Journal of Public Health and Epidemiology Vol. 2(5), pp. 93-99, August 2010
Available online at http://www.academicjournals.org/jphe
©2010 Academic Journals

Full Length Research Paper

Prevalence and constraints of typhoid fever and its control in an endemic area of Singida region in Tanzania: Lessons for effective control of the disease

Allen Malisa* and Honest Nyaki

Department of Biological Sciences, Faculty of Science, Sokoine University of Agriculture, P. O. Box 3038, Morogoro, Tanzania.

Accepted 2 June, 2010

Typhoid fever (TF) is an important communicable disease that is endemic to Tanzania, quite often complicated with malaria co-infection leading to diagnostic complications and significant mortality. Despite considerable control efforts, the disease continues to persist in Singida urban leading to significant morbidity and mortality. This paper retrospectively examines morbidity and mortality trend of typhoid infection for the past five years in Singida urban. By using questionnaire, Focus Group Discussion (FGD) and direct observational methods, the authors report interview results of 120 respondents from the study community, regarding their awareness of TF and its control methods. Results showed that, the TF prevalence records revealed a fluctuating trend with annual incidence rate of 580 – 1,400/100,000 persons, and an overall increase from 771 – 942 cases/100,000 persons ($p \leq 0.0001$) between 2003 and 2007. While 88% of the respondents were aware of TF disease, 53% were unaware of its control methods. The study also revealed an acute shortage of diagnostic laboratory services which indicated that, 75% of health facilities had no such services. In adequate knowledge about personal hygiene, scarcity or lack of access to safe water, improper drainage systems and problems of unsanitary toilets in Singida urban were some of the obstacles to effective TF control. Effective TF control measures in the study district, as in other areas in the tropics, requires integration of intensive health education as a public health tool, provision and access to safe water supply and adequate strengthening of health systems.

Key words: Typhoid fever, prevalence, Singida urban, control measures.

INTRODUCTION

TF continues to be a major public health problem in many developing countries. Its etiological agent is *Salmonella typhi*. Globally, TF is an important cause of morbidity and mortality in many regions of the world, with an estimated 12 - 33 million cases leading to 216,000 - 600,000 deaths annually (Pang et al., 1995; DeRoeck, 2007). The disease is endemic to areas of Africa, India, South and Central America, characterized by rapid population growth, increased urbanization, and limited safe water, infrastructure and health systems (Uneke, 2008). The biggest challenge perhaps is the emergence and spread of multidrug-resistant strains of bacteria causing TF, and the complication with malaria co-infection, leading to significant morbidity and mortality (Gupta, 1994; Bhutta, 1996; Bhan et al., 2005; Siddiquia et al., 2006).

The disease is transmitted through faecal-oral route via contaminated water and food, especially by food-handling carriers and human beings are the only known reservoiur and host for TF (Butter, 1992). TF is of important socioeconomic impact because, most of the time, several months are necessary for a patient to recover and be

*Corresponding author. E-mail: malisa56@yahoo.com, amalisa@suanet.ac.tz. Tel: 255 232603404.

Abbreviations: FGD, Focus group discussion; **TF,** typhoid fever; **DMO,** district medical officer; **SPSS,** statistical package for social science programs.

able to work normally again. Although, the etiologies of TF and malaria are different, TF by a bacteria, malaria by a protozoan and transmitted via different mechanisms, both diseases share rather similar symptomatology (Uneke, 2008). Because both diseases share social circumstances which are important to their transmission, individuals in areas endemic for both diseases are at substantial risk of contracting both these diseases, either concurrently or an acute infection superimposed on a chronic one (Keong and Sulaiman, 2006). While high prevalence of malaria is an established fact, it is only within the last decade that an unusually high number of illnesses have been diagnosed as malaria co-existing with TF (Samal and Sahu, 1991; Sur et al., 2006; Kanjilal et al., 2006). Malaria and TF often present with mimicking symptoms especially in the early stages of TF (Ammah et al., 1999; Ohanu et al., 2003; Agwu et al., 2009). The situation often presents a diagnostic problem and in most cases could lead to diagnostic confusion. As a result of this, the importance of definitive laboratory-based diagnosis cannot be overemphasized.

