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Assessing differences in cholera risk factor prevalence between migrant Haitians and Dominicans in the Dominican Republic

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BA, University of Minnesota, Morris, 2011

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Abstract

Assessing differences in cholera risk factor prevalence between migrant Haitians and Dominicans in the Dominican Republic

Andrea Lund

Background: When cholera emerged in Haiti, it quickly spread across the island of Hispaniola, reaching the Dominican Republic in less than a month. The epidemic in the Dominican Republic has been mild in compared to the Haitian epidemic, but the cholera burden has been disproportionately borne by certain marginalized groups. Cholera risk is associated with access to water, sanitation and hygiene (WASH) infrastructure, and this study sought to examine differences in cholera risk factor prevalence between migrant Haitians and Dominicans living in an agricultural province of the Dominican Republic, focusing on WASH infrastructure and cholera knowledge.

Methods: A cross-sectional survey was carried out in the Duarte Province, Dominican Republic in July 2012. A total of 363 surveys were completed in Haitian (n = 103) and Dominican (n = 260) households in 18 provincial communities. The survey instrument included modules for demographic information; cholera knowledge; socioeconomic status; and access to WASH infrastructure. Binary logistic regression was used to assess differential access to WASH infrastructure between Haitians and Dominicans, and Poisson regression was used to assess differences in numerical scores of cholera knowledge.

Results: Dominican and Haitian households differed greatly on many demographic characteristics, with low educational attainment and socioeconomic status among Haitians compared to Dominicans. Access to improved drinking water was low among both groups, but Haitians had lower access in both rural (aOR = 0.005, 95% CI 0.002, 1.02) and urban (aOR = 0.21, 95% CI 0.05, 1.01) areas. No differences in access to sanitation were detected between Haitians and Dominicans (aOR = 1.00, 95% CI 0.57, 1.76) after adjusting for socio-demographic confounders. Haitians had lower knowledge of cholera symptoms and transmission than Dominicans, even when adjusting for confounders (aOR = 0.66, 95% CI 0.55, 0.81).

Conclusions: Access to household WASH facilities differs across nationality, but is affected by socio-demographic factors as well as urban-rural geography. Provincial health authorities should target WASH interventions to migrant Haitian and rural agricultural communities in order to eliminate cholera from the province. Low cholera knowledge among Haitians may reflect low access to health care and could be addressed through community-based outreach efforts.

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CHAPTER I: LITERATURE REVIEW

Cholera

Cholera is an enteric illness caused by the bacterium *Vibrio cholerae.* Transmission of the bacterium occurs via the fecal-oral route, and individuals become infected upon ingestion of contaminated food or water (1). Within the intestine, the bacterium releases an enterotoxin that provokes voluminous and watery diarrhea (2). The most severe manifestations of the disease can involve a dramatic loss of fluids (up to 1 liter per hour) whereby death from dehydration can occur within hours if fluids are not restored (2). Case fatality rates approach 50% when left untreated , but can be as low as 0.5% with oral rehydration therapy (2, 3).

Epidemic spread of cholera has long-been associated with human movement. Up until the 19th century, cholera was confined primarily to riverine environments of South Asia. The year 1817 marked the beginning of cholera's epidemic spread, and the world has since seen seven pandemics of cholera (4). Historical analysis of the first six pandemics attributes the onset of cholera's epidemic spread to the colonization of the Indian subcontinent, which resulted in a rise in human movement (4). Transcontinental transportation of troops and slaves and the development of global trade routes during colonial times facilitated the spread of cholera from Asia to Europe, Africa and eventually the Americas, reaching the Western Hemisphere during the second pandemic (1829-1851) (5, 6). Prior to 2010, the only time cholera had been documented on the island of Hispaniola was during the fourth pandemic (1863-1879) (7) when, in 1865, an outbreak affected the Dominican Republic but not Haiti. While much of the rest of the

Western Hemisphere remained under colonial rule during this time, Haiti had been an independent state for nearly 75 years and was not importing slaves or soldiers like many other countries in the region (5). The relative lack of human movement in and out of Haiti is thought to have protected the country from the epidemic cholera that circulated throughout Latin America and the Caribbean during the fourth pandemic.

The seventh pandemic began in 1961 in Indonesia and is still ongoing (4). During this time, cholera has become endemic on multiple continents, and a new strain of *V. cholera* - the O1 El Tor biotype – emerged (2, 8).With a higher ratio of carriers to cases and an ability to survive longer in the environment, the El Tor strain has essentially outcompeted its predecessor (O1 classical biotype) and been the predominant strain circulating during the seventh pandemic (1, 8). Further evolution of *V. cholerae* during the seventh pandemic has yielded an atypical strain of El Tor *V. cholerae,* which was identified in the Haitian epidemic and has been associated with increased toxin production and more severe disease outcomes.

Cholera on Hispaniola

On October 21, 2010, the Haitian National Public Health Laboratory confirmed the first cases of cholera on the island of Hispaniola since the mid-19th century (5, 9). Initially detected in the Haiti's Artibonite Valley, cholera had spread rapidly across the island, reaching every department in Haiti as well as the neighboring Dominican Republic within a month of the first confirmed case (9-11). The first cases in the Dominican Republic were reported on November 16, 2010 (9). While the spread of cholera was explosive in Haiti, it was less so in the Dominican Republic (12). Cases in

the Dominican Republic peaked midway through 2011, and by the end of the year, over 20,000 suspected cases and 371 deaths had been reported nationally (13). Conversely, Haiti reported over half a million cases of the disease and 7,000 deaths in 2011 (14). While cholera has affected just 0.22% of the population of the Dominican Republic, the cholera burden has been disproportionately borne by areas with vulnerable populations, namely rural and agricultural areas, marginalized urban areas and border zones; twenty percent of cholera deaths registered in the Dominican Republic were among people of Haitian descent (13, 15).

Inequities in Water and Sanitation

While the global spread and introduction of cholera is governed by patterns of human movement, its local spread largely depends on local sanitary environments. Transmission of cholera is essentially interrupted when safe water sources and sewage collection become available eliminating human contact with infectious feces (Figure 1) (16). For this reason, cholera disappeared from most industrialized countries by the early 20th century when improvements in water and sanitation infrastructure were implemented (4, 17). Water and sanitation improvements have been established as an important means of reducing diarrheal illness worldwide, including cholera(18-20) Despite the widespread accessibility of safe water and sanitation in the developed world, tremendous disparities in access still persist worldwide. An estimated 1.1 billion people worldwide are without improved drinking water supplies and 2.6 billion have no access to improved sanitation (21). Only half of the population in developing regions uses improved sanitation (22) . In Latin American and the Caribbean, 117 million people are estimated

to have no access to improved sanitation facilities, including an estimated 70% of the region's rural population (22).

The Millennium Development Goals (MDGs) have outlined targets for improvements in access to safe drinking water and basic sanitation in developing countries (23). The WHO/UNICEF Joint Monitoring Program for Water Supply and Sanitation classifies improved sanitation by facilities that "hygienically separate human excreta from human contact" and safe water sources are characterized by construction that protects the source from microbiological contamination (24). While the world is on track to meet its drinking water target, the same cannot be said for the sanitation target (22, 23, 25). Such is the case in Latin America and the Caribbean as a region as well as the countries of Hispaniola. Haiti and the Dominican Republic were among only six countries in the region that had not yet achieved the MDG for safe water provision in 2008 (25, 26). Even so, differences in the provision of water and sanitation infrastructure between Haiti and the Dominican Republic are stark: in 2010, 86% of people in the Dominican Republic benefited from access to improved sanitation compared to a mere 17% in Haiti (27-29). This disparity has been cited as a major determinant of the relative severity of the cholera epidemic in the two countries (11, 27). Haiti's dearth of sanitation infrastructure has provided an optimal environmental for *V. cholerae's* rapid spread, while comparatively high sanitation coverage in the Dominican Republic has minimized contact between human populations and infectious excreta. Disparities in the accessibility of water and sanitation infrastructure also exist across urban-rural gradients (22, 26).

Haitian Migration to the Dominican Republic

Haitians, keen to escape poverty and lack of economic opportunity in their home country, have been migrating to the Dominican Republic since the early 20th century (30). Originally sanctioned by the state to satisfy the need for inexpensive labor on Dominican sugar plantations, the presence of Haitians has been ingrained into the operation of the Dominican economy for nearly a century (30-32). Today, the need for Haitians in the sugar harvest has shifted to other agricultural commodities (i.e. rice, coffee and tobacco) as well as construction (30, 31). Estimates of the number of Haitians currently living in the Dominican Republic range from 500,000 to 1.5 million, though no reliable data are available (30).

Although Haitians have been an essential labor force in the Dominican economy, they remain a marginalized population in Dominican society. Very few Haitians living in the Dominican Republic are legally authorized to do so despite the fact that many have lived in the Dominican Republic for multiple generations or have been recruited by the agriculture industry to work in Dominican fields (30). A nationalistic sentiment of *anti-haitiansmo* (anti-Haitianism) among Dominicans commonly denies Haitians citizenship, legal protection, access to health care and education (30, 31, 33, 34). As a result, Haitians often are often spatially segregated from mainstream Dominican society, limited to low-wage informal work and exposed to poorer living conditions, including diminished access to improved sanitation and safe drinking water (32).

After cholera emerged in Haiti, migration patterns on Hispaniola made it only a matter of time before cholera would make its way across the border into the Dominican Republic (14). Indeed, the first confirmed case of cholera in the Dominican Republic was in a 32-year old Haitian woman who had been traveling in Haiti days before she became

ill (13). Although the cholera epidemic in the Dominican Republic has been relatively mild, certain marginalized groups, including migrant Haitians and their Dominican neighbors may be at particular risk for infection (13). This is particularly true in rural agricultural areas where coverage of safe water and improved sanitation is relatively low (compared to urban areas) and cholera could easily spread in the event of the introduction of *V. cholerae*. So long as cholera and Haitian migration remain prevalent on Hispaniola, cholera will remain a threat to these marginalized populations in the Dominican Republic. As the Pan American Health Organization and its partners scale up efforts to eliminate cholera from Hispaniola, this understanding of vulnerable populations will be central to successful targeting of interventions (11, 14, 35)

CHAPTER II: MANUSCRIPT

Introduction

Cholera is a diarrheal illness caused by the bacteria *Vibrio cholerae*. Although the majority of infections are asymptomatic, severe manifestations lead to dramatic fluid loss and can result in death within hours if left untreated (2). Spread by the fecal-oral route, cholera transmission is easily interrupted with access to safe water sources and adequate sanitation infrastructure (1). For these reasons, much of the developed world has been cholera-free since the 19th century (4). However, the same cannot be said for many developing regions of the world, where safe water and sanitation infrastructure are often inadequate (22). These conditions leave a large proportion of the world's population vulnerable to diarrheal pathogens, including cholera.

Cholera emerged on the island of Hispaniola in October 2010 in Haiti's Artibonite Valley and spread rapidly across the island, reaching every department in Haiti and areas of the Dominican Republic within a month (9, 10). Haiti experienced over half a million cases of cholera, including 7,000 deaths, in 2011, while the epidemic in the Dominican Republic was comparatively mild (20,000 cases and less than 400 deaths) (13, 14). The relative severity of the Haitian epidemic is attributed to the lack of water and sanitation infrastructure nationwide (27). When cholera was introduced, the country was still recovering from its January 2010 earthquake, where already tenuous water and sanitation provisions had been compromised (36). In contrast, sanitation coverage in the Dominican Republic is relatively high (86% compared to just 17% in Haiti) (28, 29).

