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Changes in childhood malnutrition and mortality after institution of a Community Health Worker program in four rural Guatemalan villages

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January 2008

Abstract

While community health workers (CHWs) are being implemented in several developing countries, there has been little work done to evaluate their effectiveness in reducing childhood malnutrition among participating communities. Our study evaluates the effectiveness of CHWs in three Guatemalan villages by comparing anthropomorphic measures and mortality rates of children under five before and after the implementation of a CHW program. While one community showed no significant change in malnutrition rates in terms of height-for-age calculations, two other communities showed improved malnutrition rates in terms of height-for-age. Weight-for-age comparisons were not statistically significant, and while childhood mortality remained unchanged in one community, there was a 5% improvement in childhood mortality for the other communities combined.

Introduction

Historically, the Guatemalan government has attempted to reduce childhood mortality rates by targeting easily treatable diseases. In 1977 the World Health Authority (WHA) decided unanimously that the target of member governments and the World Health Organization (WHO) should be "the attainment by all citizens of the world by the year 2000 of a level of health that will permit them to lead a socially and economically productive life."[1] Although there has been much discussion on how to achieve these goals, particularly strong movements have been made toward a more communally based health care approach.[2] Primary health care, as defined by WHA documents, can be broken down into a list that includes:

1. Health education

2. Environmental sanitation, especially of food and water

3. The employment of community or village health workers

4. Maternal and child health programs, including immunization and family planning

5. Prevention of local and endemic diseases

6. Appropriate treatment of common diseases and injuries

7. Provision of essential drugs

8. Promotion of nutrition

9. Traditional medicine[1]

In other words, the WHA advocates a health care system that emphasizes health education, environmentalism, treatment of common diseases with inexpensive and easily obtainable medications, and the empowerment of citizens not only with education but also with the basic medical training needed to treat common diseases. Unfortunately, using the specific framework laid out by the WHA, it was found that in Central America the political will did not exist to support such systems, and more importantly "the cultural milieu in which Central Americans interact with their society fosters an individualistic, commercial, and paternalistic citizen/society relationship rather than the cooperative, community-oriented and democratic spirit needed for successful development of

integrated local health systems."[3] One positive outcome, however, was the institution of primary health care workers and some isolated examples showed positive results.[3]

In 1994, the government of Guatemala began to restructure its health system, with the goal of changing not only the deleterious effects of disease, but also their fundamental causes. This initiative was further supported by the Peace Accords of 1996.[4] Previously, Guatemala's health sector consisted of public and private institutions, non-governmental organizations, and a sector of traditional medicine surviving from the Mayan culture. Because less than 60% of the population had some form of health service coverage under this system, and because this percentage had not changed significantly since 1990, the government designed a Comprehensive Health Care System (SIAS) which is currently being implemented.[4]

The goal of SIAS is to provide basic health care to the entire population that is without access, using existing resources and community organization and participation to achieve this purpose. Under SIAS, the Guatemalan Ministry of Health contracts out to NGOs to extend health services to those that would otherwise not receive them. Specific, simplified, and ongoing health services are provided by community volunteers, under the support and supervision of institutional personnel. SIAS has implemented the Pan American Health Organization program's *Atención Integrada a las Enfermedades Prevalentes de la Infancia (AIEPI)* community health worker training program. Unlike traditional health personnel, these volunteers work closely with the community, and are trained by a health team to provide them technical, logistic, and decision-making support.

These community volunteers are trained in:

- care of pregnant women through prenatal monitoring, administration of tetanus toxoid, provision of iron supplements, and care during delivery

- child health care, vaccination, control of acute respiratory infections and diarrheal diseases, and nutritional evaluation and care of children under 2 years of age

- emergency and acute disease care (diarrhea, cholera, respiratory infections, malaria, dengue, tuberculosis, rabies, STDs, and others, depending on local epidemiological profile, and when to administer antibiotics)

In 2000, the UN convened a summit to define its role in the 21st century, and developed eight goals in accordance with the United Nation's stated purpose of promoting social progress and better standards of life in larger freedom. The eight goals are aimed at meeting the needs of the world's poorest people by 2015 and were agreed to by all nations and are called the UN Millennium Development Goals (UNMDGs). The first UNMDG sets out to eradicate extreme poverty and hunger by 2015. Included within that goal is to reduce childhood malnutrition as measured by the percentage of children who are underweight (less than one standard deviation below age matched means for weight). Strategies recommended by the UN for reducing childhood malnutrition include exclusive breastfeeding for the first six months of life, improving access to clean water and sanitation, reducing infectious disease, and increasing supplementation of micronutrients. The fourth UNMDG aims to reduce mortality by two-thirds in children

under five years old, creating a concrete goal for child mortality reduction in all developing nations including Guatemala.[5]