In most parts of the tropics, the specific diagnosis of concurrent malaria and TF is based on blood smear microscopy and Widal test and in rare cases with the inclusion of bacterial culture. However, in the most extreme situation, in some of the rural settings of Africa, clinical diagnosis (based on symptoms) remains the only option for each of the two diseases, making accurate diagnosis very unlikely. Consequently, it is of concern that poor diagnosis continues to hinder effective typhoid and malaria control in the tropics. A combination of factors, including non-specific clinical presentation of the diseases, high prevalence of asymptomatic infections in many areas, lack of resources and insufficient access to trained health care providers and health facilities, and widespread practice of self-treatment for clinically suspected malaria or TF, contributes to the poor diagnosis in the tropics. Despite the importance of concurrent malaria and TF in the tropics, the challenges associated with the diagnosis and the public health implications have not been comprehensively reviewed.

Although, the disease is endemic in most of Tanzania mainland regions, scientific reports continue to be lacking. Morogoro and Singida regions are among the regions where TF incidence continues to be high, despite the control efforts taken both nationally and regionally. According to the Singida urban health report of 2007, TF rank number two, second to dysentery in the national list of notifiable diseases (Anon, 2007). Control measures to combat typhoid includes, but not limited to, health education about personal hygiene, especially regarding hand-washing after toilet use and before food preparation, provision of a safe water supply, proper sanitation systems and exclusion of disease carriers from food handling (Parry, 2004; Bhan et al., 2005). Although, the introduction of TF vaccines in routine vaccination programs in Africa and Asia would be highly beneficial in view of the burden of disease and cost of illness to governments and individuals (Ochiai et al., 2007), so far, only two countries, China and Vietnam, have incorporated typhoid vaccination into their routine immunization programs, and only in a limited fashion (WHO, 2009). The reason why these efforts have not be more generalized lies in part in the fact that most developing countries are uncertain of their true TF disease burden, due to lack of rapid diagnostic tools, infrequency of laboratory testing and poor reporting system (Chaignat et al., 2007). Singida region is situated in the centre of the country and is described to be one of the “drought-prone” areas in Tanzania (Anon, 2006). The main source of water supply is through land drilled wells and in some areas, both pit latrines and water wells are in close proximity, making cross contamination of the water very likely. Food crises and water shortages are common among the 1.1 million populations living in Singida region (Anon, 2006).

Being an important communicable disease in the national list, TF has received considerable control efforts at national, regional and district levels. However, despite all the efforts the disease continues to persist in Singida urban leading to significant morbidity and mortality (District health officer, 2008 personal communication). The objective of this study was to review available data to determine the temporal occurrence of TF in Singida urban for the past five years. Through combination of questionnaire, focus group discussion (FGD) and direct observation the authors also investigate constraints to the typhoid disease eradication in the municipality.

METHODOLOGY

Study area

The study was conducted between December 2008 and January 2009 in Singida urban. Singida urban is one of four administrative Districts in Singida region. It is enclosed with Singida (R) district. Singida region is located in the central zone of Tanzanian Mainland and it experiences unimodal rainfall starting from October - May, the rest of the year remains dry. It is one of the drought prone areas of the country, and the main source of water supply is land drilled wells.

Data collection

The data collected were both quantitative and qualitative. Qualitative data was collected through two focus group discussions (FGD), one composed of twenty health workers, ten from each of government and private health facilities, and the second group was composed of ten community members, five from each of the two divisions of Singida urban district. The participants were purposively selected with the help of either the District Medical Officer (DMO) or village chairman, so that a good representation of health facilities or villages, wards and divisions was achieved. In all groups there were equal numbers of males and females. Discussions were directed by a question guide and moderated by scientist. Each lasted for about two hours and focused on awareness of TF, its transmission and control, availability and accessibility of health services, environmental sanitation and personal hygiene practices.

Quantitative data was collected using interviewer-administered

questionnaire that was administered to 120, randomly selected respondents. To avoid bias, the participants to the FGDs were excluded from questionnaire interview, since they already were informed than the others. The questionnaire was designed focusing on the same variables that were used in FGDs, with few socio-demographic additions including age, gender, geographical location and level of education. Secondary data included the district typhoid morbidity and mortality records between 2003 and 2007 and these were obtained from the Singida urban District Medical Officer.