Relations between Haiti and the Dominican Republic are marked by a long history of migration. Since the early 20th century, Haitians have sought economic opportunity in the Dominican Republic's agricultural industries (30). After cholera emerged in Haiti, migration patterns on Hispaniola made it only a matter of time before cholera would make its way across the border into the Dominican Republic (14). Indeed, the first confirmed case of cholera in the Dominican Republic was in a 32-year old Haitian woman who had been traveling in Haiti days before she became ill (13).

While Haitians comprise an essential labor force in the Dominican Republic, they remain a marginalized population in Dominican society (30, 31, 33, 34). Haitians are at disproportionate risk for infection, as people of Haitian descent comprised 20% of reported cholera cases in the Dominican Republic in 2011 (13). Studies have documented that areas where Haitians commonly live (rural and agricultural areas, marginalized urban areas and border zones) are also thought to be at highest risk for cholera infection for the paucity of access to adequate water and sanitation (13). Despite these disparities, few studies address the dynamics of cholera risk in the Dominican Republic. Understandably, the epidemic in Haiti has received more attention for its relative severity, but an in-depth understanding of the drivers differential risk for cholera will be essential as long as *V. cholerae* remains on the island and migration between Haiti and the Dominican Republic continues. Comprehensive knowledge of cholera risk on both sides of the island is necessary if the Pan American Health Organization's hopes to eliminate cholera from Hispaniola (11, 35). Effective targeting will be central to any elimination strategy in the Dominican Republic.

Risk factors for cholera have been well-characterized over decades of study. Municipal water supplies have become a rare focus of transmission in the current pandemic, and provision of household tap water led to reductions in cholera incidence (8, 37). In contrast, consumption of untreated water from surface waters (rivers, irrigation channels and unprotected wells continues to play an important role in cholera transmission (8, 38, 39). Water treatment has been an important protective factor in both the current and previous epidemics (10, 39). Improvements in water, sanitation and hygiene infrastructure have been shown to diminish the burden of diarrheal pathogens transmitted via the fecal-oral route, such as cholera (40, 41). Socioeconomic status has been shown to be associated with cholera risk, serving as an indicator of environmental and living conditions that modify cholera risk (42-45)

The goal of this study was to examine how risk for cholera differed between migrant Haitians and Dominicans living in the Duarte Province of the Dominican Republic. Varying degrees of cholera risk factors can be observed across the province. The working hypothesis was that the prevalence of risk factors for migrant Haitians living in the province was greater than for their native Dominican neighbors. While the Duarte Province experienced only a small proportion of cholera cases reported nationwide (202 cases and 6 deaths) in 2011, the province is home to major city as well as agriculture in rural areas, making it an interesting place to study cholera risk (13). The province's rice industry provides work for migrant Haitians and a wide spectrum of water and sanitation conditions can be observed across the urban-rural gradient. This question was addressed through a household knowledge, attitudes and practices (KAP) survey in 18 communities in 4 of the province's 7 municipalities.

Methods

Setting and Study Team

Through a long-standing community-based research partnership between the Emory University School of Nursing and the Universidad Autónoma de Santo Domingo-Centro Universitario Regional del Nordeste (UASD-CURNE), research was conducted in collaboration with UASD-CURNE and the provincial Ministry of Health office (46, 47). We conducted a cross-sectional survey in the Duarte Province, Dominican Republic from July 8 - July 15, 2012 to measure the various risk factors described above. Located in the fertile Cibao Valley in the northeast of the country (Figure 2), the province is home to approximately 283,805 residents, 118,328 of whom live in rural areas (48). The cultivation of rice and cacao are prevalent in the Cibao Valley, and in 2003, 60.9% of the province's land cover was dedicated to agriculture (48).

The province's largest city, San Francisco de Macorís, has a population of 138,167 and is the nation's third largest city (48). The study team consisted of four American graduate students, four Dominican research assistants and four bilingual (Spanish-Kreyól) Haitian research assistants. Research assistants were hired and trained to complete household surveys in their native language. Training included ethics, inclusion/exclusion criteria, sampling protocol, informed consent, technical definitions of survey items and the proper registry of data on the questionnaire form. The study received exemption from Emory University's Institutional Review Board (Study #IRB00057667).

Sampling Methodology

Eighteen communities were purposely selected on the basis of likely presence of cholera or cholera-likely conditions; within each community, random samples of households were selected to statistically represent their communities. Consequently, the overall sample represents the region of the Dominican Republic where cholera was present or likely. We sampled households within 18 selected communities for administration of a cross-sectional survey using a structured questionnaire in 4 municipalities in the Duarte province. Selection of communities was based on recommendations from contacts in the provincial Ministry of Health office. Selected communities (Table 1) were identified as being vulnerable to cholera according to the following criteria: those with confirmed cases of cholera during the 2011 outbreak; those with a mixed population of Haitian and Dominican residents; or those recommended to the research team by the provincial office of the Ministry of Health based on their own interest in program planning. Since no local or regional census data documenting the migrant Haitian population were available, consultation with local professional and community-level contacts identified communities with a substantial population of Haitian residents. All 18 communities belonged to 4 of the Duarte province's 7 municipalities and 6 were considered rural.

Sampling routes for a random-walk selection within each survey community were planned through preliminary field visits using maps of the four survey municipalities. Maps were acquired from local municipal offices, and conversations with municipal functionaries informed the identification of borders and composition of each of the surveying communities. Data collection began from a logical central point in each

community. Most communities were small enough such that one research assistant could be assigned to sample along a single street from the starting point, proceeding according to the established sampling interval. In larger communities, in which the number of streets was greater than the number of research assistants, data collection began at a locally-recognized community meeting point and a random-walk procedure was used to select the street and direction for surveying.

Lack of population data at the community level presented a challenge to classic random-walk sampling. Hence a pseudo random-walk procedure was used, employing a random sampling interval. Households were sampled systematically and the population was weighted. In two instances, a relatively large sampling interval was generated for a community that was too small for that interval to be feasibly used. In these cases (24 de abril and Las Mercedes de Castillo), it was obvious upon arrival that the determined sampling interval was too large and another number (between 1 and 5) was randomly chosen as the new sampling interval.

Approximately 20 household surveys were completed in each of the 18 communities for a total sample size of n = 363. Sample size was chosen based on a 20 x 18 cluster design, determined to be sufficient to detect 15% difference in risk factor prevalence at a 95% confidence level with 80% power. Several of the selected communities had few, if any, Haitian residents. This was especially true in the urban communities of San Francisco de Macorís, where eight communities yielded only Dominican surveys (n = 78). In these communities, it was necessary for Haitian research assistants to perform surveys in Spanish with Dominican residents.

Population Estimates and Sampling Weights

Population estimates were derived using the quadrat method for migrants and Dominican populations in each community (49, 50). Google Earth™ (San Francisco, CA) images of each community were obtained and overlaid with a grid. Upon visual inspection of each map, grid cells appearing to be populated were numbered and a single grid cell was selected at random in which a household-level census was carried out. An enumerator visited each household in the randomly selected grid cell and asked for the number and nationality of each household's residents. The number of residents found in the selected grid cell was then multiplied by the number of populated grid cells for that community. This method yielded the relative number of Haitian and Dominican households in each community, and these data were used to calculate household and post-stratification weights.

Survey Instrument

The survey instrument was designed to assess potential differences in cholera risk between Dominicans and migrant Haitians living in the Dominican Republic with respect to cholera knowledge and water and sanitation practices. The survey instrument included modules for basic demographic information; knowledge of cholera symptoms and transmission; occurrence of cholera in the household and health care seeking attitudes and behaviors; socioeconomics; migration history and documentation status (specific to Haitian respondents); and access to water, sanitation and hygiene (WASH) infrastructure as well as practices related to WASH. Socioeconomic measures included household assets and observation of household construction materials. Water and sanitation

practices were assessed through a combination of structured questions and observations regarding sources and treatment of drinking water, available toilet and hand-washing facilities and household water storage practices. Responses to water source and toilet facility items were categorized according to the WHO Joint Monitoring Program's improved-unimproved criteria (24).

Spanish and Kreyòl versions of the survey were utilized in the field. Survey items were developed in English. A preliminary Spanish translation was reviewed and revised by Dominican research assistants. Using this revised version, Haitian research assistants translated the survey from Spanish to Kreyòl. The Kreyòl version was then back-translated by an individual who was not otherwise involved in the study and spoke native Kreyòl and fluent Spanish. Research assistants piloted the survey instrument in two non-survey communities (one rural and one urban), which served as field training and also identified where final revisions to the instrument were needed.

Data Management

Survey data were double-entered using Microsoft Excel (Redmond, WA). Excel Compare (Bamaul, Russia) was used to identify inconsistencies between the two files, and reference to the hard copy surveys was used to resolve any discrepancies. Once all inconsistencies had been resolved, hard copies were destroyed. Statistical analyses were conducted using SAS 9.3 (Cary, NC). Calculations of demographic and risk factor frequencies were stratified by self-reported nationality and account for sampling weights.

Numerical knowledge scores were calculated from responses to two survey items: one assessing knowledge of cholera symptoms and another assessing knowledge of

cholera transmission pathways. Respondents were asked to enumerate cholera symptoms from memory, receiving no prompts from research assistants. A maximum of 4 correct symptoms and 4 correct transmission pathways were included in the questionnaire for a maximum cumulative knowledge score of 8. Each correct answer was awarded one point. Incorrect answers and responses of “Don’t know” were awarded zero points. Correct responses were based on documents created and distributed by the Dominican Ministry of Health (51).

Primary and secondary drinking water sources were considered in assigning an improved/unimproved classification to each household. Survey respondents were asked to indicate a single primary source of drinking water as well as any additional sources of drinking water that were used in the household. Bottled water is a prevalent source of drinking water in the Dominican Republic, and was considered improved when a household has access to piped water either inside or outside the home (24). Household that reported bottled water as their principal drinking water source were thus classified according to this criteria: improved if piped water was enumerated as a secondary source and unimproved if piped water was not enumerated as a secondary source.

The use of principal component analysis reduced 23 survey items addressing possession of household assets into a single measure of socioeconomic status (52). The Eigenvalue-one criterion and examination of the scree plot indicated that the first component, which explained 22.75% of the variance, was the most meaningful. The rotated factor pattern revealed that six variables (household electricity, television, refrigerator, cooling fan, washing machine and cooking stove) loaded exclusively on this component. These variables are consistent with field observations of asset possession as

an indicator of socioeconomic status in the province and were then assigned factor scores. Natural breaks in the distribution of factor scores indicated that this variable could be categorized into socioeconomic quintiles.

Descriptive Analysis

Rao-Scott Chi-square tests and crude binary logistic regression were used to quantify differences in demographic characteristics between Haitians and Dominicans while accounting for sampling weights. Unweighted frequencies and weighted percentages are reported. Weighted percentages are considered representative of the entire population in the 18 surveyed communities. Bivariate logistic regression accounting for weighting and sample design were used to quantify crude relationships between cholera risk factors and self-reported nationality.

