission of the enteric fever in other studies [10,20,21]; however, we did not find any association with source of drinking water and practices of water treatment, storage and use. The finding can be explained by the development of partial immunity due to repeated low dose exposure to *Salmonella typhi* through contaminated water supply [7,10].

Table 3 Adjusted odds ratio (OR) and 95% confidence interval (CI) of characteristics independently associated with typhoid fever in Karachi, Pakistan 1999—2001 (cases = 88; controls = 165).

Characteristic	OR (95% CI)
Number of person in household	1.9 (1.2, 3.1)
Soap available near hand washing facility	
No	2.6 (1.1, 6.3)
Yes (*Reference*)	1
Use medicated soap	
No	11.2 (1.3, 97.6)
Yes (*Reference*)	1
Aware of contact with known typhoid case	
No	3.7 (1.6, 8.4)
Yes (*Reference*)	1

We registered typhoid cases that were positive by serology only besides registering culture positive cases. The reason for this was that evidence available at the time of our study showed high sensitivity and specificity of Typhidot® test [22—25]. Nevertheless more recent work have found it less sensitive and specific [26,27]. This might have lead to mixing of the cases and non-cases the magnitude of which cannot be ascertained.

Due to logistic reasons we could not evaluate quality of water supplied to household and carrier state of food handlers. Carrier rate in Karachi has been found to be extremely low [10]. Therefore, we expect no significant changes in our results even if adjusted for the variable.

Although the questionnaires were standardized and interviewers had been sensitized to ask the questions verbatim, cases were likely to recall exposures better as compared to controls. Therefore recall bias could have been introduced but to reduce the effect both the case and controls were interviewed on the same day as soon as the diagnosis has been made, to make the time frame similar.

It could be thus summarized that poor personal hygiene probably partly due to poor environmental hygiene compounded by the overcrowding and scarcity of resources make the situation favorable for transmission of typhoid infection. Lack of awareness about the process of transfer of the disease facilitates the transmission even further. So there is urgent need to take steps to improve personal as well as environmental hygiene besides rising awareness about the disease.

Substantial increase in life expectancy has been attributed to the application of the holistic principles of hygiene and public health. Risk assessment, risk management, and risk communication are basic steps of a modern holistic strategy [28]. This and other studies have taken forward the risk assessment and risk management process. Now it is important that risk communication, i.e. creating awareness about the prevention of typhoid fever should be done so that morbidity and mortality could be reduced.

