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Desirability for a typhoid fever vaccine among rural residents, Pemba Island, Tanzania

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ABSTRACT

Background: Surveillance data indicate that *Salmonella enterica* serotype Typhi (*S.* Typhi) is a significant cause of morbidity and mortality in Africa. With limited anticipated short-term improvements in sanitation and water infrastructure, targeted vaccination campaigns may be an important prevention tool for typhoid fever.
Methods: A cross-sectional survey was conducted with 435 randomly selected households in four rural villages on Pemba Island, Tanzania. A dichotomous 'readiness to pay' variable was created to assess vaccine desirability. Data analyses included univariate and bivariate descriptive statistics and binary logistic regression. Bivariate outcomes (ANOVA, *t*-tests, and chi-square) and odds ratios with 95% confidence intervals are reported.
Results: A total of 66% respondents stated that they would pay for a typhoid fever vaccine in the future. Readiness to pay was not significantly associated with household expenditures. Readiness to pay was associated with use of local Primary Health Care Units (PHCUs) compared to use of cottage or district hospitals (OR 1.8 [95% CI, 1.2–2.7]: $p = .007$) and with knowledge of someone being sick from typhoid fever (OR 2.2 [95% CI, 1.0–4.5]: $p = .039$). Respondents perceiving prevention measures as more effective (OR 1.0 [95% CI, 1.0–1.2]: $p = .009$) were also more likely ready to pay. Preferred methods of communication of information about a typhoid fever vaccine included broadcasting via microphone ('miking'), radio, and door-to-door visits.
Conclusions: With rapid increase in numbers of licensed and promising vaccines, policy makers and health administrators are faced with decisions regarding allocation of scarce health resources for competing interventions. Community residents need to be informed about diseases which may not be readily recognized, diagnosed, and treated. Perceived vulnerability to the disease may increase likelihood of vaccine desirability. A better local understanding of typhoid fever is needed for general prevention measures, increasing treatment access, and future vaccination campaigns.

1. Introduction

Salmonella enterica serotype Typhi (*S.* Typhi) was estimated to cause over 400,000 deaths in Africa in the year 2000 [1]. Multi-drug resistant (MDR) strains of *S.* Typhi and non-Typhi serotypes of *S. enterica* are difficult to treat and are associated with increased disease severity [2–4]. In a review on the prevalence of bloodstream infections in Africa which included 22 studies and 58,296 patients, *S. enterica* was the leading pathogen in febrile patients admitted to hospital. Among adult and children patients respectively, 42% and 21% of isolated bacteria were *S. enterica* [5].

In a hospital-based surveillance in northern Tanzania, among 112 patients 14 years and older with bacterial or fungal disease, 23% were blood culture positive for *S.* Typhi [6]. Population-based

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surveillance in urban and rural Kenya, isolated *S.* Typhi from 6.4% of blood cultures in one urban site and the adjusted incidence rate was 2243/100,000 among children ages 2–4 years—a rate comparable to those recorded in Asian urban slums. Seventy-five percent of isolates in the study were MDR [7]. Recent data from our study site on Pemba Island, Zanzibar showed adjusted incidence rates of 110/100,000 among all age classes [8].

The currently available Vi capsular polysaccharide vaccine is a single-dose, injectable vaccine recommended for use in individuals aged 2 years and older. Trial data indicate protection for up to 3 years with a cumulative efficacy of 55%. The vaccine has been shown to be safe [9]. In addition, a Vi conjugate vaccine bound to recombinant fetoprotein A of *Pseudomonas aeruginosa* (Vi-rEPA) has been found to be effective and safe and provides longer lasting immunity in infants less than one year [10]. Vaccination trials and feasibility studies have been implemented in *S.* Typhi endemic areas of Asia [11]. With increasing evidence for a high typhoid fever burden in Africa there is a need to revisit the role of vaccination programs in the context of limited likelihood of short-term improvements in sanitation and water supply [7].

Multiple integrated political-economic and socio-cultural factors affect vaccine desirability and acceptance. Policy makers and national health administrators are often reluctant to add vaccines to existing programs based on limited disease burden data in a context of limited public health resources [12]. At the local level, participation in public health campaigns depends on stakeholders' perceptions and experiences with a targeted disease and previous vaccine programs, household and community decision-making processes, and healthcare infrastructure and utilization patterns. In addition, community-level politics, conflicts, and institutional relationships can play a major role in vaccine uptake [13–16].