Regression Analysis

Multiple imputations (n = 5) were performed on four variables so that regression analyses could account for the complex sampling design and produce valid estimates. Weighted sequential hot deck (WSHD) imputation was selected as an appropriate method for its ability to handle general patterns of missingness, impute categorical data and account for sampling weights (53, 54). Additionally, WSHD is a non-model based approach, which made it possible to impute missing values for dependent variables in regression analyses. No variable had more than 10% missing values. All regression analyses were performed by imputation with the multiply imputed data sets. Parameter estimates were then analyzed using PROC MIANALYZE in order to account for

variability introduced via imputation and produce valid effect estimates and confidence intervals (55).Three binary logistic regression models assessed differential access to household WASH infrastructure. Dependent variables included whether a household had (a) an improved drinking water source, (b) an improved toilet facility and (c) a hand washing facility. Poisson regression was used to assess differences in numerical knowledge scores between Haitians and Dominicans. In all regression analyses, self-reported nationality was the independent variable of interest. All models controlled for three potential confounders: socioeconomic status, educational attainment and urban-rural geography. Effect modification of urban-rural geography on nationality was also explored for all four outcomes.

Results

Demographic Frequencies

Survey data from 363 households were collected in 18 provincial communities. The sample comprised 260 Dominican households and 103 Haitian households. A total of 2 households (0.6%) reported having experienced a case of cholera in the previous 18 months. One of these self-reported cases was reported in an urban Dominican household, and the other in a rural Haitian household.

Haitians and Dominicans differed substantially on many demographic characteristics. Of 260 Dominican survey respondents, 199 were female (74.7%), compared to 42 of 103 Haitians (30.1%, $p < 0.01$; Table 2). On average, Haitians were younger than Dominicans, with a mean age of 31.1 years compared to Dominicans, who were 43.6 years of age on average (Table 2; $p < 0.01$). A total of 75 Haitian respondents (70.6%) had no more than primary education, while more than half of Dominicans (57.8%) had a secondary or university education ($p > 0.05$; Table 2). Nearly all Haitians surveyed (93.1%) fell into the lowest two socioeconomic quintiles, and none were in the highest socioeconomic quintile. In contrast, almost half of Dominicans (44.94%) were in the highest socioeconomic quintile ($p < 0.01$; Table 2).

Cholera Risk Factors

Notable disparities in cholera knowledge were present between the two groups. Most Dominicans (78.4%) were able to identify diarrhea as the principal symptom of cholera, compared to less than half (47.2%) of Haitians ($p < 0.01$; Table 3). The majority of Dominicans (56.4%) were also able to identify nausea as a symptom of cholera, while

just 53 Haitians (18.7%) identified dehydration as a symptom ($p < 0.01$; Table 3). Haitian knowledge of cholera symptomology was significantly lower than Dominicans with 53 respondents (47.2%) identifying diarrhea as a symptom and 38 (40.4%) reporting no knowledge of cholera symptoms ($p < 0.01$; Table 3). A total of 36 Haitians (27.0%) also reported no knowledge of cholera transmission pathways compared to just 25 (9.7%0 of Dominicans ($p < 0.01$; Table 3). While Haitians demonstrated significantly lower knowledge of cholera transmission pathways compared to Dominicans, Haitians identified the consumption of contaminated water as a transmission pathway as often as Dominicans (55.8% versus 54.0%; $p = 0.83$; Table 3). Reports of no knowledge of cholera transmission pathways were still high among Haitians (27.0%), but at least 30% of Haitians identified each of the four correct transmission pathways (Table 3).

Access to WASH infrastructure differed between Haitians and Dominicans. A total of 30 Dominican households (11.5%) had no access to any WASH infrastructure (Figure 3a). Sanitation was the most prevalent form of WASH infrastructure available to Dominican households, with the combination of sanitation and hygiene infrastructure available to 91 Dominican households (35.0%) and sanitation alone available to 71 Dominican households (27.3%; Figure 3a). Improved water was the least accessible form of WASH infrastructure for Dominicans with just 38 households (14.6%) having access either singly or in combination with other types of infrastructure (Figure 3a). In contrast, a total of 32 Haitian households (31.1%) had no access to any of the three types of WASH infrastructure (Figure 3b). Hygiene infrastructure was the next most common WASH scenario, which was available to 18 Haitian households (17.5%) singly and an

additional 10 Haitian households (2.5%) in combination with other types of WASH infrastructure (Figure 3b).

Access to improved water sources was low among both Haitians and Dominicans (approximately 20%), and did not differ between groups (cOR = 1.06, 95% CI 0.49, 2.16; Table 3). A total of 184 Dominican households in the surveyed communities (70.5%) had access to an improved sanitation facility, while this was true among only 38% of Haitians (cOR = 0.27, 95% CI 0.14, 0.53; Table 3). Hand washing facilities were available in less than half of both Haitian and Dominican households, but were slightly more common among Dominicans (cOR = 0.65, 95% CI 0.32, 1.32; Table 3). While storage of drinking water in the home was a pervasive practice among both Dominicans and Haitians (87.2% vs. 83.0%, p = 0.37; Table 3), treatment of drinking water was relatively uncommon for both groups. A total of 51 Dominican households (21.7%) reported treating drinking water before consumption, compared to 16 Haitian households (5.5%; cOR = 0.21, 95% CI 0.11, 0.41; Table 3). Hand soap was present in 98 Dominican households (33.4%) and 21 Haitian households (16.0%), (cOR = 0.37, 95% CI 0.17, 079; Table 3). Exposure to local surface waters (either bathing in or drinking from a river or canal) was generally low, but was significantly higher among Haitians compared to Dominicans ($p < 0.01$; Table 3).

Differences between Haitians and Dominicans were complemented by marked demographic and risk factor differences between urban and rural areas of the province (Table 4). A total of 46 out of 243 urban households were Haitian (5.6%), whereas nearly a quarter (n = 57) of rural households in the surveyed communities were Haitian ($p < 0.05$; Table 4). While the distribution of socioeconomic quintiles did not differ across

urban and rural areas, educational attainment was lower in rural areas with 89 rural respondents reporting no more than primary schooling (74.3%) compared to urban areas, where nearly 50% of residents had at least secondary education ($p < 0.05$; Table 4). Access to WASH infrastructure also differed between urban and rural communities. Urban areas were less likely to have access to improved water ($p < 0.05$; Table 4). Improved sanitation coverage was high in urban areas (80.4%; Table 4), and significantly less so in rural areas (49.4%; $p < 0.01$). Hand washing facilities were available in 41.4% ($n = 95$) of urban homes, but only 18.1% ($n = 24$) of rural homes ($p < 0.05$; Table 4).

Regression Analyses

While access to improved drinking water did not differ between Haitians and Dominicans (cOR = 1.06, 95% CI 0.51, 2.22; Table 3), it did differ significantly for urban and rural communities ($p < 0.01$; Table 4). Controlling for socioeconomic status, participant education and urban-rural geography, the direction of the association changed (aOR = 0.77, 95% CI 0.46, 1.27; Table 5), indicating that Haitians may be slightly less likely to have access to improved water. A test for urban-rural effect modification was marginally significant ($p = 0.05$; Table 5) and indicated that Haitians were less likely to have access to improved drinking water in both urban and rural communities, but were much less likely to have access to improved water in rural areas (aOR = 0.005, 95% CI 0.002, 1.02; Table 5) compared to urban areas (aOR = 0.21, 95% CI 0.05, 1.01; Table 5).

Crude estimates of sanitation access indicated that Haitians were much less likely to have access to an improved toilet facility in their homes compared to Dominicans (cOR = 0.52, $p < 0.0$; Table 3). Rural areas were similarly less likely to have access to

improved sanitation ($p < 0.01$; Table 4) compared to urban areas. However, there was no difference in improved sanitation access between Haitians and Dominicans after controlling for socioeconomic status, participant education and urban-rural geography (aOR = 1.00, 95% CI 0.57, 1.76; Table 5). There was also no evidence of urban-rural modification on the effect of nationality on improved sanitation access ($p = 0.18$; Table 5).

No difference in access to household hygiene infrastructure was detected between Haitian and Dominican households (cOR = 0.65, 95% CI 0.32, 1.32; Table 5). However, rural areas were less likely to have access to hygiene infrastructure ($p < 0.01$; Table 5). Models adjusted for socioeconomic status, participant education and urban-rural geography found that Haitians were significantly more likely to have access to hygiene infrastructure than their Dominican neighbors (aOR = 1.78, 95% CI 1.07, 2.96; Table 5). The effect of nationality was significantly modified by urban-rural geography ($p = 0.01$, Table 5). The likelihood of increased access to hygiene infrastructure among Haitians was greater in rural areas (aOR = 43.18, 95% CI 2.94, 6.33) than for urban areas (aOR = 6.57, 95% CI 1.72, 25.17; Table 5).

Haitians had lower knowledge of cholera compared to Dominicans (cRR = 0.59, 95% CI 0.52, 0.68) and levels of knowledge did not differ between urban and rural areas ($p > 0.05$; Table 4). Controlling for socioeconomic status, participant education and urban-rural geography changed the rate ratio slightly but did not change the conclusion. Even when accounting for potential confounders, Haitians have lower knowledge of cholera symptoms and transmission compared to Dominicans (aRR = 0.66, 95% 0.55,

0.81; Table 5). There was no evidence of urban-rural effect modification in this relationship ($p = 0.67$; Table 5).

Discussion

These findings reveal the influence of socio-demographic factors as confounders and effect modifiers in the relationship between nationality and cholera risk factors in vulnerable communities in the Duarte province. Access to improved water appeared to be the same for Haitian and Dominican households, but when accounting for confounding and effect modification, Haitian were less likely to have access to improved water, particularly in rural areas. Dominicans appeared to have better access to sanitation infrastructure, but adjusting for confounders eliminated differences between the two groups. Access to household hygiene infrastructure did not differ between Haitian and Dominican households. However, after adjusting for confounding and effecting modification, Haitians appeared to have greater access to hygiene infrastructure, particularly in rural areas. The influence of socio-demographic factors for each of the outcomes of interest highlights the complexity of the dynamics of WASH access and cholera knowledge acquisition in these provincial communities. Similarly, urban-rural geography plays a significant role in modifying the effect of nationality on some, but not all, WASH-related cholera risk factors.

Water

In the case of improved water access, Haitian nationality appears to have a heterogeneous impact in rural versus urban communities. While the overall odds ratio adjusted for socioeconomic status, participant education and urban-rural geography showed no difference in improved water access between Haitians and Dominicans, stratified estimates reflected that Haitians were far less likely to have access than Dominicans, an effect that was exacerbated in rural areas. Qualitative data collected through focus group discussions in both urban and rural

survey communities found that poverty was a substantial barrier to improved water access among migrant Haitians living in rural areas (56).

