DETERMINATION OF THE PREVALENCE OF TYPHOID IN PROVINCIAL AND SELECTED DISTRICT HOSPITALS IN KENYA

By

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DECLARATION

I, Samuel Gikunju Maingi, hereby declare that this thesis is my original work and has not been presented for a degree in any other University.

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DEDICATION

To my wife, Mary M. Gikunju and sons Maingi, Wanjohi, Kimaru and Njaro whose moral and material support made it possible for me to complete this work. May it be a good showcase for them.

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LIST OF ABBREVIATIONS

WHO – World Health Organisation

CDC – Centers for Disease Control and Prevention

CSF – Cerebro spinal fluid

USA - United States of America

ROK - Republic of Kenya

UK – United Kingdom

SPSS – Statistical Package for Social Sciences

DOMU – Disease Outbreak Management Unit

MOH – Ministry of Health

ABSTRACT

Accurate and reliable detection of typhoid infection in Kenya has been riddled with many problems. Some uncertified health reports have consistently indicated high infection rates in most parts of the country. The most common diagnostic tool in most health facilities has largely been clinical impressions. In some cases Widal test and more rarely isolation of the causative agent through culture has been carried out during routine practice. It has hence been difficult to estimate accurately the prevalence and disease burden associated with typhoid in Kenya from records maintained by Provincial and some selected District Hospitals. The aim of this study was to estimate the prevalence of typhoid by creating accurate data and analyzing the same appropriately.

This study examined specimens in laboratory by culturing to isolate *Salmonella typhi*. All samples came from patients who were clinical suspects of typhoid fever.

Data analysis was conducted using statistical package for social sciences (SPSS) version 10.0. Comparative analysis of typhoid specific morbidity showed that some parts of the country namely Nyanza, Eastern and Rift Valley were most affected. The results showed no significant statistical difference between the sexes infected ($\chi 2=0.56$; df=1;p=0.454). It demonstrated that there was no difference in infectivity among different age groups,($\chi_2=0.174$;df=1; p=0.677).

The study has shown that typhoid cases have been clinically over diagnosed leading to consequent unnecessary high treatment costs and probable drug resistance in patients.

The data showed a proportion of 1:20 for confirmed cases to those that were clinically diagnosed. There was a statististical difference between Widal test and culture confirmed cases (χ_2=36.851; p=0.000; df=1). It was also demonstrated that there were other infections (brucellosis, *Escherichia coli*, shigellosis) which were clinically similar to typhoid in presentation. The results could serve as a guide to policy makers on areas of emphasis in the ongoing prevention and health promotion_measures in terms of immunization, sanitation, health education and operational research. The study results will benefit health workers in their day-to-day practice when diagnosing typhoid. It also forms a basis for further research by interested parties including insurance industry, government/local authority agents et cetera, for planning purposes.

CHAPTER 1: INTRODUCTION AND LITERATURE REVIEW

1.1 General Introduction

Typhoid is an infectious enteric fever, which is contracted through eating food or drinking water that has been contaminated with *Salmonella typhi*. It is recognized by the sudden onset of sustained fever, severe headache, nausea and severe loss of appetite. It is sometimes accompanied by a hoarse cough and constipation or diarrhoea. Typhoid is an internationally as well as a locally notifiable disease and sometimes does occur as an epidemic (WHO, 1997).

Typhoid has a worldwide distribution and is one of the faecal-oral transmitted groups of bacilli. Its prevalence is determined largely by hygienic standards and practices among individuals and communities. The prevalence of this disease has indeed been used as an indicator of the level of community hygiene. Typhoid fever is more common in areas of the world where hand washing is less frequent and water is likely to be contaminated with sewage (CDC-Travellers Health, 2000).

Typhoid appears to be an exception to several epidemiological expectations partly because it may be in the process of establishing a comfortable commensal relationship with man. It can live and multiply in the gall bladders of carriers whose health it does not affect.

1.2 Literature Review

1.2.1 History of typhoid fever

Typhoid is a disease which has been affecting people since time immemorial without being specified because its symptoms resemble those of other diseases such as malaria, typhus fever, dysentery and others (Bopp *et al.*,1999).

Up to the 19th century there was confusion between typhus fever and typhoid. However, in 1836 Dr. Gerhard from Philadelphia (U.S.A.) identified the disease. In 1840 Dr. A.P. Stewart from Glasgow (U.K.) further described the disease.

Between 1849-1851 Sir William Jenner from United Kingdom, undertook the first successful definition of typhoid, clearly delineating it from typhus, which is spread by lice and has differing symptoms. Karl J. Erberth isolated the first causal organism for typhoid in 1880, thus providing the basis for a definitive diagnosis.

It was difficult to establish a historical diagnosis prior to that time, but scholars working on the history of Jamestown, Virginia (USA) believe a typhoid outbreak was responsible for the deaths of over 6000 settlers between 1607 and 1624. In the war against South Africa in the late nineteenth century, British troops lost 13000 men to typhoid, as compared to 8000 battle deaths (WHO, 1997).

By the end of the 19th century, there was development of paratyphoid fever (caused by *Salmonella paratyphi*) which resembled dysentery, typhoid and food poisoning (Manson – Bahr, 1996).

1.2.2 Causative Organisms

The organism that causes typhoid fever is *Salmonella typhi* or typhoid bacillum. Two types are known.

The most common type which is motile and the rare non-motile Vi strain (Stokes, 1970). There is also *Salmonella para typhi* A, B and C which resemble in their general morphological characteristics and staining reactions with *Salmonella typhi* but differ from it in their biochemical and immunological reactions. *Paratyphi* C causes mild attacks of fever (Manson – Bahr, 1996).

1.2.3 Reservoir

Human hosts constitute the only known reservoir of the infection. This may be in form of overt case of the disease, an ambulatory "missed" case or symptom less carrier (Lucas *et al.*, 1993). About 2-4% of the patients become chronic carriers of the disease and in most parts of the world faecal carriers are more common than urinary carriers. The carrier state is more common among persons infected during middle age especially females (Lucas *et al.*, 1993; Benenson, 1975).

1.2.4 Chronic Carrier

A chronic carrier is defined as a person whose stool is positive for *Salmonella typhi* for at least a year continuously following an episode of the disease (Bennet *et al.*, 1996). A person with positive stool cultures without any history of the disease can spread infection to others or cause contamination. These organisms are viable and fully infective and are a source of new infections. Chronic carriers are a threat to the community around them (Bennet *et al.*, 1996; Sonhani *et al.*, 1998).

An example of a chronic carrier dangerous to the community is that of the Craydon outbreak of 1937 which resulted in 310 cases with 43 deaths. The source of the infection was a workman who had gone down a well to effect repairs.

Another case of how one person can spread the infection, especially if a food handler, is that of Mary Mallon (or Typhoid Mary) who during her career as a cook in and around New York between 1901-1914, caused approximately 1,344 cases of typhoid and she died of it in 1938 (Parry, 1969).

The presence of Vi agglutinin in the serum in a dilution greater than 1:10 is suggestive of a carrier state. Carriers are either chronic or convalescent. Eradication of carrier state can be difficult (Kumar *et al.*, 1999).

1.2.5 Pathogenesis

Infection is by ingestion; from the small intestine the organisms pass through the lymphatics to the mesenteric glands, whence after a period of multiplication they invade the blood stream via the thoracic duct. The liver, gall bladder, spleen, kidney and bone marrow become infected during this bacteriamic phase in the first seven to ten days of infection. From the gall bladder a further invasion of the intestine results, and lymphoid tissue – Peyers patches and lymphoid follicles – are particularly involved in an acute inflammatory reaction and infiltration with mononuclear cells, followed by necrosis, sloughing and formation of characteristic typhoid ulcers (Cruickshank, 1975). Haemorrahage of varying degree may occur and, less frequently, perforation through necrotic Peyers patch may complicate the illness.

Salmonella typhi is present in large numbers in the inflamed tissue in the ulcers and is found in the intestinal and faecal material; it may localize in the kidney and appear in the urine, sometimes producing a marked bacilluria .

The bacillus is found in other lesions occurring as complications or sequele of typhoid fever, like acute suppurative periotitis and ostitis, abscess of the kidney, acute cholecystitis, bronchopneumonia, empysema and ulcerative endocarditis (Cruickshank, 1975).