We utilized household survey data from four villages on Pemba Island, Zanzibar to assess potential barriers to typhoid fever vaccine desirability among local residents. Specific research questions are: (1) do household demographics and healthcare utilization patterns affect residents' desire for a typhoid fever vaccine; (2) do experiences with and perceptions of typhoid fever and availability of treatment affect residents' desire for a typhoid fever vaccine; and (3) what information do residents require to make a decision about vaccination and what is the preferred media of communication.

2. Materials and methods

The current research on vaccine desirability was conducted in conjunction with a hospital-based, typhoid fever surveillance study on Pemba Island [8]. Data collected included qualitative interviews with policy makers, healthcare administrators, local village leaders (shehas), and residents, and a randomized household survey. Data presented in this paper are from the household survey. Qualitative research findings in relation to perceptions of typhoid fever and healthcare utilization from the perspectives of policy makers, health administrators, and community leaders and residents are available elsewhere [17].

2.1. Research site

Zanzibar is an archipelago located off the coast of Tanzania and includes two main islands, Unguja and Pemba. In the Republic of Tanzania and Zanzibar, the 2009 Gross National Income (GNI) per capita was US$500. In 2007, over 33% of the population was living below the national poverty line [18]. Life expectancy is estimated at 57 years for males and 59 years for females [19]. In 2009, the mortality rate for children under 5 years was 107.9, which is lower compared with the rates for the sub-Saharan region and other low-income countries. In 2008, 45% of the rural population had access to safe water which is comparable to the general sub-Saharan region but lower than the global average for low-income countries [18]. The current research was conducted on Pemba Island. In the 2002 census, Pemba Island's population was approximately 350,000 with over 80% of the residents living in rural areas [20].

To assess potential effect of experience with typhoid fever on perceptions, health-seeking behaviors, and vaccine desirability, four research villages in the southern region of Pemba were purposively selected by the local and international research team members based on culture confirmed typhoid fever cases from these villages. Two villages (Pujini and Uwandani) had recent blood-culture confirmed cases of typhoid fever while two villages (Matale and Umangani) had no confirmed cases. The villages differed in distance and ease of access to the island administrative center and the district hospital.

2.2. Research population and sampling strategies

An estimated sample size of 330 was determined based on calculations for independent samples and a proportionate difference of 0.15 (power = .80, alpha = .05). Oversampling was used to address non-participation or inability to locate selected households. The research team utilized lists of assigned household numbers in each village for randomization purposes. These numbers were assigned and marked on village housing structures as a part of a Public Health Laboratory-Ivo de Carneri/Johns Hopkins University database. A total of 487 households were randomly selected and 435 (89.3%) households participated. Reasons for non-participation were absent during the data collection days, household could not be located, or the home was abandoned. A single person within each household was interviewed. Inclusion criteria for respondents was: (1) 16 years and older; and (2) a permanent resident of the selected household.

2.3. Instrument development and outcome measures

The household survey was developed based on typhoid fever pre-vaccination survey instruments previously used in Hue, Viet Nam [16] and Kolkata, India [21]. These instruments were based on a socio-cultural model for vaccine up-take which included integrated political-economic, socio-cultural, household and individual-level factors [12]. For the current analysis, we included healthcare infrastructure/utilization, household and village level experience with typhoid fever, and individual perceptions regarding typhoid fever and benefit of a vaccine. Modifications were made to the survey questions and response items based on local socio-cultural context, e.g., types of available healthcare facilities, and the qualitative interview data which was collected in two of the survey research villages (Pujini and Matale). The final survey included five sections: (1) demographics; (2) general healthcare utilization and accessibility; (3) hypothetical healthcare use for symptoms associated with typhoid fever; (4) knowledge, experience with, and perceptions of typhoid fever (including vulnerability, severity, prevention, treatment); and (5) participation in the Expanded Program on Immunization (EPI), vaccine desirability, and preferred methods of communication about a typhoid fever vaccine. The survey was piloted and the final version translated to Swahili. Outcome measures for the current analysis are described in Table 1.

2.4. Data collection

Data were collected in October 2010 during three consecutive days in each village. Prior to data collection, the local village leaders were provided with information about the survey and asked to assist with locating the selected households. Trained data

Table 1
Outcome measures.