Data analysis

Both quantitative and qualitative data from primary sources were edited and coded. The hand sheets were prepared and data entered into the computer. Data analysis was done using Statistical Package for Social Science programs (SPSS) and results generated in frequency tables. Histograms of the typhoid morbidity and mortality were prepared in excel using crude mortality rates. Statistical comparison of TF prevalence between years was carried out using chi squared analysis in STATA version 9.2

RESULTS

Temporal trend of TF occurrence in the study area

This study has reviewed typhoid records in Singida urban for the past five years, to establish the temporal trend of occurrence of the disease in the district. Results indicate that there is a fluctuating trend of typhoid occurrence in the study district. The annual typhoid disease burden increased from 771 cases per 100,000 persons in 2003 to 1,402 cases per 100,000 persons in 2004 ($p \leq 0.0001$), followed by a decrease to 1,228 cases per 100,000 in 2005 ($p \leq 0.002$) and finally further down to the lowest prevalence of 579 cases per 100,000 persons recorded in 2006 ($p \leq 0.0001$) (Figure 1). However, the disease incidence increased again to an estimated 942 cases per 100,000 in 2007 ($p \leq 0.0001$). The overall TF prevalence between 2003 and 2007 indicate an increasing trend from 771 - 942 cases/100,000 persons ($p \leq 0.0001$). A closer view on the distribution of the above described annual typhoid incidences among four quarters of each year, suggests a change in the disease occurrence pattern in recent years. Between the year 2003 and 2005 typhoid cases were highest in the second quarter (April - June) while between 2006 and 2007, typhoid cases were highest either in the third quarter (July - September in 2006) or the fourth quarter (October - December in 2007) (Figure 2).

The review of five years (2003 - 2007) TF mortality records in the district indicates that, there was highest mortality record of 14 cases in 2003, followed by a decrease to a record low mortality of 5 ($p \leq 0.001$) cases in 2004. The mortality increased to 11 ($p \geq 0.05$) cases in 2005 and peaked again to 14 ($p \geq 0.05$) cases in 2006 and finally dropped to 10 ($p \geq 0.05$) cases in 2007 (Figure 3). Generally, the overall TF mortality trend between 2003 and 2007 indicated a decreasing trend from 14 - 10 ($p \geq 0.05$), which was not statistically significant. Quite strikingly, the data suggests there was a reciprocal relationship between typhoid cases and its mortality. When typhoid cases were greatest, the mortality due to typhoid were lowest and the vice versa (Figure 4)

Survey results

Qualitative data

Local awareness of TF, its transmission and control

Majority of participants seemed to be remarkably aware of the TF and some of them associated it with drinking of unboiled water. It was also clear that majority of participants were also informed of some of the signs of TF. Fever, general body weakness, headache and stomach ache were some of the symptoms frequently mentioned by the participants. However, very few participants were aware of mode of transmission and control of typhoid disease. The few participants who said that the disease is transmitted through drinking of unboiled water could not explain how water gets contaminated. Discussions from the two groups comprised of health workers indicated that health workers were very informed of the transmission and control of typhoid disease. Most of them correctly said that typhoid is transmitted by the faecal-oral route, primarily by ingesting food or water contaminated by faeces or urine. The control measures advocated to be taken by the health workers are health educational programmes organised at ward level and through household visits. According to participants, through these programmes, community members are educated on the importance of hygienic practices, particularly hand washing before eating and preparing food and after going to the toilet.

Availability and accessibility of health services

All participants indicated to seek medical care from health facilities, and none mentioned traditional healers. Most of the participants said prescription and medication without prior laboratory testing was a predominant practice and very few indicated to have done laboratory testing prior to medication. Some of them complained of poor and unacceptable standards of some health facilities, while others cited the shortage of trained health personnel. A long distance required for one to reach a health facility was also found to be a problem, particularly in rural areas. Some of the participants who had suffered TF before bitterly complained about the way their cases were handled. Accordingly, they had their cases initially been treated to be malaria and when the condition turned serious, that is when the health personnel actually thought of checking for typhoid. Some participants added that widal test, a serological testing for typhoid disease, is not a routine test and it is done only when requested by

