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**WATER, SANITATION, AND HYGIENE SERVICES BEYOND 2015:
IMPROVING ACCESS AND SUSTAINABILITY**

Changes in pediatric diarrhoea and infant mortality rates after a large scale WASH program in Honduras

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Using longitudinal data from records obtained from the Honduras Department of Public Health, paediatric diarrhoea and infant mortality rates were tracked over a six year period during which a large scale WASH intervention occurred in the Department of Colón, Honduras. Rates of paediatric diarrhoea and infant mortality from Colón were compared to national rates as well as a nearby department matched by using the Human Development Index. Both paediatric diarrhoea and infant mortality dropped significantly faster in Colón than in the control department and the national rates, supporting local assertions of the impact of such large scale interventions on childhood health and survival.

Introduction

In 2006, Water Missions International (WMI), a faith-based, non-profit engineering organization that provides sustainable water treatment capacities and sanitation facilities for people in developing countries, received a grant from the Pentair Foundation to provide safe water source access and toilet systems to the department of Colón, Honduras. Colón, one of eighteen departments composing Honduras, has a population of approximately 340,000 people and has historically been one of the poorest departments in the country. For all households that lacked adequate sanitation facilities and agreed to assist in installation, sanitary pit latrines with pour-flush toilets (toilets with water traps and no reservoir that are flushed by pouring a bucket of water into the basin) were provided. The water treatment technology uses a combination of multimedia, multistage filters and chlorination to provide treated water for drinking and cooking that meets the most stringent class of WHO drinking water standards. In addition, WMI implemented community development programs that included education and microenterprise strategies to insure sustainability of these interventions.

In the baseline study phase of the project, water sources for 613 communities were identified. Various water quality measurements were taken from the community water sources by standard membrane filter test. High counts of coliform bacteria indicative of fecal contamination were found in 100% of the water sources. As previously reported, initial stool tests also showed 29.3% (53 of 181) of volunteer subjects from the twelve communities that had been randomly selected from the state of Colón carried at least one waterborne, protozoan parasite (Deal, Nazar, et al. 2010). Also as reported previously, after installation of the facilities the prevalence of positive protozoan parasite levels was significantly lower in the intervention group as compared to the test group (Deal 2011). Even greater reduction of disease rates (at least 52%) were noted in the medical chart reviews of visits to the local health facility for diarrhoea and dysentery as well as self-reporting of the same diseases via ethnographic interviews. Ethnographic data further suggested widespread acceptance and community-wide reproduction of the awareness of health benefits derived from consuming treated water.

Upon completion, the project provided access to water to approximately 257,377 people of the department in the form of 203 community-managed water treatment systems. The population that did not have access to the water treatment systems resided primarily in small, rural communities that were too small (<800 individuals) to support and maintain the system or resided in one of the two urban centers. In addition,

15,652 poor-flush latrines with cement superstructures were constructed serving approximately 103,303 people. In all communities, WASH training was provided with regular follow-up for at least one year.

Prompted by verbal reports from local officials of health improvements attributed to the project, WMI received a grant from the Pentair Foundation to review the public health records for pediatric diarrhoea and infant mortality rates of the country, the department of Colón, and a department matched by appropriate indicators.

Methods and materials

Permissions from the Honduras Department of Health (HDOH) and the Colón Department of Health were obtained to review all pertinent public health records from 2004 forward. This included pediatric diarrhoea rates at both the national and department level from 2004 until 2012, as well as infant mortality rates for 2005 and 2011 (the years such data was collected).

Gracias A Dios was selected as a control department based upon the Human Development Index (HDI) as published by the United Nations Development Programme (UNDP) for 2004—the year closest to the project start time. The HDI is a geometric mean of normalized indices for three critical developmental dimensions—health, education, and per capita income. (United Nations Development Programme 2015) In 2004, the UNDP gave nearly identical HDI's for both Gracias A Dios (.636) and Colón (.635). Gracias A Dios shares a border with Colón and is also a coastal department.