Demographics	Residency (categorical); gender (male/female); age (continuous); employment (yes/no); number of children in household (continuous); marital status (categorical); monthly household expenditures (continuous); household electricity (yes/no); occupation (categorical); education (categorical); "how many children (ages 8–18) currently attending school" (all/some/none/not applicable)
Ready to pay	Pay for vaccine for self/adult (yes/no); pay for vaccine for child (yes/no/not applicable); amount pay for self/adult and for child (continuous). Dichotomous variable created for 'readiness to pay' included those who would pay for self/adult and or child and those who would pay for neither
Healthcare utilization	"Where do you usually go to receive healthcare for yourself and other household members?" (Primary Health Care Units, Primary Health Care Centers, District Hospital, Other); time in minutes to healthcare facility most often used (continuous); how many times used a healthcare facility in the past 6 months (continuous)
Experience with typhoid fever	"Has anyone in your household ever had typhoid fever" (yes/no/don't know); "Are you aware of anyone who has been quite sick from typhoid fever" (yes/no/don't know); dichotomous variable created for residency in villages with confirmed typhoid fever cases and villages with no confirmed cases.
Perceptions of typhoid fever and prevention/treatment measures	*Severity* for children less than one year, 1–10 years, 11–18 years, adults 19–50 years, adults 51+ (not so serious/serious/very serious/don't know or not sure) [scale range 5–15; Cronbach's alpha = .95]. *Vulnerability:* "How likely is it that someone in your household would get typhoid fever" (very likely/somewhat likely/unlikely/don't know or not sure). *Availability of prevention measures* "Health education", "Garbage disposal", "Water treatment", "Clean water supply", "Sewage disposal", "Hygienic latrines", "Drainage disposal" (not available/not adequate/adequate/don't know) [scale range 7–21; Cronbach's alpha = .85] *Efficacy of prevention measures* "How well do the following prevent typhoid fever": eating well cooked foods, eating clean foods, drinking boiled water, wash hands before meals, not share meals between households, improving tap water supply, improving disposal of feces, improving garbage disposal, covering food and water, building health awareness (little or no prevention/somewhat or partial prevention/good or full prevention/don't know) [scale range 10–30; Cronbach's alpha = .94] *Benefit of typhoid fever vaccine* "How much would a typhoid fever vaccine benefit children less than one year, 1–10 years, 11–18 years, adults 19–50 years, adults 51+ (not at all/little/somewhat/very much/don't know) [scale range 5–20; Cronbach's alpha = .95] *Treatment availability* "Is there an effective treatment for typhoid fever" (yes/no)
Information and sources of information	"What information about a vaccine for typhoid fever would you require to decide to get it or not" (categorical); "How should the information be disseminated (categorical) [note: more than one response possible for each item]

collectors were provided with the lists of selected households. U.S. project investigators and the local project coordinator supervised data collection to ensure that the correct households were identified, that questions were asked as designed, and responses correctly recorded.

Data collectors read the survey questions and either read multiple responses or asked for an open answer depending on the item. Responses were recorded on a survey form and each survey took approximately 30 min. Respondents were given a package of laundry soap for their time.

2.5. Data management and analysis

Household survey data were double entered into Microsoft FoxPro 7.0 (Microsoft, Seattle, WA, USA) by trained local staff. Raw data were reviewed and corrected as necessary. The raw data were converted to and analyzed in SPSS (version 11.5) and frequencies, means, and ranges were run for further data cleaning. Variables were created from a sum total of scale items which measure perceptions of typhoid fever including severity, vulnerability, prevention availability, and effectiveness and perceived benefit of a typhoid fever vaccine (see Table 1). A 'readiness to pay'[3] dichotomous variable was created from two separate items which asked participants if they would pay for a single dose of the typhoid fever vaccine for themselves and for a child in the household (as applicable). Readiness to pay is defined as those residents who would pay for the vaccine for themselves, their child, or both; those respondents who would not pay for self or child were coded as 'not ready to pay'.

Univariate analysis including frequencies and means with standard deviations provided descriptive data. Bivariate analysis including Pearson's chi square (categorical) and t-tests and ANOVA (continuous) were used to assess initial significant differences for ready to pay and not ready to pay respondents and independent variables associated with household and respondent demographics, healthcare utilization, and experience and perceptions of typhoid fever. Binary logistic analysis was conducted with readiness to pay as the dependent variable to further test significance and control for potential confounding factors. Categorical independent variables were indicator coded. Odds ratios were calculated and are presented with 95% confidence intervals (95% CI).

2.6. Research ethics

The protocol and survey instrument were approved by the ethics board at the International Vaccine Institute, Seoul, Korea and through the Zanzibar Research Council Ethics Committee. Consent forms were read to respondents and depending on literacy either signed or imprinted with a fingerprint. For illiterate respondents, a witness signed the form to acknowledge consent. The data collectors were trained in research ethics.