Dr. Angelo Tomedi, with the assistance of the University of San Carlos medical school in Guatemala, began planning a CHW program for several villages in Guatemala in 2003. They started by conducting a needs assessment survey in Loma Linda in April of 2004. In November of 2004 CHWs were trained and placed in Loma Linda. Another needs assessment was conducted in several other villages near Quetzaltenengo, and CHWs were trained in those villages in October 2005. The training was conducted using a modification of the AIEPI program developed by the Pan America Health Organization (PAHO). So far CHWs have been trained in the communities of Pasac Segundo, Las Majadas, Loma Linda, and Chuiziribal.

Evaluations of these programs have yet to be conducted and we feel that it is equally important to determine whether CHWs are making a difference in reducing malnutrition, improving feeding practices, reducing mortality rates, and serving the populations that are of the lowest socioeconomic status. Additionally, evaluations of community health worker programs have been limited to presence of midwives or birth attendants, family planning and birth control distribution programs, prenatal care and breastfeeding practices all of which have yielded positive results.[6; 7; 8; 9; 10]

Despite the aforementioned programs, Guatemala is a developing nation with the third highest child mortality rate in the Western hemisphere—47/1,000 live births—compared to 8/1,000 live births in the United States.[11] Past national campaigns have led to major improvements in certain areas of health care in Guatemala over the last twenty years. For example, a major immunization campaign that began in 1987 increased vaccination from 23% in 1987 to 97% (tuberculosis) and 85% (diptheria/pertussis/tetanus and measles) in 2003.[11; 12] However, in children under five years old, diarrhea and pneumonia with malnutrition as a contributing factor are the leading causes of death. Estimates show that nearly one in five children under the age of five develops an acute respiratory infection each year. Of these, less than two thirds receive care from a health care provider.[11] Many of the cases of pneumonia are bacterial infections secondary to a viral upper respiratory infection. Further, less that a quarter of children with diarrhea receive oral rehydration therapy. Both oral rehydration solution and antibiotic treatment for bacterial pneumonia have been well established to improve mortality rates in the cases of diarrhea and upper respiratory infections.[13; 14] Additionally, malnutrition is major problem in Guatemala children. Nearly a quarter of Guatemalan children under five are considered to be underweight, and almost half suffer from moderate to severe stunting.[11]

We chose to address whether or not there has been a change in malnutrition rates as measured by low weight-for age (underweight) and low height-for-age (stunting) since the institution of the CHWs. Past studies have shown that educational interventions can significantly improve nutritional outcomes.[15; 16] Baseline z-scores for height-for-age and weight-for-age of approximately 400 children were taken in three villages prior to the training of the CHWs; two (Pasac Segundo and Chuiziribal) in October of 2005 and a third (Loma Linda) in March of 2005. We revisited all three of these villages to re-measure the children and assess for any changes in malnutrition or child mortality.

Materials and Methods

      The study focused on children under the age of five years in three rural, agrarian, Guatemalan villages: Chuiziribal and Pasac Segundo (collectively known as Cantel) and Loma Linda. The research team was based in Quetzaltenango to survey both Chuiziribal and Pasac Segundo as these villages were easily accessible by bus. Loma Linda was surveyed in one day as its location was not easily accessible by bus for multiple trips. Over the course of two weeks the villages were surveyed with the assistance of the community health care workers (CHWs) as guides. The research teams split into groups of 2-3 persons to more efficiently cover all of the households with children of the designated age. The families were consented for the research questions and for permission to weigh and measure the children. Children were weighed using Salter Scales and questionnaires were administered to an adult within the household, preferably the mother or primary caretaker. Children less than 24 months of age were measured by determining the recumbent length using an infantometer, a rigid measuring board designed for this purpose. Children 24 months of older were measured by determining vertical height using a stadiometer. Data was recorded on the questionnaire pertaining to the child. Participating families were given a year's supply of 75 mg Zinc tablets for each child. A recent study by Abdullah and colleagues showed that 75mg of Zinc given once weekly to malnourished children in Bangladesh for ten months significantly reduced the rates of both pneumonia and diarrhea with no adverse effects on serum copper or hemoglobin levels.[17] Those families who chose not to participate were equally offered the Zinc supplements.