Focus group participants in this qualitative study also described experiences of discrimination that influenced their economic situation. Rural Haitian migrants often received lower pay for the same agricultural work as their Dominicans peers, an experience that has been documented in previous literature on the Haitian experience in the Dominican Republic (20, 30, 57). This disparity makes the purchase of bottled water from local vendors and the installation of piped infrastructure cost-prohibitive for many rural Haitians (56). As a result, rural Haitian focus group participants reported using water from open sources, such as the irrigation canals widespread in the rural agricultural areas, for lack of economic resources (56).

The water and sanitation scenarios present in the rural communities of Pimentel and Las Guaranas exemplify their vulnerability to cholera. Geographic isolation makes rainwater one of the only safe sources of drinking water. Bottled water, which is considered the safest source of water in the province and is widely sold in urban areas, is harder to access in isolated rural communities (56). These rice-growing communities are served by an irrigation canal, which serves a wide variety of purposes for residents. Residents often bathe and defecate in the canal, as well as use its water for cooking, washing dishes and washing clothes. In times of low rainfall, the canal also serves as a source of drinking water out of necessity (56). These communities are also not served by any sort of municipal sanitation system. Any sanitation facility that exists involves dug latrines that often discharge directly into the canal (56).

Across the urban-rural gradient and among both Haitians and Dominicans, access to improved drinking water sources is consistently low. This is due in large part to the prevalent use of bottled water for primary sources of drinking water, which the Joint Monitoring Program

considered unimproved (24, 58). The 2008 census reports that 39% of households in the Duarte Province received water from municipal systems either inside or outside the home, but no distinction is made between drinking water and water used for other purposes (48). Based on field observations, piped water was seldom used for drinking. Lack of municipal accountability for providing safe water results in widespread distrust of the piped water system, and the majority of provincial residents purchase bottled water (58). A number of companies compete to sell five gallon bottles of purified water in provincial communities, which are widely available in urban areas and less so in rural areas (56).

When bottled water is available in rural areas, the cost of transportation often doubles the price of the product and making the cost prohibitive for many migrant Haitians (56).Therefore, reports of bottled water use in rural areas may be distinct from those reported in urban areas. Focus group data indicate that use of surface water may be higher than detected in the survey, and that use of bottled water may be over-reported (56). These results highlight the limitations of the binary JMP indicator for drinking water supply, whose simplicity obscures important context-specific dynamics, and fails to capture the political, economic and geographic factors that influence the availability and use of clean water in the Duarte province (40). Further study of the complexity of drinking water access in the context of the province, where trust in the safety of piped water is low, trust in commercially available bottled water is high and availability of bottled water varies greatly across the urban-rural gradient is warranted in order to better understand the role water supply plays in mediating cholera risk.

The pervasiveness of water storage in these communities also emphasizes the importance household water storage practices, a substantial determinant of risk for cholera and other water-borne illnesses. Even if a water source is not contaminated, poor household water storage

practices can increase the risk of contamination (59). Treatment and safe storage of household water supplies has similarly been found to reduce the occurrence of diarrheal illness (60, 61). While household water storage was common in the surveyed communities, treatment of drinking water was relatively uncommon. A closer examination of point-of-use water treatment and storage practices (storage vessel characteristics and retrieval methods) among migrant Haitians and Dominicans in urban and rural areas of the Duarte Province would shed light on an important aspect of cholera risk

Sanitation

While crude estimates indicate that migrant Haitians suffer from low access to sanitation technologies, this appears to be due in large part to the demographic differences between Haitians and Dominicans. Controlling for potential confounders eliminated any difference in improved sanitation access between the two groups. This result was homogenous across urban-rural geography and emphasizes the importance of social factors in cholera risk.

Social determinants have long been considered an important aspect of cholera risk. Ecologic associations between socioeconomic status and cholera occurrence have been identified from surveillance data from the 1990s cholera epidemic in Latin America (42, 43, 62, 63). Recent work has addressed this relationship more directly through analysis of longitudinal data in Bangladesh, in which socioeconomic status explained more variation in cholera occurrence than any other variable, including sanitation (44). The multidimensionality of socioeconomic status has been suggested to serves as a proxy for many of cholera's environmental risk factors, including those related to WASH infrastructure, and has been proposed as a central risk factor for cholera (45). Therefore, observed disparities in access to improved sanitation may be more a

result of Haitians' marginalized position in Dominican society, than it is of fundamental differences between the two groups.

This finding is particularly meaningful in the socio-cultural context of Haitian-Dominican relations in the Dominican Republic. Despite their contributions to the Dominican economy, Haitians have been confined to the margins of Dominican society, suffering discrimination in various forms. Haitians are commonly denied education, equitable pay, legal protection and access to health care (30, 33, 57, 64, 65). Sentiments of anti-Haitianism have been exacerbated by the cholera epidemic, in that Haitians have been blamed and stigmatized for bringing cholera to the Dominican Republic (20, 56, 66). Although cholera emerged in the Dominican Republic as a result of the epidemic in Haiti, care should be taken to emphasize the culpability of poor living conditions and inadequate WASH infrastructure instead of allowing the blame to rest on Haitians themselves. Discrimination against Haitians can put this population at increased risk for cholera through no fault of their own. With discrimination leading to decreased access to WASH infrastructure and potentially increased risk for cholera, blaming Haitians for cholera's presence in the Dominican Republic may only perpetuate a vicious cycle.

Hygiene

Crude analyses found no difference in access to hygiene infrastructure between Haitians and Dominicans. However, accounting for confounders changed the direction of the association, with the conclusion that Haitian households were more likely to have access to a hygiene facility. This effect was modified by urban-rural geography, in that Haitians in rural areas were much more likely to have hygiene infrastructure in their homes than in rural areas. Field observations for this study do not support this conclusion, as hygiene infrastructure was infrequently available

if not entirely absent in rural communities. This finding is similarly not supported by the literature. It is possible that rural Haitian respondents interpreted the survey question differently than expected, and households that utilized the irrigation canal for hand washing answered yes when they were asked if they had a place to wash their hands. Since hand hygiene is highly dependent on available water supply, we would expect water and hygiene results to be similar in direction and magnitude (40, 67). The most readily available water supply in many of the rural communities is the irrigation canal, a source of surface water with a high risk of contamination. Exposure to surface water has been identified as a major risk factor for cholera infection in the current pandemic (8, 38, 39)

Knowledge

Although crude differences in water and sanitation infrastructure can be largely explained by demographic differences between Haitians and Dominicans, cholera knowledge among Haitians was lower than knowledge among Dominicans even after controlling for socioeconomic status and education. Knowledge scores were based on information prepared and distributed by the Dominican Ministry of Health. Consequently, the differences in cholera knowledge observed between Haitians and Dominicans may be the result of poor penetration of the Ministry's cholera education messages in migrant Haitian communities.

This likely reflects a combination of factors. Migrant Haitians in the Duarte province encounter several barriers to health care access, causing many to avoid seeking care and eliminating the opportunity for communication of cholera prevention information in the clinical setting (68). As a result, dissemination of cholera information in the clinical setting is limited to the minority of Haitians covered by the national insurance program or able to afford fee-for-

service care (68, 69). Poor knowledge among Haitians may also reflect the difficulty of reaching a marginalized part of Dominican society. For fear of deportation or mistreatment, migrants may avoid contact with any authority, and as a result, not have any contact with health authorities unless absolutely necessary (30).

Linguistic and cultural barriers may also contribute to low cholera knowledge among migrant Haitians (68, 70). Spanish proficiency among Haitians varies greatly depending on length of time spent in the Dominican Republic: multi-generational Dominico-Haitians are more proficient than seasonal migrants (30). Any communication between Dominican health authorities and Haitians is limited by the ability of each party to communicate in their second language. Similarly, traditional beliefs about disease causation among Haitians may differ from biomedical explanations of cholera transmission that were tested in the survey (71). To address language barriers, the Dominican Ministry of Health created and distributed cholera education materials in Haitian Kreyól, but these materials relied heavily on text, rendering the content inaccessible to the large proportion of migrant Haitians with little or no education (69).

Strengths and Limitations

This study provides a unique analysis of the distribution of cholera risk factors in communities considered to be vulnerable to cholera transmission. Cholera's risk factors have been well-characterized throughout its long history of global pandemics, but few studies examine community-based risk factor prevalence, especially in the context of the current epidemic on Hispaniola. Similarly, the majority of studies of cholera on Hispaniola have been conducted on the Haitian side of the island. While the epidemic in Haiti has been far more severe and caused significantly more morbidity and mortality than the epidemic in the Dominican Republic, a

detailed understanding of the areas of high risk in the Dominican Republic will be crucial for PAHO's ongoing cholera elimination efforts on the island.

While the study fills a critical knowledge gap, it has several limitations. The cross-sectional nature precludes the inference of any causal relationships. Limitations of sample size also made the detailed examination of certain risk factors, such as exposure to surface water, impossible. Exposure to surface water, either through bathing or drinking, is considered a major risk factor in the current pandemic. This exposure was infrequent in our sample, but appeared to be more common among Haitians and in rural areas. In futures studies, surface water exposure may be an important consideration in assessing cholera risk in highly vulnerable communities. By examining only household WASH facilities, we neglected to account for the risk for cholera faced by many people in the work place. Rural focus group participants reported that men who work in the rice fields commonly drink water from the canal while they work (56). This emphasizes the importance of examining holistic exposure scenarios, as inadequate WASH infrastructure may be present not only at home, but also in schools and workplaces (40).

Because population estimates for surveyed communities were not available at the time of data collection, the random walk methodology had to be adapted to this limitation. A pseudo random walk methodology utilized randomly-generated sampling intervals, instead of population-based sampling intervals. This worked well in most communities, but in a couple communities, the pre-determined sampling interval was too large and a new one had to be chosen at random. Despite this limitation, the quadrat method was used after data collection to obtain population estimates for use in analysis. All analyses incorporated post-stratification weights generated from these population estimates. A final limitation in the current study involves the low population of Haitian residents in several, mainly urban communities. In these communities,

it was necessary for Haitian research assistants to complete surveys with Dominican households (n = 78). While Haitian research assistants were proficient in Spanish, cultural tension between Haitians and Dominicans in the Dominican Republic is substantial and may have biased survey responses in these communities.

CHAPTER III: PUBLIC HEALTH IMPLICATIONS

The dynamics of cholera risk in the most vulnerable communities of the Duarte Province are complex. Access to household WASH facilities differs across self-reported nationality but is also affected by socio-demographic factors as well as urban-rural geography. Moreover, the effects of these factors are not uniform across the different types of WASH infrastructure. In order for the Pan American Health Organization to achieve its goal of eliminating cholera from the island of Hispaniola, prevention and education efforts in the Dominican Republic will need to be targeted to the most vulnerable communities (11, 35). Targeted interventions, which should include provision of WASH infrastructure as well as epidemiologic surveillance, are essential to prevent the disease from becoming endemic on the island (14, 20, 35). In the Duarte province, efforts should be focused on reaching the marginalized migrant Haitian communities as well as rural agricultural areas where adequate water and sanitation infrastructure coverage is poor.

The presence and use of irrigation canals in many rural communities represents a significant risk factor for cholera that can and should be mitigated by provincial authorities (38). Water and sanitation infrastructure, oft cited as the most effective means of cholera prevention, should be sought to minimize exposure to the contaminated surface water available in the canals (14, 36, 41, 72). Rural Haitian focus group participants identified sanitation infrastructure as one of the main interventions provincial authorities could undertake to improve their living conditions and mitigate their risk for cholera (56). This corresponds to the top priorities expressed by the global poor: a need for water and sanitation provision (40).