Infant mortality rates (deaths per thousand for infants less than one year of age) were available for the entire country as well as Colón for the years 2005 and 2011. Infant mortality data for Gracias A Dios was not collected by the public health officials prior to 2011. All data was scanned or photographed, then transcribed into spreadsheets. Over 34,000 data points were included and where appropriate subjected to linear regression analysis.

Findings

From 2005 until 2012, Honduras experienced a country-wide reduction in pediatric diarrhoea rates. Some of this reduction may be due to the institution of a rotavirus vaccination program that was implemented in all departments in 2009 (Ulloa-Gutierrez and Avila-Aguero 2014). Colón experienced a reduction in pediatric diarrhoea at a rate significantly greater ($p < .005$) than found in either the national rates (Figure 1) or in the control department of Gracias A Dios (Figure 2). HDOH officials reported to us that infant mortality data for Gracias A Dios was not collected until 2011, therefore longitudinal comparisons between departments for this measurement was not possible. In 2011, however, the infant mortality rate in Colón was 62.7% less than the rate found in Gracias A Dios (19 per thousand vs 51 per thousand). Also, Colón experienced a drop in infant mortality rates that was almost twice as great as the national trend (15.6% vs 29.6%) as seen in Table 1.

While a cause and effect for these favorable trends cannot be definitively established with this type of study, the trend toward a decrease in diarrhoea rates seen in Colón follows closely with the cumulative number of the population served by water treatment systems and by total access to latrines (Figure 3).

Conclusions

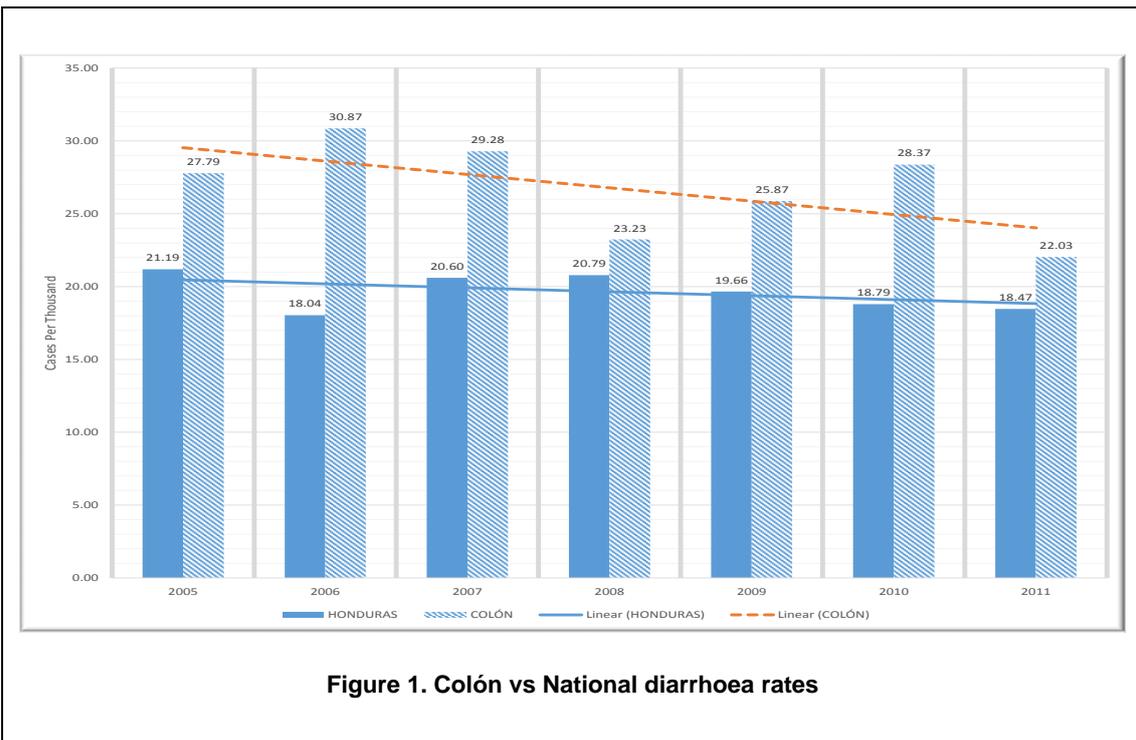
The broad array of causes of diarrhoea and infant mortality which are unrelated to water and hygiene create an equally broad array of potential confounding variables in this study. These include regional fluctuations in disease rates, socioeconomic changes, vaccinations (especially for rotavirus), and variations in reporting accuracy. While complete control of these variables is not possible, they are reasonably mitigated by comparing trends in Colón over time with identical indicators in the country as well as the control department, Gracias A Dios. In all cases, the trends toward improvement were greatest in Colón.