3. Results

3.1. Knowledge of typhoid fever vaccine

Data from the qualitative component of the project indicated that community residents were unaware of a typhoid fever vaccine. Therefore, participants were provided with a brief verbal description of the vaccine which included that the vaccine is an injection, a single dose, and "works about 70% of the time".

3.2. Readiness to pay

Participants were asked if they would take the vaccine for free. Since a vast majority of residents would take the vaccine if free (98% for self and 99% for child), we utilized a 'readiness to pay' item as a

[3] *Note*: We are using the term 'readiness to pay' to avoid confusion with the health economic concept and methodologies for "willingness to pay" (WTP).

Table 2
Demographic characteristics by ready and not ready to pay for vaccination.

		Not ready to pay	Ready to pay	*p* value[a]
Gender	Male	24.8% (32/129)	29.4% (73/248)	$p = .341$
	Female	75.2% (97/129)	64.3% (175/129)	
Age (mean)		40.9 yrs. [SD 16.5] ($N = 127$)	40.8 yrs. [SD 15.1] ($N = 236$)	$p = .966$
Marital status	Married	82.2% (106/129)	77.7% (192/247)	$p = .353$
	Single	5.4% (7/129)	3.6% (9/247)	
	Divorced/separated	3.9% (5/129)	7.7% (19/247)	
	Widow/widower	8.5% (11/129)	10.9% (27/247)	
Children in HH (mean)		5.4 [SD 3.0] ($N = 129$)	5.5 [SD 3.0] ($N = 248$)	$p = .821$
Children (8–18 years) attend school	All	46.7% (50/107)	28.7% (54/188)	**$p = .004$**
	Some	31.8% (34/107)	48.9% (92/188)	
	None	21.5% (23/107)	22.3% (42/188)	
Monthly expenditures (mean)		US$95 [SD $64]	US$97 [SD $63]	$p = .807$
Electricity (yes)		16.4% (21/128)	16.9% (42/248)	$p = .896$
Respondent education	No schooling	41.4% (53/128)	40.5% (100/247)	$p = .102$
	Koran school[b]	21.9% (28/128)	13.4% (33/247)	
	Primary school	19.5% (25/128)	27.9% (69/247)	
	Secondary school	17.2% (22/128)	18.2% (45/128)	

Bold significance indicates $p < .05$.
[a] Significance based on Pearson's chi square and independent samples *t*-tests.
[b] Koran school refers to religious institutions focused on teaching children the Koran and Islamic theology.

proxy measure of level of vaccine desirability. Respondents (13%; 58/435) who were unsure or did not know if they would pay for both their child(ren) and self were excluded. The total sample size for these analyses was 377 above the minimum calculated sample size (330). Overall, 66% (248/377) respondents stated they would pay for the vaccine in the future. Among those 248 persons ready to pay, 99% were willing to pay for both adults and children. The mean amounts respondents would pay for the vaccine for adults was US$1.6 (SD, US$3.9) and for children US$1.4 (SD, US$3.4). Readiness to pay for the vaccine was neither related to amount willing to pay for self ($F = .349$, df 3: $p = .790$) or child ($F = .593$, df 3: $p = .621$), nor monthly household expenditure quartiles ($X^2 = -0.430$, df 3: $p = .939$) (see Table 2).

3.3. Demographics

Approximately 25% of surveys were conducted per village (range 23–27%). Seventy three percent (318/435) of respondents were female and mean age was 41.1 years (SD 15.6, range 18–96). Male respondents were significantly older than female respondents (47.1 vs. 38.9 years: $t = 5.0$, df 412: $p < .001$). All respondents were Muslim. Overall, 79% (342/434) of respondents were married and mean number of children per household was 5.5 (SD 3.0, range 0–15). Mean monthly household expenditure was ~US$97 (SD US$61) and 15% (66/432) households had electricity. Forty-three percent (187/433) respondents had no schooling, 24% (102) had primary school education, 18% (76) secondary school education, and 16% (68) had attended Koran school. Thirty-five percent (122/343) respondents reported all of their school-age children were attending school; 44% (15) reported some children attending school; and, 21% (71) respondents reported no children attending school. Primary occupation was farming (65%; 282/432). Respondents not ready to pay were more likely to report that all of their children attend school ($X^2 = 11.0$; df 2: $p = .004$) (Table 2).