In 2-5 per cent, of convalescents, the typhoid bacillus persists in the body, sometimes for an indefinite period. In such chronic carriers, the bacilli are most commonly present in the gall bladder or rarely in the urinary tract and are excreted in faeces or urine (Cruickshank, 1975).

Diagnosis of typhoid is done using three methods:

a) Clinical impression: This is where clinicians use the presenting signs and symptoms only, to reach a diagnosis.

b) Widal test: This is a laboratory serological test carried out on blood specimen.

c) Culture: Isolation of *Salmonella typhi* through culture of specimen in laboratory. The specimen may be blood, stool, urine or cerebral spinal fluid (CSF) (ROK, DOMU, 2001)

1.2.6 Bacteriology

Salmonella typhi is a gram-negative aerobic non-sporing bacteria. It can survive in water for 7 days, in sewage for 14 days and in ice cream for 1 month. However it is destroyed by heat (Lucas *et al.*, 1993; Punjani *et al.*,1997).

Inocula of at least 100,000 bacteria are necessary to initiate disease. The incubation period ranges from 8 to 28 days, depending on inoculum size and immune status of the host. Bacteria proliferate in mononuclear and spread by way of the blood to the spleen, liver and bone marrow, where further proliferation in macrophages occurs (Johenne *et al.*, 1981; Cheesbrough, 1984; Bennet *et al.*, 1996).

After ingestion, the typhoid bacilli invade the intestinal mucosa, proliferate in its lymphoid tissue, and later enter the bloodstream. Only then do symptoms occur. After the bacteria have entered the circulatory system, many organs are affected, especially the liver, spleen and reticuloendothelial system (Cruickshank, 1975; Weatherall *et al.*, 1988).

1.2.7 Mode of transmission

The disease is transmitted through food or water contaminated by faecal matter or urine from infected person or carrier (Bopp *et al.*,1999). Flies act as passive vectors due to fluid contacts with their legs, when they commute between latrines and kitchens. Transmission can also occur directly in the family through contacts with a patient or a chronic carrier. Indirectly, improperly washed fruits and vegetables which are consumed raw, can also transmit bacillus. About 90% of the cases are transmitted indirectly through contaminated foods or consumables (Lucas *et al.*, 1993).

The most important measure for controlling transmission is observance and maintenance of high standards of hygiene at personal, household and community levels (W.H.O. 1997)

1.2.8 Methods of Prevention

Typhoid fever can be prevented by observation of personal hygiene and environmental sanitation (W.H.O. 1997) such as:

a) Protection, purification and chlorination of public water supplies
b) Boiling of all drinking water
c) Sanitary disposal of faecal matter
d) Fly control by screening and spraying with residual insecticides
e) Control of fly breeding sites through adequate garbage collection
f) Elimination of open garbage dumping sites
g) Sanitary supervision of processing, preparation and serving foods in public eating places
h) Provision and use of hand washing facilities
i) Identification and treatment of typhoid cases and carriers
j) Education of convalescing patients and chronic carrier on personal hygiene and then exclusion from food handling activities.
k) Education of the general public on sources of infection and modes of transmission
l) Regular medical examination for all food handlers
m) Green salad leaves can be immersed for 15 minutes in undiluted vinegar or 1% sodium hypochlorite solution.
n) Fresh intact fruits should be pealed at the time of consumption after washing (Benenson, 1975; WHO, 1997).

1.2.9 Immunization

Typhoid fever can, to a limited extent be controlled by use of a vaccine. From 1845 onwards, Almroth Wright developed a concept of active immunization by use of vaccines made up of killed organisms. He believed that inoculation of killed vaccine made the blood highly bactericidal to the *Typhosum bacillus*. The vaccine he developed was known as T.A.B. and was first used by the British army. The benefit was noted in the 1st World War when the incidence of the fever in the army was only 2.35 compared to 105 in the Boer war which they undertook without being immunized. The immunization has a high immunity against typhoid and paratyphoid fevers A&B for about 2 years (Borgman, 1994). The most recent vaccine typhim VI is prepared from the capsular polysaccharide VI antigen of *Salmonella typhi*. It is one dose of 0.5ml. given intra muscularly or subcutaneously. It confers 95-100% sero-conversion against typhoid fever for a minimum of 3 years (Mirza *et al.*, 1995).

1.3 Rationale for the Study

1.3.1 Problem Statement

The annual world-wide occurrence of typhoid fever is estimated at 17 million cases, with approximately 600,000 deaths (WHO, 1997). In developing countries millions develop the disease and the mortality rate is as high as 30% (Kumar *et al.*, 1999). In Kenya reported cases were, 1830, 1427 and 4122 while deaths were 288, 183 and 309 for the years 1998, 1999, and 2000 respectively. These figures however do not reflect the situation on the ground. They are very low as compared to the actual cases which are treated for typhoid, since most of them are reported as diarrhoea and while others are not reported at all (ROK-HIS, 2002).

Typhoid-like complaints have informally been widely reported from both public and private health facilities and within communities, sometimes resulting in self-medication. Typhoid is an expensive disease to treat besides having a direct effect on the socio-economic activities of those infected and affected. Typhoid is however an easily preventable disease if hygiene is observed especially in feeding habits (WHO, 1997).

The problem, therefore, is the high incidences of typhoid reported in public health facilities, since it is difficult to determine what proportion of the suspected/ reported cases are actually typhoid. This is largely attributed to the problems inherent in the clinical diagnosis of typhoid. Typhoid, malaria, and diarrheogenic (escherichia coli) infections have similar symptoms and are often clinically misdiagnosed or cross-matched (Cruickshank, 1975).

However, a keen clinician can differentiate fever as potrayed in malaria in contrast to fever seen in typhoid. Fever from malaria comes gradually and is intermittent, while fever in typhoid occurs suddenly and is continous during course of disease.

1.3.2 Research questions

a) Is typhoid fever an actual problem of public health importance in Kenya?

b) Has the prevalence of typhoid been exaggerated as a result of misdiagnosis in public health facilities?

1.3.3 Justification of the Study

Epidemic typhoid is common in most of Africa, Asia and Central and South America (Weatherall *et al.*, 1988). A proportion of 1:100 patients in Africa admitted in adult medical wards, reportedly have typhoid while in the same hospitals the disease comprises 1.5% of

all paediatric admissions (Weatherall *et al.*, 1998). In developing countries, the modern parts of cities and towns are usually almost free of typhoid, general hospitals derive a large majority of their patients from slums, peripheral shanty towns and rural districts where sanitation and water supply are rudimentary (Weatherall *et al.*,1998).

Early in the year 2001 two outbreaks/epidemics of typhoid were reported in Embu and Nakuru towns of Kenya in February and May, respectively (ROK., 2001). With the current socio-economic decline and deterioration of services especially clean water supplies and sewerage disposal from local authorities, sanitation related diseases especially diarrhoeas are bound to increase. Typhoid being one of the sanitation related infections are no exception. This study has drawn conclusions, which will be useful in new and ongoing public health disease prevention strategic programmes.

The importance of identifying aetiologic strains in this study was both epidemiologic and academic. It will enhance further focused research to realize efficient diagnosis and management of typhoid in Kenya.

1.4 Null Hypotheses

a) Cases of typhoid in Kenya have remained low.

b) Prevalence of typhoid is uniformly distributed regionally in Kenya.

1.5 Objectives of this study

1.5.1 General Objective

The general objective of this study was to estimate the prevalence and regional distribution of typhoid fever in Kenya.

1.5.2 Specific Objectives

The specific objectives were:

a) To determine the prevalence of typhoid fever among people of Kenya through culture isolation of *Salmonella typhi* in the study area.

b) To determine the regional distribution of typhoid in Kenya.

c) To determine strains of *Salmonella typhi* commonly associated with typhoid in Kenya.

CHAPTER 2: MATERIALS AND METHODS

2.1 Study Areas

Kenya is one of the East African countries bordered by Sudan, Ethiopia, and Somalia to the north and east, Uganda, to the west, Tanzania and Indian Ocean to the south. It is a tropical country and is divided almost into two equal parts by the Equator. It therefore has a hot humid climate most of the year. This is a good environment for the proliferation of microbes and more so *Salmonella* species.