Performance on the water and sanitation MDG indicators depends just as much on political will as it does on financial and human resources (73). Dominican public health professionals have an important role to play in promoting the provision of WASH services in the local and national political context. Even though the construction and maintenance of WASH infrastructure is beyond the scope of responsibility of the health sector, health authorities can leverage the health benefits of WASH infrastructure through inter-sectoral dialogue and advocate for the appropriate WASH investments in the appropriate places (40, 73).

Recent reforms in the Dominican national water supply and sanitation agency (INAPA) have aimed to decentralize the administration of service provision and have had some success establishing regional government-based water and sanitation providers in other provinces of the Cibao Valley (74). A pilot program overseen by USAID in an eastern Dominican province has also established community-based organizations, called Rural Water and Sanitation Associations, to assume responsibility for operation and administration of local water and sanitation services (75). An evaluation of this program has emphasized the need for demand-driven, community-based infrastructure (75). As the decentralization of INAPA continues and responsibility for water and sanitation provision gets delegated to regional and local authorities, health authorities in the Duarte province should be incorporated into this dialogue in order to provide necessary and sustainable WASH services in the provincial communities where they are most needed.

Low cholera knowledge among migrant Haitians in the survey reflects several possible barriers to health communication in the province. Educational messages about cholera appear to not have reached many of the Haitians living in both rural and urban areas. Given the tremendous potential for educational campaigns to improve hygiene and other preventive health

practices, health messaging in the Duarte province should be tailored to the social, political and geographic characteristics of the province's Haitian population (76). In addition to potential literacy and language barriers, Haitians encounter substantial barriers to health care in the clinical setting.

Radio messages were used in Haiti in response to cholera epidemic and resulted in successful adoption of cholera prevention behaviors (77). Despite the effectiveness of radio as a medium of health communication in Haiti, very few Haitians in the surveyed communities (8.9%) reported receiving health information from the radio and less than half of Haitian households (42.1%) owned a radio, making this an unlikely means of successful communication with Haitians in the province. Moreover, media-based communication is often difficult with low literacy populations, and communication with migrant Haitian populations in the Duarte province may be best accomplished through a community-based approach (69, 71, 78).

Mobile medical units were demonstrated to be a sustainable means of providing preventive health care and education to migrant Haitians living in Dominican sugar cane plantations and could potentially be implemented in the communities of the Duarte province to reach migrant Haitian residents (79). Doing so may also alleviate some of the barriers to healthcare that Haitians in the Duarte province experience, namely the cost of care and transportation (68). In doing so, language and cultural barriers will also need to be addressed; few Dominicans speak Kreyòl, healthcare personnel included (30). The cultural and language barriers could potentially be overcome through the recruitment and training of Haitian community health workers.

While improved knowledge of cholera among would improve Haitians' ability to recognize symptoms and potential for transmission, knowledge alone is limited in the impact it's

on risk reduction (69). The adoption of risk reduction behaviors is also highly dependent on economic, social and cultural factors, and educational campaigns should be accompanied by necessary improvements in WASH infrastructure (69). However, improved communication of health messages with migrant Haitian communities has the potential to do much more than reduce cholera risk. Community-based outreach initiatives may help to alleviate some of the barriers to healthcare experienced by the migrant Haitian population in the Duarte province.

References

1. Hart CA, Shears P. Bacterial Enteropathogens. In: Cook GC, Zumla AI, eds. *Manson's Tropical Disease*: Saunders, 2009.
2. Miller JG. Cholera - Modern Pandemic Disease of Ancient Lineage. *Emerging infectious diseases* 2011;17(11):2099-14.
3. Sack DA, Sack RB, Balakrish Nair G, et al. Cholera. *Lancet* 2004;363:223-33.
4. Lee K. The global dimensions of cholera. *Global Change and Human Health* 2001;2(1):6-17.
5. Jenson D, Szabo V. Cholera in Haiti and Other Caribbean Regions, 19th Century. *Emerging infectious diseases* 2011;17(11):2130-5.
6. Ryan ET. Haiti in the Context of the Current Global Cholera Epidemic. *Emerging infectious diseases* 2011;17(11):2175-6.
7. Barua D. History of Cholera. In: Barua D, Greenough III WB, eds. *Cholera*. New York: Plenum, 1992:1-36.
8. Glass RI, Black RE. The Epidemiology of Cholera. In: Barua D, Greenough III WB, eds. *Cholera*. New York: Plenum, 1992:129-54.
9. Centers for Disease C, Prevention. Update on cholera --- Haiti, Dominican Republic, and Florida, 2010. *MMWR Morbidity and mortality weekly report* 2010;59(50):1637-41.
10. O'Connor KA, Cartwright E, Loharikar A, et al. Risk Factors Early in the 2010 Cholera Epidemic, Haiti. *Emerging infectious diseases* 2011;17(11):2136-8.
11. Periago MR, Frieden TR, Tappero JW, et al. Elimination of cholera transmission in Haiti and the Dominican Republic. *Lancet* 2012;379(9812):e12-3.
12. Dowell SF, Braden CR. Implications of the Introduction of Cholera to Haiti. *Emerging infectious diseases* 2011;17(7):1299-300.
13. Pimentel R, Moya J. Epidemia de colera en Republica Dominicana. *Colera en Republic Dominicana: Lecciones aprendidas a un ano de la epidemia*. Santo Doming: PAHO/WHO, 2012.
14. Gulland A. Building hygiene infrastructure is key to ending Haitian cholera epidemic, agree agencies. *BMJ* 2012;344:e95.
15. Pena E, Pimentel R. Analisis de la mortalidad por colera en Republica Dominicana, 2010-2011. *Colera en Republica Dominicana*. Santo Domingo: PAHO/WHO, 2012.
16. Gangarosa EJ, Tauxe RV. The Latin American Cholera Epidemic. In: Barua D, Greenough III WB, eds. *Cholera*. New York: Plenums, 1992.
17. Okun DA. The Value of Water Supply and Sanitation in Development: An Assessment. *American Journal of Public Health* 1988;78(11):1463-7.
18. Esrey SA. Water, Waste and Well-Being: A Multicountry Study. *American Journal of Epidemiology* 1996;145(6):609-23.
19. Esrey SA, Potash JB, Roberts L, et al. Effects of improved water supply and sanitation on ascariasis, diarhhoea, dracunculiasis, hookworm infection, schistosomiasis and trachoma. . *Bull World Health Organization* 1991;69(5):609-21.
20. Poirier MJP, Izurieta R, Malavade SS, et al. Re-emergence of Cholera in the Americas: Risks, Susceptibility and Ecology. *J Global Infect Dis* 2012;4(3):162-71.
21. Montgomery MA, Elimelech M. Water and Sanitation in Developing Countries: Including Health in the Equation. *Environ Sci Technol* 2007;41(1):17-24.

22. WHO/UNICEF. Progress on Sanitation and Drinking Water: 2010 Update. Geneva: World Health Organization and UNICEF, 2010.
23. The Millennium Development Goals Report. New York: United Nations, 2010.
24. WHO/UNICEF. Joint Monitoring Program (JMP) for Water Supply and Sanitation. Geneva; 2004. (http://www.wssinfo.org/definitions-methods/watsan-categories/). (Accessed).
25. The Millennium Development Goals: A Latin American and Caribbean Perspecitve. United Nations, 2005.
26. Drinking Water, Sanitation, and the Millennium Development Goals in Latin America and the Caribbean. Interamerican Development Bank, 2010.
27. Tappero JW, Tauxe RV. Lessons learned during public health response to cholera epidemic in Haiti and the Dominican Republic. *Emerging infectious diseases* 2011;17(11):2087-93.
28. Joint Monitoring Program for Water Supply and Sanitation. Estimates for the use of improved sanitation facilities - Haiti. WHO/UNICEF, 2012.
29. Joint Monitoring Program for Water Supply and Sanitation. Estimates for the use of improved sanitation facilities - Dominican Republic. WHO/UNICEF, 2012.
30. Ferguson J. Migration in the Caribbean: Haiti, the Dominican Republic and Beyond. Minority Rights Group International, 2003.
31. Simmons D. Structural violence as social practice: Haitian agricultural workers, anti-haitianism and health in the Dominican Republic. *Human Organization* 2010;69(1):10-8.
32. Martin P, Midgely E, Teitelbaum M. Migration and development: whither the Dominican Republic and Haiti. *International Migration Review* 2002;36(2):570-92.
33. Watch HR. Haitians and Dominico-Haitians in the Dominican Republic. *Illegal People*, 2002.
34. Wooding B, Moseley-Williams R. Inmigrantes haitianos y dominicanos de ascendencia haitiana en la Republica Dominicana. In: Internacionales ICplR, ed: Cooperacion Internacional para el Desarollo, 2004.
35. Bompanque D, LeDuc G, Vesenbeckh S, et al. Elimination of cholera transmission. *Lancet* 2012;379:e46-7.
36. Farmer P, Almazor CP, Bahnsen ET, et al. Meeting Cholera's Challenge to Haiti and the World: A Joint Statement on Cholera Prevention and Care. *PLoS Neglected Tropical Diseases* 2011;5(5):e1145.
37. Gerolomo M, Penna MLF. Cholera and living conditions, Brazil. *Revista de Saude Publica* 2000;34(4):342-7.
38. Birmingham ME, Lee LA, Ndayimirije N, et al. Epidemic cholera in Burundi: patterns of transmission in the Great Rift Valley Lake region. *Lancet* 1997;349:981-5.
39. Tauxe RV, Mintz E, Quick R. Epidemic Cholera in the New World: Translating Field Epidemiology into New Prevention Strategies. *Emerging infectious diseases* 1995;1(4):141-6.
40. Bartram J, Cairncross S. Hygiene, Sanitation and Water: Forgotten Foundations of Health. *PLoS medicine* 2010;7(11):e1000367.
41. Azurin JC, Alvero M. Field evaluation of environmental sanitation measures against cholera. *Bull World Health Organization* 1974;51:19-26.