Conflict of interest statement

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References

[1] WHO. Typhoid vaccines: WHO position paper. Report. Geneva: WHO; February 8, 2008. Report No.: 6.
[2] Mirza SH, Beeching NJ, Hart CA. Multi-drug resistant typhoid: a global problem. J Med Microbiol 1996;44 (5):317—9.
[3] Bhan MK, Bahl R, Bhatnagar S. Typhoid and paratyphoid fever. Lancet 2005;366(9487):749—62.
[4] Gaind R, Paglietti B, Murgia M, Dawar R, Uzzau S, Cappuccinelli P, et al. Molecular characterization of ciprofloxacin-resistant *Salmonella enterica* serovar *typhi* and *paratyphi* A causing enteric fever in India. J Antimicrob Chemother 2006;58(6):1139—44.
[5] Bhutta ZA. Current concepts in the diagnosis and treatment of typhoid fever. BMJ 2006;333(7558):78—82.
[6] WHO. Shaping the future. Report. Geneva: WHO; 2003.
[7] Black RE, Cisneros L, Levine MM, Banfi A, Lobos H, Rodriguez H. Case—control study to identify risk factors for paediatric endemic typhoid fever in Santiago, Chile. Bull World Health Organ 1985;63(5):899—904.
[8] Velema JP, van Wijnen G, Bult P, van Naerssen T, Jota S. Typhoid fever in Ujung Pandang, Indonesia—high-risk groups and high-risk behaviours. Trop Med Int Health 1997;2(11):1088—94.
[9] Vollaard AM, Ali S, van Asten HA, Widjaja S, Visser LG, Surjadi C, et al. Risk factors for typhoid and paratyphoid fever in Jakarta, Indonesia. JAMA 2004;291(21):2607—15.
[10] Luby SP, Faizan MK, Fisher-Hoch SP, Syed A, Mintz ED, Bhutta ZA, et al. Risk factors for typhoid fever in an endemic setting, Karachi, Pakistan. Epidemiol Infect 1998;120(2):129—38.
[11] Siddiqui FJ, Rabbani F, Hasan R, Nizami SQ, Bhutta ZA. Typhoid fever in children: some epidemiological considerations from Karachi, Pakistan. Int J Infect Dis 2006;10(3):215—22.
[12] NIPS. Pakistan population data sheet and estimates of population by provinces and districts of Pakistan 2001, 2004, 2011 & 2021. Islamabad: National Institute of Population Studies; 2002.
[13] Kool M, Dik V, Linden J. Squatter settlements in Pakistan: the impacts of upgrading. Lahore: Vanguard Books; 1988.
[14] Battikhi MN. Occurrence of *Salmonella typhi* and *Salmonella paratyphi* in Jordan. New Microbiol 2003;26(4): 363—73.
[15] Hosoglu S, Celen MK, Geyik MF, Akalin S, Ayaz C, Acemoglu H, et al. Risk factors for typhoid fever among adult patients in Diyarbakir, Turkey. Epidemiol Infect 2006;134(3): 612—6.
[16] Gasem MH, Dolmans WM, Keuter MM, Djokomoeljanto RR. Poor food hygiene and housing as risk factors for typhoid fever in Semarang, Indonesia. Trop Med Int Health 2001;6(6):484—90.
[17] Ejemot RI, Ehiri JE, Meremikwu MM, Critchley JA. Hand washing for preventing diarrhoea. Cochrane Database Syst Rev 2008;(1) [CD004265].
[18] Pether JVS, Scott RJD. *Salmonella* carriers: are they dangerous? A study to identify finger contamination with Salmonellae by convalescent carriers. J Infect 1982;5(1):81—8.
[19] Bendig JW. Surgical hand disinfection: comparison of 4% chlorhexidine detergent solution and 2% triclosan detergent solution. J Hosp Infect 1990;15(2):143—8.
[20] Srikantiah P, Vafokulov S, Luby SP, Ishmail T, Earhart K, Khodjaev N, et al. Epidemiology and risk factors for endemic typhoid fever in Uzbekistan. Trop Med Int Health 2007;12(7):838—47.
[21] Tran HH, Bjune G, Nguyen BM, Rottingen JA, Grais RF, Guerin PJ. Risk factors associated with typhoid fever in Son La province, northern Vietnam. Trans Roy Soc Trop Med Hyg 2005;99(11):819—26.
[22] Bhutta ZA, Mansurali N. Rapid serologic diagnosis of pediatric typhoid fever in an endemic area: a prospective comparative evaluation of two dot-enzyme immunoassays and the Widal test. Am J Trop Med Hyg 1999;61(4): 654—7.
[23] Choo KE, Davis TM, Ismail A, Tuan Ibrahim TA, Ghazali WN. Rapid and reliable serological diagnosis of enteric fever: comparative sensitivity and specificity of Typhidot and Typhidot-M tests in febrile Malaysian children. Acta Trop 1999;72(2):175—83.
[24] Gopalakrishnan V, Sekhar WY, Soo EH, Vinsent RA, Devi S. Typhoid fever in Kuala Lumpur and a comparative evaluation of two commercial diagnostic kits for the detection of antibodies to *Salmonella typhi*. Singapore Med J 2002;43(7):354—8.
[25] Jesudason M, Esther E, Mathai E. Typhidot test to detect IgG & IgM antibodies in typhoid fever. Indian J Med Res 2002;116:70—2.
[26] Dutta S, Sur D, Manna B, Sen B, Deb AK, Deen JL, et al. Evaluation of new-generation serologic tests for the diagnosis of typhoid fever: data from a community-based

surveillance in Calcutta, India. Diagn Microbiol Infect Dis 2006;56(4):359—65.
[27] Naheed A, Ram PK, Brooks WA, Mintz ED, Hossain MA, Parsons MM, et al. Clinical value of Tubex and Typhidot rapid diagnostic tests for typhoid fever in an urban community clinic in Bangladesh. Diagn Microbiol Infect Dis 2008;61(4):381—6.
[28] Exner M, Hartemann P, Kistemann T. Hygiene and health—–the need for a holistic approach. Am J Infect Control 2001;29(4):228—31.