Kenya has an elaborate health delivery system comprising of well distributed static facilities as well as public health care extension services. The Ministry of Health mainly provides these services, with collaborative activities from stakeholders like N.G.O.s, donor agencies, private sector and community efforts. The services given are broadly categorized as curative, preventive, promotive, and rehabilitative. These include diagnosis and treatment of communicable diseases such as typhoid.

Kenya is also a typical developing country with less than a quarter of its population able to access clean safe drinking water. Over 80% of this population use pit latrines for faecal disposal. This scenario portends well for *Salmonella* multiplication and in contemporary thinking, increases risk factors for transmission.

The participating institutions were all provincial hospitals and at least one district hospital in each province. These hospitals were chosen on the basis of the high populations they serve and their capacity to carry out laboratory diagnosis.

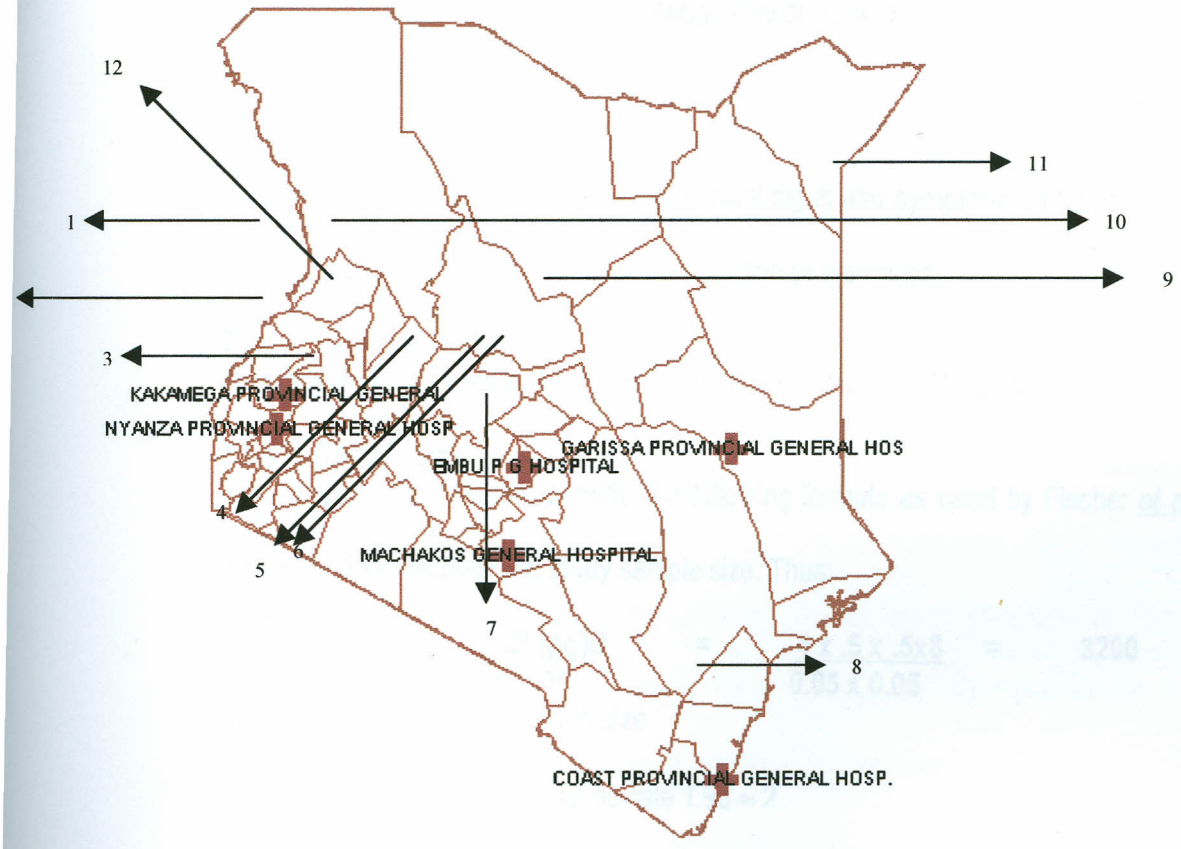
The actual hospitals included in the study were:

	Name of province		Name of hospital
a)	Rift Valley	-	Nakuru Provincial General Hospital
		-	Eldoret Referral Hospital
		-	Kapsabet District Hospital
b)	Nairobi	-	Kenyatta National Hospital
		-	Mbagathi Hospital
c)	Nyanza	-	Nyanza Provincial Hospital
		-	Kisii District Hospital
		-	Siaya District Hospital
d)	Western	-	Kakamega Provincial Hospital
		-	Busia District Hospital
e)	Coast	-	Mombasa Provincial Hospital
		-	Msambweni District Hospital
f)	Central	-	Nyeri Provincial Hospital

		-	Kirinyaga District Hospital
g)	Eastern	-	Machakos General Hospital
		-	Embu Provincial Hospital
		-	Meru District Hospital
h)	North Eastern	-	P.G.H. Garissa
		-	Wajir District Hospital

Figure 1:LOCATION OF KENYA IN THE MAP OF AFRICA

Figure 2: TYPHOID PREVALENCE PARTICIPATING PROVINCIAL AND DISTRICT HOSPITALS 2002-2003



KEY

1. BUSIA
2. SIAYA
3. KISII
4. NAKURU
5. NYERI
6. KIRINYAG
7. NAIROBI
8. KWALE
9. MERU
10. UASINGI
11. WAJIR
12. NANDI

2.2 Study Population and sample size determination

2.2.1 Study population

Specimens were collected from clients attending Outpatient Department and who presented with signs and symptoms suggestive of typhoid.

2.2.2 Inclusion criteria

Specimen collected from patients with clinical signs and symptoms of typhoid fever, such as fever, severe headache, malaise constipation or diarrhoea.

2.2.3 Exclusion criteria

Specimen from patients without clinical signs and symptoms 0f typhoid.

2.2.4 Sample size

Assuming an infective rate of 50%, the following formula as used by Fischer *et al.*, 1998 was applied to calculate the study sample size. Thus:

$$n = \frac{Z^2 (pq)D}{I^2} = \frac{4 \times .5 \times .5 \times 8}{0.05 \times 0.05} = 3200$$

Where n = Sample size

Z = normal deviate $1.96 \approx 2$

P = estimated proportion with disease (0.5)

q = estimated proportion without disease (0.5)

I = Precision (Significant Level) (0.05)

D = Number of provinces (design effect) 8

Therefore each province had a sample of 400 specimens/samples.

2.2.5 Ethical considerations

Information concerning all those who participated was kept confidential and their identities were not included in this report.

The researcher had approval from Kenyatta University as well as the Ethics Committee of the Ministry of Education, Science and Technology before the study commenced.

2.3 Design

It was a cross-sectional study taken in prospect for five months between July and December of the year 2002. The study was carried out concurrently in all the hospitals.

2.4 Sampling Procedure

Patients with signs and symptoms of typhoid fever were purposefully sampled at outpatient Departments of the respective hospitals. Full medical history was taken and clinical examination was done as a matter of routine. Rectal swabs were taken where patients were not able to pass stool. Urine was taken from some patients. Blood samples were inoculated into sterile bottles with culturing media and transported to the nearest participating laboratory within four hours. These laboratories had almost similar human as well as logistical capacity. The type of specimen (stool, urine, CSF or blood) taken was dependent on length of infection, which was estimated by when the first symptoms were noticed by patients. Where it was within the first week of infection blood samples were used whereas if it was two weeks and beyond stool was preferred.

2.5 Laboratory Procedures

2.5.1 Stool

(i) Macroscopy examination was done to check blood, nature of stool (i.e. whether loose, hard or rice watery) and smell as routine.

(ii) Stool culture

Stool was put directly into Decoxycholate Citrate Agar (DCA). After this, Selenite was introduced to sub-culture on DCA after 24 hours. Typical colonies which resemble *Salmonella typhi* were picked.

These were put into urea broth or Triple Iron Sugar (TSI) and incubated for 24 hours upon which typing was done for obvious reaction of *Salmonella typhi*.