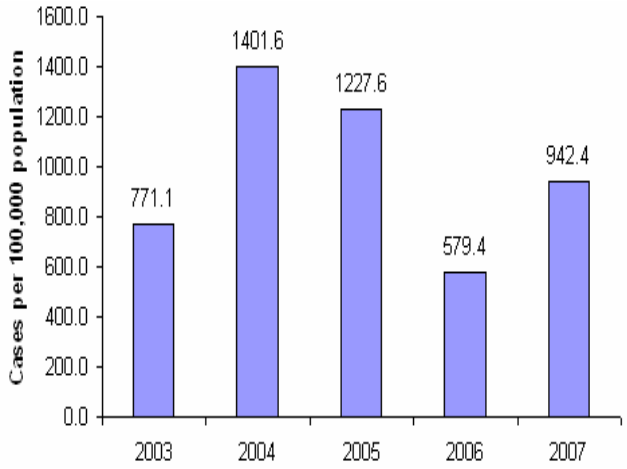

Figure 1. Annual cases of TF in Singida urban between 2003 – 2007

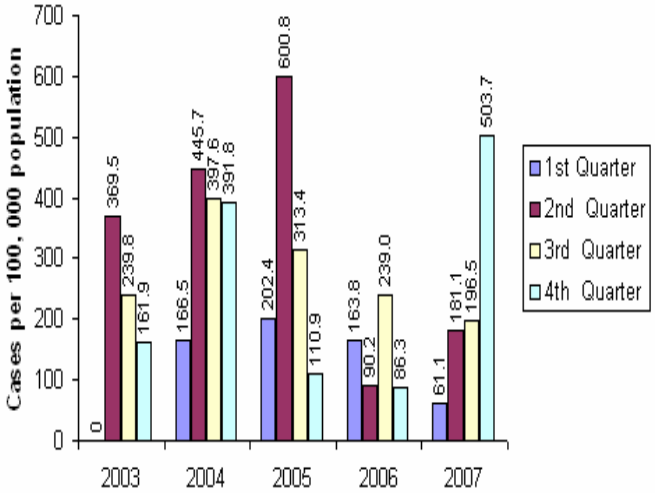

Figure 2. Quarterly typhoid cases in Singida urban between 2003 - 2007.

few knowledgeable persons or when treatment of a formerly perceived malaria case fails treatment and that the symptoms are suggestive of typhoid. Discussion with health personnel group along with direct observation provided an in-depth coverage of health facilities serving the district. There were sixteen health facilities, of which, one was a Regional hospital, three were health centres (one government and two private) and twelve were dispensaries (eight government and four private). The three health centres and the hospital were all located in town and were the only health facilities that were equipped with diagnostic laboratory facilities. However, it was clear from the participants (health workers) that none of the three health centres had the capacity to culture and isolate *S. typhi*, and thus their laboratory diagnostic capacity were limited to serological (widal) test. None of

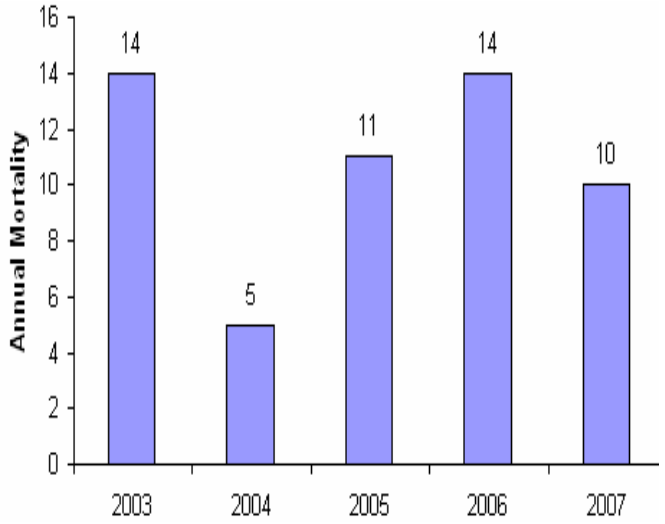

Figure 3. Typhoid mortality in Singida urban between 2003 - 2007.