3.4. Healthcare utilization practices

A majority of respondents used government funded health facilities including out-patient Primary Health Care Units (PHCU) (47%), out-patient and short-term in-patient care Primary Health Care Centers (PHCCs) (39%), and the district hospital (11%). Mean travel time to respondent's primary health care facility was 48 min (SD 37) and mean number of visits in the past six months was 3.5 (SD 3.2). Respondents who reported use of village Primary Health Care Units (PHCUs) for general health care were more likely to report readiness to pay compared to respondents who used Primary Health Care Centers (58%) and the district hospital (58%) ($X^2 = 10.2$, df 2: $p = .006$) (Table 3).

3.5. Experience and perceptions of EPI

Over 87% of respondents stated that all of their children had participated in EPI with less than 2% stating that none of their children participated. There was no association between level of EPI participation and readiness to pay ($X^2 = 0.242$, df 2: $p = .886$). However, those ready to pay were more likely to be "very satisfied" with EPI ($X^2 = 15.0$, df 2: $p = .001$) (Table 3).

3.6. Experience with typhoid fever

Ten percent of respondents reported having experienced typhoid fever in their household and 25% reported knowledge of someone who had been sick with typhoid fever. These variables were analyzed in conjunction with residency in villages with or without confirmed cases of typhoid fever. Residency in villages with confirmed cases of typhoid fever ($X^2 = 5.1$, df 1: $p = .025$) and knowing someone who had been sick with typhoid fever ($X^2 = 6.2$, df 1: $p = .013$) were associated with readiness to pay (Table 3).

3.7. Perceptions of typhoid fever

Respondents were asked a series of items regarding perceived vulnerability and severity of typhoid fever, prevention efficacy and availability, treatment availability, and perceived benefit of a typhoid fever vaccine (Table 3). Overall, the typhoid fever vaccine was perceived to be "somewhat" or "very" beneficial for infants <1 year (86.6%; 376/434), children one to ten years (88.7%; 385/434), adolescents 11–18 years (85.0%; 369/434), adults 19–50 (79.9%; 347/434) and adults 51+ years (72.5%; 314/433). Respondents classified as 'ready to pay' perceived prevention measures as more effective compared to those 'not ready to pay' ($t = 5.3$, df 370: $p < .001$) and perceived more benefit to receiving a typhoid fever vaccine than those 'not ready to pay' ($t = 3.6$, df 351: $p < .001$).

Table 3
Health care utilization, and experience and perceptions of typhoid fever by ready and not ready to pay for vaccination.

		Not ready to pay	Ready to pay	*p* value[a]
Health care utilization	PHCU	38.1% (48/126)	55.6% (133/239)	*p* = **.006**
	PHCC	48.4% (61/126)	34.7% (83/239)	
	District hospital	13.5% (17/126)	9.6% (23/239)	
	Distance to facility (mean)	50 [SD 37] (129)	45 [SD 36] (244)	*p* = .201
	Visits past 6 Mos. (mean)	3.4 [SD 2.9] (81)	3.6 [SD 3.5] (170)	*p* = .655
Experience with EPI	No children use EPI	1.8% (2/112)	1.8% (4/223)	*p* = .886
	Some children use EPI	11.6% (13/112)	9.9% (22/223)	
	All children use EPI	86.6% (97/112)	88.3% (197/223)	
Satisfaction with EPI	Not satisfied	1.9% (2/107)	0.9% (2/224)	*p* = **.001**
	Satisfied	70.1% (75/107)	48.7% (109/224)	
	Very satisfied	28.0% (30/107)	50.4% (113/224)	
Experience with typhoid fever	In household	10.4% (13/125)	10.2% (25/244)	*p* = .963
	Know someone sick	16.7% (20/120)	28.7 (68/237)	***p* = .013**
	Live in village with confirmed cases	42.6% (55/129)	54.8% (136/248)	*p* = .092
Perceptions of typhoid fever	Perceived vulnerability[b]	2.0 [SD 0.8] (98)	1.8 [SD 0.7] (207)	*p* = .092
	Perceived severity[b]	11.9 [SD 2.8] (119)	12.0 [SD 2.8] (236)	*p* = .650
	Prevention effectiveness[b]	28.6 [SD 4.8] (124)	30.8 [SD 3.1] (248)	***p* < .001**
	Prevention availability[b]	17.4 [SD 3.4] (125)	17.8 [SD 4.0] (248)	*p* = .610
	Vaccine benefit[b]	16.4 [SD 4.0] (112)	17.8 [SD 3.1] (241)	***p* < .001**
	Treatment availability	94.7% (107/113)	94.9% (224/236)	*p* = .929

Bold significance indicates $p < .05$.