2.5.2 Blood culture

Blood was taken asceptically into culture media (Trypton Broth) and incubated at 37°C for upto 7 days. Cultures were checked every day for turbidity and subcultured in either MacConkey Agar or DCA. This was incubated overnight and then checked for growth. Non-Lactose Fermenters (NLF) were picked and put into TSI and Urea Broth. This was incubated overnight upon which typical reaction of *Salmonella typhi* was checked.

2.5.3 Urine culture

The procedure carried out was similar to stool culture.

2.5.4 Cerebro Spinal Fluid (CSF) culture

The sample was collected asceptically and immediatelly put in a sterile container. This was subcultured in MacConkey agar and incubated at 37°C for 24 to 48 hours.

Growth was checked and differentiation was done using stains and sugars.

2.5.5 Widal Test

This is a demonstration of antibodies by serological technique in an agglutination reaction. The agglutination tests were most frequently carried out in the ordinary clinical laboratories for the diagnosis of enteric infections and were in this context known collectively as the Widal test.

This serological analysis was carried out on all samples. Antigenic components of H, and O were determined independently using already prepared and standardized suspensions obtained from a single commercial source. This guaranteed comparability of the results from the different participating laboratories.

Specimen of blood was made to separate serum from plasma through clotting. Serum was then introduced into separate H and O antisera on slides. The same was gently mixed and observed for characteristic agglutination. Upon agglutination, the process was followed by titration in tubes with dilutions of 1:20, 1:40, 1:80, 1:160, 1:320, and 1:640.

Infection was inferred with titres of 1:80 and above. Ideally, two specimen are examined, one taken at an early stage while the other is taken after one week or ten days. However this was not feasible for diagnosis had to be made on the first reading in all the hospitals as was recommended under similar circumstances by Stewart *et al.*, (1977).

Paired sera are often difficult to obtain and specific chemotherapy has to be instituted on the basis of a single Widal test. Moreover, many patients have limited financial means and cannot afford to have 2 Widal tests. Therefore, the interpretation of a single Widal test was common in daily practice (Nsutebu *et al.*, 2002).

2.5.6 Quality Control -

All participating laboratories had one technical assistant who underwent a one-week refresher training in the theory and practice of typhoid fever laboratory diagnosis. All the laboratories were supplied with adequate and critical reagents from a central source. They were given at least one positive sample for reference and control.

Preserved isolates identified in the provincial and district hospital laboratories were submitted to a central laboratory within the National Public Health Laboratory Services (N.P.H.L.S) complex in Nairobi for quality check.

Characterization of the *Salmonella typhi* strains was appropriately carried out in the laboratory using molecular techniques.

2.6 Data Collection

a) Methods

Results of laboratory analysis were recorded in registers or line lists.

b) Research Instruments

Registers and line lists.

c) Enumerators and Research Assistants

Clinicians, Laboratory and Public Health Technicians.

2.7 Data Management and Analysis

2.7.1 Storage

Data was initially stored in hard copies or paper before it was transferred to computer. Several backup copies were made in software or discs. Analysed information was stored in both hard and software.

2.7.2 Analysis

Data analysis was carried out using the Statistical Package for Social Sciences (SPSS) software. Chi-square was applied to test for statistical differences of prevailing prevalences, i.e. between sexes, different ages, sample types and regions.

CHAPTER 3: RESULTS

3.1 The prevalence of typhoid in Kenya.

In this study, a total of 3121 samples were analysed from patients clinically diagnosed for typhoid fever. These samples were drawn from 1659 males (53.2%) and 1462 female

(46.8%) patients. This finding suggests that there was a more or less similar prevalence level of typhoid in male and female study subjects. Approximately 88.1% or 2751 patients were aged 18 years and above and were regarded as adults while 11.9% or 370 of them were under 18 years of age and represented the children. The adult population appeared to carry the heaviest burden of typhoid in this study.

As shown in Table 1, the majority of these samples (96.5%) were stool, 3.2% were blood, 0.2% urine and 0.03% comprising CSF. It was apparent that the national prevalence of typhoid in Kenya based on the number of clinical cases in a population of 28.9 million (ROK, Population census 1999) was high, being approximately 1.08 per 10,000. However, when the same clinical samples were assayed serologically using Widal test, 789 or 25.3% were positive for *Salmonella typhi* antibodies.

On use of bacterial culture method, currently recommended as the gold standard in the confirmatory diagnosis of typhoid, only 163 or 5.2% of all the clinical samples were positive (Table 2). There was a significant difference in the proportion of samples that were positive on comparison of the Widal test and the culture method ($\chi^2 = 36.851$; P = 0.000; df =1) as shown on Table 2. Based on the confirmatory culture method, the national prevalence of typhoid changes from 1.08 per 10,000 to 0.06 per 10,000, suggesting that confirmed cases of typhoid in Kenya may after all not be such a big public health problem. In endemic areas in developing countries an annual incidence of ten or more per thousand (>10/1000) is not infrequent, but in developed countries the rates of one case per 100,000 or even per 1,000,000 population are now common (Hobson, 1979).

When the positive cases for typhoid by culture method were scored for sex and age groups, there was no significant difference in the proportion of infected males and females

(Table 3, p=>0.05) while the same was true for the proportion of infected adults to that of children (Table 4, p=>0.05).

The proportion of children compared to the adults positive for typhoid by culture method appeared higher (87.1%) compared to the children (12.9%) but population of the adults was greater than seven (7) fold as compared to the population of children in this study.

As shown in Table 5, the culture method picked infection by *Salmonella typhi* from stool and blood samples but none from both urine and CSF. This finding suggests that the method should be used to confirm infections from both stool and blood samples more efficiently than from urine and CSF.

Furthermore, the results of this study did not detect any *Salmonella typhi* infection in both urine and CSF using widal serological test either.

Table 1: THE DISTRIBUTION OF SAMPLES FROM PATIENTS CLINICALLY DIAGONOSED WITH TYPHOID BY TYPE OF SPECIMEN. 2002-2003

Type of Specimen	Number of Samples (n)	Proportion (%)
Stool	3013	96.50
Blood	100	3.20
Urine	7	0.20
CSF	1	0.03
TOTAL	3121	100.00

Table 2: THE DISTRIBUTION OF POSITIVE CASES OF TYPHOID FROM CLINICAL SAMPLES BY METHOD OF CLINICAL DIAGNOSIS. 2002-2003.

	Clinical Impression	Widal Test	Culture
Positive Cases (n)	3121	789	163
Proportion (%)	100	25.3*	5.2*
Negative Cases (n)	0	2332	2958
Proportion (%)	0	74.7	94.8

*Significant difference ($\chi^2 = 36.851$; P = 0.000; df =1).

Table 3: THE DISTRIBUTION OF CULTURE CONFIRMED POSITIVE CASES OF TYPHOID AMONG MALE AND FEMALE STUDY SUBJECTS. 2002-2003.

Culture	Sex of Patient		Total
	Male	Female	
Total	1659	1462	3121
Negative Cases	1577	1381	2958
Positive Cases	82	81	163
Proportion of total positive cases (%)	4.94**	5.54**	5.22
Proportion of positive (%)	50.3**	49.7**	100

** = No significant difference ($\chi 2$= 0.561; P = 0.454 df= 1)

Table 4: THE DISTRIBUTION OF CULTURE CONFIRMED POSITIVE CASES OF TYPHOID AMONG THE ADULTS AND CHILDREN IN THIS STUDY. 2002-2003.

Culture	Age Group		Total
	Adults	Children	
Total	2751	370	3121
Negative Cases	2609	349	2958
Positive Cases	142	21	163
Proportion of total positive cases (%)	5.2**	5.7**	5.2
Proportion of positive cases (%)	87.1	12.9	100

** = No significant difference ($\chi^2 = 0.174$; P = 0.677; df = 1)

Table 5: THE DISTRIBUTION OF CULTURE CONFIRMED CASES OF THYPHOID BY TYPE OF SPECIMEN IN THIS STUDY. 2002-2003.