42. Ackers M, Quick RE, Drasbeck CJ, et al. Are there national risk factors for epidemic cholera? The correlation between socioeconomic indices and cholera incidence. *International Journal of Epidemiology* 1998;27:330-4.
43. Talavera A, Perez EM. Is cholera disease associated with poverty? *J Infect Dev Countries* 2009;3(6):408-11.
44. Root ED, Rodd J, Yunus M, et al. The Role of Socioeconomic Status in Longitudinal Trends of Cholera in Matlab, Bangladesh, 1993-2007. *PLoS Neglected Tropical Diseases* 2013;7(1):1-11.
45. Emch M, Yunus M, Escamlla V, et al. Local population and regional environmental drivers of cholera in Bangladesh. *Environmental Health* 2010;9(2).
46. Foster J, Burgos R, Tejada C, et al. A community-based participatory research approach to explore community perceptions of the quality of maternal-newborn health services in the Dominican Republic. *Midwifery* 2010;26(5):504-11.
47. Foster JW, Chiang F, Burgos RI, et al. Community-based participatory research and the challenges of qualitative analysis enacted by lay, nurse, and academic researchers. *Research in nursing & health* 2012;35(5):550-9.
48. Oficina Nacional de Estadística. Perfil Provincial de Duarte. 2008.
49. Henderson A. Desk Review: Estimating Population Size in Emergencies. *Strengthening Emergency Needs Assessment Capacity (SENAC)*. Rome, Italy: United Nations World Food Program, 2006.
50. Koedeam A. Rapid estimation of affected population figures: Desk Review. Assessment Capacities Project (ACAPS), 2012.
51. SESPAS. Enfermedad Colera. In: Social SdEdSPyA, ed. Santo Domingo, Dominican Republic.
52. Vyas S, Kumaranayake L. Constructing socio-economic status indices: how to use principal component analysis. 2006.
53. Cox BG. The Weighted Sequential Hot Deck Imputation Procedure. Presented at Proceedings of the Survey Research Methods Section1980.
54. Andridge RR, Little RJA. A Review of Hot Deck Imputation for Survey Non-Response. *International Statistical Review* 2010;78(1):40-64.
55. Little RJA, Rubin DB. *Statistical Analysis with Missing Data*. 2nd ed. Hoboken, New Jersey: John Wiley & Sons; 2002.
56. Blocker FM. *Clorox and Canal Water: Characterizing Cholera Risk Factors for Haitian Migrants Living in the Dominican Republic*. Atlanta, Georgia: Rollins School of Public Health, Emory University; 2013.
57. Howard D. Development, racism and discrimination in the Dominican Republic. *Development in Practice* 2007;17(6):725-38.
58. Grady C, Younos T. Water Use and Sustainability in La Altagracias, Dominican Republic. In: Center VWRR, ed. Blacksburg, Virginia: Virginia Polytechnic Institute and State University, 2010.
59. VanDerslice J. All Coliforms Are Not Created Equal: A Comparison of the Effects of Water Source and in-House Water Contamination on Infantile Diarrheal Disease. *Water Resources Research* 1993;29(7):1983-95.
60. Quick R, Venezel LV, Mintz E, et al. Diarrhea Prevention in Bolivia through Point-of-Use Water Treatment and Safe Storage: A Promising New Strategy. *Epidemiol Infect* 1999;122(1):83-90.

61. Malavade SS, Narvaez A, Mitra A, et al. Cholera in Ecuador: Current Relevance of Past Lessons Learnt. *J Global Infect Dis* 2011;3(2):189-94.
62. Borroto RJ, Martinez-Piedra R. Geographical patterns of cholera in Mexico, 1991-1996. *International Journal of Epidemiology* 2000;29:764-72.
63. Collier S, Cobb N, Cortelyou C. Prospecting Infectious Disease Prevention through Water, Sanitation and Hygiene in a Dominican Batey. *Journal of Global Health* 2011;1(2):13-20.
64. Tavernier LA. The Stigma of Blackness: Anti-Haitianism in the Dominican Republic. *Socialism and Democracy* 2008;22(3):96-104.
65. Bartlett L, Jayaram K, Bonhomme G. State literacies and inequality: Managing Haitian immigrants in the Domincan Republic. *International journal of Educational Development* 2011;31:587-95.
66. Briggs CL. Modernity, Cultural Reasoning and the Institutionalization of Social Inequality: Racializing Death in a Venezuelan Cholera Epidemic. *Comparative Studies in Society and History* 2001;43(4):665-700.
67. Hunter PR, MacDonald AM, Carter RC. Water supply and health. *PLoS medicine* 2010;7(11):e1000361.
68. Leventhal S. A Gap Between Ideals and Reality: The Right to Health and the Inaccessibility of Healthcare for Haitian Migrant Workers in the Dominican Republic. *Emory International Law Review* Forthcoming
69. Hubley JH. Barriers to health education in developing countries. *Health Education Research* 1986;1(4):233-45.
70. Lasseter JH, Callister LC. The Impact of Migration on the Health of Voluntary Migrants in Western Society: A Review of the Literature. *J Transcult Nurs* 2009;20(1):93-104.
71. DeSanits L, Thomas JT. Health education and the immigrant Haitian mother: cultural insights for community health nurses. *Public Health Nurs* 1992;9(2):87-96.
72. Waldman RJ, Mintz E, Papowitz HE. The Cure for Cholera -- Improving Access to Safe Water and Sanitation. *New England Journal of Medicine* 2013;368(7):592-4.
73. Cairncross S, Bartram J, Cumming O, et al. Hygiene, sanitation, and water: what needs to be done? *PLoS medicine* 2010;7(11):e1000365.
74. Walker I, Velasquez M. Regional Analysis of Decentralization of Water Supply and Sanitation Services in Central America and the Dominican Republic. *Activity Report No 65*. Washington, D.C.: U.S. Agency for International Development, 1999.
75. International R. Evaluation of USAID Strategy to Increase Potable Water Access and Sanitation in Rural Areas. Research Triangle Park, NC, 2006.
76. Quick R, Thompson BL, Zuniga A, et al. Epidemic cholera in rural El Salvador: risk factors in a region covered by a cholera prevention campaign. *Epidemiol Infect* 1995;114:249-55.
77. Beau De Rochars VE, Tipret J, Patrick M, et al. Knowledge, attitudes, and practices related to treatment and prevention of cholera, Haiti, 2010. *Emerging infectious diseases* 2011;17(11):2158-61.
78. Einarsdottir J, Passa A, Gunnlaugsson G. Health Education and Cholera in Rural Guinea-Bissau. *Int J Infect Dis* 2001;5:133-8.
79. Crouse HL, Macias CG, Cruz AT, et al. Utilization of a mobile medical van for delivering pediatric care in the bateys of the Dominican Republic. *International Journal of Emergency Medicine* 2010;3(4):227-32.

80. Wagner EG, Lanoix JN. Excreta Disposal for Rural Areas and Small Communities. *Monograph series No 39*. Geneva World Health Organization, 1958.

Table 1. Summary of characteristics and survey counts for each of sampled communities

Community	Municipality	Setting	Cholera Reported[a]	Surveys		
				Total	Spanish	Kreyòl
Las Mercedes	Castillo	Urban	NA	20	20	0
Barrio El Carmen	Castillo	Urban	NA	20	0	20
Pueblo Nuevo	Las Guaranas	Rural	NA	21	11	10
Las Mercedes	Las Guaranas	Rural	NA	20	10	10
La Enea	Las Guaranas	Rural	NA	20	10	10
Los Limones	Pimentel	Rural	NA	20	10	10
Caobete	Pimentel	Rural	NA	20	12	8
San Martin	SFM	Urban	Yes	23	7	16
Hermanas Mirabal	SFM	Urban	Yes	20	20	0
Santa Ana	SFM	Urban	Yes	20	20	0
Vista del Valle	SFM	Urban	No	21	21	0
Los Chiripos	SFM	Urban	No	20	20	0
La Espinola	SFM	Urban	No	19	19	0
Ventura Grullon	SFM	Urban	Yes	22	22	0
La Ceniza	SFM	Urban	Yes	20	20	0
24 de abril	SFM	Urban	No	18	18	0
El Caimito	SFM	Rural	Yes	19	10	9
Los Rieles	SFM	Urban	Yes	20	10	10

[a] Community-level data available only for municipality of San Francisco de Macoris. NA indicates non-SFM communities for which community-level data were not available

Table 2. Demographic frequencies of surveyed households stratified by self-reported nationality

	Dominican N (%)	Haitian N (%)	p-value[a]
Geographic Setting			
Urban	197 (51.7)	63 (34.5)	< 0.05
Household Size			
1-2 people	51 (20.6)	33 (31.1)	REF
3-5 people	168 (64.6)	56 (54.3)	0.18
6+ people	41 (14.7)	13 (13.1)	0.78
Respondent Age			
18-24	35 (16.2)	29 (24.1)	REF
25-34	64 (24.5)	46 (49.0)	< 0.05
35-44	62 (20.9)	19 (19.3)	0.80
45-54	29 (9.9)	3 (3.2)	0.06
55+	70 (28.5)	5 (3.4)	< 0.05
Respondent Gender			
Female	199 (64.3)	42 (4.2)	< 0.05
Respondent Education			
None	30 (12.3)	15 (14.3)	REF
Primary	120 (49.4)	60 (56.3)	0.41
Secondary +	110 (38.3)	28 (29.4)	0.28
Socioeconomic Quintile			
Lowest Two	45 (18.6)	93 (93.1)	REF
Middle	68 (26.5)	8 (6.6)	< 0.05
Highest Two	146 (54.9)	2 (0.4)	< 0.05

[a] Rao-Scott Chi-Square

Table 3. Frequencies and bivariate associations between cholera risk factor and self-reported nationality

	Dominican[1] N (%)	Haitian N (%)	cOR	p-value
Symptom Knowledge				
Diarrhea	205 (78.4)	52 (47.2)	0.25	< 0.01
Nausea	158 (56.4)	34 (39.7)	0.51	0.05
Dehydration	53 (18.7)	3 (1.5)	0.07	< 0.01
Stomach ache	65 (65.0)	7 (2.5)	0.08	< 0.01
Don't Know	31 (13.0)	38 (40.4)	4.53	< 0.01
Transmission Knowledge				
Drink contaminated water	151 (54.0)	52 (55.8)	1.07	0.83
Eat contaminated food	144 (51.0)	38 (32.2)	0.46	0.02
Not washing food	117 (48.5)	24 (32.0)	0.50	0.06
Not washing hands	169 (65.2)	39 (34.4)	0.28	< 0.01
Don't Know	25 (9.7)	36 (27.0)	3.45	< 0.01
Overall Knowledge				
None (0)	21 (7.9)	28 (23.8)	3.64	< 0.01
Low (1-4)	135 (52.6)	61 (63.5)	1.57	0.17
High (5-8)	104 (39.5)	14 (12.7)	0.22	< 0.01
WASH Infrastructure and Practices				
Improved Water Source	40 (19.8)	27 (20.2)	1.06	0.87
Improved Sanitation Facility	184 (70.5)	37 (37.9)	0.27	< 0.01
Hand washing Facility	122 (42.0)	28 (31.5)	0.65	0.23
Treat Drinking Water	51 (21.7)	16 (5.5)	0.21	< 0.01
Store Drinking Water	219 (87.2)	75 (83.0)	0.72	0.37
Soap Present in Home	98 (33.4)	21 (16.0)	0.37	0.01
Bathe in River or Canal	4 (1.5)	17 (35.4)	35.32	< 0.01
Drink from River or Canal	1 (0.04)	8 (23.4)	778.54	< 0.01

[1] Reference category for cOR calculations

Table 4. Demographic and risk factor frequencies stratified by urban-rural geography