[a] Significance based on Pearson's chi square and independent samples *t*-tests.

[b] Higher mean scores indicates greater perceived vulnerability and disease severity, greater effectiveness and availability of prevention measures, and greater benefit from vaccination.

3.8. Vaccine desirability: binary logistic analysis

Utilizing findings from the bivariate analysis, we conducted binary logistic analysis to further understand vaccine desirability (ready to pay, not ready to pay). These data indicate that utilization of the Primary Health Care Units for general health care and perceptions that prevention efforts are efficacious are associated with readiness to pay (Table 4).

3.9. Information needed regarding the typhoid fever Vi vaccine

Over 40% (169/411) of participants stated that they would not need any information prior to using the vaccine. Primary information that respondents needed was 'more information about typhoid fever' (22%: 95/429), 'effectiveness of the vaccine' (19%: 83/427), 'adverse effects' (12%: 55/426), and 'vaccine cost' (13%: 54/427). While need for information and content did not differ by 'readiness to pay', the preferred medium for information delivery differed significantly between the two groups. Overall, public broadcasting ('miking') was the preferred method by both groups, but was more often mentioned by those 'not ready to pay'. Additional methods preferred by those 'ready to pay' included newspapers, community meetings, radio, television, leaflets, and posters and banners (Table 5).

Table 4
Binary logistic regression analysis for variables associated with ready to pay.

Variable	Odds ratio with 95% confidence interval	*p* value
Children's (ages 8–18 years) school status (all vs. some/none)	OR 1.27 [95% CI .85–1.87]	*p* = .244
General health care utilization (Primary Health Care Unit vs. Primary Health Care Center/District Hospital)	OR 2.00 [95% CI 1.30–3.11]	*p* = **.002**
Satisfaction with EPI	OR 1.74 [95% CI .97–3.12]	*p* = .065
Know someone sick from typhoid fever (yes vs. no)	OR .48 [95% CI .22–1.02]	*p* = .057
Live in village with confirmed typhoid fever (yes vs. no)	OR .67 [95% CI .36–1.24]	*p* = .204
Efficacy of prevention measures (high vs. low)	OR 1.10 [95% CI 1.01–1.24]	*p* = **.022**
Benefit of typhoid fever vaccine (high vs. low)	OR 1.04 [95% CI .95–1.14]	*p* = .351

Bold significance indicates $p < .05$.

4. Discussion

Surveillance data indicate that *S.* Typhi is a significant cause of morbidity and mortality in Africa. Increasing migration and urbanization are associated with increases in typhoid fever incidence [7]. These data suggest a role for typhoid fever vaccine programs. For successful introduction of typhoid fever vaccine programs there is a need to assess local residents' knowledge and perceptions of typhoid fever and the general desirability of a vaccine. In the current paper, we utilize respondents' readiness to pay for the vaccine as a proxy for vaccine desirability. In this and other studies including research in Zanzibar and the democratic republic of Congo, a vast majority of respondents state a hypothetical willingness to receive a free vaccine [22–24]. In a longitudinal assessment of vaccine acceptance and up-take in Zanzibar during an oral cholera mass vaccination campaign, prior to vaccination 97% of respondents stated they would take a free vaccine. Follow-up post-vaccination revealed less than 50% of those respondents received the required two doses [23,25]. Since readiness to pay was not linked to household expenditure levels or to other socio-economic indicators, e.g., household electricity, education, this approach could be one means of measuring level of vaccine desirability prior to implementation of a demonstration project or mass immunization program.

Table 5
Preferred method of information delivery by 'readiness to pay'.

	Not ready to pay	Ready to pay	*p* value
Miking	61.9% (78/126)	51.0% (123/241)	*p* = **.047**
Radio	18.3% (23/126)	33.6% (82/244)	*p* = **.002**
Door to door	19.8% (25/126)	24.7% (60/243)	*p* = .294
Television	3.2% (4/126)	17.3% (42/243)	***p* < .001**
Community meeting	4.8% (6/126)	11.1% (27/243)	*p* = **.043**
Mosque	9.5% (12/126)	4.9% (12/243)	*p* = .090
Newspaper	2.4% (3/126)	11.5% (28/243)	*p* = **.043**
Leaflet	0	8.2% (20/243)	*p* = **.001**
Poster/banners	0	3.3% (8/242)	*p* = **.039**

Bold significance indicates $p < .05$.