Culture	Specimen Type from patients				TOTAL
	Stool	Blood	Urine	CSF	
Total	3013	100	7	1	3121
Negative Cases (n)	2855	95	7	1	2958
Positive Cases (n)	158	5	0	0	163
Proportion of total positive (%)	5.2	5.0	0	0	5.2
Proportion of positive – positive (%)	96.9	3.1	0	0	100

No significant difference ($\chi 2 = 0.454$; $p = 0.929$; $df = 1$)

Table 6: THE DISTRIBUTION OF CULTURE CONFIRMED CASES BY WIDAL TEST CONFIRMED CASES. 2002-2003.

Culture	Widal Test		Total
	Positive	Negative	
Postive	74(a)	89(b)	163
Negative	715(c)	2243(d)	2958
TOTAL	789	2332	3121

Predictive value = a/a+b = 0.45

Widal specificity = a/a+c = 0.09

Significant difference ($\chi 2 = 36.851$; $p = 0.000$; $df = 1$)

3.2 The Regional Distribution of the Prevalence of Typhoid in Kenya

3.2.1 The Provinces

In all the participating hospitals Clinicians were left to do their diagnosis as routine to avoid bias. In other words their participation was blind. It is therefore important to once again note that all specimens were taken from clinically diagnosed cases of typhoid fever.

The total 3121 sample units were 100% clinical typhoid and were distributed among the provinces, during the study period, as shown in Table 7.

It was clear that unlike the national picture, some provinces had significant prevalence levels of typhoid fever as confirmed through culture, (Rift Valley (21%), Nyanza (26%) and Eastern (20%)) as shown in Table 8. It was also demonstrated that there existed significant differences between the culture confirmed cases by province ($\chi 2 = 59.780$; $p = 0.000$; $df = 7$). This is shown in Table 8.

Figure 1 illustrates the big difference in the numbers of Widal test diagnosed cases in comparison to culture confirmed cases as seen during the study period in different provinces.

Table 7: THE NUMBER OF CLINICAL CASES OF TYPHOID DIAGNOSED BY PROVINCES DURING THE STUDY PERIOD 2002-2003.

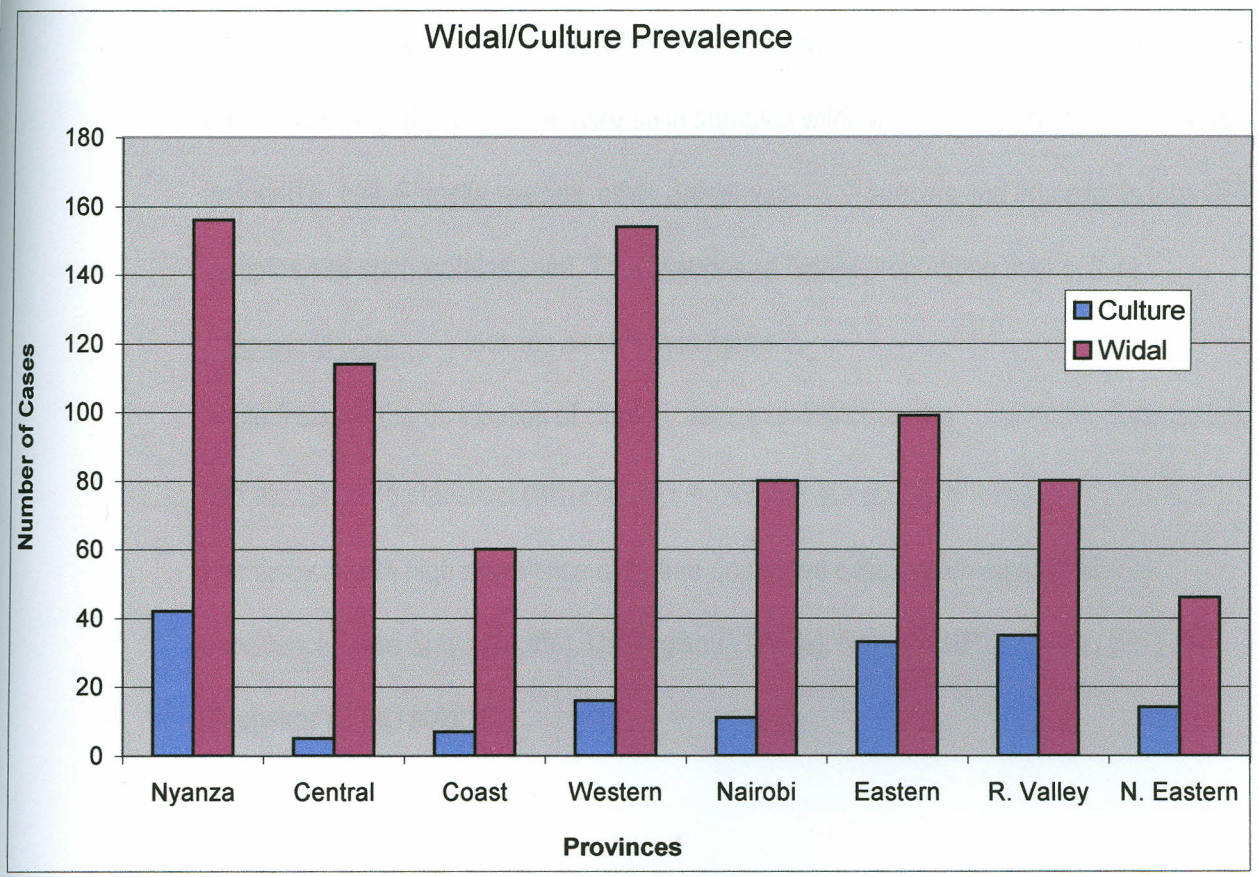
No.	Name of Province	Number of clinically diagnosed cases	Proportion (%)	Cumulative Percent
1.	Nyanza	442	14.2	14.2
2.	Central	400	12.8	27.0
3.	Coast	361	11.6	38.5
4.	Western	403	12.9	51.5
5.	Nairobi	397	12.7	64.2
6.	Eastern	409	13.1	77.3
7.	Rift Valley	403	12.9	90.2
8.	North Eastern	306	9.8	100.0
	Total	3121	100.0	

Table 8: THE PROPORTIONS OF CULTURE POSITIVE TYPHOID CASES DIAGNOSED BY PROVINCE DURING STUDY PERIOD

No	Name of Province	Number of culture positives	Proportion (%)
1.	Nyanza	42	26.0
2.	Central	5	3.0
3.	Coast	7	4.0
4.	Western	16	10.0
5.	Nairobi	11	7.0
6.	Eastern	33	20.0
7.	Rift Valley	35	21.0
8.	North Eastern	14	9.0
9.	Total	163	100.0

Significant difference ($\chi 2$ =59.780; P=0.000; df=7)

Figure 3: COMPARISON FOR WIDAL TEST AND CULTURE POSITIVE CASES BY PROVINCE DURING THIS STUDY 2002-2003



3.2.2 PREVALENCE BY DISTRICTS

Analysis was done to reflect individual district prevalences of typhoid. The study demonstrated wide significant differences among districts on culture confirmed cases of typhoid ($\chi 2 = 104.567$; $p = 0.000$; $df = 17$) as is shown in Table 10. The study revealed other pathogens (figure 2) and more so in samples without *Salmonella typhi*. These included E. coli, Shigella species, other Salmonella species and brucella. In total 288 samples had such isolates seen. They comprised higher proportions than culture *Salmonella typhi* isolates as shown in figure 2.

Table 9 shows the distribution of clinical cases per district as seen during the study period, and also showed statistical difference ($\chi 2 = 749.692$; $p = 0.000$; $df = 17$).

The districts with high prevalence of culture confirmed cases taken against clinical prevalence, were Siaya (18.4%), Uasin gishu (12.4%), Nakuru (10%), Kisumu (9%) and Machakos (7%)(Table 10).

Table 9: THE NUMBER OF CLINICAL CASES OF TYPHOID DIAGNOSED BY DISTRICTS DURING THE STUDY PERIOD 2002-2003.