	Urban[2] (n = 243)	Rural (n = 120)		
Variable	N (%)	N (%)	cOR	p-value
Nationality				
Haitian	46 (5.6)	57 (23.8)	5.26	< 0.01
Education				
None	27 (10.2)	18 (15.5)	REF	REF
Primary	109 (43.4)	71 (58.8)	0.89	0.8
At least Secondary	107 (46.5)	31 (25.7)	0.36	0.04
SES Quintile				
Lowest Two	76 (23.7)	62 (35.2)	REF	REF
Middle	53 (26.0)	23 (22.2)	0.61	0.23
Highest Two	113 (51.3)	35 (42.6)	0.57	0.12
Knowledge				
None	29 (11.0)	20 (9.1)	REF	REF
Low	125 (49.3)	71 (59.9)	1.46	0.34
High	89 (39.8)	29 (31.0)	0.94	0.88
WASH Access				
Water	30 (12.4)	37 (28.9)	2.87	< 0.01
Sanitation	172 (80.4)	49 (49.4)	0.23	< 0.01
Hygiene	95 (41.4)	24 (18.1)	0.33	< 0.01

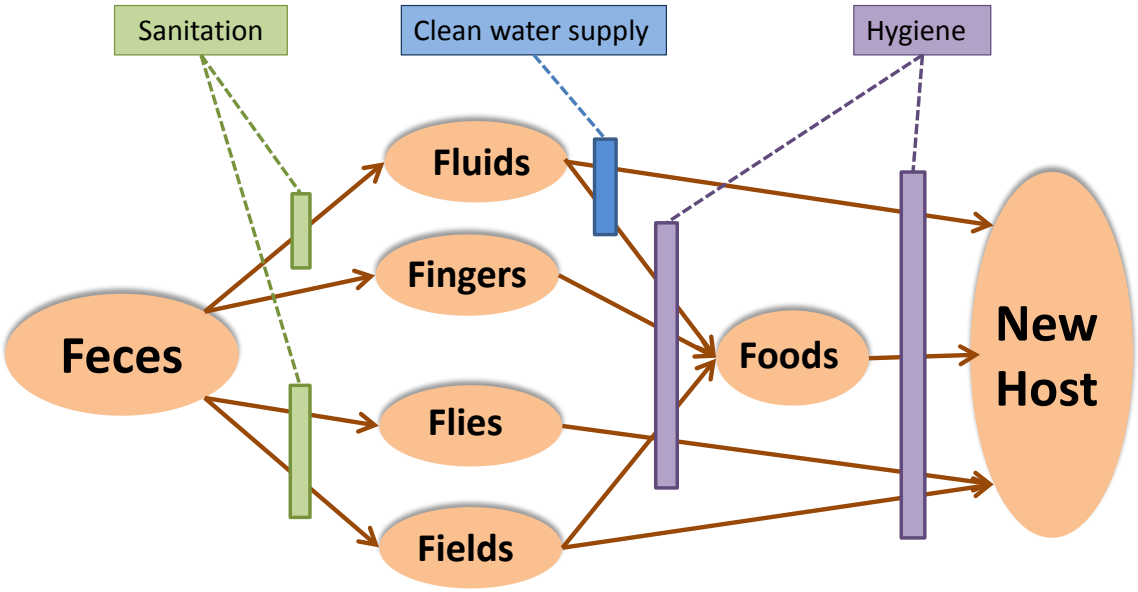
[2] Reference category for cOR calculations

Table 5. Adjusted odds ratios and 95% confidence intervals measuring association between cholera risk factors and nationality (Haitian vs. Dominican) controlling for urban/rural geography, education and socioeconomic status. Including overall and stratum-specific estimates for urban-rural effect modification

	Overall		Urban		Rural		
Outcome	aOR	95% CI	aOR	95% CI	aOR	95% CI	p-value[a]
Water	0.77	0.46, 1.27	0.21	0.05, 1.01	0.05	0.002, 1.02	0.05
Sanitation	1.00	0.57, 1.76	2.45	0.67, 8.97	5.99	0.45, 80.48	0.18
Hygiene	1.78	1.07, 2.96*	6.57	1.72, 25.17	43.18	2.94, 633.4*	0.01
Knowledge[b]	0.66	0.55, 0.81*	0.94	0.65, 1.23	0.88	0.30, 1.46	0.67

*indicates significance at $\alpha = 0.05$, [a] Wald test for effect modification, [b] adjusted rate ratio (aRR)

Figure 1. Transmission pathways of fecal-oral pathogens and points of water, sanitation and hygiene intervention



Source: (80)

Figure 2. Locations of surveyed municipalities in the Duarte Province, Dominican Republic

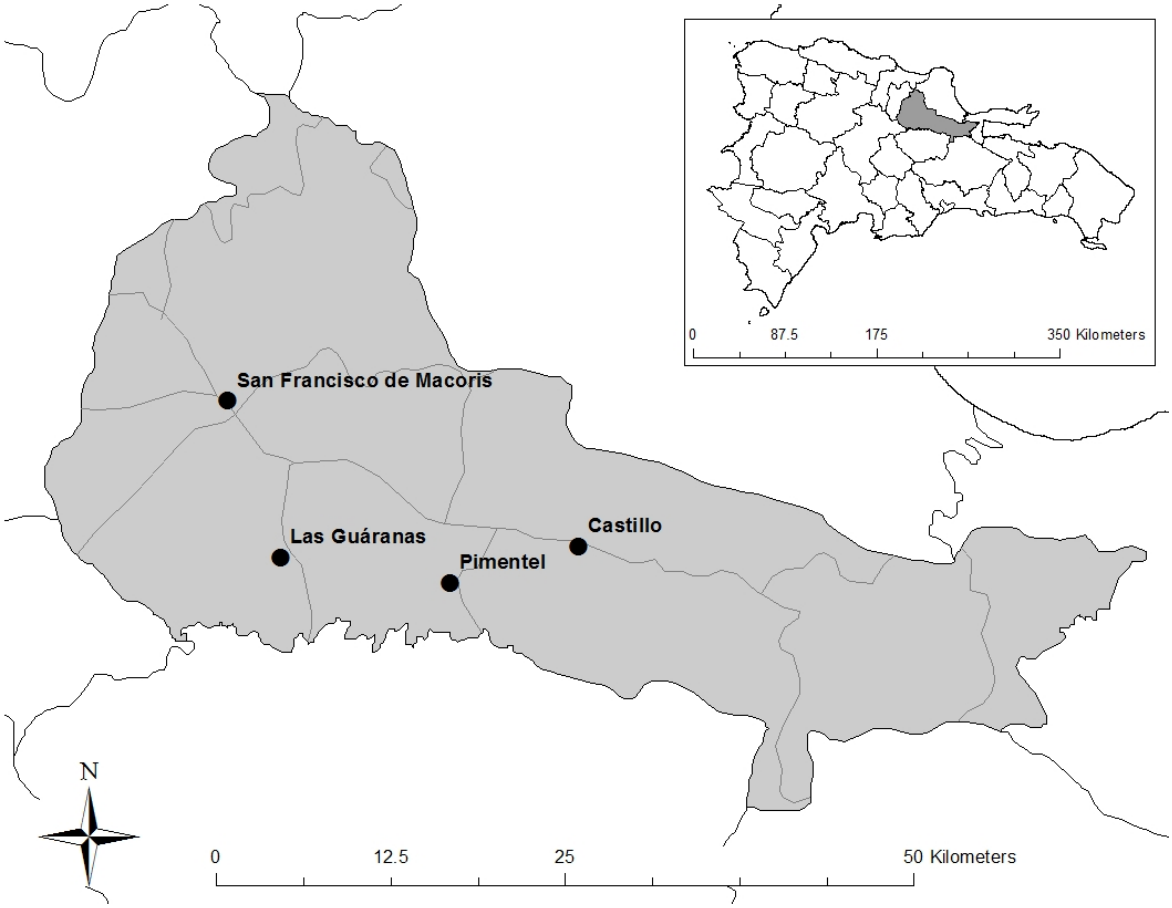
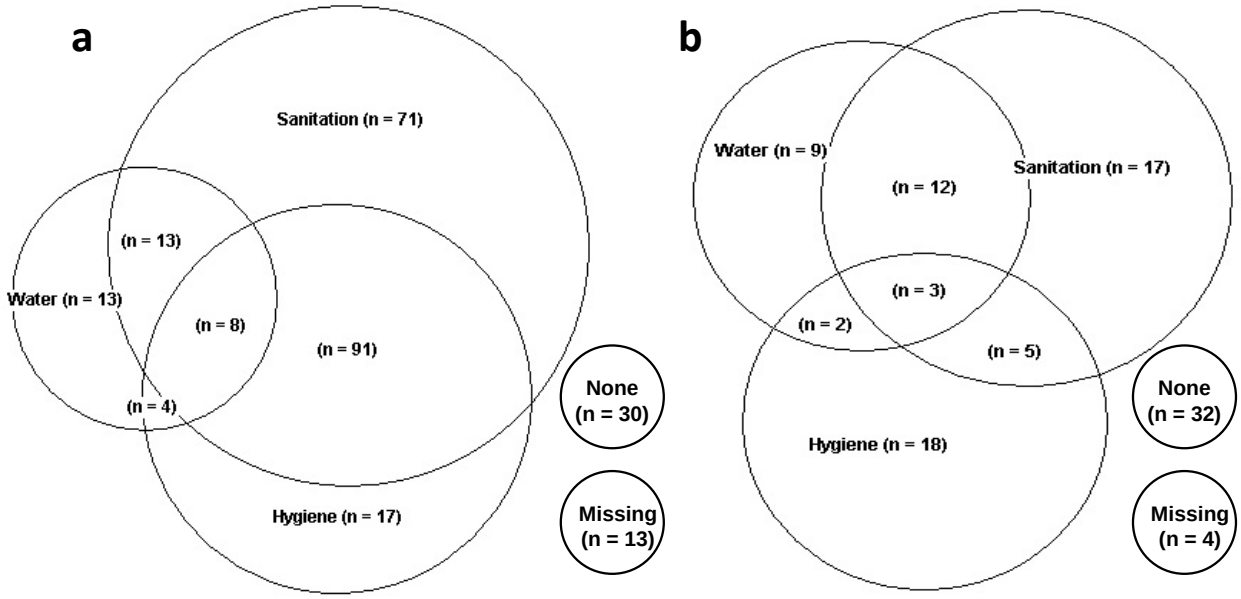


Figure 3. Access to household WASH facilities among (a) Dominicans and (b) Haitians