The presented data suggest that individuals who use the local Primary Health Care Units (PHCUs) compared to those using either the Primary Health Care Centers (PHCCs) or the district hospital were more likely ready to pay. This greater desirability for the vaccine could result from perceived vulnerability for disease misdiagnosis and/or complications. PHCUs have very limited supplies and equipment and are only designed to provide first line out-patient health services for common diseases and injuries. In contrast, PHCCs and the district hospital provide more diagnoses services and treatments, include in-patient care services and are staffed by higher level providers.

To enhance residents' willingness to be vaccinated, there is need for appropriate messages which provide information about disease symptomology and potential vulnerability due to limited sanitation and safe water supply. Current health education efforts on Pemba Island promote activities, e.g., boiling water, for reduction of cholera—however, at the time of this study similar prevention messages were not delivered regarding typhoid fever. Local institutional support from schools, clinics and hospitals could help facilitate health education efforts about disease recognition, prevention, and future participation in a vaccination program. Of interest in the current findings, those respondents ready to pay expressed greater confidence in the efficacy of general preventive practices for typhoid fever. This suggests the need to integrate general prevention messages within vaccine promotion and communication activities to increase not only vaccine up-take but also confidence in alternative preventive measures.

There were a number of significant differences in preferred media by readiness to pay. Those not ready to pay preferred 'miking.' Preferences for radio, television, newspapers, leaflets, and posters and banners among those respondents ready to pay for vaccinations may be indicative of higher education. These finding support the need for multimedia vaccination campaigns.

5. Conclusions

The Global Alliance for Vaccine Introduction (GAVI) 2008 Vaccine Investment Strategy recommends implementation of typhoid fever vaccine in high prevalence countries in Asia and Africa [26]. The World Health Organization (WHO) has put forth recommendations for the introduction of typhoid fever vaccines in endemic regions among high-risk populations and to control outbreaks during epidemics [27,28]. With the increase in numbers of licensed and promising vaccines, policy makers and health administrators are faced with difficult decisions regarding the allocation of scarce health resources [17,29]. To make appropriate decisions regarding vaccination, community residents need to be informed about disease risk, prevention efficacy and treatment availability. More precise means of measuring vaccine desirability prior to vaccination can enable development of communication campaigns and messages which target specific groups who may be less likely to receive the vaccine.