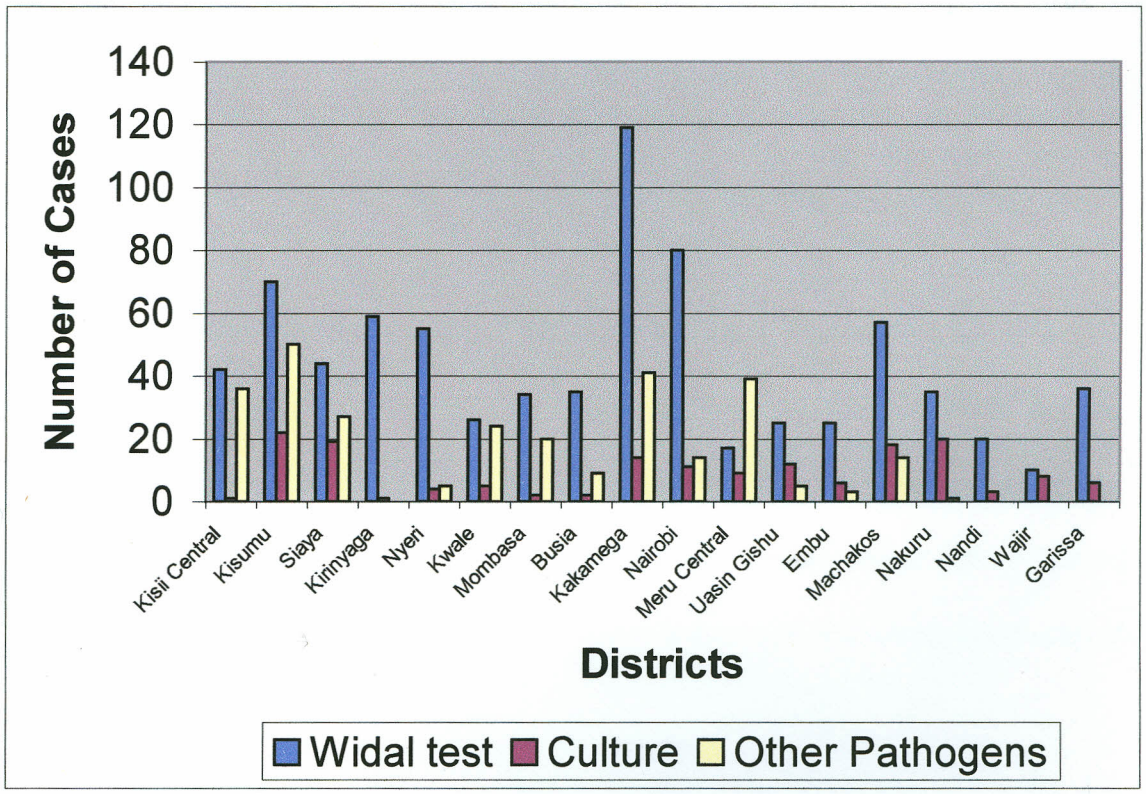
No.	Name of district	Number of clinically diagnosed cases	Proportion(%)	Cumulative Percent
1.	Kisii Central	95	3.0	3.0
2.	Kisumu	244	7.8	10.9
3.	Siaya	103	3.3	14.2
4.	Kirinyaga	200	6.4	20.6
5.	Nyeri	200	6.4	27.0
6.	Kwale	141	4.5	31.5
7.	Mombasa	220	7.0	38.5
8.	Busia	100	3.2	41.7
9.	Kakamega	303	9.7	51.5
10.	Nairobi	398	12.7	64.2
11.	Meru Central	85	2.7	66.9
12.	Uasin Gishu	97	3.1	70.0
13.	Embu	74	2.4	72.4
14.	Machakos	250	8.0	80.4
15.	Nakuru	205	6.6	87.0
16.	Nandi	100	3.2	90.2
17.	Wajir	150	4.8	95.0
18.	Garissa	156	5.0	100.0
	Total	3121	100.0	

Significant difference χ^2 =749.692; p =0.000; df =17.

Table 10: THE NUMBER OF CULTURE DIAGNOSED CASES BY DISTRICT DURING STUDY PERIOD 2002-2003.

No.	Name of district	Culture		Total
		Positive	Negative	
1.	Kisii Central	1	94	95
2.	Kisumu	22	222	244
3.	Siaya	19	84	103
4.	Kirinyaga	1	199	200
5.	Nyeri	4	196	200
6.	Kwale	5	136	141
7.	Mombasa	2	218	220
8.	Busia	2	98	100
9.	Kakamega	14	289	303
10.	Nairobi	11	387	398
11.	Meru Central	9	76	85
12.	Uasin Gishu	12	85	97
13.	Embu	6	68	74
13.	Embu	6	68	74
14.	Machakos	18	232	250
14.	Machakos	18	232	250
15.	Nakuru	20	185	205
15.	Nakuru	20	185	205
16.	Nandi	3	97	100
16.	Nandi	3	97	100
17.	Wajir	8	142	150
17.	Wajir	8	142	150
18.	Garisa	6	150	156
18.	Garisa	6	150	156

Figure 4: COMPARISON OF POSITIVE WIDAL, CULTURE CASES AND OTHER PATHOGENS IDENTIFIED BY DISTRICTS DURING STUDY PERIOD 2002-2003



SALMONELLA TYPHI TYPHI STRAINS

The study was able to identify only one type of *Salmonella typhi* in all the 163 isolates. The strain was identified as the common motile Vi strain. (Stokes, *et. al.*,1970).

CHAPTER 4: DISCUSSION

To determine the prevalence of typhoid in Kenya the study attempted to determine the prevalence of typhoid fever in all the eight provinces of the country. The study also attempted to determine prevalence of typhoid in selected districts in an attempt to differentiate prevalence levels and predictive values of different regions of Kenya. In addition, the study looked into the relationship between different prevalences as shown by three levels of diagnosis which are commonly applied in Kenyan hospitals. The study attempted to determine prevalence by clinical diagnosis, prevalence by widal test and prevalence by isolation of *Salmonella typhi* by culture. Using culture as the true prevalence the study established levels of infection in different sexes as well as different age group. Finally it determined the most commonly used type of specimen in detection of typhoid fever.

Typhoid fever is a preventable disease at individual, household, community and administrative levels. To achieve this, accurate information on the disease is very important. It is through accurate information that decisions made can be useful to eliminate or control disease occurrence. Moreover, there are high risks of increase in drug resistance as well as carriers in cases of inaccurate diagnosis and consequential inappropriate treatment. Control of epidemics is of great concern since its consequences are usually alarming and devastating in nature. The study involved at least one laboratory technician (research assistants) per hospital for diagnosis and records. Clinicians were blindly involved, thus they were left to carry out diagnosis and specimen requests for laboratory analysis as routinely done to avoid bias.

Out of a target of 3200 samples the study managed 3121 samples or 98% of target. All the hospitals involved had a common characteristic of possessing wide catchment areas. The patients came from long distances and it was not uncommon to get others who came from different districts or even provinces from the serving hospital. Good examples of these were Kisii, Kisumu and Nakuru. It was also noted that patients came from both urban and rural setups. An interesting observation was that all those confirmed as having typhoid in Nairobi city came from slum areas where clean water supply and sanitation are marginal and often missing altogether (Kibagare, Kwa Njenga, Kibera and Kangemi. This lack of clean water and sanitation is an indicator of poor hygienic status (Muleta *et. al.*, 2001).

The samples were evenly distributed among the provinces albeit a few differences. The mean sample distribution by province was 390 with a range of 306 in North Eastern to 442 in Nyanza.

Adults who participated comprised 88% while children were 12% of the total. Adults were considered to be all those above the age of eighteen years old and children were those below the age of eighteen. The infection rate among adults was 5% while children showed an infection rate of 6%, showing no significant difference (chi square=0.174; p=0.677). Whereas the prevalence in adults was 4.5% it was 0.7% in children. At the same time, 87% of the positive samples came from adults while children accounted for 13%. These prevalence patterns are in conformity with the Embu and Nakuru outbreaks where prevalence among children was observed as minimal.

Samples from male patients were 53% while female patients contributed 47%. However the total positive samples were equally distributed at 50% in each of the two groups. The infection rate among males was 49% while it was 55% among females. This infection rate

pattern also relates well with the Embu and Nakuru outbreaks of the year 2001, where more females were affected than males (M.O.H. Reports). There was no significant difference in infection among the two sexes (chi square= 0.561; p=0.454; df=1).

Out of the 3121 samples examined, 3013 or 96.5% were stool, 100 or 3.2% were blood while 7 or 0.2% were urine and one from CSF. This is significant because it shows that most people reach hospitals after suffering for one week and over. This could be attributed to various socio-cultural-economics reasons which were not extraporated in this study.