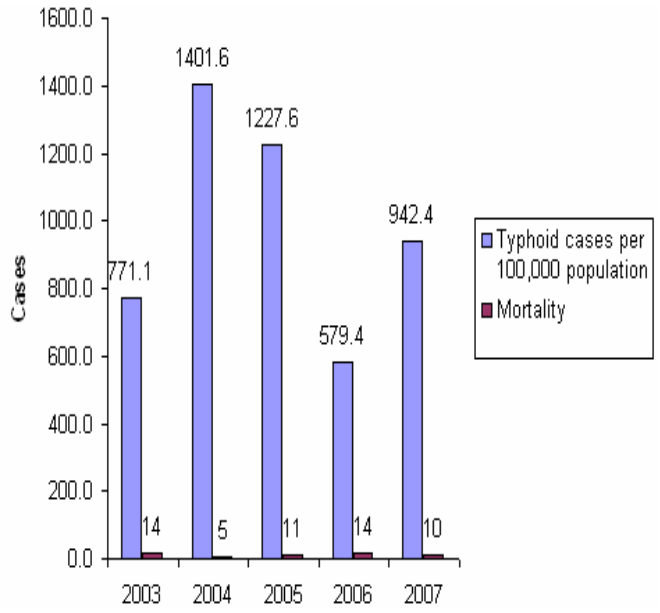

Figure 4. Annual typhoid morbidity and mortality in Singida urban between 2003 - 2007.

the periurban health centres had diagnostic laboratory facilities.

Environmental sanitation and personal hygiene practices

There was group consensus that the method used to dispose the human excreta was mainly through pit latrine and most of the latrines were not equipped with water facility. It was also noted that personal hygiene,

especially regarding hand-washing after toilet use, before food preparation and before starting eating was not a common practice among majority of Singida urban residents particularly in the periurban areas. While some of the participants claimed to treat drinking water by boiling and few others by treating with water guard, most of participants indicated that they usually drink untreated water.

Quantitative data

A total of 120 randomly selected respondents, whose socio-demographic attributes are shown in Table 1 were interviewed. Most (87.5%) of the respondents were aware of typhoid disease while 12.5% were not. Sixty percent of the respondents were aware of important symptoms of typhoid while the remaining 40% were not. However, 57.5% of the respondents were unaware of typhoid transmission methods, while 52.5% were unaware of the typhoid control measures (Table 2).

Few (47.5%) of the respondents had had at least a laboratory test before medication, whereas, 52.5% of the respondents had never had laboratory testing before medication when they required medical services (Table 3).

Ninety five percent of the respondents had pit latrine type of toilets while the Asian/Western type of toilets accounted for only 5% of the toilets possessed by the participants. Out of 42.5% of respondents who claimed to drink treated water, 30% treat by boiling and the remaining 12.5% use chemicals (water guard) for water treatment. Majority (57.5%) of respondents relied on untreated water for drinking.

DISCUSSION

Retrospective analysis of TF records in Singida urban indicates fluctuating pattern of occurrence over time, with an overall increasing trend that was highly statistically significant. The incidences of 580 - 1,400/100,000 persons observed in our study are far higher compared to 0.38 - 8.6/100,000 persons reported in Vietnam (Kelly-Hope et al., 2008), 13/100,000 persons in Egypt (Crump et al., 2003) and are even higher than the 180 - 573 cases per 100,000 persons reported in three urban slums of Karachi, Kolkata and North Jakarta (DeRoeck, 2007). Although, this order of typhoid prevalence is by far higher and calls for the need to strengthen typhoid, control protocols that are currently being implemented in Singida urban, these results requires careful interpretation because TF in the tropics presents a huge diagnostic challenge. In most parts of Africa, TF diagnosis is done based on mainly clinical presentation and on serological (widal) test which is associated with numerous limitations (Uneke, 2008). Although, widal test is inexpensive and readily available in most health care settings in the tropics, serious doubts have been raised regarding its validity, and there is currently numerous reports suggesting it is an inaccurate, and of limited diagnostic value (Buck et al., 1987; Chew, 1992; Choo, 1993; Agwu et al., 2009). A separate study conducted in non-endemic areas indicated that cross-reaction can occur as a consequence of latent and post infectious diseases prevalent in the tropics namely, tuberculosis, pneumonia, amoebiasis, rickettsial diseases, rheumatoid arthritis and chronic active hepatitis (Koeleman, 1992). Culture and isolation of *S. typhi*, which is the confirmatory and reliable test for TF is not available in most of health facilities and even in the few centres where it exists, evidence suggests it is not routinely requested by physicians (Pearson and Guerrant, 2000). In the present study, 75% of the Singida urban district health facilities had no diagnostic laboratory. Since, the TF prevalence data reported here were collected from the district health facilities, they are most likely subject to the above described limitations. Incidence rates derived from cultured confirmed cases of TF alone would therefore be more informative as evidence suggests overestimation of up to 95% (10 vs 0.5) (Mbuh et al., 2003) when estimating using serological (widal) test compared to bacteriological isolation method. According to Crump et al. (2004), Asia, with 274 cases per 100,000 persons has the highest incidence of TF cases worldwide, especially in Southeast Asian countries and on the Indian subcontinent, followed by sub-Saharan Africa and Latin America with 50 cases per 100,000 persons.