      Childhood malnutrition rates were determined by using the definitions of the World Health Organization Global Database on Child Growth and Malnutrition for underweight (low weight-for-age) and growth stunting (low height-for-age). Low weight for age, which encompasses moderate and severe categories, is defined as weight ≤ 2 SDs below the mean weight for age of the National Center for Health Statistics (NCHS); low height-for-age (encompassing moderate and severe) is ≤ 2 SDs below the mean height for age; mild underweight and growth stunting are defined as weight and height between -2 and -1 SD; and "normal" is defined as $> - 1$ SD.[18]

      The data was compiled using EpiInfo and analyzed using SAS, SPSS and EpiInfo statistical software. For comparison, similar surveys and child data collected in the same villages in April 2004 and October 2005 by Tomedi was also entered into EpiInfo and analyzed in the same fashion.

Results

Loma Linda: childhood malnutrition

      Before in the institution of the CHW program, 110 children under five were identified, weighed, and measured in Loma Linda in April of 2004. Of those children, 52 (49%) were male and 55 (51%) were female. In March of 2006, nearly 18 months following the CHW training, 65 children were identified, weighed, and measured in Loma Linda. Of these children, 34 (52%) were male and 31 (48%) were female. Age

characteristics of the children are shown in table 1. Three children in 2004 and one child in 2006 were excluded from further analysis due to unknown birthdates. In 2004, 40 children (39%) were classified as normal height-for-age, compared to 13 (21%) in 2006. In 2004, 23 children (22%) showed mild stunting, compared to 24 (38%) in 2006. In 2004, 41 children (39%) showed moderate to severe stunting, compared to 26 (41%) in 2006. Six children in 2004 and two children in 2006 were excluded from the height-for-age calculations for missing length/height measurements. In 2004, 44 children (43%) were classified as normal weight-for-age, compared to 32 (52%) in 2006. In 2004, 27 children (26%) were classified as mildly underweight, compared to 13 (21%) in 2006. In 2004, 32 children (31%) were classified as moderately to severely underweight, compared to 17 (27%) in 2006. Seven children in 2004 and three children in 2006 were excluded from the weight-for-age calculations for missing weight measurements. The change in malnutrition rates, defined as < 2 SD below the mean weight or height for age, were found to not be statistically significant within the village of Loma Linda and therefore no difference in malnutrition rates could be appreciated. However, although not a primary outcome of the study, it was discovered that the nuber of children in the study that changed from mild (< -1 to -2 SD) in the height-for-age categories was statistically significant, suggestive of mild growth stunting, without a significant change in weight for age.

Loma Linda: childhood mortality

In 2004, 62 households were surveyed in Loma Linda, compared to 38 in 2006. In 2004, 59 households responded to the question: "In the past year, has a child passed away in your family?" In 2006, all of the households responded to this question. In 2004, 2 households (3%) reported having lost a child under 5 in the last year, compared to one household (3%) in 2006. This was not statistically significant.

Cantel: childhood malnutrition

Before in the institution of the CHW program, 298 children under five were identified, weighed, and measured in the villages of Pasac Segundo and Chuiziribal, in March of 2005. Due to their close proximity and similar demographics, we have combined data for these villages into one group, labeled Cantel. Of those children, 137 (46%) were male and 158 (54%) were female. In March of 2006, 12 months after the CHW training, 268 children were identified, weighed, and measured again in Cantel. Of these children, 131 (49%) were male and 137 (51%) were female. Age characteristics of the children are shown in table 1. One child from 2005 was excluded from further analysis due to an unknown birth date. In 2005, 57 children (20%) were classified as normal height-for-age. This increased to 86 (32%) in 2006. In 2005, 93 children (32%) showed mild stunting. This decreased to 78 (29%) in 2006. In 2005, 139 children (48%) showed moderate to severe stunting. This decreased to 101 (38%) in 2006. Nine children in 2005 and three children in 2006 were excluded from the height-for-age calculations for missing length/height measurements. In 2005, 102 children (36%) showed normal weight-for-age, compared to 105 (40%) in 2006. In 2005, 98 children (34%) were mildly underweight, compared to 80 (31%) in 2006. In 2005, 87 children (30%) were

moderately to severely underweight, compared to 76 (29%) in 2006. Eleven children in 2005 and seven children in 2006 were excluded from the weight-for-age calculations for missing weight measurements. The childhood malnutrition data are summarized in Table 2. There was a statistically significant reduction in malnutrition rates in Cantel as measured by height-for-age (p = 0.002), but not weight-for-age (p = 0.51).