Out of the total stool samples 5.2% were found to be infected. Blood and stool samples showed an infection rate of 5.0% each, while the urine and CSF samples did not yield any *Salmonella typhi*. The study demonstrated that there was no statistical difference between stool, blood, urine and CSF infection rates by culture(χ_2 =0,454; p =0.929;df = 3).

The stool samples represented 97% of total sample positivity while only 3% positives were blood. Given the above mentioned almost equal infection rates, this huge overall difference in positivity among the specimen types could be explained by the small number of blood samples in comparison to stool samples examined.

A total of 789 or 25.3%of all samples were widal positive. This is five times more than the actual positives. Out of these only 74 or 2.3% of the total proved to be truly positive upon culture. The other 715 or 90.6% were culture negative. This therefore confirms that widal test results are not very reliable. There is definitely an extremely significant difference with obvious results of probable misdiagnosis and consequent patient mismanagement.

It was determined that out of a total of 163 samples which were truly positive, 89 of them or 55% were negative on widal test. This would lead to missed cases and therefore again wrong management.

4.1 CLINICAL DIAGNOSIS

This level of diagnosis relied on the skill and experience of the doctors and clinical officers. They used the signs and symptoms portrayed by patients to create the impression of typhoid. Thus, the 3121 samples were given by clinically confirmed cases of typhoid.

a) WIDAL TEST

In the course of the enteric fevers, the patient usually developed a high titre of agglutinins for the causative organism (Cruickshank *et al.*, 1975). The detection and estimation of these antibodies was carried out by the widal reaction. As suggested and in agreement with the book, Bacteriology, Virology and Immunity for Students of Medicine, the study was not able to take two specimen for test of rising titre after 10 days but instead only one sample was used (Stewart *et al.*, 1977).

This test was applied to all blood samples. This is not a confirmatory test, yet on day to day practice it is usually relied on as an indicator of Typhoid. As shown by the results of the study an overall 25.3% of the clinical suspects were widal positive.

b) CULTURE

Isolation of *Salmonella typhi* is the only confirmatory test for typhoid fever. This was carried out on all specimens. The overall prevalence as shown by culture is 5.2%. However significant differences in prevalence were seen between provinces as well as between districts.

4.2 REGIONAL PREVALENCES

The lowest prevalence among the provinces was in Central at 1.3% while the highest was Nyanza province at 9.0%. and thus was significant (χ_2=59.780; p=0.000; df=7). The district with the lowest prevalence was Kirinyaga at 0.5% and the highest was Siaya at 18.4%. There was significant difference in prevalence between the districts (χ_2=104.567; p=0.000; df=17).

The districts had a mean prevalence of 5.83% and a median prevalence of 4.2%.

4.3 COMPARISON OF TEST METHODS

a) PREDICTIVE VALUES

When the two laboratory diagnostic methods were compared the study revealed that the positive predictive value was 0.45 or 45%, for Widal measured against culture. This answers the question as to, when one is told that he or she is positive by widal test, what are the chances that he/she is really positive? And here the illustration is that the probability is less than half that one would be actually positive for typhoid fever.

This also indicates the degree of unreliability of widal test as currently applied in public hospitals.

b) SPECIFICITY OF TESTS

The study results show a specificity value of 0.09 or 9% when again Widal test is measured against culture. This shows how unspecific the Widal test is in the detection or confirmation of typhoid fever. This demonstration was strengthened by the fact that other pathogens and non-pathogens were isolated upon culture of Widal positive, none

Salmonella typhi carrying samples. This also clarifies the degree of cross reaction of various bacteria when subjected to Widal test.

c) SENSITIVITY

When Widal test was measured against culture it yielded a sensitivity value of 0.02.

4.4 THE BACTERIA STRAIN

Salmonella are Gram-negative, motile non-sporing, non-capsulated bacilli which is morphologically indistinguishable from E. coli. Over 1000 species have now been described whose great majority differ only in antigenic composition. The enteric fever group comprises organisms capable of causing enteric fevers in man, *Salmonella typhi* and Paratyphoid bacilli. These species are found only in the intestinal tract of man for whom they have a high degree of pathogenicity and in whom they cause invasive disease. The toxicity of the Salmonella is due to the somatic antigen complex. The basis of the toxicity for the somatic antigen has not been completely determined but clearly depends on the presence of lipid – A (Stokes *et. al.*, 1970).

With the exception of *Salmonella typhi* the Salmonella do ferment maltose, glucose, mannitol and dulcitol producing acid and gas. *Salmonella typhi* ferments maltose, glucose and mannitol, producing acid and not gas.

The antigens of importance in identification are H or flagellar antigens, the O or somatic antigens and the Vi antigens. Many Salmonella species are diphasic in relation to their flagellar antigens whereby the organism may have one or other of two sets of flagellar antigens. These sets are known as phase 1 and phase 2. However, some Salmonella species like *Salmonella typhi* are monophasic, meaning that the flagellar antigens do exist only in one phase. Phase 1 antigens are more specific and they were used in this study to identify only one strain of *Salmonella typhi* in Kenya (Stewart *et al.*,1977).

4.5 BACTERIOPHAGE TYPING

This is done in a number of Salmonella species by sub-dividing into types on the basis of their susceptibility to bacteriophage. Bacteriophages or phages are viruses that are parasitic on bacteria. They exhibit a marked specificity of action, each phage being capable of attacking only groups of closely related bacteria. Phage typing is important in *Salmonella typhi* in which 80 types and subtypes have been defined worldwide. The phages used for *Salmonella typhi* are specific for the Vi form. This is of considerable value in epidemiological investigations for it helps to trace the source of outbreaks of typhoid fever. Thus, if a carrier is responsible for an epidemic, he should harbor the phage type found in that epidemic (Stewart *et al.*, 1977).

This study had resource and time limitations and therefore did not manage to do phage typing. This therefore should be taken up in the future.

CHAPTER 5: A SUMMARY OF CONCLUSIONS

The study showed a wide prevalence disparity between

a) The study showed a wide prevalence disparity between the most used method of clinical impression to diagnose typhoid fever and the culture method used to isolate *Salmonella typhi* or to confirm typhoid.

b) There exists a significant difference in prevalence between Widal test as commonly applied and isolation of *Salmonella typhi* by culture.

c) The national prevalence of typhoid as a public health problem is very low which is a reflection of prevailing endemicity levels.

d) Some specific districts in the Rift Valley, Nyanza and Eastern provinces have highly significant prevalences of typhoid fever.

e) The slum areas in the city of Nairobi are pockets of high prevalence of typhoid.

f) Only one type of *Salmonella typhi* was identified in the study.

g) Statistical difference does not exist between the infection of the two sexes (male and female).

CHAPTER 6 : RECOMMENDATIONS AND SUGGESTIONS FOR FUTURE WORK

6.0 Recommendations

a) There is need for improving on diagnosis of typhoid by applying culture as routine practice.

c) There is need for continuous and reliable surveillance together with proper notification of typhoid fever as a problem of public health importance. This should

be applied at all levels. Thus, the community, the health facilities, the districts, provinces and national levels.

d) The Ministry of Health should have a specific programme of controlling typhoid with the ultimate goal of eradicating it altogether. This programme should have an inter-sectoral and intra-sectoral approach.

e) Regular epidemiological surveys should be carried out to guide appropriate action.

f) Epidemic thresholds for each district should be suitably determined while at the same time national guidelines for early warning signs should be established.

g) Monitoring of drug resistance and sensitivity patterns should be implemented to enhance effective case management at facility level.

h) Current strategies on communicable diseases control should be evaluated with the aim of enhancing capacity, efficiency and effectiveness.

i) Institutional infection control systems should be well established so as to eradicate probable nosocomial or hospital based transmissions.

6.1 Suggestions for future research work

a. Determination of socio-economic advantages of prevention over disease management.

b. Assessment of risk factors of typhoid fever in the most prevalent districts.

c. Determination of drug sensitivity and multi-drug resistance patterns of *Salmonella typhi* in specific areas.

d. Epidemiological survey for mapping of *Salmonella typhi* in the country through phage typing.

e. Determination of socio-cultural-economics of vaccination to high-risk groups.