Appendix A: Survey Instrument

A. Informed Consent		
Hello, my name is _____. I am working on a research Project with Emory University and the Universidad Autónoma de Santo Domingo. The research investigates the knowledge, attitudes and practices of community members towards cholera. If you agree to participate, I will ask you a series of questions about what you know about cholera, the water you a drink and sanitary facilities you use. Some questions may be uncomfortable, but your participation is completely voluntary and the collected data will be completely anonymous. You are free to withdraw from the study at any time.. o Yes, participant gives consent to participate Initials of interviewer: _____		
B. Demographic Data		
B10.	How old are you?	___ ___ years
B20.	**Observación:** Participant gender	o Male [0] o Female [1]
B30.	What is the primary language spoken in your home?	o Spanish [1] o Kreyól [2] o Spanish and Kreyól [3]
B40.	Educational level achieved by participant:	o None or illiterate [0] o Primary (1-5) [1] o Intermediate (6-8) [2] o Secondary (9-12) [3] o University (>12) [4]
B50.	What is the educational level of the person with highest level of educational achievement in the household?	o None or illiterate [0] o Primary (1-5) [1] o Intermediate (6-8) [2] o Secondary (9-12) [3] o University (>12) [4]
B60.	How many currently people sleep and live in the household?	___ ___ people
B70.	How many children under 5 years of age currently live and sleep in the household?	___ ___ children under 5
C. Knowledge of Cholera		
D10.	Can you tell me what the symptoms of cholera are?	**Do not read options, listen to participant's answers and mark all that apply:**

		o Diarrhea [D11] o Nausea [D12] o Fever [D13] o Dehydration [D14] o Lack of appetite [D15] o Fatigue [D16] o Stomach ache [D17] o Headache [D18] o Don't know [D19]	
D20.	Is diarrea from cholera distinct from other kinds of diarrea?	o Yes [1] o No [0]	o Don't know [9]
D30.	What is the main way a person can become sick with cholera?	**Do not read options, listen to participant's response and mark the answer (<u>only one</u>) that applies:** o Drink contaminated or untreated water [1] o Eat raw or undercooked food [2] o Not washing food before eating [3] o Through the air [4] o Through mosquitoes or insects [5] o Not washing hands, lack of hygiene [6] o Swim or bathe in contaminated water [7] o Shaking hands [8] o Contact with someone who has been in Haiti [9] o Contact with a Haitian [10] o Witchcraft [11] o Eating contaminate seafood [12] o Other (specify: _____) [13] o Don't know [99]	
D40.	What are other ways **(plural)** that a person can become sick with cholera?	**Do not read options, listen to participant's responses and mark all that apply:** o Drink contaminated or untreated water [D41] o Eat raw or undercooked food [D42] o Not Through the air [D44] o washing food before eating [D43] o Through mosquitoes or insects [D45] o Not washing hands, lack of hygiene [D46]	

		o Swim or bathe in contaminated water [D47] o Shaking hands [D48] o Contact with someone who has been in Haiti [D49] o Contact with a Haitian [D50] o Witchcraft [D51] o Eating contaminated seafood [D52] o Other (specify: _____) [D53] o Don't know [D99]

E. Healthcare Seeking

E10.	Has someone in your household been sick with cholera in the last 18 months? **Definition of a case of cholera: sudden onset of frequent, liquid diarrhea with a rice water consistency ; sometimes accompanied by nausea, vomiting and stomach ache**	o Yes [1] o No [0] **(--> E20)**

If there have been a case of cholera, please tell me the age and sex of the person who got sick with cholera and if and where they sought medical attention:

	a. Age		b. Sex	c. Sought medical attention?	d. Where sought?
E11.	___ ___	o years o months	o Female [1] o Male [0]	o Yes [1] o No [0]	o UNAP [1] o Municipal hospital [2] o Regional hospital [3]
E12.	___ ___	o years o months	o Female [1] o Male [0]	o Yes [1] o No [0]	o UNAP [1] o Municipal hospital [2] o Regional hospital [3]

E20.	How far is the nearest health center form your house?	___ ___ ___ meters **(one block = 100 meters)**
E30.	How long does it take you to travel to the nearest Health center from your house?	___ ___ ___ minutes _____ hours
E40.	What type of transportation do you most frequently use to travel to the health center?	o Walk [1] o Bicycle [2] o Motorcycle [3] o Public transportation [4] o Personal vehicle [5]
E50.	In the last month, have your or another member of your household gone to the health	o Yes [1]

	center?	o No [0] **(--> E70)**
E60.	How would you rate the care you received?	<u>Care in general</u> o Excellent [1] o Very good [2] o Good [3] o Acceptable [4] o Bad [5] o Not applicable [6] <u>Care for diarrhea</u> o Excellent [1] o Very good [2] o Good [3] o Acceptable [4] o Bad [5] o Not applicable [6]
E70.	Has anyone in your household been sick and not been able to seek health care?	o Yes [1] o No [0] **(--> E80)**
E80.	What were the reasons for which that person did not seek care in a health center?	**Marque todas que corresponden:** o Cost of care [E81] o Lack of transportation [E82] o Prefer home care [E83] o Lack of legal documentation [E84] o Waiting time [E85] o Other (specify: _____) [E86]
E90.	**Where do you receive new or information about cholera?**	**Marque all that apply for each country where information about cholera was received:**

In DR [E91]	**In Haiti [E92]**
• Television [a]	• Television [a]
• Radio [b]	• Radio [b]
• Brochures [c]	• Brochures [c]
• Newspaper [d]	• Newspaper [d]
• Neighbors [e]	• Neighbors [e]
• Mobile phone [f]	• Mobile phone [f]
• Health personnel [g]	• Health personnel [g]
• Community	• Community meeting

		meeting [h] • Church [i] • Truck with megaphone [j] • Other (specify: _____) [k]	[h] • Church [i] • Truck with megaphone [j] • Other (specify: _____) [k]
F. Socioeconomic Indicators			
F10.	How many rooms are in the house?	___ ___ rooms	
F20.	How many rooms are used for sleeping?	___ ___ rooms	
F30.	**Observation in middle class houses:** Is a maid employed in the house?	o Yes [1] o No [0]	
F40.	Does anyone in the household own agricultural land?	o Yes [1] o No [0]	
F50.	**Observatoin:** Does someone in the household own farm animals, such as chickens, cows, pigs or doves?	o Yes [1] o No [0]	
F60.	What type of fuel is used in the household for cooking?	**Mark all that apply:** o Gas [F61] o Wood [F62] o Electricity [F63] o Charcoal [F64]	
F70.	Does the household have the following assets?	**Marque todos que apliquen:** o Electricity [F71] o Radio [F72] o Television [F73] o Computer [F74] o Cellular phone [F75] o Residential phone [F76] o Refrigerator [F77] o Microwave [F78] o Stove [F79] o Cooling fan [F80] o Washing machine [F81] o Bicycle [F82]	

		o Car [F83] o Motorcycle [F84]
G. Migration and Documentation History		
G10.	Where were you born?	o Dominican Republic [1] o Haiti [2]
G20.	How do you identify yourself in this country?	o Dominican [1] o Haitian [2]
G30.	How do others identify you in this country?	o Dominican [1] o Haitian [2]
G40.	**If participant is Domincan:** Do you have a cédula?	o Yes [1] o No [0]
G50.	**If participant is Haitian:** Do you have a legal document in the Dominican Republic?	o Yes [1] o No [0]
G60.	**If participant is Haitian:** In your opinion, if a Haitian does not have legal papers in the Dominican republic, is it more difficult to seek health care services?	o Yes [1] o No [0]
G70.	**If participant is Haitian:** do you experience discrimination in your community?	o Yes [1] o No [0]
G80.	How long have you lived in the Dominican Republic?	___ ___ years ___ ___ months
G90.	**If participant is Haitian:** When was the last time you went to Haiti?	___ /___ /___ DD / MM / YY
H. WASH Access and Practices		
H10.	What is the **principal** source of drinking water for members of your household?	**Mark a single response:** o Piped water inside the home [1] o Piped water outside the home [2] o Rainwater [3] o Tanker truck [4] o Bottled water [5] o Protected well [6] o Unprotected well [7] o Surface water (river, lake, canal) [8] o Other (specify:_____) [9]

H20.	Do members of your household regularly use another source of drinking water?	o Yes [1] o No [0] **(--> H40)**	
H30.	What are the other sources of water that members of your household regularly use?	**Mark all that apply:** o Piped water inside the home [1] o Piped water outside the home [2] o Rainwater [3] o Tanker truck [4] o Bottled water [5] o Protected well [6] o Unprotected well [7] o Surface water (river, lake, canal) [8] o Other (specify:_____) [9]	
H40.	In the last week, have you drunk water from a river or canal?	o Yes [1] o No [0]	
H50.	Do you treat water in any way to make it safer to drink?	o Yes [1] o No [0] **(--> H60)**	
H50a.	How do you treat drinking water?	**Marquen todos que apliquen:** o Chlorine [H51] o Boiling [H52] o Filtration (sand, ceramic, etc.) [H53] o Fabric filter [H54] o Exposure to UV [H55] o Let it settle [H56] o Lemon [H57]	
H50b.	How drops of chlorine do you add to every gallon of water?	___ ___ drops	o Don't know [99]
H50c.	How many minutes do you wait before drinking water after adding chlorine?	___ ___ minutes	o Don't know [99]
H60.	In the last week, have you swam, bathed or worked in the canal?	o Yes [1] o No [0]	
H80.	Where do members of your household go to the bathroom?	o Latrine [1] o Toilet [2] **(--> H80b)** o No service available **[**4] **(--> H90)**	
H80a.	Does the latrine have a slab?	o Yes [1] o No [0]	

H80b.	Do you share this facility with people who do not live in your household?	o Yes [1] o No [0]	
H80c.	Can you show me where members of your household go to the bathroom?	o Yes [1] o No [0] **(--> H90)**	
H80d.	**Interviewer observation:** What type of facility is it?	**Mark a single response:** o Private toilet [1] o Shared toilet [2] o Private latrine with slab [3] o Private latrine without slab [4] o Shared latrine with slab [5] o Shared latrine without slab [6] o No service available [8] o Not observed [9]	
H80e.	**Interviewer observation:** Is fecal matter present on floor, seat or walls of the facility?	o Yes [1] o No [0] o Not observed [9]	
H90.	Do you have a place to wash your hands?	o Yes [1] o No [0] **(--> H100)**	
H90a.	Can you show me where you wash your hands?	o Yes [1] o No [0]	
H90b.	**Interviewer observation:** Is the hand washing facility within 10 steps of the toilet facility?	o Yes [1] o No [0]	
H90c.	**Interviewer observation:** Is there soap in the hand washing facility?	o Yes [1] o No [0]	o Not observed [9]
H90d.	**Interviewer observation:** Is there a towel for drying hands at the hand washing facility?	o Yes [1] o No [0]	o Not observed [9]
H100.	Do you store water in your household? ¿	o Yes [1] o No [0] **(--> I10)**	
H100a.	Can you show me where you store water in your house?	o Yes [1] o No [0]	
H100b.	**Interviewer observation:** Does the storage vessel have a tap or spigot?	o Yes [1] o No [0]	

H100c.	**Interviewer observation:** Is the storage vessel kept covered?	o Yes [1] o No [0]	o Not observed [9]
H100d.	**Interviewer observation:** Does the storage vessel have a narrow mouth?	o Yes [1] o No [0]	o Not observed [9]
H100e.	What do you use stored water for?	**Mark all that apply:** o Drinking [H100e1] o Cooking [H100e2] o Bathing [H100e3] o Washing clothes [H100e4] o Cleaning [H100e5]	
H100f.	How do you retrieve water from the storage vessel?	o Ladle (or utensil with handle)[1] o Cup (or utensil without handle) [2] o Tap or spigot [3] o Pouring [4] o Other (specify: _____)[5]	
	I. Household Observations		
I10.	What is the primary floor material?	o Concrete [1] o Tile [2] o Wood [3] o Dirt [4] o Ceramic [5]	
I20.	What is the primary roof material?	o Tile/shingle [1] o Thatched/straw [2] o Madera [3] o Zinc/corrugated metal [4] o Concrete [5]	
I30.	What is the primary material of the exterior walls?	o Concrete/block [1] o Wood [2] o Zinc/corrugated metal [3]	