Cantel: childhood mortality

In 2005, 227 households were surveyed in the two villages of Cantel, compared to 162 in 2006. In 2005 and 2006, all households responded to the question: "In the past year, has a child under five passed away in your family?" In 2005, 16 households (7%) reported having lost a child under 5 in the last year, compared to 4 household (2%) in 2006. This 5% difference was almost statistically significant, *p*-value = 0.06.

TABLE 1. Gender/Age Characteristics

N=741	Loma Linda			Cantel		
	2004 n (col %)	2006 n (col %)	P-value	2005 n (col %)	2006 n (col %)	P-value
Number of Children	110	65		298	268	
Number of Households	62	38		227	162	
Gender						
Male	52 (49%)	34 (52%)	0.75	137 (46%)	131 (49%)	0.61
Female	55 (51%)	31 (48%)		158 (54%)	137 (51%)	
Age (months)						
0 – 6	16 (15%)	10 (16%)	0.39	35 (12%)	35 (13%)	0.58
7 – 12	7 (7%)	5 (8%)		27 (9%)	31 (12%)	
13 – 18	12 (11%)	4 (6%)		26 (9%)	22 (8%)	
19 – 24	11 (10%)	7 (11%)		24 (8%)	23 (9%)	
25 – 36	23 (22%)	14 (22%)		65 (22%)	49 (18%)	
37 – 42	14 (13%)	7 (11%)		39 (13%)	29 (11%)	
43 – 48	11 (10%)	3 (5%)		35 (12%)	23 (9%)	
49 – 54	9 (8%)	5 (8%)		23 (8%)	31 (12%)	
55 – 60	4 (4%)	9 (14%)		23 (8%)	25 (9%)	
Missing	3	1		1	0	

Fisher's Exact Test was used to test for gender difference and Chi-squared test was used to test for age difference.

TABLE 2. Childhood Malnutrition

	Loma Linda			Cantel		
	2004 n (col %)	2006 n (col %)	P-value[2]	2005 n (col %)	2006 n (col %)	P-value[2]
Height for Age						
Normal > -1SD	40 (39%)	13 (21%)	0.02	57 (20%)	86 (32%)	.002
Mild <-1 SD to -2 SD	23 (22%)	24 (38%)		93 (32%)	78 (29%)	
Moderate & Severe < -2 SD	41 (39%)	26 (41%)		139 (48%)	101 (38%)	
Missing[1]	6	2		9	3	
Weight for Age						
Normal > -1SD	44 (43%)	32 (52%)	0.58	102 (36%)	105 (40%)	0.51
Mild <-1 SD to -2 SD	27 (26%)	13 (21%)		98 (34%)	80 (31%)	
Moderate & Severe < -2 SD	32 (31%)	17 (27%)		87 (30%)	76 (29%)	
Missing[1]	7	3		11	7	

[1]Missing for Height for Age and Weight for Age occurred when child had missing gender, age, height, or weight values.
[2]Fisher's exact test results reported in the tables are for differences among the three categories (normal; mild; moderate & severe).

TABLE 3. Childhood Mortality

	Loma Linda			Cantel		
	2004 n (col %)	2006 n (col %)	P-value	2005 n (col %)	2006 n (col %)	P-value
Number of Households	62	38		227	162	
Child passed away in past year?						
Yes	2 (3%)	1 (3%)	1.0	16 (7%)	4 (2%)	0.06
No	57 (97%)	37 (97%)		211 (93%)	158 (98%)	
Missing	3	0		0	0	

[1]Fisher's exact test was used to test for difference between groups.

