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Socioeconomic drivers of vaccine uptake: An analysis of the data of a geographically defined cluster randomized cholera vaccine trial in Bangladesh ☆

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ABSTRACT

Background: Evaluations of oral cholera vaccines (OCVs) have demonstrated their effectiveness in diverse settings. However, low vaccine uptake in some settings reduces the opportunity for prevention. This paper identifies the socioeconomic factors associated with vaccine uptake in a mass vaccination program.
Methods: This was a three-arm (vaccine, vaccine plus behavioral change, and non-intervention) cluster randomized trial conducted in Dhaka, Bangladesh. Socio-demographic and vaccination data were collected from 268,896 participants. A geographical information system (GIS) was used to design and implement the vaccination program. A logistic regression model was used to assess the association between vaccine uptake and socioeconomic characteristics.
Results: The GIS supported the implementation of the vaccination program by identifying ideal locations of vaccination centres for equitable population access, defining catchment areas of daily activities, and providing daily coverage maps during the campaign. Among 188,206 individuals in the intervention arms, 123,686 (66%) received two complete doses, and 64,520 (34%) received one or no doses of the OCV. The vaccine uptake rate was higher in females than males (aOR: 1.80; 95% CI = 1.75–1.84) and in younger (<15 years) than older participants (aOR: 2.19; 95% CI = 2.13–3.26). Individuals living in their own house or having a higher monthly family expenditure were more likely to receive the OCV (aOR: 1.60; 95% CI = 1.50–1.70 and aOR: 1.14; 95% CI = 1.10–1.18 respectively). Individuals using treated water for drinking or using own tap as the source of water were more likely to receive the OCV (aOR: 1.23; 95% CI = 1.17–1.29 and aOR: 1.14; 95% CI = 1.02–1.25 respectively) than their counterpart. Vaccine uptake was also significantly higher in participants residing farther away from health facilities (aOR: 95% 1.80; CI = 1.36–2.37).
Conclusion: The GIS was useful in designing field activities, facilitating vaccine delivery and identifying socioeconomic drivers of vaccine uptake in the urban area of Bangladesh. Addressing these socioeconomic drivers may help improve OCV uptake, thereby effectiveness of the OCV in a community.

1. Introduction

Cholera is a severe diarrheal disease causing 1.3–4.0 million cases and 21,000–143,000 deaths annually [1]. As the organism, *V. cholerae* is a part of the normal flora in the surface water of the earth [2], the disease is not eradicable. Therefore, improvements in socio-economic factors and infrastructure, access to safe drinking water and improvement of sanitation systems,

☆ Informed consent was obtained from the study participants. The research was approved by the IRB of the International Centre for Diarrhoeal Disease Research, Dhaka, Bangladesh (the Research Review and Ethical Review Committee) and the IRB of the International Vaccine Institute. The study is registered in the Clinical Trials Data Bank (http://clinicaltrials.gov number NCT01339845).

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vaccination and standard medical treatment are considered as key interventions towards reducing the burden of cholera [3,4].

Due to cholera's severity and rapid progression, prevention and early treatment are essential. Recent advancements in surveillance, medical treatment and the availability of affordable cholera vaccines have helped reduce the case fatality ratio over time [5]. In the last ten years, oral cholera vaccines (OCVs) have been deployed in both mass vaccination programs, feasibility studies and during outbreaks [6–9]. However, vaccine uptake rates have varied in different geographic settings [10]. The uptake rate of two doses of OCV was 74% in Vietnam, 76% in Uganda refugee camp and 76% in Guinea during outbreak situations [11–13]. When used in mass vaccination programs, the vaccine uptake rate was 79% in rural Haiti [14], but much lower in Mozambique (41%), Zanzibar (50%) and India (60%) [9,15,16].

OCVs have been playing an important role in prevention and control efforts [17]. It is known that vaccine effectiveness in the community depends on the rate of vaccine uptake in the population [18]. As OCVs have been shown to provide direct and indirect protection [19], higher levels of vaccine coverage in the community lower the risk of cholera among residents in the community [19,20] meaning the broader community will benefit because of herd immunity from the vaccine [19].

In early 2011, a cholera vaccine effectiveness study was conducted in Bangladesh targeting 268,869 people in a low income, urban area of Dhaka using a geographically defined cluster randomized trial [21]. Two dose vaccine uptake in the trial was 66% [6]. Following recent successful adoption in large-scale vaccine trials, we used a geographic information system (GIS) to support trial implementation [22].

In this study, we describe the use of GIS in a large field trial of a cholera vaccine. We also investigated the socioeconomic drivers of vaccine uptake in this clinical trial.