This study confirms verbal reports from Colón public health officials that the pediatric diarrhoea rates as well as the infant mortality rate of Colón have significantly decreased over the time that widespread installation of safe water treatment facilities as well as flush latrines were installed by WMI. When compared to national disease and mortality rates, the difference is statistically significant with a $p < .005$. Compared to the control department (Gracias A Dios), the differences were even more profound with a $p < .001$. These findings sharply contrast with similar work by WMI in Uganda where no discernable health impacts were found in communities with identical water treatment facilities (Deal, Massa, et al. 2014). Any of a great number of causes of the differences are possible. Of most interest is that the knowledge of waterborne diseases and their causes found in communities in Uganda was higher than that found in

Honduras where the impact appears greater. This has profound implications in community development strategies which often continue to depend heavily upon learning models to encourage behavior change with little attention being given to the many other social determinates of health (Irwin and Scali 2010).

While firm conclusions cannot be drawn from this study, these findings provide a significant level of support for the contention from Honduran public health officials that disease rates for Colón were profoundly improved by the availability of community-based water treatment facilities widespread installation of flush toilets. As one measure, had the infant mortality rate in Colón continued upon the national track rather than that which was observed (15.6% decrease rather than 29.6% decrease), at least 40 more newborns would have died per year than was observed.

Table 1. Infant mortality per thousand			
	Colón	Gracias A Dios	Honduras
2005	27.0	N/A	29.25
2011	19.0	51	24.7
Percent Change	29.6%		15.6%