The quarterly reports of TF prevalence indicates a clear shift of the disease occurrence pattern in the study district, which corresponds very well with the recent change in the timing of rainy and dry seasons. In recent years, most parts of the country have experienced the change of timing of rainy season from traditionally January - May to March - July or in extreme cases, the main rains shifts to Sept - December, which seems to match with the observed shift of high transmission time of TF from April - June (2nd quarter) between 2003 - 2005 to July - September (3rd quarter) in 2006 and October - December (4th quarter) in 2007. The TF high transmission season normally takes place at the latter part of rainy season. The mortality rate observed in this study (0.3 - 2%) compares well with previously reported case-fatality rates, which varied from 10 - 30% before the advent of antibiotics, but has now been reduced to about 1 - 4% with appropriate antibiotic therapy (Crump et al., 2004). However, the observed reciprocal relationship between the TF prevalence and mortality is a matter of concern. The reason for that relationship is not readily available but the authors speculate that it is possible that low prevalence of the disease is associated with more virulent bacteria and the vice versa.

Survey of TF disease awareness to the local people indicated they were quite informed about the disease and

Table 1. Socio-demographic information of the respondents (N = 120).

Variable	Number (%)
Age (years)	
10 - 30	63 (52.5)
31 - 50	39 (32.5)
51 - 70	18 (15)
Gender	
Females	72 (60)
Males	48 (40)
Geographical location	
Low land	39 (32.5)
Upland	81 (67.5)
Level of education	
Limited formal education	18 (15)
Primary education	87 (72.5)
Secondary education	15 (12.5)

Table 2. Levels of awareness of the typhoid disease and its control among the community (N = 120).

Variable	Number (%)
Typhoid disease	
Aware	105 (87.5)
Not aware	15 (12.5)
Signs and symptoms	
Aware	72 (60)
Not aware	48 (40)
Transmission	
Aware	51 (42.5)
Not aware	69 (57.5)
Control measures	
Aware	57 (47.5)
Not aware	63 (52.5)

its symptoms. However, most of them were either unaware of the transmission and control of TF or could not conceptualize the complex transmission chain of the disease and its control. Consequently, most of respondents indicated to depend on untreated water for drinking. Most of Singida urban population rely on land drilled wells for drinking water and greater part of the urban area is placed on lowland, making water contamination very likely as result of improperly designed drainage system. Moreover, most of participants claimed to depend on pit latrine for the disposal of human excreta and most of these toilets were not equipped with water

Table 3. Diagnostic services, environmental sanitation and personal hygiene (N = 120).

Variable	Number (%)
Laboratory test	
Test before medication	57 (47.5)
No test before medication	63 (52.5)
Type of toilet	
Pit latrine	114 (95)
Western type	6 (5)
Treatment of drinking water at home	
Boiling	36 (30)
Chemical treatment (water guard)	15 (12.5)
No treatment	69 (57.5)

facility. These finding have huge implication in the implementation of typhoid control measures and highlights the need of intensive educational campaigns to ensure adherence and the practice of personal hygiene in general.