2. Method

2.1. The study area

The study was conducted in Mirpur in Dhaka, Bangladesh, which is one of the most densely populated cities in the world [23]. Surveillance data from icddr,b (International Centre for Diarrhoeal Disease Research, Bangladesh) hospitals shown that 6 of the 16 wards (the lowest level administrative unit) in Mirpur had a high incidence of cholera cases (2–6 cases per 1000 diarrheal hospitalizations). These wards were selected for conducting the study [6]. The population in the study was registered through a census survey conducted by trial staff.

2.2. Constructing the GIS database

A geographic information system (GIS) was used to monitor vaccine uptake on a daily basis during the campaign and as a research tool. The satellite derived Quick Bird image constructed the household level GIS. The image was enhanced using an image processing software package (ERDAS Imagine, Atlanta, USA) to facilitate the digitization of house parcel boundaries. Differential GPS (Global positioning system) was used to capture data at several identifiable points on the image to be used as ground control points (GCPs). Most of the GCPs were selected from the periphery of the study area so that possible errors would converge towards the middle of the area. The GPS data were collected in the WGS-84 (World Geodetic Systems-84) datum in the latitude/longitude system and were subsequently transformed into the Everest 1830 (Bangladesh Transverse Mercator, BTM). The GCP coordinates within the BTM projection were then integrated with the satellite images using the ERDAS Imagine software for geo-referencing. The resultant root mean square (RMS) errors were approximately two meters, which was considered sufficiently accurate for the purpose of constructing the GIS database. After geo-referencing the image, on screen digitization was performed keeping the image as a backdrop (Fig. 1). Each geographic feature such as structures, roads, water bodies was stored as a separate entity in the GIS database. A ground survey was done with the digitized map to link the structures to the household data. Subsequently, the GIS database was

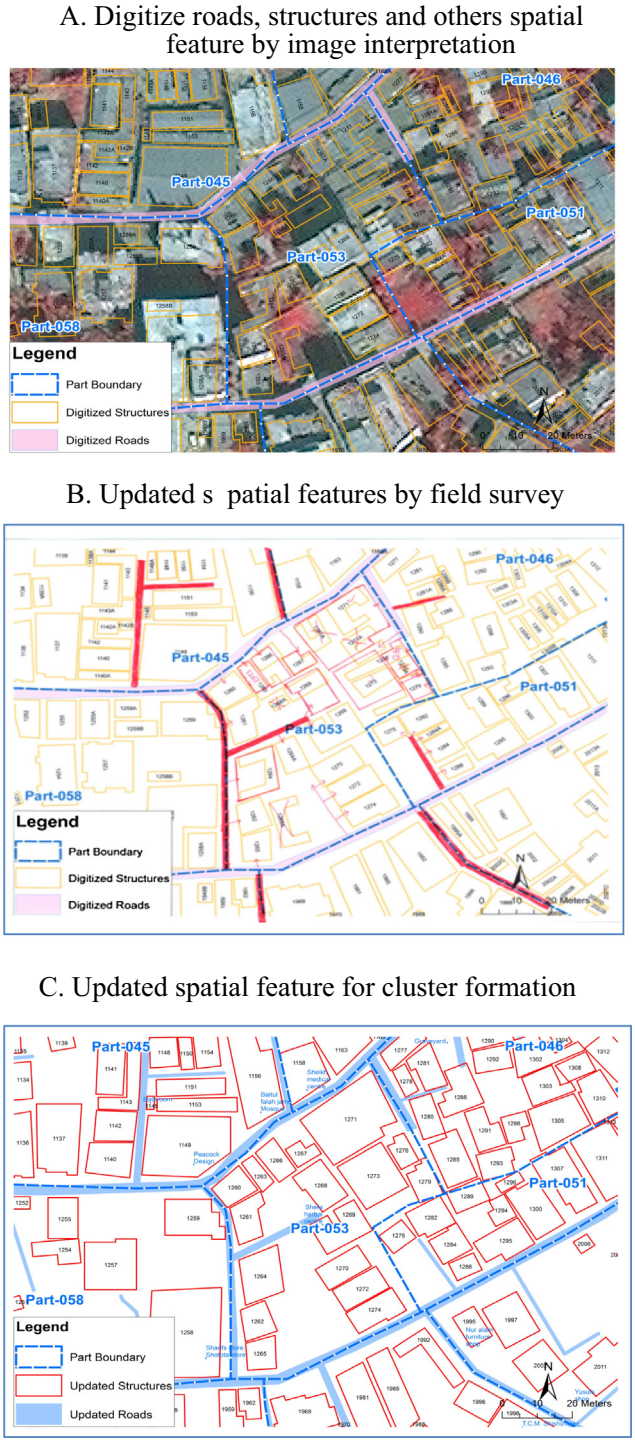

Fig. 1. Creation of the spatial database for the study area.

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