Discussion

Our results are difficult to interpret, as a variety of factors can impact the response of an impoverished community to an intervention like the implementation of CHW's. While on the one hand, no significant change was appreciated within the Loma Linda community, there is also a general trend of improvement in terms of stunting in the two Cantel communities. Loma Linda showed a statistically significant shift from the normal to mild stunting category, but with no statistically significant change in the size of the moderate/severe stunting category. Cantel demonstrated a statistically significant shift from both moderate/severe and mild stunting categories to the normal range. Malnutrition in terms of weight-for-age showed a general trend of improvement in Loma Linda and Cantel, although not statistically significant. Childhood mortality did not change from baseline in Loma Linda. However, childhood deaths under five years of age decreased five percent from baseline in Cantel.

Possibly the most significant factor that may be responsible for the poorer outcome (in terms of stunting) of the Loma Linda community compared to Cantel is Hurricane Stan's impact on the Loma Linda region. Guatemala was the country hardest hit by this disaster, and Loma Linda's proximity to the coast and relative isolation made it vulnerable to Stan's aftermath. The hurricane hit in October 2005 and severely damaged roads, isolating the village from access to many of their resources for several weeks.

Based on the CHW's and their training, it was expected that Loma Linda would have shown greater improvement over Cantel as there were more CHW's in Loma Linda. Six CHW's were trained in Loma Linda versus three in Cantel, giving Loma Linda an advantage of more CHW's per capita. In addition, the Loma Linda CHW's were previously trained as midwives and were therefore more invested in the community at baseline. This was also evident in the commitment of these women to the operation and success of the coffee cooperative, the community's major source of income. However, the community's reliance on the coffee cooperative could have made them more vulnerable to the environmental impact of Hurricane Stan.

Factors that favored improvement in Cantel include its proximity to a major city, Xela (Quetzaltenango) and its distance from the coast, sheltering it somewhat from the impact of Hurricane Stan. Since Cantel has a small clinic within its municipality, it is likely that these residents had better access to medical care than those in Loma Linda. In addition, Cantel had a larger population and therefore provided a larger data set.

It is also possible that these changes or a portion thereof occurred independent of the CHW's. We did not compare the changes observed in Loma Linda and Cantel with those of other communities without a CHW program. It is possible that similar changes could have been observed in different communities with or without CHW's. If substantial improvements in childhood malnutrition and mortality take place in the future in these communities, it would be paramount to verify those changes are in fact due to the presence of CHW's.

Although every effort was made to preserve the accuracy of our data collection, there are many factors that make our data set less than perfect. Human error may account for some inaccuracy. Stadiometers, infantometers, and salter scales were zeroed before each new measurement, although variability between data collectors, from team to team, and from year to year, could have altered our results. Variability in parent participation also played a role. Several households were reluctant to allow their small children to be weighed without clothing or diapers, causing the measured weight to be larger than actual weight, possibly underestimating the number of underweight children. It would have been possible to exclude these children from the data analysis, although we risked having too small an N for our study, and chose to include them nevertheless, as exclusion of these children would have also introduced a bias (the previous research team also encountered the same problem). Geographic constraints also played a role. Village guides from year to year may not have covered the same municipal boundaries, leading to missed households. Also, no strict record of houses-visited was maintained (this may explain why fewer children were surveyed in Loma Linda in 2006). The difference in number of houses visited in Loma Linda, 38 in 2006 versus 62 in 2004, is noteworthy and speculation can only be given that the difference can be attributed to the difference in households or area surveyed based on the village guides or that the aftermath of the hurricane may have caused a change in population. In such a small community, an event may have drawn families or entire families or households out of the village on the day that the households were surveyed. This difference could have a statistically significant impact in a village with already such small numbers and could potentially change the findings appreciated within the study.

Our study has several limitations. First, we did not attempt to quantify the presence of CHW's in the community or relate this variable to those changes observed in the malnutrition data. Our study also did not further investigate the nature of the CHW visits themselves. We would need to know much more about what sort of advice was given at each visit, or whether or not antibiotics were distributed, to attribute improvements in malnutrition entirely to the presence of CHW's. Equally important, there is variability in the skill, experience and education of each CHW, and this is difficult to quantify. Furthermore, we did not assess for changes in malnutrition data for particular age groups, i.e. 0-6 months of age.

To conclude, our study of three rural Guatemalan communities and the impact that community health workers may have on childhood malnutrition and mortality presents both interesting and puzzling outcomes. We will continue to follow these communities in the future and collect more data to assess the contribution that CHW's may make in developing countries around the world.

Acknowledgements

Lastly, we thank the welcoming communities of Loma Linda and Cantel for their participation.

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