Different studies have demonstrated the importance of educational campaigns for the control of typhoid (Lohiniva et al., 2008; Uneke, 2008). The study conducted in rural Egypt showed that promotion of hand washing campaign alone, had a great impact in the control of TF (Lohiniva et al., 2008). In the current study, there was a discordant of information between the health workers and the community member's focus group discussants. While the health workers group discussants claimed to routinely conduct educational campaigns through targeted home or ward visits, the community group discussants unanimously indicated inexistent of such campaigns. Given the importance of educational campaigns for the control of the disease, it is very unlikely that the high incidences of TF observed in this study will decrease significantly without strengthening the control protocols. A study conducted in India identified that, improved personal hygiene, targeted vaccination campaigns and intensive community health education are the public health measures that could help to prevent and control TF (Sur et al., 2006).

Laboratory diagnostic service was identified as a major problem, as the majority of health facilities did not have laboratory facility. Most of prescriptions therefore relied on clinical diagnosis. Because of the overlap between the clinical signs of TF and malaria, the clinical diagnosis approach is subject to huge errors in the tropics, where the two diseases are highly endemic. It is important to note that, although erroneous interpretation of widal test results may lead to misdiagnosis and mismanagement, clinical diagnosis without the benefit of any laboratory test is unacceptable in the tropics and most likely is the contributing factor to the major morbidity and mortality. A

study conducted in Cameron found that the number of fever cases diagnosed as malaria-TF co-infection were actually overestimated (Ammah et al., 1999). Consequently, although, the widal test is far from being a perfect diagnostic tool, in endemic areas, the test is still of significant diagnostic value provided judicious interpretation of the test is made against a background of pertinent information, especially data which relate to agglutinin levels in normal individuals and in non-typhoidal fevers common in the region (Pang and Puthucheary, 2009).

The findings of this study highlight the public health challenges facing African populations where TF remains endemic. The scarcity or lack of access to safe water, improper drainage systems and problems of unsanitary toilets in Singida urban needs immediate attention. Most importantly, the health systems in Singida urban, as in most endemic areas, need to be strengthened to be able to deliver appropriate services, including installation of recommended diagnostic services in all health facilities. As a public health preventive measure, intensive community health education need to be integrated into TF disease control protocol.

REFERENCES

Agwu E, Ihongbe JC, Okogun GR, Inyang NJ (2009). High incidence of co-infection with malaria and typhoid in febrile HIV infected and AIDS patients in Ekpoma, Edo state, Nigeria. Braz. J. Microbiol., 40: 329-332.

Ammah A, Nkujo-Akenji T, Ndip R, Deas JE (1999). An update on concurrent malaria and typhoid fever in Cameroon. Trans. R. Soc. Trop. Med. Hyg., 2: 127–129.

Anon (2006). District health report of 2006 in Singida.

Anon (2007). Singida municipal health report.

Bhan MK, Bahl R, Bhatnagar S (2005). Typhoid and paratyphoid fever. Lancet, 366(9487): 749-762.

Bhutta ZA (1996) Impact of age and drug resistant on mortality in typhoid fever. Arch. Dis. Child., 75: 214-217.

Buck R, Escanilla J, Sangalang RP, Cabangan AB, Santiago LT (1987). Diagnostic value of single, pre-treatment Widal test in suspected enteric fever cases in the Philippines. Trans. R. Soc. Trop. Med. Hyg., 81: 871-873.

Butter T (1992). Typhoid fever. In: Wyngaarden, J.B., Smith, L.H., Bennett, J.C. editors. *Cecil textbook of medicine,* XIX edition. Philadelphia, USA: W.B. Saunders Co: pp. 1690-1692.

Chaignat C, Clemens J, Favorov M, Klugman K, Kariuki S, Levine MM (2007). Report of the Typhoid Immunization Group to SAGE. Geneva: WHO SAGE meeting; November.

Chew SK (1992). Diagnostic value of Widal test for typhoid fever in Singapore. J. Trop. Med. Hyg., 95: 288-291.

Choo KE (1993). Usefulness of Widal test in diagnosing childhood typhoid fever in endemic area. J. Pediatr. Child. Health Care, 29: 36-42.

Crump J, Youssef FG, Luby SP, Wasfy MO, Rangel JM, Taalat M, Oun SA, Mahoney FJ (2003). Estimating the incidence of typhoid fever and other febrile illnesses in Developing countries. Emerg. Infect. Dis., 9(5): 539-544.