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References

[1] Crump JA, Luby SP, Mintz ED. The global burden of typhoid fever. Bull World Health Organ 2004;82:346–53.
[2] Rowe B, Ward LR, Threlfall EJ. Multi drug resistant *Salmonella Typhi*: a worldwide epidemic. Clin Infect Dis 1997;24(Suppl. 1):S106–9.
[3] Weill FX. Typhoid fever: facing the challenges of resistant strains. Med Sci (Paris) 2010;26(11):969–75 [English abstract].
[4] Bhutta ZA. Current concepts in the diagnosis and treatment of typhoid fever. Br Med J 2006;333:78–82.
[5] Reddy EA, Shaw AV, Crump JA. Community-acquired bloodstream infections in Africa: a systematic review and meta-analysis. Lancet Infect Dis 2010;10(6):417–32.
[6] Crump JA, Ramadhani HO, Morrissey AB, Saganda W, Mwako MS, Yang LY. Invasive bacterial and fungal infections among hospitalized HIV-infected and HIV-uninfected adults and adolescents in Northern Tanzania. Clin Infect Dis 2011;52(3):341–8.
[7] Breiman RF, Cosmas L, Njuguna H, Audi A, Olack B, Ochieng JB, et al. Population-based incidence of typhoid fever in an urban informal settlement and a rural area in Kenya: implications for typhoid vaccine use in Africa. PLoS ONE 2012;7(1):e29119.
[8] Thriemer K, Ley B, Ame S, von Seidlein L, Pak GD, Chang NY, et al. The burden of invasive bacterial infections in Pemba, Zanzibar. PLoS ONE 2012;7(2):e30350, http://dx.doi.org/10.1371/journal.pone.0030350.
[9] Fraser A, Paul M, Goldberg E, Acosta CJ, Leibovici L. Typhoid fever vaccines: systematic review and meta-analysis of randomized controlled trials. Vaccine 2007;25(45):7848–57.
[10] Thiem VD, Lin FY, Canh Do G, Son NH, Anh DD, Mao ND, et al. The Vi conjugate typhoid vaccine is safe, elicits protective levels of IgG anti-Vi, and is compatible with routine infant vaccines. Clin Vaccine Immunol 2011;18(5):730–5.
[11] Ochiai RL, Acosta CJ, Danovaro-Holliday MC, Baiqing D, Bhattacharya SK, Agtini MD, et al. A study of typhoid fever in five Asian countries: disease burden and implications for controls. Bull World Health Organ 2008;86:260–8.
[12] Kaljee L, Pack R, Pach A, Nyamete A, Stanton B. Socio-behavioral research methods for introduction of vaccine in the Disease of the Most Impoverished project. J Health Popul Nutr 2004;22(3):293–303.
[13] Nichter M. Vaccinations in the Third World: a consideration of community demand. In: Nichter M, Nichter M, editors. Anthropology and International Health. Amsterdam: Gordon and Breach Publishers; 1996. p. 329–66.
[14] Streefland P, Chowdury AMR, Ramos-Jimenez P. Patterns of vaccination. Soc Sci Med 1999;49:1705–16.
[15] Chen X, Stanton B, Wang X, Nyamette A, Pach A, Kaljee L, et al. Differences in perception of dysentery and enteric fever and willingness to receive vaccines among rural residents in China. Vaccine 2006;24(5):561–71.
[16] Kaljee L, Pham V, Son ND, Hoa NT, Thiem VD, Canh DG, et al. Trial participation and vaccine desirability for Vi polysaccharide typhoid fever vaccine in Hue City: Viet Nam. Trop Med Int Health 2007;12(1):25–36.
[17] Kaljee L, Pach A, Thriemer K, Ley B, Ali SM, Jiddawi M, et al. Utilization and accessibility of healthcare on Pemba Island, Tanzania: implications for health outcomes and disease surveillance for typhoid fever. Am J Trop Med Hyg 2013;88(1):144–52.
[18] The World Bank. GNI per capita, Atlas method; 2011. Available at: http://data.worldbank.org/indicator/NY.GNP.PCAP.CD [accessed 28.06.11].
[19] Ministry of Health and Social Welfare. Health sector performance profile, Up-dated; 2010. Available at: http://hdptz.esealtd.com/fileadmin/documents/Basket_Documents_2011/Health_Sector_Performance_Profile_Report_2010.pdf [accessed 5.07.12].
[20] The United Republic of Tanzania. National bureau of statistics, Analytical report; 2006. Available at: http://www.nbs.go.tz/pdf/2002opcensus.pdf [accessed 28.06.11].
[21] Sur D, Manna B, Chakrabarty N, Kaljee LM, Riel R, Pach A, et al. Vaccine desirability during an effectiveness trial of the typhoid fever polysaccharide Vi vaccine: Kolkata, India. Hum Vaccin 2009;5(9):614–20.
[22] Kaljee L, Genberg B, von Seidlein L, Thiem VD, Canh DG, Tho LH, et al. 2007 Issues of acceptability and accessibility of a shigellosis vaccine, Nha Trang, Viet Nam. J Health Popul Nutr 2004;22:150–8.
[23] Schaetti C, Chaignat CL, Hutubessy R, Khatib AM, Ali SM, Schindler C, et al. Social and cultural determinants of anticipated acceptance of an oral cholera vaccine prior to a mass vaccination campaign in Zanzibar. Hum Vaccin 2011;7(12):1299–308.
[24] Merten S, Schaetti C, Manianga C, Lapika B, Chaignat CL, Hutubessy R, et al. Local perceptions of cholera and anticipated vaccine acceptance in Katanga province, democratic republic of Congo. BMC Public Health 2013;13(1):60.
[25] Schaetti C, Ali SM, Hutubessy R, Khatib AM, Chaignat CL, Weiss MG. Social and cultural determinants of oral cholera vaccine uptake in Zanzibar. Hum Vaccin Immunother 2012;8(9):1223–9.
[26] GAVI vaccine investment strategy; 2013. Available at: http://www.gavialliance.org/about/strategy/vaccine-investment-strategy [accessed 23.03.13].
[27] Nossal GJ. Vaccines and future global health needs. Philos Trans R Soc Lond B Biol Sci 2011;366(1579):2833–40.
[28] World Health Organization. Typhoid vaccines: WHO position paper. Weekly epidemiological record; 2008. Available at: http://www.who.int/wer/2008/wer8306.pdf [accessed 04.09.12].
[29] DeRoeck D, Clemens JD, Nyamete A, Mahoney RT. Policymakers views regarding the introduction of new generation vaccines against typhoid fever, shigellosis and cholera in Asia. Vaccine 2005;23:2762–74.