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APPENDICES

APPENDIX 1: ESTIMATION OF TYPHOID FEVER PREVALENCE IN KENYA.2002-2003

Lab Code No----------

Id No	Age	Sex	Province	District	Division	Village	Specimen Type	Culture Results	Widal Results	Other Pathogens

APPENDIX 2: ONE WAY ANOVA

		Sum of Squares	df	Mean Square	F	Sig.
Widal Test	Between Groups	19.788	7	2.827	15.445	0.000
	Within Groups	569.750	3113	0.183		
	Total	589.538	3120			
Culture	Between Groups	2.959	7	0.423	8.684	0.000
	Within Groups	151.528	3113	4.868E-02		
	Total	154.487	3120			
Other pathogens	Between Groups	22.192	7	3.170	41.254	0.000
	Within Groups	239.231	3113	7.685E-02		
	Total	261.424	3120			

APPENDIX 3: THE NUMBER OF CULTURE CONFIRMED CASES DIAGNOSED BY PROVINCE DURING THE STUDY PERIOD. 2002-2003.

No.	PROVINCE	Culture		Total
		Positive	Negative	
1.	Nyanza	42	400	442
2.	Central	5	395	400
3.	Coast	7	354	361
4.	Western	16	387	403
5.	Nairobi	11	386	397
6.	Eastern	33	376	409
7.	Rift Valley	35	368	403
8.	North Eastern	14	292	306
8.	North Eastern	14	292	306
	TOTAL	163	2958	3121
	TOTAL	163	2958	3121

APPENDIX 4: THE NUMBER OF WIDAL TEST DIAGNOSED CASES BY PROVINCE DURING THE STUDY. 2002-2003.

No.	PROVINCE	Widal Test		Total
		Positive	Negative	
1.	Nyanza	156	286	442
2.	Central	114	286	400
3.	Coast	60	301	361
4.	Western	154	249	403
5.	Nairobi	80	317	397
6.	Eastern	99	310	409
7.	Rift Valley	80	323	403
8.	North Eastern	46	260	306
	TOTAL	789	2332	3121

APPENDIX 5: DISTRIBUTION OF SPECIMEN TYPE BY PROVINCE. 2002-2003

No.	Provinces	Specimen Type				Total
		Stool	Blood	Urine	CSF	
1.	Nyanza	441	1			442
2.	Central	387	13			400
3.	Coast	343	18			361
4.	Western	395	3	5		403
5.	Nairobi	395	1	1		397
6.	Eastern	407	1	1		409
7.	Rift Valley	401	1		1	403
8.	North Eastern	244	62			306
	Total	3013	100	7	1	3121

APPENDIX 6: DISTRIBUTION OF SAMPLES BY GENDER BY PROVINCE DURING THE STUDY. 2002-2003.

No.	Province	Sex of patient		Total
		Male	Female	
1.	Nyanza	179	263	442
2.	Central	251	149	400
3.	Coast	246	115	361
4.	Western	201	202	403
5.	Nairobi	209	188	397
6.	Eastern	210	199	409
7.	Rift Valley	182	221	403
8.	North Eastern	181	125	306
	TOTAL	1659	1462	3121

APPENDIX 7: DISTRIBUTION OF WIDAL TEST RESULTS BY DISTRICTS DURING STUDY PERIOD. 2002-2003.

No.	Name of District	Widal Test		Total
		Positive	Negative	
1.	Kisii Central	42	53	95
2.	Kisumu	70	174	244
3.	Siaya	44	59	103
4.	Kirinyaga	59	141	200
5.	Nyeri	55	145	200
6.	Kwale	26	115	141
7.	Mombasa	34	186	220
8.	Busia	35	65	100
9.	Kakamega	119	184	303
10.	Nairobi	80	318	398
11.	Meru Central	17	68	85
12.	Uasin Gishu	25	72	97
13.	Embu	25	49	74
14.	Machakos	57	193	250
15.	Nakuru	35	170	205
15.	Nakuru	35	170	205
16.	Nandi	20	80	100
16.	Nandi	20	80	100
17.	Wajir	10	140	150
17.	Wajir	10	140	150
18.	Garissa	36	120	156
18.	Garissa	36	120	156
	Total	789	2332	3121
	Total	789	2332	3121

APPENDIX 8: NUMBER OF SPECIMEN AND TYPE BY DISTRCTS ANALYSED DURING THE STUDY. 2002-2003.

No.	Name of District	Specimen Type				Total
		Stool	Blood	Urine	CSF	
1.	Kisii Central	95				95
2.	kisumu	243	1			244
3.	Siaya	103				103
4.	Kirinyaga	200				200
5.	Nyeri	187	13			200
6.	Kwale	141				141
7.	Mombasa	202	18			220
8.	Busia	98		2		100
9.	Kakamega	297	3	3		303
10.	Nairobi	396	1	1		398
11.	Meru Central	85				85
12.	Uasin Gishu	95	1		1	97
13.	Embu	74				74
14.	Machakos	248	1	1		250
15.	Nakuru	205				205
16.	Nandi	100				100
17.	Wajir	149	1			150
18.	Garissa	95	61			156
	TOTAL	3013	100	7	1	3121

MINISTRY OF EDUCATION, SCIENCE AND TECHNOLOGY

Telegrams: "Education", Nairobi
Telephone: Nairobi 334411
When replying please quote
Ref. No. MOEST 13/001/32C 135/2
and date

JOGOO HOUSE "B"
HARAMBEE AVENUE
P.O. Box 30040
NAIROBI

30th July, 20..02

Samuel Gikunji Maingi
Kenyatta University
P.O. BOX 43844
NAIROBI

Dear Sir

RE: RESEARCH AUTHORISATION

On the basis of your application for authority to conduct research on 'Estimation of Typhoid prevalence as a problem of Public Health Importance in Kenya, I wish to let you know that you have been authorised to conduct research in all Provinces in Kenya for a period ending 30th August, 2003.

You are advised to report to all the Provincial Commissioners and all the Provincial Commissioners and all the Provincial Directors of Education before embarking on your study.

Upon completion of your research project, you are advised to deposit two copies of your research findings to this Office.

Yours faithfully

A. G. KAARIA
FOR: PERMANENT SECRETARY/EDUCATION

CC

All the Provincial Commissioners

All the Provincial Directors of Education

APPENDIX 10:RESEARCH AUTHORIZATION BY THE NATIONAL ETHICS COMMITTEE.

KENYATTA UNIVERSITY
DEPARTMENT OF ZOOLOGY

APPENDIX 11:POST GRADUATE CONFERENCE
AUGUST 2003

ABSTRACT FORM

TITLE: ESTIMATION OF THE PREVALENCE OF TYPHOID AS A PROBLEM OF PUBLIC HEALTH IN KENYA.

By: SAMUEL GIKUNJU MAINGI (MPHE)
Supervisors: Prof. A.S.S. Orago (K.U.), Prof. Romanus Okelo (K.U.) and Dr. Njeri Wamae (K.E.M.R.I.)

ABSTRACT

Objective: To determine the prevalence of Typhoid Fever in Kenya.

Setting: All provincial hospitals and selected district hospitals.

Design: A cross – sectional study done prospectively for a four months period.

Subjects: Three thousand one hundred and twenty one specimen taken from patients with signs and symptoms of typhoid fever. Clinical screening was done by clinicians at the out patient clinics upon which specimens were produced in the laboratories for culture and serological tests.

Results: The overall prevalence in the study area was 5.2%. The prevalence range in different provinces is between 1.25% and 9%, while the range in different districts is between 0.5% and 18.4%. There was significant statistical differences among regions($p<0.001$). Prevalence rate did not differ significantly between sexes and between ages ($p> 0.05$).There was significant difference in comparative prevalence between serological test (widal) and bacteria isolation by culture ($p<0.001$).

Conclusion: The study shows that the national prevalence rate of typhoid fever in Kenya is very low. It shows that prevalence rates are high and of significant public health concern in specific regions of Rift Valley, Eastern and Nyanza provinces. Health education, clean water supply, hygienic sanitation and immunization of high risk groups is highly recommended.

APPENDIX 9: LOCATIONAL MAP OF KENYA SHOWING PROVINCES AND DISTRICTS