Crump JA, Luby SP, Mintz ED (2004). The global burden of typhoid fever. Bull. Wld. Health Org., 82: 346-53.

De Roeck D, Jodar L, Clemens J (2007). Putting typhoid vaccination on the global health agenda. N. Engl. J. Med., 357: 1069-1071.

Gupta A (1994). Multidrug-resistant typhoid fever in children: epidemiology and therapeutic approach. Pediatr. Infect. Dis. J., 13: 134-140.

Kanjilal SD, Dutta A, Mondal RK, Chakravorti S (2006). Uncomplicated falciparum malaria complicated by salmonella septicaemia: cause not coincidence. J. Indian Med. Assoc., 104: 646-648.

Kelly-Hope LA, Alonso WJ, Thiem VD, Canh DG, Anh DD, Lee H, Miller MA (2008). Temporal trends and climatic factors associated with bacterial enteric diseases in vietnam, 1991-2001. Environ. Health Perspect., 116: 7-12.

Keong BCM, Sulaiman W (2006). Typhoid and malaria co-infection: an interesting finding in the investigation of a tropical fever. Malaysian J. Med. Sci., 13: 74-75.

Koeleman JG (1992). Retrospective study to determine the diagnostic value of Widal test in nonendemic country. Eur. J. Clin. Microbiol. Infect. Dis., 11(2): 167-170.

Lohiniva AL, Saeed M, El-Sayeed N, Talaat M (2008). Clean hands: prevention of typhoid fever in rural communities in Egypt. Int. Q Community Health Educ., 28(3): 215-227.

Mbuh FA, Galadima M, Ogbadu L (2003). Rate of co-infection with malaria parasites and *Salmonella typhi* in Zaria, Kaduna State, Nigeria. Ann. Afr. Med., 2: 64-67.

Ochiai RL, Acosta CJ, Agtini M, Bhattacharya SK, Bhutta ZA, Do CG (2007). The use of typhoid vaccines in Asia: the DOMI experience. Clin. Infect. Dis., 45(1): S34-8.

Ohanu ME, Mbah AU, Okonkwo PO, Nwagbo FS (2003). Interference by malaria in the diagnosis of typhoid using Widal test alone. West Afr. J. Med., 22: 250-252.

Pang T, Puthucheary SD (1983). Significance and value of the Widal test in the diagnosis of typhoid fever in an endemic area. J. Clin. Pathol., 36: 471-475.

Pang TZ, Bhutta A, Finlay BB, Altwegg M (1995). Typhoid fever and other salmonellosis: a continuing challenge. Trends Microbiol 3: 253-255.

Parry CM (2004). Typhoid Fever. Curr. Infect. Dis. Rep., 6: 27-33.

Pearson RD, Guerrant RL (2000). Enteric fever and other causes of abdominal symptoms with fever. In: Mandell, G.L., Bennett, J.E., Dolin, R., editors. *Principles and practice of infectious diseases*, V edition. New York: Churchill Livingstone. pp. 1136-1150.

Samal KK, Sahu JCS (1991). Malaria and Widal reaction. J. Assoc. Phys. India, 39: 745-747.

Siddiquia FJ, Rabbania F, Hasanb R, Nizamic SO, Bhuttac ZA (2006). Typhoid fever in children: some epidemiological considerations from Karachi, Pakistan. International Society for Infectious Diseases doi:10.1016/j.ijid.2005.03.010

Sur D, von Seidlein L, Manna B, Dutta S, Deb AK, Sarkar BL, Kanungo S, Deen JL, Ali M, Kim DR, Gupta VK, Ochiai RL, Tsuzuki A, Acosta CJ, Clemens JD, Bhattacharya SK (2006). The malaria and typhoid fever burden in the slums of Kolkata, India: data from a prospective community-based study. Trans. R. Soc. Trop. Med. Hyg., 100: 725-733.

Uneke C (2008). Concurrent malaria and typhoid fever in the tropics: the diagnostic challenges and public health implications. J. Vector Borne Dis., 45: 133-142.

WHO (2009). Diarrhoeal diseases. http://www.who.int/vaccine_research/diseases/diarrhoeal/en/index7.html [Site visited on 1st October, 20.