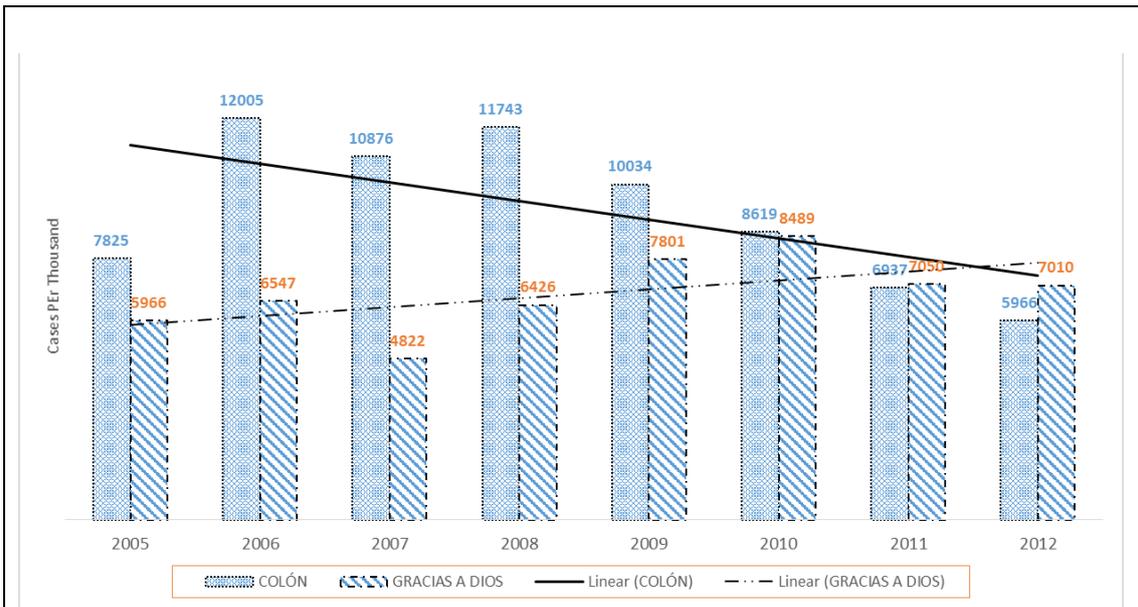


Figure 2. Colón Vs Gracias a dios diarrhoea rates

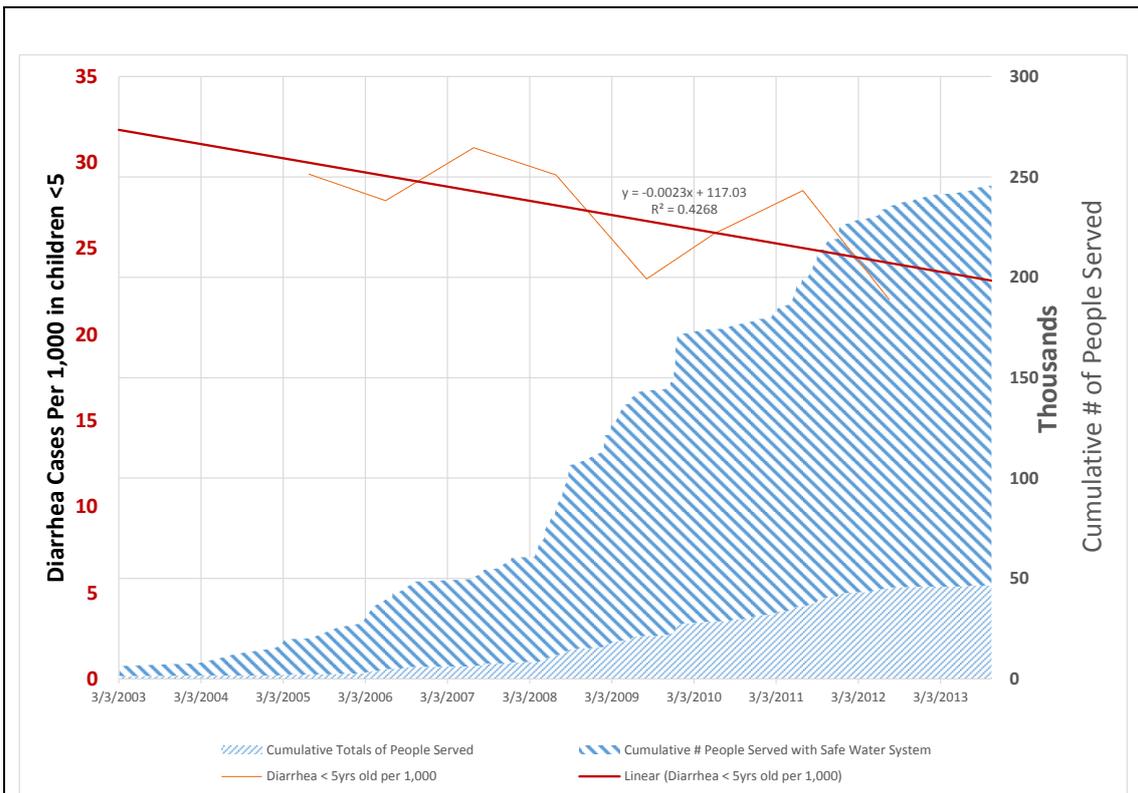


Figure 3. Under age 5 diarrhoea rates and population served by water treatment

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